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Special Issue
ON

Goat
Production and Management

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Preface

India occupies first position in terms of goat population and milk production. In spite of annual slaughter of about 42% goats, the population continues to increase at an average rate of about 3.4% per year. Goat sector witnessed significant increases in output of its products like meat, milk and skin. India is home to 148.88 million goats with 37 recognized breeds and contributes 6.38 million tonnes (3%) milk and 1.09 million tonnes meat (13.53%). The 20th livestock census showed a 10.1% increase in population over 19thlivestock census. Rajasthan, West Bengal, Uttar Pradesh, Bihar, Madhya Pradesh and Maharashtra are major goat population states accounting for 20.84, 16.28, 14.48, 12.82, 11.06 and 10.60%, respectively (DAHD 2019). These 37 goat breeds in India have been developed in different regions to cater to the multi-facet needs of people in different regions of the country. The sector also generates gainful employment to millions of rural farm families. Chevon (goat meat) is most preferred and widely consumed meat in the country. Since ancient times goat milk has traditionally been known for its medicinal properties and has recently gained importance in human health due to its proximity to human milk for easy digestibility and its all-round health promoting traits.

Goat plays a significant role in providing supplementary income and livelihood to millions of resource poor farmers and landless laborers of rural India. Small ruminant rearing ensures self-employment and acts as a cushion in distress situations like drought and famine. Goat rearing is second largest activity of livestock sector after the cattle. Goat production system in India has been slowly moving from extensive to intensive system of management for commercial production of goats. However inadequate availability and poor quality of feed resources, high incidence of diseases and inadequate knowledge on appropriate management of small ruminants have been identified as some of the major constraints. Therefore, many cost effective technologies have been developed in recent times to boost in productivity and food security. The need of the day is to validate and disseminate these technologies to farmers at their door step so that they are encouraged to adopt them.

*The present book entitled **"Goat Production and Management"** is a step toward recent researches and advances in goat farming in India. The book may be very useful for farmers, student and goat entrepreneurs engaged in sustainable goat production.*

Editors

CONTENT

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

CHAPTER - 1

Significance of Goat Meat and Meat Products in Human Nutrition

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ABSTRACT

Meat is the flesh of animals is used for food. It is mainly composed of water, a good source of protein, fat, essential amino acids and vitamins, minerals such as iron, selenium, zinc and vitamin B_{12}essential for meeting the nutrition requirements of human beings. Goats are important producers of meat besides milk, fiber and skin. Generally, goat meat is called as Chevon. Goat meat is low in calories, total fat, saturated fat and cholesterol than nutritional meats. Meat is raw normally eaten after it has been cooked and seasoned or processed in a various way. Meat is a major contributor of lipids to the human diet. Consumers have become more interested in the fat composition of meat with respect to the nutritional guideline recommendations in order to reduce total fat and saturated fatty acids (SFA) intake while increasing the consumption of polyunsaturated fatty acids (PUFA). The slaughter rate of goat meat is at level of 39.7% as compared to 31.8% for sheep and 11% for buffaloes respectively. As per the latest report of basic animal husbandry statistics, the livestock population has shown an increase of 4.82% from 2012-2019. Among the livestock species sheep showed maximum increase 14.013%, 10.14% for goat, 1.34% for cattle, 1.06% for buffalo respectively. India produces around 5.3 million metric ton of meat and 75 billons of eggs annually. India ranks 2nd in goat meat production in world. India's exports in sheep and goat meat have increased and major export destinations are Saudi Arabia, UAE, Qatar, Germany and Oman. Export of goat meat in India is regulated by statutory body i.e, APEDA. Goat meat can be prepared in a variety of ways stewed, curried, baked, grilled, barbecued, minced, canned, fried made in to sausages. Several goat meat products like kebab, biryani, rogan-josh, Tikka, Kofta are quite popular with the consumers. In India, the rice preparation of mutton biryani uses goat meat as its primary ingredients to produce rich taste. Each and every individual part or organ in the goat meat has unique medicinal value. Demand for goat meat in U.S has exceeded domestic supply in recent years. In fact, the goats are widely adaptable to and productive in a wide range of environment means the goat meat will remain one of the staple red meats of the world.

Key words: *Chevon, Humans, Nutritional importance and Value-added products.*

INTRODUCTION

Meat is generally defined as the skeletal muscles from animals, including the connective tissue and fat naturally associated with the muscle, but might also include all the edible parts.

It's an animal flesh and worldwide eaten as a food. Mainly composed of water, a good source of protein, fat, all essential amino acids, vitamins, minerals such as iron, selenium, zinc and

Indian Journal of Livestock and Veterinary Research
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vitamin B_{12}.Meat and meat products contain essential nutrients of high biological values thus are important in human nutrition. The consumption of meat and meat products has been increasing tremendously in developed as well as in developing countries. Goat meat is called as chevon. Generally, goats were domesticated and descended from the bezoar/ wild goat *i.e* *Caprahircus* in the hills of western Asia. Goats were represents one of the earliest species of livestock domesticated by pastoralist approx. 9,000 years ago. Now-a-days Goat population is increasing tremendously, worldwide around 850 million and representing about 1,156 different breeds but chevon consumption is less than beef. In India, goat meat was preferred than mutton.

Meat Composition

Goat meat provides good source of protein and essential amino acids to meet the dietary requirements of the average adult consumers. The amino acid composition varies very little between the species of lean meat basis and it's more significant on whole meat basis. It has high biological value approx. 60.4. Goat meat provides an excellent source of iron because of available heme iron portion is 5-10% than non-haem iron. The degree of saturation fat influences the consistency, chemical composition and sensory characteristics of carcass fats and shelf life of meat products. Consumers have become more interested in the fat composition of meat with respect to the nutritional guideline recommendations in order to reduce total fat and saturated fatty acids (SFA) intake while increasing the consumption of polyunsaturated fatty acids (PUFA) (Wood *et al*., 2003). Thus, monitoring the meat fatty acid profile has gained momentum and there is a growing demand for fast and efficient alternative method to monitor meat fatty acids profiles.

The PFA/SFA ratio should be high and be at least 0.45. Within PUFA, a high proportion of n-3 fatty acids is beneficial while the ratio of n-6/n-3 of less than 5 is acceptable. Chevon has an advantageous fatty acid profile and it is an ideal food for health conscious consumers. Grain feeding improves the ratio of PUFA/SFA, and also improve n-6/n-3 ratio to unfavorable level. The cholesterol content of goat meat generally varies between 30 and 60 mg/100g. Saturated fats (bad fats) increase the risk of cardiovascular disease and other chronic diseases while unsaturated fats (good fats) can improve cholesterol level in blood, alleviate inflammation, stabilizer heart rhythm and have numerous other useful effects.

Chemical Composition of Goat Meat

Chemical composition of goat meat is affected by race, gender, environmental condition, management, and food composition, weight at slaughter, health status, and method of slaughter as well as procedures of handling carcasses after slaughter. Lean goat meat contains approximately 75.42%, 3.55%, 19.95 % and 1.06% of water, fat, protein, mineral matter respectively. The energy value is approximately 580 kJ per 100 g. The nutritional value of meat of goat and sheep is nearly equal. Goat meat in the human diet is healthier alternative compared with other types of red meat, owing to low content of saturated fatty acids and cholesterol in goat meat.

In comparison with the carcasses of sheep of the same age and sex, goat carcasses are smaller in size and have less fat on the surface. In relation to sheep carcass, meat of the younger one of goat contains a high percentage of muscle and a low percentage of bone and fat. On contrary, a lower percentage of fat on carcasses surface may result in cold shortening.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Water impacts the quality of the meat, particularly the juiciness and tenderness. The muscles compromise of approximately 75% water, which is disseminated within the myofibrils, cell membrane (sarcolemma) and muscle bundles.

Adipose tissue of goat carcasss contains 50-95%, 3-35%, 2-15%, 0.1- 0.6% of fat, water, protein, mineral matter respectively. The fat composition of adipose tissue varies considerably and hinge on nutrition, breeding, age, type of animal etc.

Meat of ruminants consuming green grass contain more PUFA, n-3 PUFA, CLA, vitamin E, beta-carotene and vitamin when compared with meat of ruminants fed with grains. The fat composition of goats meat is analogous to other ruminants and contains large quantities of SFA, lower amounts of the PUFA, C18:1 and C18:2 trans and cis isomers ofFA.

Vitamins and Minerals
Goat meat is a rich source of B vitamins (B1, B2, PP), minerals (P, Mg) and microelements.

Minerals
The minerals are inorganic chemical elements present in very minute quantities and gain access to the body through food. They provide assistance in metabolism, hormones and enzymes synthesis, healthily growth of the organism etc. Food must be fortified with essential vitamin and mineral in required proportion in order to maintain a healthy balanced diet that supports a healthy growth.

The standard composition of normal adult mammalian muscle is 75% water, 19% protein, 2.5% lipid, 1.2% carbohydrate and 1.6% nitrogenous compound,0.65% minerals and <0.1% vitamins. The composition of muscle varies with age increases. As sarcoplasmic proteins accumulate and muscle hypertrophy occurs, the water: protein ratio will be changed. A greater intermuscular fat content which occurs at heavier masses and in older animals would decreases the relative content of other nutrients.

Comparison of Nutrient Analysis of 100 gm Portion of Lean Meat

S.no	Nutrient	Goat	Chicken	Beef	Veal	Lamb	Mutton	RDI
I	**General**							
1	Fat g	14.7	13.6	2.8	1.5	4.7	4.0	-
2	Protein g	25.8	27.2	23.2	24.8	21.9	21.5	46-64
3	Calories, K cal	239	239	498	477	546	514	6.5-15.8MJ
4	Cholesterol, mg	111	88	50	51	66	66	-
II	**Minerals (in mg)**							
5	Iron	2.6	1.3	1.8	1.1	2.0	3.3	8-18
6	Calcium	29.8	15.0	4.5	605	7.2	6.6	1000-1300
7	Sodium	90.7	82	51	51	69	71	460-920
8	Zinc	5	2	4.6	4.2	4.5	3.9	8-14
9	Magnesium	27.9	23.5	25	26	28	28	310-420
10	Potassium	362.7	223	363	362	344	365	2800-3800

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

11	Phosphorous	68	182	215	260	194	290	1000
12	Copper	2	0.07	0.12	0.08	0.12	0.22	1.2-1.7
13	Selenium	-	-	17	<10	14	<10	60-70
III	**Vitamins**							
14	Vitamin A, IU	40	161.2	<5	<5	8.6	7.8	700-900
15	Thiamin (B_1), mg	0.37	0.06	0.04	0.06	0.12	0.16	1.1-1.2
16	Pyridoxine (B_4), mg	0.2	0.4	-	-	-	-	-
17	Cobalamin(B_{12}) ,mg	0.65	0.30	2.5	1.6	0.96	2.8	2.4
18	Pantothenic acid, mg	0.35	1.03	0.35	1.50	0.74	1.33	4-6
19	Niacin, mg	2.96	8.47	5	16.0	5.2	8.0	14-16
20	Vitamin (B_6)	-	-	0.52	0.8	0.10	0.8	1.3-1.7
21	Beta-carotene, mg	-	-	10	<5	<5	<5	700-900
22	Alpha- tocopherol, mg	-	-	0.63	0.50	0.44	0.20	7-10

Source: *Nutrient Profile information taken from USDA, Human Nutrition Hand book 8-5 and Johnson (1987).*

Comparison of Meat, Poultry and Sea Food
(Skinless, Lean, Trimmed and Broiled or Roasted)

Food	Calories (K.cal)	Carbohydrate (g)	Protein (g)	Fat (g)	Cholesterol (mg)
Pink salmon	127	0	18-22	4	57
Chicken Breast	142	0	25	3	73
Pork Tenderloin	159	0	16	5	80
Beef Sirloin	171	-	32	7	76
75% Lean ground beef	235	0	-	15	75
95% Lean Sirloin	144	-	-	4	39
95% Lean Hamburger	171	-	-	7	76
Lamb	227	-	27	12	-
Venison loin	139	-	22	5	62
Pork shoulder	207	-	22	13	82
Veal cutlet	155	-	28	4	112

Source: *USDA National Nutrient Database for Standard Reference (2006).*

Amino Acid Composition of Muscle Protein of Goat, Beef, Pork and Beef Collagen
(mg/g protein)

Amino acid	Goat	Beef	Pork	Lamb	Beef collagen
Aspartic acid	-	88	89	85	43
Threonine	48	40	51	49	18
Serine	-	38	40	39	35
Glutamic acid	-	144	145	144	99
Proline	-	54	46	48	114
Glycine	-	71	61	67	187
Alanine	-	64	63	63	74
Valine	54	57	50	52	23
Methionine	27	23	25	23	8

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Cystine	-	14	13	13	0
Isoleucine	51	51	49	48	15
Leucine	84	84	75	74	28
Tyrosine	-	32	30	32	67
Phenylalanine	35	40	41	39	21
Histidine	21	29	32	27	8
Lysine	74	84	78	76	30
Arginine	75	66	64	69	75
Tryptophan	15	11	13	13	0

Source: *Extracted from srinivasan et al. (1974) and pellet and young (1990).*

Mineral Content in Different Meat (mg per 100g of meat)

Mineral	Chicken	Beef	Lamb	Pork	Veal
Calcium	-	8	9	8	10
Phosphorous	129	127	124	130	145
Iron	1.9	2.0	2.1	1.5	1.7
Sodium	263	228	241	223	226
Potassium	96	183	181	178	214

Source: *USDA, handbook No.8 in processed meat by pearson et al.*

Vitamin Content in Different Meat (mg per 100g of meat)

Vitamin	Chicken	Beef	Lamb	Pork	Veal
Vitamin A	-	-	-	-	-
Thiamine	0.02	0.01	0.02	0.19	0.03
Riboflavin	0.16	0.16	0.17	0.20	0.20
Niacin	3.5	3.5	3.3	2.7	4.3
Ascorbic acid	0	0	-	-	-

Source: *USDA, handbook No.8 in processed meat by pearson et al.*

Consumption Pattern

Human eating preferences and the many influences on these preferences, including the constituents of palatability, flavor, taste and texture, tend to dictate dietary composition. According to the United Nations Food and Agriculture Organization, pork is the most widely eaten meat in the world (36%) followed by poultry (33%), beef (24%) and goats/ sheep (5%). The popularization of goat meat is subjected to the common culture of few communities and the forces of civilization. Western countries consumers are generally not preferred, even though they were changed food habits because of its low fat and cholesterol contents and favorable sensory characteristics. Globally, Scenario of chevon consumption pattern is increased during since 20 years.

The main reasons were:

1) increase the awareness in consumers about nutrient composition.
2) less environmental issues
3) Traceability of animal products from organic/ natural production system

There are no religious restrictions regarding the raising of goats /the consumption of their milk, meat and other products, rather they have more demand and price will be high in the special days for goat meat *i.e*. seasonal with festivals like Christmas and Easter.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Nutritive Value of Goat Meat

The nutritional value of goat meat becoming increasingly important in the human health management , because it is not only contains less total fat and cholesterol, but also content of saturated fatty acids are lower than in the traditional types of meats.

Red meat possesses high myoglobin content and offers a high level of bio-available iron. The availability of haem iron is 5-10% more than non-haem iron. The lesser availability of non-haem iron boosts the absorption of non-haem iron from other foods. Lean meats are low in Ca content and hence they fail to provide the recommended daily allowance (RDA). Deboned meat inclined to have higher content of Ca that ranges between 0.05-0.75 percent. Phosphorus is vital for bone formation, enzymes and energy metabolism. Lean goat meat is rich in thiamine, riboflavin and niacin found 4.5 mg folic acid and 2.8 mg vitamin B_{12} per 100g.

Chevon has healthier and good nutritional status than red meats. In goat meat have the limiting amino acids such as lysine, threonine and tryptophan. Expressing amino acids in mg bOg meat, the supply of amino acids is determined largely by the amount of protein in a particular cut of meat. Meat is an important source of lysine, since 100g lean meat would provide 30-50% of the total protein needs of an adult and 6-100% of estimated lysine needs

The dressing percentage of goat carcasses tend to be less than that sheep, mainly due to the reduced carcass fat content of goats. The average dressing percentage of goat carcass between from 50-55%. In case of goat carcass, almost all parts of the carcass was consumed. Carcass fat content of goats is low and fat accreation occur much later in the growth process compared with other domesticated ruminants.

Goat Meat Quality

When food is present abundantly, quality parameters effects consumption indirectly. They gain importance when meat is merchandised and free choice between themeat types is available for the consumer. These parameters should be evaluated properly while processing meat.

pH

Goat muscle contains high contain of myoglobin, aerobic (red) and anaerobic (white) muscle fibres and manifest similar postmortem biochemical alteration as beef and mutton. The muscle pH drops and get stabilized at around pH *5.4* thus exhibit a similar pattern like red meat carcasses.

Variations take place owing to differences between muscles, sexes and pre-mortem stress. Exhaustive pre-mortem stress produces dark, firm and dry meat with a high ultimate pH (pH >6.0) With the loss of water binding capacity of the muscle, pH changes and reaches the isoelectric point of the muscle proteins; this triggers the onset of rigor mortis and activation of proteolytic enzymes, namely cathepsins, that causes ripening of meat.

Tenderness and Flavor

Several studies have reported that goat meat is less tender compared to sheep. Muscles of male Boer goat kids have higher content of collagen with a lower collagen solubility in

Indian Journal of Livestock and Veterinary Research
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comparison with male lambs of 4 sheep breeds. lamb and mutton are tenderer with lower fibrous tissue residue and a strong aroma than Angora and Boergoat meat. Goat breeds also may vary in their meat quality. Angora goat'smeat's flavor is more acceptable and tenderer with fewer residues when compared to meat of Boer goats. This is due to lower content of collagen and higher collagen solubility. Difference in tenderness could not be concluded by evaluating collagen alone. Other factors should also be considered such as, muscle fibre size, the type of matrix formed by collagen and the state of muscle contraction.

The toughness of goat is due to marketing of mature animals, where the collagen content in the connective tissue has lesser ability to gelatinise under the influence of heat and moisture. The meat of kid is as in the case of cabrito, a tender delicacy. Muscle fibres of goat meat are thicker and the fibre bundles larger than sheep. Goat meat has a characteristic courser grain appearance.

Electrical Stimulation

Goat carcasses, possess poor insulating subcutaneous fat cover, and are prone to muscle toughening effects of cold shortening. This can be prevented by electrically stimulation of the carcasses just afterslaughter. This process fosters the rate of postmortem glycolysis, depletes the ATP source required for muscle contraction owing to the anaerobic state. The contractile properties of muscle are diminished, rigor mortis is advanced and the enzymes necessary for aeging of meat are activated. Electrical stimulation of goat carcasses enhances meat tenderness.

Electrical stimulation expedites accelerated processing of carcasses by hot boning, particularly after a 2 hr conditioning period, with no deleterious effect on total bacterial count, tenderness or cooking loss. Advantages of hot boning are a reduced loss of massin chillers, less carcass chiller space, faster throughput and packaging of themeat.

Muscle: Bone Ratio

A greater carcass and leg length bring about a less compact carcass that may be elucidated as signifying poor muscling.

Characteristics of Fat

Fat is an essential dietary component that provide both easily metabolisable energy as well as essential fatty acids. Fat enhance the palatability of the food and thus partiality to deep fried foods, spreads (butter, margarine), oil-based salad dressings etc are uses in foods.

Carcass and Meat Quality

Fat is a significant carcass or meat quality determinant. The chemical and physical properties of fat ascertainthe organoleptic properties, keeping quality and nutrient value of meat. The degree of saturation of fat, hinge on the number of double bonds in the component's fatty acids. Low carcass fat content in goats has implications on the conversion of muscle to meat and ultimately meat quality. Internationally, goat meat is one of the best lean meats with good nutritive character. Goat meat has light red colour, coarser texture and characteristic goaty flavor and aroma, less juiciness compared with mutton. Branched chain fatty acids may contribute to the strong goaty odour has been associated with 4-ethyloctanoic acid in goat meat.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Comminuted Products and Value-Added Products

Even though goat meat posses desirable flavour, aroma, tenderness and juiciness, a panel reported that up to 40% substitution of beef by Angora goat meat is quite acceptable in frankfurters. The goat frankfurters are firm, resilient and springy under forefinger pressure and have a desirable textural attribute in quality emulsified sausages. It maintains its form and shape at the time of peeling, indexing and packaging operations. Cured and smoked buttocks of low voltage electrically stimulated carcasses have desirable aroma, tenderness, juiciness and tastiness. Smoked and cured goat buttock or leg could be considered as delicacy and could be easily compete with other products such as smoked beef and pork gammon.

Medicinal Uses of Goat Meat

Man is a complex creature surviving in a complex environment, under several degrees of psychological and physical stress. The most severe physical stressor is nutritional stress. Even though it is reported that only 1-2% of the world population suffers severe malnutrition, to a greater or lesser extent all societies, social and economic status groups suffers from nutritional stress that is manifested in different pathological conditions.

Meat and meat products contain essential nutrients of high biological values thus are important in human nutrition. The consumption of meat and meat products has been increasing tremendously in developed as well as in developing countries. A diet rich in non-saturated fatty acids is correlated with reduced risk of stroke and coronary heart diseases. Hence the American Heart association recommends goat meat to people with heart–related problems.

Goat meat is easily digestible because of the unique molecular structure of muscle. Goat milk can be used for treatment of direct/ indirect cow milk allergy in humans. Compare to cow's milk, goat milk is easily digestible because it has predominant smaller fat globule. Hence its alternative and valuable source for babies, adults and nursing mothers also. Goat milk have short and medium chain fatty acids which have recognized as a medical values for many diseases and disorders for humans. The major proteins of cow milk consist mainly of casein, beta –lactoglobulin, alfa lacto globulin but goat milk had differ in genetical aspect by having either none it means null type / much it means high type.

Null type has some specific characteristics such as

1) rennet coagulation time is shorter
2) less resistance to heat treatment
3) curd firmness is weaker
4) higher pH
5) less cheese yields

Taurine is a type of chemical called an amino sulfonic acid. It occurs naturally in goat milk, the substance added to health drinks and revitalizers and reports are showing that goat milk contributed to the treatment of diabetics. In additionally, goat milk is feeding to children/ infant treated with digestive malnutrition. Anti clotting drugs has been made from the milk of genetic engineered goats. Especially who are suffer with cardiac diseases by consuming of goat meat through diet they had reduced lower hyperlipemic state.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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In Japan, people are believing that have been eating of chevon as medicinal dish for recover from fatigue and regaining physical strength during pregnancy and labor. According to medical and pediatric literature, consuming goat meat is treatment benifits with medium chain fatty acids in case of mal absorption syndrome, premature infant feeding, cholesterimia, gall stones, cystic fibrosis. The by-products from goat include manure, hide and skin which can be processed into leather goods, blood meal for human and animal feed, horns, bones and hooves which are processed into many saleable products. Using of goat milk soap is a remedy for dry skin and act as moisturizer. It contains alpha hydroxyl acids AHAs, that can helpful to reduce the appearance of fine lines, wrinkles and age spots and give more youthful look. Aimspro is made of the blood of goats that have been injected with killed Human immunodeficiency virus, multiple sclerosis patients by improving their eye sight. Lean meat as a good source of iron particularly important in women health of reproductive age. Goat brain increases the memory power, and cool down the eye temperature and also increases Semen production. Boiling of goat legs its leaves some essences. The essences help to cure throat related problems and it also provides sufficient strength to the bones and muscle. Chest of goat helps to reduce phlegm troubles. Head heals the heart diseases. Body temperature is coming normal while eating of goat tongue. Goat testicles have been used in ayurvedic medicine to enhance male sexuality in human beings

CONCLUSION

Marketing of goat meat as lean and healthy product should be a major future initiative to improve the acceptance of goat meat as a alternative source of good quality protein from animal origin.

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CHAPTER - 2

Castration of Goat

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ABSTRACT

Meat quality is one of the major factors of concern for consumers while purchasing meat in the market. Improper handling and lack of proper vaccine dosage have resulted in meat spoilage resulting in meat quality issues. Castration is a process of maintaining good quality meat in goats by removing testicles from male animals. It had been a routine part of animal husbandry for avoiding unwanted pregnancies. The age of the goat is also an important factor for castration. Different methods adopted for castration are discussed in this chapter. The need for the castration of goats and the advantages associated with it include the production of tender and flavored meat and the prevention of injuries in livelihood. Apart from the advantages, certain limiting factors prevailing in castration were hot flashes, sterility problems, osteoporosis, and genital modification, etc. This chapter also deals with the effect of castration on body weight, meat production, the immune system, and disease resistance power.

Keywords: *castration, body weight, feed composition, immune system.*

INTRODUCTION

Small ruminants are gaining popularity in livestock production throughout the globe. These are popularly known as poor man's cow. Goat farming involves the raising and breeding of domestic goats to produce meat and milk. Castration is a common practice that has improved breed management. Production of fatty carcasses has been one of the main focuses by markets. This is one of the important tools for enhancing the productivity of sheep. Castration offers various advantages such as improved productivity, avoiding unwanted pregnancies, reducing goaty smell, and preventing the breeding of related individuals. This book chapter emphasizes the need of castration, methods involved in castration and various effects of castration on various aspects like feed consumption, hormones, live weight and disease resistance power.

Age of Castrating Goats

Younger goats tend to be the ideal goats for castration as older animals develop stress during growth. As the chance of complications increases over time, a few days of age to three weeks are considered ideal for castration of lamb/kids. It was also found that testicles descend into the scrotum and painkiller scan be avoided over the course of time. Castration is advised to have performed in less than 3 weeks of age. In rare cases, it was also performed at a later stage yearling to 2 years old due to stunted growth, lack of desired muscling and conformation.

Methods of Castration

1. **Surgical Castration**
   In this method, testicles are surgically removed using a clean, sterile sharp knife, one–sided razor blade or scalpel, warm water, disinfectant, syringes, tetanus antitoxin, and fly

Indian Journal of Livestock and Veterinary Research
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control spray. The procedure of surgical castration is followed by various steps such as: washing hands and instruments, pushing testicles into the scrotum, cutting off one-third of the scrotal sac with a cut to manipulate each testis separately to the open end, grasping one of the testes with fingers. If in case segment of the spermatic cord is protruding below the cut scrotum, measures are taken to remove them as the entry of bacteria is seen using the body cavity. Antiseptic is then applied to the castration site and the lamb/kid is placed in the draft-free pen (Yami *et al.,* 2008).

2. **Elastrator**
   Cutting of blood supply to the testicles with a heavy-duty rubber band or ring can be performed using an elastrator and castrating bands. This method is called the Elastrator method. This method was suggested as ideal for young animals who are 7 to 10 days of age as scrotal tissues remain undeveloped. This can be an easy method of castration as it provides a continuous supply of rings. Female-like appearance can be seen in the case of these early castrated animals.

3. **Burdizzo (Emasculatome) Method**
   Crushing spermatic cord and associated blood vessels leading to the testicles was performed to destroy the blood vessels using an instrument called a Burdizzo. It is also called as the least painful method. Burdizzois advised to be in good condition and can be different for different sizes. Burdizzos tear scrotal tissue and produce unwanted sounds in action. Castration using burdizoo can be performed using various steps such as proper restraining of animals by assistants, placing of jaws of burdizzo onto the upper scrotum, clamping the burdizzo over the cord on the side of scrotum, releasing the burdizzo and moving it to lower to a new site closer to the testicles, locating the cord on the other side of scrotum, positioning burdizzo over it and examine the mark on each side (Yami*et al.,* 2008).

Effect of Castration on Live Weight, Dressed Percentage

Castration was considered as a useful technique for increasing the rate of maturity of late indigenous breeds. Studies reported that castrated males have significantly higher weight gains than entire males. At,0-12 and 13-24 months, castrated males had a significantly higher average weight in castrates than entire males (Nsoso*et al.,* 2004).

Effect of Castration on Feed Conversion Efficiency and Carcass

Faster growth rate was witnessed in intact males due to more feed consumption than castrates. Fatter carcasses were observed more in early castrates than intact kids (Louca*et al.,* 2010). Studies also reported that daily feed intake was not affected by castration techniques. Carcass length was measured in centimeters with a measuring tape from anterior edge on the first rub up to the anterior edge of the bone of the same side of each split half. The mean of the two halves was recorded as carcass length whereas back fat thickness was measured along vertical column against first rib and last luminar vertebra with a supplied thyroxine and high protein level (Nagarajan*et al.,* 2005).

Effect of Castration on Fatty Acid Composition

Castration reported an effect on fatty acid composition in terms of hormones. Change in hormonal levels was reported due to metabolic status in livestock, promoting the efficiency of feed conversion (Lee *et al.,* 2023).

Indian Journal of Livestock and Veterinary Research
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Effect of Castration on Meat Production and Quality

One of the most advantages of castration in the goat is enhancement of the meat production as well as the quality. Castration plays an important role in improving the tenderness of meat as it surges the carcass's back fat thickness and intramuscular fat content (IMF). The meat yield in the carcass subjected to half castration and complete castration were 67.88 and 62.11 per cent respectively. Complete castration tremendously increased the IMF content by nearly 4-fold. The development of the flavour of cooked meat is greatly influenced by the presence of MUFAs (Mono saturated fatty acids) like oleic acid. Castration exhibited an influence over the fatty acid profile of meat by lowering the content of PUFA (Poly unsaturated fatty acids) and increasing the content of MUFA (Mono saturated fatty acids). Castration also has an effect over the amino acids and volatile flavoured compounds (Hoa*et al.,* 2022). Another study suggested the emphasizes on the ability of castration to increase the fatness in goat meat (Goetsch*et al.,* 2011). The flavor, texture, juiciness and palatability of meat could be improved through castration. Castration not only increased the fat content but also the cholesterol and saturated fat content of meat. The cholesterol content of the castrated meat elevated from 54.37 mg to 63.75 mg per 100 g (Santos-Filho, 2005). Castrated meat of goat that was 3 to 5 months old had a dressing percentage of 88.7 percent, while those that belonged to 10 to 12 months had 41.1 percent(El-Hag, 2007).

The percentage of drip loss, cooking loss and water holding capacity in castrated meat accounted to 2.72, 28.67 and 85.67 percent respectively. The cooking loss of castrated meat was lower than the of uncastrated ones whereas, the drip loss and the water holding capacity of the former was higher than the latter. Regarding the pH, the ultimate and the cooked pH of the castrated meat were lower than that of the uncastrated meat (Hossain, 2022). It was also observed that the crude fat, pH, water holding capacity of the high forage castrated meat was higher than the non-castrated ones accounting to 5.44 per cent, 6.03, 51.04 per cent respectively. The cooking loss, shear force, volatile basic nitrogen and aerobic plate count of the castrated meat is lower than the latter accounting to 32.66 per cent, 6.78 Kgf, 6.76 mg per 100 g and 2.30 log CFU per gram. The castrated lamb meat also exhibited the highest oleic, palmitic, stearic and linoleic acid contents. The amount of the aforementioned acids in high forage castrated meats were 32.68, 23.02, 15.72 and 10.29 per cent respectively. The values of the same in that of low forage castrated meat were 38.56, 24.00, 14.44 and 8.81 percent respectively. To put in a nutshell, the castrated high forage meat contains 40.52 percent saturated fats and 59.48 percent unsaturated fats among which MUFA contributes to 36.76 percent and PUFA contributes to 22.73 percent (Lee*et al.,* 2023).

Effect of Castration on Disease Resistance Power

Castration was the most effective for weight gain and to overcome goat smell. Castration was also used as an effective tool for cattle with abnormalities such as cryptorchids and small testicles (Kunene and Fossey, 2006). Castration is one of the preconditioning techniques such as vaccination and horn tipping that helps improve the immunity and the quality of the animals. It was also reported that castration greatly helped to minimize the incidence of mortality due to bovine respiratory diseases. (Duff and Galyean, 2007). Castration techniques that include mechanical and surgical types are typically associated with sterilization of animals. Despite improving the quality of the animals, they are associated with injury, long healing duration and pain. Therefore, to overcome the issue, a new, painless, anti-friendly technique called immune-castration has evolved. Immunocastration helps in treating sex-hormone related diseases in the animals (Ahmed *et al.,* 2022). It is also reported that

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immunecastration, which is a painless procedure, highly strengthens the immune system and could be done for late as well as young production (Fan-mei., 2022).

Effect of Castration on Body Weight

The effect of castration on body weight gain/loss in goat meat is influenced by the age at which castration is done, the type of castration method used, Average feed intake, breed of the animal, environmental factors and so on. Studies conducted on the impact of body weight by, (Zamiri, 2011) reported that castrated and intact goat calves 3 months old underwent fattening periods of 2,3,4,5or6 months. Both groups' average body weights differed significantly ($p<0.01$) from one another. The difference between the intact (68.8% and 8.5%) and castrated (65.4% and 12.5%) carcass mean lean and fat percentages was significant. The findings showed that, after three months of fattening, the 7-month-old castrated goats gained more weight (75kg) than the intact goats (45kg). Castration only increases the carcass yield and not the body weight, according to another study by (Nahimana *et al.*, 2019) in which it was found that castration had a depressing effect on weight gain (4.47kg versus 5.97kg). (Abdulkareem *et al.*, 2018) investigated the influence of castration methods on body weight, growth performance and nutrient digestibility of Savanna Brown Goats. It was stated that there were no significant differences in the initial and final body weights for the 6 various castration treatment techniques that were carried out on diverse weight bases. However, the data also revealed some statistically significant ($p<0.05$) differences in the dry matter, crude protein, crude fiber, ash, fat, and nitrogen digestibility between open castrates, close castrates, and non castrates. Yet other study conducted by(Munahi, 2017) stated that the efficiency of using unilateral spermatic cord torsion castration technique in comparison to Burdizzo castration method on Iraqi local black goats. The results concluded that the body weight of adult animals were increased significantly ($p<0.01$) in all castrate groups. The means of body weight gained of U. torsion and Burdizzo method were 7.69 ± 0.26, 6.12 ± 0.4140 and weight gained of control groups is 3.48 ± 0.4283 Kg. Animals in U. torsion group got the lesser body weight compared to Burdizzo method. From the findings mentioned above, it can be concluded that based on the method, age and feed given to goats after castration, improves the carcass yield and body weight, reduces the unpleasant flavor and improves the odor of the meat.

Effect of Castration on Immune System

It is believed that the immune function of both animals as well as human beings are greatly dependant on the gonadal steroid hormonal functions. Even though castrated animals did not show higher levels of the synthesis of antibodies namely IgG, IgM and IgA, the study clearly indicated that three- to four-month-old castrated male animals exhibited elevated levels of autoreactive antibodies such as anti-thyroglobin and anti-rheumatoid factor (Viselli *et al.* 1995). Studies was also carried out among goats in order to analyse the gender dependent variation in the immune response of female, male and castrated male animals.

The immune response was carried out based on the lymphocyte count as well as total leucocyte count. It is considered that the female goats have better immune response and other parameters when compared to the male goats. This is due to the fact that the male goats have higher testosterone, which is the peripheral gonadal hormone. Thus, this is the major reason for the low immunity in the male goats. Since the castrated and the female goats lack testosterone, they are benefitted with a comparatively better and strong immune system (Haldar, 2012).

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Comparison between Castrated and Non-castrated Goat Male on Feed Composition and on Body Weight

The fattening performance, slaughter, and carcass characteristics of intact and castrated Angora goat babies butchered at various slaughter weights were investigated by (Ünal, 2021). Castration raised the percentages of non-carcass fat and the depth of back fat. Castration had an impact on the composition of the carcass; the percentages of lean and bone in the carcass decreased (P<0.001) and the percentage of total fat increased (P<0.001). Slaughter weight (SW) had an effect on carcass composition; as SW increased, lean (P<0.001) and total fat (P<0.001) percentages increased and carcass bone percentages decreased (P 0.001). Castration and raising slaughter weight had an impact on the lean/fat ratio (P<0.05 and 0.001, respectively). Studies reported that castration had a negative effect on both daily weight gain and feed conversion ratio in Angora male goats. (Louca, 2010) conducted the study with Damascus goat breeds, in which intact male infants until the age of 9 months (56 kg live weight), developed more quickly and used nourishment more effectively than castrates. Following this, intact children had intense sexual behavior, which caused them to stop developing entirely in contrast to castrated children, who continued to grow. Early castrates had bigger carcasses weight than uncastrated children, as then fat percentage increased. In this study, castration of male young children at the age of around 7.5 months (44 kg live weight) was unsuccessful, and the young people did extremely poorly. The flesh of intact goats had a taint of various strength, but none of the early or late castrates had any. Carcass weight will have the advantages in comparison to intact and castrated goat meat. Another research was conducted with Turkish hair goat kids (Koyuncu, 2007), on an average daily weight gain basis. There were not much difference between Intact and Castrated kids, and the gain was recorded as (102g and 77g) which is comparatively less, but the dressing percent was lower (P<0.01) for intact than castrates. In terms of the carcass yield, intermuscular fat was higher than intact male kids.

CONCLUSION

Castration of goats is an essential process as it makes goat less aggressive and reduces the smelly “billy goat” odour. The most common method of castration is the use of elastrator. Different methods involved in castration and the steps involved in the process of castration are also widely discussed in this chapter. Castration of goat are reported to have an impact on aspects like live weight, dressed percentage, meat production, meat quality, immune system and disease resistance power. A comparison between castrated and non-castrated goat male is also carried out on feed consumption and body weight. Castration are known to have an effect on various domains such as live weight, fatty acid composition, sex hormones, immune system, disease resistance power.

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CHAPTER - 3

Nutrition Management of Goat

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ABSTRACT

Nutrition is a very basic entity that will help humans for their survival. It can be acquired from different sources of food consumed by the people. Goats are well-known browsers digesting higher amounts of fat and roughage belonging to a small group of ruminant families. Nutrition of goats can be classified on the basis of age, sex, breed and production system, body size, climate and physiological stage. Feeding strategies are an utmost important factor as these are some of the significant ways by which energy, protein, minerals, and vitamins are supplied across body. Nutrition for newborn goats and different classes of goats helps to gain a better understanding of nutrition requirements for different groups. Various requirements of goat are enlisted in this chapter such as water requirement, energy requirement, protein requirement, and mineral requirement. It also discusses methods of feeding management and schedules for nutrition management in goats to ensure proper well-being through an adequate supply of nutrition.

Keyword: *goat, nutrition, feeding, management.*

INTRODUCTION

Goats are small ruminant animals and efficient browsers which have contributed a major part in livestock production. This livestock production could be enhanced by proper supply of nutrients in goats such as water, carbohydrates, fat, protein, vitamin and minerals respectively**.**3-4% body weight expressed in pounds is contributed by daily feed intake of goats. feed intake is influenced by various factors such as body weight, % of dry matter in feed eaten, palability, and physiological stage of goats. Apart from these nutritional requirements, nutritional disorders prevalent in goats and the feeding schedule of goats are widely discussed in this chapter.

Nutritional Requirements of Different Classes of Goat

All animals need proper nutrition in order to be healthy and productive, and it is the core of efficient production systems. An effective preventative health programme cannot solve issues brought on by inadequate diet. The nutritional constraints on reproduction cannot be overcome by improved reproductive technologies. For efficient goat production, the nutrition of the goat is therefore a factor of the utmost importance. The science of nutrition focuses on giving nutrients to animals in quantities and in forms that they will eat. These nutrients must be supplied in an economical way in order for production to be sustainable and profitable (Hart, 2008).

Water

Depending on nutrition, consumption, and weather, a 110 lb goat will need between 1 and 3 gallons of water each day, with the need for more water during the warmest days of the summer. For every pint of milk produced, a breastfeeding goat needs an additional quart of

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water. 2.5 gallons of water are needed each day for a goat to raise twins while producing 5 quarts of milk at the height of lactation. If goats are eating green food, then the water present in the plant food can supply a large portion of their water needs. However, water must be provided to meet the need if dry feed, like hay, is ingested.

Carbohydrates

Although cellulose is sometimes referred to as fibre, the term also includes other compounds like hemicellulose and lignin. Young plants' fibre may be easily digestible. It offers a lot of energy, but mature, older plants' fibre is usually inefficiently absorbed and may only offer half the amount of other carbohydrates. In general, the amount of digestible energy increases as the amount of fibre decreases. However, for a healthy rumen to function, a specific minimum fibre level is needed.

Goats are more susceptible to acidosis, founder, urinary calculi, and enterotoxemia than cattle and sheep are too high-concentrate diets. When feeding goats consume high concentrate diets, it is important to progressively increase the concentration of concentrate in the diet to maintain a minimum of 12% crude fibre or around half of the diet as grass, browse or hay. Additionally, health issues with goats on high-grain diets must be closely monitored.

Fat

On a weight basis, fats, also known as lipids, have twice the amount of energy as carbohydrates. Due to the low-fat content of plants, ruminant diets often include little fat. Goats eat plant waxes as fats while they graze and forage, but they do not digest them. To provide more energy to diets, fat may be added. High quantities of added fat, however, inhibit the digestion of fibre unless they are made dormant in the rumen. These lipid sources, which are referred to as "bypass," are occasionally utilised in meat goat meals but are mostly not.

Protein

Protein supplements are typically administered to ruminant animals to make up for nutritional deficiency. Most of the eaten protein is broken down by bacteria in the rumen, which then uses the amino acids to create bacterial protein. In addition, bacteria may produce considerable amounts of protein from non-protein sources like urea if given enough energy (Rankins, 2002).

Vitamins

The goat needs to be given fat-soluble vitamins because it cannot produce them on its own. The required amounts of vitamins in formulated diet are 80 IU/lb of vitamin E, 2,000 IU/lb of vitamin D, and 5,000 IU/lb of vitamin A (IU - international units, a measurement of the strength of vitamins). The fat-soluble vitamins can be retained in the liver in large quantities.
Animals technically require vitamin K, which aids in blood clotting. In the digestive tract, vitamin K is generated by the microorganisms and absorbed. Goats typically don't require vitamin K supplements.

Minerals

Minerals are inorganic nutrients, which are classified as microminerals and macrominerals. Microminerals are generally required in smaller quantities at ppm level whereas macrominerals are required in larger quantities at 0.1% or more in the diet. Calcium, phosphorus, sodium, potassium, chloride, sulphur, and magnesium are macrominerals. Iron, copper, cobalt, manganese, zinc, iodine, selenium, molybdenum, and other elements are

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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examples of microminerals. The body uses minerals in many different ways. Some, like calcium and phosphorus, have a variety of functions in addition to being important structural elements of bones and teeth. Other minerals act as electrolytes or help the nerves operate.

Feeding Schedule of Goats

- **Feeding Schedule of Adult Animals**

There is no demand to supplement concentrate mixture if grass is abundant. According to age, pregnancy, and lactation, animals in poor grazing conditions may be supplemented with a concentrate combination at a rate of 150 to 350 g per animal per day. The concentrate mixture utilised in the adult feed has a 13% digestible crude protein content (Solaiman, 2010).

- **Feeding Schedule of Non-pregnant Animals**

There is no need to supplement with a concentrate mixture if pasture is readily available. Animals in poor grazing condition may get 150–200 g of concentrate per animal per day as a supplement.

Feeding Schedule of Pregnant animals

- **During the first 4 months of pregnancy:**

Pregnant animals should have access to good grass for four to five hours every day. Available green fodder must be added to their diet at a rate of 5 kg per head each day.

- **During the last 1 month of pregnancy:**

Up to parturition, foetal growth increases by 60–80%, and ewes may develop pregnancy toxemia if there is insufficient energy in their nutrition. Animals should therefore be permitted in very good quality pasture for 4-5 hours each day at this time. Animals should be fed a concentrate combination at a rate of 250–350 g/animal/day in addition to grazing. Available green fodder should be added to their diet at a rate of 7 kg per head each day.

- **Feeding schedule at lambing time**

The grain allowance should be decreased when lambing time draws near or soon following lambing, but good quality dry roughage is provided at will. On the day of delivery, it is typically advisable to feed modestly while providing lots of fresh, cool water. The ewe must be provided just enough light warm water soon after lambing. The ewe's ration may be gradually raised after delivery so that she receives the entire allotment in separate doses six to seven times each day. During the first several days, heavy and laxative feedstuffs should be included in the ration. It is best to combine wheat bran and barely, oats, or maize at a 1: 1 ratio.

- **Feeding schedule of lambs/kids (upto 3 months of age)**

Feed the newborns colostrum as soon as possible. Keep the mother and newborns together for 2-3 days after birth to provide them regular access tomilk. Feed the lambs or kids milk two to three times per day after the first three days, up until weaning. The young ones should be taught to eat green roughages at around two weeks of age. The little ones should be given the concentrate combination at one month of age.

- **Colostrum feeding**

For the first three or four days, the infant should be permitted to suckle its dam in order to obtain a sufficient supply of colostrum. In order to reduce child mortality, colostrum feeding

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

is crucial. For lambs and young children, cow colostrum is also effective. 100 ml of colostrum are administered for every kg of live weight. Propionic acid at 1-1.5 percent (vol/wt) or formaldehyde at 0.1 percent can be used to preserve colostrum. Due of its ability to maintain a low pH, propionic acid is favoured for preservation. To ensure higher quality, the chemically altered colostrum is stored in a cold environment (Rankins, 2012).

- **Creep feeding**

Starting the creep feed is possible during one month old and up to two to three months old. Creep feeding's major goal is to provide more nutrients for their quick growth. The recommended daily amount for lambs and young animals is 50–100 grams. Protein should make up 22%. At a rate of 15 to 25 mg/kg of feed, antibiotics like oxytetracycline or chlortetracycline can be combined.

- **Three to twelve months of age**

Grazing for around eight hours every day in the pasture is recommended. Supplementing the concentrate mixture between 100 and 200 grams of protein per animal per day is also essential. Dry feed aat night and on rainy days throughout the summer is also a major requirement.

Measures to Prevent Nutritional Disorders in Goat

- **Enterotoxemia**

In stable-fed goats, regular, small-volume feedings of milk, grain, and pasture are the most effective way to prevent enterotoxemia. One large meal every day is not recommended. Feeding high-quality forages as an energy/protein supplement rather than cereal grains will help minimise the intake of fermentable carbohydrates in goats. Lactic acidosis, which can result in the secondary consequence of enterotoxemia, is indicated by acute indigestion and a rumen pH of less than 4.8. A good immunization regimen for both the mother and the child will be beneficial for prevention (Hart, 2008).

- **Polioencephalomalacia**

Thiamine (200-500 mg, IV, IM, or SC) can usually be used to successfully treat affected animals. Animals rarely resume a reasonable level of output if serious brain damage has occurred, despite the rapid and virtually immediate reaction. Treatment needs to start right away. The diet should be changed to omit grains, consume more forage, and, when necessary, cut back on excessive sulfate/sulfide intake. Thiamine mononitrate may help with prevention during stressful situations or when predisposing foods are inevitable.

- **Pregnancy Toxemia**

A drench of 200-300 mL of propylene glycol or glycerol can be utilised as an energy source to stop so much body fat from being digested in the early stages of the condition, when symptoms first manifest. The preferred treatment, however, is the intravenous injection of glucose (5 percent dextrose or 50–120 mL of a 23 percent calcium borogluconate solution into a litre of 5 percent dextrose). Maintaining a healthy body condition score, recognising pregnant females with twins and triplets and feeding them appropriately, lowering the incidence of chronic disease, shearing long-fibered does in late gestation, and possibly supplementing the diet with niacin (1 g/day during late gestation) should all be goals of prevention. Providing sufficient winter feedstuffs and keeping an eye on changes in body condition throughout gestation will help to lower the prevalence of this ailment.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

- **Urinary Calculi**

By reducing phosphorus intake to the bare minimum and maintaining calcium : phosphorus ratio >2:1 (with the phosphorus content of the diet 0.45%), the incidence of urinary struvite calculi can be decreased. The use of anionic salts like ammonium chloride (0.5 percent of the complete diet), dietary tetracycline, sufficient vitamin A (or beta-carotene) intake, increased dietary intake of NaCl, reducing grain intake, minimising use of pelleted cereal grains, and making sure there is an ample source of fresh, clean, palatable water available at all times have all been found to be beneficial. Animals with the condition may respond well when given ammonium chloride (7–14 g/day for 3-5 days). Consumption of forages with a high silica concentration is linked to the disease in range sheep and goats.

Nutritional Health Problems and Related Diseases of Goat

Nutritional regulation is linked to a number of disorders. These include polioencephalomalacia, acidosis, founder, enterotoxemia, pregnancy toxemia/ketosis, and urinary calculi. Acidosis, founder, and enterotoxemia are all linked to excessive grain feeding or a sudden rise in grain consumption (Nelson and Guss, 1922).

- **Acidosis**

The production of large levels of lactic acid in the rumen as a result of the animal consuming a lot of starch is linked to acidosis. Ruminal bacteria may also produce endotoxins, which aggravate the issue.

- **Founder**

The term "founder" describes issues that arise with an animal's feet as a result of acidity. Weekly foot trimming is required due to the constricting of the blood vessels in the hoof, which over time causes the hoof to develop quickly.

- **Enterotoxemia**

Bacteria in the intestine that develop quickly and create an endotoxin in response to increased levels of starch in the diet cause enterotoxemia. The endotoxin's action causes animals to suffer greatly, and they usually pass away fast. The vaccination will aid in the disease's prevention.

- **Polioencephalomalacia**

Polioencephalomalacia, which is a thiamine deficit, is linked to high grain intake and stress. High dietary sulphur intakes, such as those derived from molasses, can raise the prevalence of the illness. The animals appear intoxicated, may be unable to stand, develop blindness, and eventually die. A high dose of thiamine (5 mg/lb), which may need to be repeated, usually has a significant effect.

The easiest way to prevent these diseases is to gradually increase the amount of grain in the diet while keeping the forage content at 50%. To help with the prevention of polioencephalomalacia, 0.25 lb of thiamine per tonne of high-concentrate diets can be added.

- **Pregnancy Toxemia**

Pregnancy toxaemia is a metabolic disorder that is typically brought on by an animal being very fat before to kidding, though it can also affect animals who are extremely thin. It is brought on by the growing fetus's increased nutritional requirement in late pregnancy, which is not being satisfied (excess fat in the body and the growing foetus limit room in the stomach

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

for food, reducing intake of the diet). Due to the rapid breakdown of fat stores brought on by this unmet nutrient need, poisonous ketone bodies are formed at high concentrations.

- **Urinary Calculi**

Urinary calculi occur as a result of a calcium shortage or ration imbalance. The ratio of calcium to phosphorus in the diet should be two to one. However, grains can contain up to 40 times as much phosphorus as calcium. Phosphorus can react with magnesium in the bladder to produce crystals that resemble stones when the overall amount of phosphorus in the diet is higher than the total amount of calcium. The urethra, which connects the bladder to the outer world, becomes clogged with crystals. Due to the urethra being longer and thinner in withers compared to does, the issue is more prevalent in males. Additionally, it forms three s-bends where the stones get caught. Urinary calculi are a serious issue. If the obstruction worsens, the goat is unable to urinate, the bladder may rupture, which will inevitably result in death. For prevention, a proper calcium-to-phosphorus ratio is essential.

Nutrition for New-Born Goats

Colostrum must be given to new - borns as soon as possible. Proteins, milk solids, globulins, lipids, and vitamin A are all abundant in it. Children are born without immune antibodies and get immunity through their mothers by consuming colostrum. Within the first three to twelve hours after birth, colostrum should make up 10% to 20% of the new-born's body weight. Colostrum, which contains antibodies, was given to young children for the first month to help boost their immune systems. When a mother dies or declines to take her children, it may be essential to bottle-feed young children. It is possible to milk colostrum from a different doe that just gave birth. Frozen colostrum can also be given after thawing. In many cases, cross-species colostrum is preferable to none at all. The cost and labour involved in raising orphaned children on milk replacement are considerable. If at all practicable, orphans should be grafted onto another doe; if this is not possible, they should only be raised on milk substitute (Rankins, 2012).

Milk substitutes should be fed in accordance with the manufacturer's instructions. To start them on a beginning feed as soon as possible is the most cost-effective strategy to nurture orphans. Commercial starters are superior to homemade mixtures. The intake is higher in pellets. Few people can also obtain the feed components needed to manufacture their own. Starter for calf will perform better. Offering 14 to 16 percent crude protein-containing corn, oats, alfalfa pellets, molasses, and soybean meal at 114 grams (0.25 lbs) per day is effective. A dry milk replacer sprinkled on top of the feed may encourage early consumption of the dry feed. Soybean hulls and various types of bran, including wheat bran, are additional ingredients that are well-known to be very palatable to young ruminants. Creep feeding is crucial for giving young goats a strong nutritious start. Creep feeding is the practise of giving young children access to nutritious food that their mothers are unable to get. The traditional method for doing this is placing the feed beyond a gate with apertures that the children can pass through but the mothers cannot. A creep meal needs to be highly palatable and include at least 16% crude protein. Commercial calf creep feed, which is commonly available, will function well. At around 6 weeks of age, young goats will normally begin ingesting sizable amounts of a creep feed. Although creep feeds don't have to be complicated, they do need to be tasty because they are competing with milk. Intake often rises when feeds are pelleted or coarsely ground. As animals get older, intake normally decreases as a result of fine grinding. Pellets ought to be bite-sized enough to be consumed. Pellet sizes greater than 5 to 7 mm may cause a decrease in intake in goats. However, until the animals are 3 to 4 weeks old,

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

palatability is the secret to a successful creep feeding strategy. The most effective creep meals are often those with 16–20% protein and low fibre content. In general, creep feeding is lucrative when feed costs are low and goat kid prices are high. When sale prices are low and feed expenses are high, the business is less economical.

CONCLUSION

This chapter provides an understanding on the various aspects of nutrition management of goats. Nutrition management and ensuring proper nutrients such as water, carbohydrates, fat, vitamin and minerals play an important role in survival of goats. Feeding schedule of goats in case of adult animals, non –pregnant animals are discussed along with feeding schedule of goats during different months. Measures to prevent nutritional disorders such as entertoxemia, polioencephalomalaria, pregnancy toxaemia, urinary calculi were studied in order to avoid further heath issues in goat. Health disorders found in goats were acidosis, founder, enterotoxemia, polioencephalomalacia etc. Apart from these, nutrition of newborn goats was also emphasized by the proper administration of pellet, milk substitutes, creep feeding and colostrum.

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CHAPTER – 4

Vaccination Schedule of Goat

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ABSTRACT

Goats are the smallest ruminants contributing to livestock species in countries. Diseases are still prevailing in goats even though they are resistant to diseases. Therefore, it is essential to advise proper monitoring techniques for ensuring the administration of appropriate vaccines at the right time. Diseases were reported in goats generally due to lack of certain facilities for pasture and rearing. Some of the diseases which were reported in goats are goat pox, foot and mouth disease, and anthrax. Studies have reported about various nutritional problems prevailing in goats such as Chlamydiosis, Toxoplasmosis, Q fever, Brucellosis and Listeriosis. Thus, primary vaccines and regular vaccines for the effective treatment of diseases were discussed in this chapter along with antibacterial vaccines, antiviral vaccines and other vaccines required for the better immune system of goats. It also focuses on the vaccination measures undertaken as a part of ensuring proper healthcare management.

Keyword*: vaccination, health care, schedule, measures.*

INTRODUCTION

Goats generally known as efficient browsers are facing various diseases in today's society due to improper pasture facilities and intensive system of rearing. The various diseases includegoat pox, foot and mouth disease, and anthrax. Therefore, ensurance of proper health facilities vaccination are considered to be the essential pillars in providing proper immunity for survival of goats. Vaccines commonly used consist of Caseous D-T, Vision CD-T, Case-Bac, Tasvax 8 etc. These vaccines must be addressed under proper preventive measures such as annual vaccine with Bar-Vac CD/T, lab testing of any abscess and regular barn cleaning etc. Studies reported that timely vaccination in goats provides benefits such as reduced mortality rate and increase body weight. Deworming of kids at first month of age and treating of ecoto-parasites are two major areas where attention is drawn to ensure proper health care. Thus, by adopting these steps, diseases can be prevented. Apart from these, profitability in sustaining healthcare of goats can also be achieved. Proper administration of vaccine and vaccine measures plays an integral role in healthcare management. Thus, this chapter deals with the various aspects like vaccine administration, vaccine measures, vaccine schedule of goats, antibacterial vaccine, antiviral vaccine.

Vaccine Administration

Vaccinations are vital components of health management programmes. These are generally used for goat in farms since they have had substantial beneficial effects on small ruminant health and production. A vaccination is an active procedure in which the animal's immune system is prompted to mount an adequate response against the delivered antigen. It is crucial to ensure the health of the animals before to each vaccination. An anthelmintic medication can be administered at least 15 days before the vaccine to improve outcomes and promote a

Indian Journal of Livestock and Veterinary Research
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stronger immune response (Lacasta*et al.,* 2015). Ensuring health and good standards of animal care on farms requires the proper administration of vaccines and the implementation of pertinent vaccination programmes. The implementation of effective vaccination programmes in flocks and herds ought to usually depend on a consideration of a number of factors, including the type of production, regional environmental and climatic conditions, prevalent infections on the farm, the farm's infrastructure, and its human resources. Furthermore, vaccinations frequently prevent zoonotic infections like Toxoplasma gondii infection and staphylococcal mastitis, which have a significant impact on public health. Thus, it is possible to ensure that the vaccinations are delivered properly and offer the high level of protection through utilising knowledge about the patterns of vaccine administration in livestock farms (Lianou*et al.,* 2022).

Vaccination Schedule in Goats

Vaccine schedule of goats are mentioned in Table 1 given below.

Table 1: Vaccination schedule of goats

S.No	Disease Name	Vaccination Schedule
1,	Anthrax	At the age of 6 month for kid- Primary vaccination. Once annually-Regular vaccination
2.	Haemorrhage Septicemia	At the age of 6 month for kid- Primary vaccination. Once annually before monsoon- Regular vaccination.
3.	Enteroxaemia	At the age of 4 month for kid, (If dam is vaccinated) - Primary vaccination At the age of 1st week for kid (If dam is not vaccinated) - Primary vaccination Before monsoon-Regular vaccination.
4.	Black Quarter	At the age of 6month and above for kid- Primary Vaccination-Primary vaccination. Once annually (before monsoon)-Regular vaccination.
5.	P.P.R (Peste Des Petits Ruminant)	At the age of 3 month and above for kid- Primary vaccination Once in three years- Regular vaccination.
6.	Foot and mouth disease	At the age of 4month and above for kid- Primary vaccination. Twice in a year (September and March)-Regular vaccination.
7.	Goat pox	At the age of 3 month and above for kid- Primary vaccination Once annually (December month)-Regular vaccination
8.	C.C.P.P	At the age of 3 month and above for kid- Primary vaccination Once annually (January month)-Regular vaccination

Vaccine Measures of Goat

It is possible to prevent shedding by immunizing sheep and goats with phase I vaccine. Additionally, studies reported that mandatory C. Burnetii surveillance in small ruminant farms improves awareness, and hygiene precautions in farms aid in reducing human contact to the organism (Brom*et al.,* 2015). A dilution strategy is described for replacing highly resistant worm populations, and numerous doable solutions for managing worms in goats are provided. The epidemiological and risk factors that affect the organism (strain virulence, infection rate of vectors), the vector (climate, season, vegetation, wild reservoir hosts, tick control), and the host (species, age, breed, genetic resistance, and immune status) all play a role in heart water control. (Bath *et al.,* 2005). Main cause of the illnesses found in sheep and

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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goats known as sheep and goat pox is the resultant of pox virus. In different kinds and different ages of animals, the diversity and range of health indications brought on by a single virus strain sometimes overlap with those brought on by other viruses from the same category or even other groups of pox viruses. Therefore, where the illnesses co-exist, contagious pustular dermatitis, which is simple to identify in nations thought to be free of sheep and goat pox, is likely frequently identified as sheep or goat pox. Vaccinia infection in sheep and goats may have previously gone undiagnosed (Kitching, 1983). The genus Capripoxvirus (CaPV) of the family Poxviridae is responsible for the economically significant and contagious viral diseases known as sheep pox, goat pox, and lumpy skin disorders in sheep, goats, and cattle, respectively. Currently, CaPV infection is widespread and common in Central Africa, the Middle East, Europe, and Asia in small ruminants (sheep and goats) (Zewdie, *et al.,* 2021). A within-herd model of Coxiellaburnetii transmission in dairy goat herds was established in order to examine the impact of control strategies and analyze the dynamics of Q fever in goat herds. The methods to control Q fever prevalence and/or the extinction of the disease in a goat herd using this individual-based stochastic model, involved the comparison of six control techniques and three herd management approaches (Bontje*et al.,* 2016).

Policymakers used the cautious principle and decided to eliminate all pregnant dairy goats or sheep on infected farms before the 2010 kidding season due to the number of cases of C. Burnetii infection in patients increased to 2009. This measure was in action at the end of 2009, preventing vaccination effectiveness in the spring of 2010 (Hogerwerf*et al.*, 2011). In most countries, the incidence has decreased due to tight immunization policies, although isolated cases are still being reported. Due to the production of extremely resistant endospores, B.Anthracis is widely disseminated in the environment. They can withstand situations that are very unfavorable, like desiccation, high temperatures, and chemical disinfectants (Karthik and Prabhu, 2021). The mainstay of current fasciolosis management in ruminants is the use of anthelmintic medications, with triclabendazole being the preferred treatment for both juvenile and mature flukes. Resistance, however, is being reported more frequently. There is an increasing demand for development of vaccines due to the presence of chemical residues in milk and meat, the emergence of drug-resistant strains, and the high cost of treatments. Several F. hepatica antigens (native and recombinant proteins) have been found, and production and laboratory animals have tested them as potential vaccination candidates (Villa-Mancera*et al.,* 2021). It is strongly advised to use antibiotics in conjunction with antipyretics and analgesics as a supportive disease management strategy to avoid secondary microbial invasion in the future. Many countries have reported the emergence of various exotic orf virus strains from various origins, primarily as a result of poorly managed cross-border virus transmission. The development of orf virus vaccines has undergone multiple attempts, with varying degrees of success. The use of traditional vaccines to treat orf is controversial because of the risk of developing short-term immunity (Bala*et al.,* 2018). Rev-1 vaccination of young animals (3-6-month-old sheep and goats) over 15 years in Greece significantly reduced the prevalence of brucellosis in people as well as abortion rates in sheep and goats. The prevalence of brucellosis in animals and its occurrence in people both rapidly increased when the immunization program was discontinued in Greece in 1994. These variables had a positive rank correlation (0.90) (Minas *et al.,* 2004).

Antiviral Vaccines of Goat

Vaccination is regarded as an affordable and prospective method of disease prevention in India and other endemic developing countries. The most frequently used vaccination for the prevention of sheep pox and goat pox are attenuated live or inactivated strains of SPPV or

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

GTPV (Bhanuprakash*et al.,* 2012). A homologous vaccine is advised for the best level of protection against either the sheep pox or goat pox, depending on the local strain. The protection produced by inactivated vaccines is insufficient and short-lived. However, a safe and effective method to protect livestock against SPPV would be an inactivated SPPV vaccine, especially after the first outbreak of the virus in the previously disease-free nation. In this line, an inactivated SPPV vaccine employing the RoumanianFanar (RF) strain exhibited potential to replace the attenuated vaccine for disease control and eradicate sheep pox in regions with endemic or non-endemic disease (Boumart*et al.,* 2016). For long-lasting immunity against CaPVs, the live vaccination is preferable (Bhanuprakash*et al.,* 2012). Susceptible animals can receive a single injection of the OIE-recommended safe dose of GTPV vaccination (102.5 TCID50) intradermally or subcutaneously. Attenuated capripox vaccines have been created using heterologous cell cultures, such as foetal muscle cells from cows and kidney cells from newborn hamsters. GTPV that has been attenuated in vero cells showed complete defense against virulent challenge (Carn, 1993). Many nations in the Middle East and Africa have utilized a single vaccine based on the 0240 strain of the Kenyan sheep and goat pox virus (KSG), which successfully protected both sheep and goats against severe strains of CaPV. In India, the SPPV-RF strain attenuated through multiple passages in primary lamb testes (PLT) cells is currently the most widely used vaccination for sheeppox and goat pox. In Tamil Nadu, the indigenous strain SPPV-Ranipet which is attenuated in ovine thyroid cells and LT cells is used. The SPPV (Srinagar) strain, which is a native strain used in the development of the novel Vero cell-adapted vaccine, has been found to be both safer and more effective than previous vaccine viruses offered in India (Yogisharadhya*et al.*, 2011). In Egypt, a trivalent vaccination which can be used as a broad-spectrum vaccine against all CaPVs diseases is created from SPPV strains (Romanian, Kenyan 0180), and GTPV vaccine with equal volume and roughly equal titre. Compared to the commercial RSPPV vaccine alone, that vaccination provides a remarkably high immunity.

Antibacterial Vaccines of Goat

B.melitensis is primarily responsible for causing brucellosis in goats, while this disease can also infect cattle and other ruminants (Bhanuprakash*et al.,* 2012). There are three distinct biovars of this disease (Boumart*et al.,* 2016). In 1887, Bruce isolated B.Melitensis, the first species in the genus Brucella from the spleens of soldiers who had died of Mediterranean fever on the island of Malta (Carn, 1993). Therefore, the prevention of human brucellosis is heavily dependent upon the prevention and control of caprine brucellosis, and similar to the control measures against any infectious illness. Immunization is the first and essential step to control animal brucellosis. The two most popular ways to control bovine brucellosis are the animal vaccination and slaughter of affected flocks. B. abortus S19, Cotton stain 45, RB51, and B.melitensis Rev.1 vaccines have been successfully used in large and small ruminants, respectively (Blasco, 1994). It is possible to protect sheep and goats against B. melitensis strain Rev.1 with an efficient, well-proven vaccination. With the help of these vaccines, the disease has been eradicated in many developed nations. But the use of these vaccines has been restricted in many nations due to the following reasons: vaccination-induced abortions in pregnant animals, transmission of the disease to humans through vaccinated animals, and Rev.1 resistance to the antibiotic streptomycin, which is used to treat the disease (Schurig*et al.,* 2002). In 2000, a vaccine made from a dead, whole cell suspension of Brucellamelitensis had been administered to calves and sheep without adjuvant or with the addition of Mycobacterium phlei or bentonite clay resulted in increased levels of humoral and cell mediated immunity (Ram *et al.,* 2000). In China Sheep and goat immunization with the attenuated B.melitensis vaccine M5-90 is used (Degiu*et al.,* 2002). However, using the

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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standard serological tests, is challenging to differentiate between the antibody responses produced by two live vaccines and those produced by naturally Brucella-infected animals. According to reports, BP26, the Periplasmic Protein of Brucella, stands out a great potential for a more accurate diagnosis of brucellosis because it is the most conserved among all brucella species and has high sensitivity and specificity for the detection of animal brucellosis by enzyme immunoassays (EIAs) (Rossetti *et al.,* 1996). Additionally, it showed excellent cellular and antibody responses (Clapp *et al.,* 2011). While the BP26-deleted M5-90 mutant lost its potential to produce protective immunity, the mutant acquired by deletion of BP26 in Rev.1 exhibited protection against B. melitensis in sheep or B. ovis in rams (Jacques *et al.,* 2007). High IgG1 titers are produced in response to this BP26 antigen in Rev. 1, and IFN-, IL-4, IL-5, and IL-6 are produced cellularly. A powerful source of defense against Brucella infections are BP26, TF (trigger factor), and omp31 (Cassataro*et al.,* 2005). Recombinant BP26 has been examined for brucellosis in sheep and goats diagnosis. The DNA vaccine encoding the outer membrane protein (OMP31) of Brucellamelitensis 16M causes an immunological response in mice (Gupta *et al.,* 2007).

Recently, it was discovered that NMP (membrane protein extracts) exhibited 90% agreement with SAT and RBPT and was more sensitive and specific in ELISA for detecting antibodies to Brucella in sheep than rBP26 (rough BP26) (Qui et al., 2012). According to recent reports, the immune system may acquire B.melitensis to antigens through an invasive E. colivector platform. Since invasive E. coli are nonpathogenic, capable of delivering antigens to antigen-presenting cells, and possess natural adjuvant qualities that enhance cellular immune responses, they may be the perfect vaccine under such circumstances (Gupta *et al.,* 2012). However, the efficacy of these mutants as vaccines with immune responses comparable to that of S-19 or Rev. 1 has yet to be demonstrated. The most effective vaccine against brucellosis in sheep and goats is the live attenuated Brucellamelitensis vaccine strain Rev.1, which is well-known around the world (Blasco*et al.,* 1994).

Other Vaccines of Goat

The ability to immunize tiny ruminant species is restricted by their comparatively low economic worth. The most crucial vaccinations are those against clostridial illnesses like tetanus and enterotoxemia. A significant factor in sheep losses in densely populated areas is enzootic pneumonia. Management of footroot disease was reported to be challenging due to great antigenic diversity of its causative agent. The vaccine against sore mouth is crucial in specific regions. Vaccination against bluetongue, despite its complexity, is necessary in some places. Concern over the pest of small ruminants is rising throughout much of Africa. In general, goats, llamas, and sheep all need the same vaccinations (Tizard, 2021). Three live attenuated PPR vaccines, Sungri 96, Arasur 87, and Coimbatore 97, are being offered in India. The PPR Sungri 96 (isolate of goat origin) vaccine was created by the Indian Veterinary Research Institute (IVRI) Mukteswar, whereas the Arasur 87 (isolate of sheep origin) and Coimbatore 97 (isolate of goat origin) vaccines were created by the Tamil Nadu Veterinary and Animal Sciences University (TANUVAS). In this study, challenge faced by sheep and goats were used to test the effectiveness of these vaccines, along with a fourth vaccine from the Institute of Animal Health and Veterinary Biologicals in Bangalore (IAH&VB), in accordance with OIE guidelines. PPR C-ELISA was also used to assess the vaccines' efficacies (Saravanan*et al.,* 2010). With an estimated 13 million head in the EU, goats are a potentially significant BTV reservoir and are also susceptible to BTV-8. However, many of these vaccinations have been used "off license" (without the customary efficacy

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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testing) in goats due to the urgency of the situation and the need to immunize animals before the BTV transmission season (Bréard*et al.*, 2011).

CONCLUSION

Vaccination schedule, its measures,and administration are well studied in this chapter to provide proper health care for goats. This measures in turn ensure disease-free environment. Due to growing demands of disease-free environment, the need of vaccines was met by development of vaccines such asCaseous D-T, Vision CD-T, Case-Bac, Tasvax 8.

Importance of various antibacterial, antiviral vaccines to treat various bacterial and virus diseases in goats are also discussed in this chapter along with the vaccine schedule management in goats. Even though various vaccines were introduced to prevent diseases, certain vaccines were used without approval during emergency, which have led to certain issues. Therefore, proper usage of legally approved vaccines must be considered.

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Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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CHAPTER - 5

Welfare and Welfare Issues in Goats

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ABSTRACT

Animal welfare is defined as the physical and mental state of animal in relation to the conditions in which it survives and dies. Animal welfare is concerned with how the animal views its own life and experiences, how it copes with the environment in which it finds itself and how its quality of life is affected. Animal welfare do not have an absolute value it may be either good or poor. Goats are major contributor of small and marginal farmers economy. The oldest and the best-known definition of animal welfare is the Five Freedoms. The Five Freedoms originated as an idea in the United Kingdom by the Farm Animal Welfare Council in 1979 and was originally focused on farm animals, although the concepts and ideas apply generally to all animals. In recent years due to increasing demand of animal products animals are reared in intensive system where animal welfare is compromised and the various welfare issues are discussed above.

Animal welfare laws and several non-governmental organizations stand in favour of animal welfare, their initiative created awareness among people for welfare of animals, but there is a vast scope of improvement in sector of animal welfare.Goat rearing has many comparative advantages over other domestic animals with poor resources. Goats are mainly reared under three production systems in India depending on the purpose, number of animals, availability of resources and agroclimatic zones. They are extensive system, Semi-intensive system and Intensive system. Every management system has its own benefits and limitations in terms of welfare. There are various welfare issues in housing, breeding, feeding, health care and vaccination, docking, shearing and transportation which have been discussed in detail in this chapter.Among livestock goat is considered as most rustic animal, hence welfare of goats was under-rated and concern raised slowly.

Keywords*: Welfare, Goat, Five freedoms, Welfare issues.*

INTRODUCTION

Animals are the eternal part of ecosystem and serving humans since long ago. Goats are known to be first reared among ruminants. Goats are serving mankind by various ways like milk, meat, skin, fibre and manure. Initially goats were reared under pastoral or extensive system but with years rise in human population created demand of animal product also, this created a necessity to develop such systems where a greater number of animals can keep in small space with feeding and watering arrangement.

Raising goats in confinement helped in achieving good production but welfare of goats in compromised. This does not mean that goats have good welfare in extensive system, every system has its own benefits and limitations. Goats are known to be very hardy animals hence limited study has been done on welfare of goats. Veterinarians are being expected to know

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more about animal welfare than only health and treatment, animal welfare matters not only because it is corelated with human welfare but animal welfare is itself a subject. To regulate animal welfare in India, Department of animal husbandry and dairying created a statutory body known as Animal welfare board of India (AWBI), which is situated in Ballabhgarh, Haryana. This chapter will help in understanding welfare, welfare issues and need of welfare in goats.

What is Welfare?

World organization for Animal Health (earlier OIE) defines animal welfare as: "*the physical and mental state of animal in relation to the conditions in which it lives and dies*". In simpler words it is the physical and physiological well-being of animals. Animal welfare does not have an absolute value, it lies between very good, good, poor and very poor. Animal welfare is based on reason and science with measurements and frameworks taking biological context into account. Numerous comprehensive frame works are available which assist to specify animal welfare more precisely, it include five freedoms and five domains of welfare.

Five Freedoms

Five freedoms are known to be oldest and best define of animal welfare. Five freedoms were described by Farm Animal Welfare Council, United Kingdom in 1979. Initially their ideas were focused on farm animals but they are applicable on all animals. The five freedoms are

1) Freedom from Hunger and thirst- providing animals with fresh water and feed to maintain health and vigour.
2) Freedom from discomfort- providing appropriate shelter, comfortable resting area and good environment
3) Freedom from pain, injury and disease- it includes rapid diagnosis, prevention and early treatment of disease
4) Freedom from fear and distress- by providing conditions in which animals are free from mental stress.
5) Freedom to express normal behaviour- by providing appropriate space, feed, environment and company of similar animals.

Five Domains

In 1994 five domain model was developed by David Mellor and co-workers in New Zealand. There are many common features among five freedoms and five domains but it divides animal welfare into five domains out of which four are concern about physical aspects while fifth is associated with mental state. Domain model was made to assess the compromise in animal welfare for animals used in teaching and research. These five domains are-

1) Nutrition
2) Health
3) Environment
4) Behaviour
5) Mental state

Welfare Issues in Goats

In this part several welfare issues are discussed, managemental practices like housing, breeding, feeding and healthcare of goats reared in different production systems if not properly adopted cause stress to goats.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Welfare Issues in Housing of Goats

Houses are the major component of animal farms. Houses are made for animals in intensive and semi-intensive systems. Appropriate houses are required to make animals safe from predators, extreme climatic conditions and theft. In goat farms there are different kind of houses like for kids, does, bucks, diseased and pregnant animals. In pastoral and extensive system there is no provision of houses, in this kind of system animal faces environmental stress during extreme environmental conditions, nutritional stress and lameness hence welfare is compromised. In houses itself there are serious welfare issues which are-

Overcrowding

Appropriate housing is necessary for good welfare and reduce the production stress. Overcrowding in goat pens cause compromise in five freedoms. Overcrowding cause thermal and physical discomfort, emission of gases from faeces cause pollution in houses which canleads to serious health issues. Concentration of pollutants in shed is directly proportional to stocking density of goats, optimum stocking density is required for welfare of goats. Appropriate space requirement and stocking density for various age group is given in following table 1.

Table 1. Showing Floor Space Requirement with Stocking Density for Different Age Groups of Goat

Age	Covered space (m^2)	Open space (m^2)	Maximum number of animals
Upto 3 months	0.2-0.25	0.4-0.5	75
3-6 months	0.5-0.75	1-1.5	75
6-12 months	0.75-1	1.5-2	75
Lactating doe	1.5-2	3-4	60
Male and pregnant doe	1.5-2	3-4	1

Poor Light and Ventilation

As goats are warm blooded animals, they maintain their homeostasis by gaining and loosing heat. They regulate their body temperature to keep themselves in thermoneutral zone, increase or decrease in temperature beyond this cause serious stress to goats. Appropriate ventilation is required in houses with arrangement of heating or cooling devices for extreme climate. Sunlight has ability to kill various disease-causing organisms, along with this sunlight helps to maintain goats vit D level and hygiene of shed. Improper ventilation cause increase in humidity and concentration of gases like ammonia (>20ppm) and carbon dioxide. Elevated level 9of humidity and gases are responsible for respiratory diseases. Optimum ventilation conditions for goat farm are described in table 2.

Table 2. Showing Ventilation Space and Optimal Environmental Conditions for Goats

Optimum air temperature	13-27 °C
Average wind velocity	5-8 km/hr
Relative Humidity	60-70 %
Orientation	East-West than next best is NE-SW

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Season	Ventilation space
Cold	2-10 % of floor area
Comfortable	25 % of floor area
Hot Dry	70% of floor area
Hot Humid	Long sides should kept open
	Ramachandran et al., 2018

Hygiene and Sanitation

Animal waste is a source of poisonous gases and disease-causing micro-organisms. The floor, manger, water through and drains of animal houses should be clean to avoid diseases. Hygiene and sanitation of shed is the effective measure to prevent goats from diseases. The floor of different sheds of goat should be cleaned twice a day. Mastitis, colibacillosis, coccidiosis and foot rot are common diseases associated with poor sanitation and hygiene. Failure in hygiene and sanitation results in compromise in welfare as freedom from disease, pain and injury is served. Various chemicals are available which can be used for the purpose of hygiene and sanitation, these are described in table 3.

Table 3. Presenting some commonly used disinfectants in goat farms

Name of Chemical	Use
Lime	Sprinkled on ground, floor and walls
Chlorine or Sodium hypochlorite	Can be used against bacteria, virus and fungi to disinfect shades
Phenol and carbolic acids	5% solution used to disinfect metallic objects, have anti-microbial property
Formaldehyde	With formalin and potassium permanganate this gas is produced, used to disinfect shades
Iodine	Antiseptic properties
Potassium permanganate	Antiseptic properties, used in foot baths

Poor Housing

Housing requirement of goats depend upon climatic condition, production system, breed and adaption. Poor housing cause decrease in production performance with high incidence of disease and mortality in the flock. Goat sheds should be elevated from ground, free of dampness with proper drainage systems with a distance of 8 meter between two houses. Poor housing leads to compromise in five freedoms specially freedom from discomfort.

Less Care during Summer, Monsoon and Winters

Goats need extra care and attention during extreme climates, inadequate housing or improper care make animals sick during these conditions. If animals frequently exposed to extreme summer, rain and cold it leads to heat stroke, pneumonia and fever. Goats are susceptible for disease during monsoon so extra care is required. To maintain welfare during extreme seasons, provide proper shelter, dry bedding, dry feed and clean water.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Welfare Issues in Feeding of Goats

Feeding is another important factor which affects goat production as well as welfare. Grazing goats are found to be nutritionally stressed, while high lactating goat of an organized farm could be nutritionally imbalanced as well. Nutrition requirement increase during pregnancy and lactation specially in females carrying twins. Goats reared under extensive system faces nutritional stress when there is no quality forage during extreme summer and cold. The welfare issues in feeding are

Late Colostrum Feeding

Colostrum is first milk produced after kidding. Colostrum contains immunoglobulins, rich in nutrients and act as laxative which helps to pass meconium. Colostrum feeding transfers antibodies from mother to kid, which helps in development of immunity. Late colostrum feeding cause poor transmission of antibodies from mother to kid. Within half to one hour after birth, colostrum should be provided to kid. Teats should be washed with lukewarm water or water containing potassium permanganate. If colostrum is not available from mother preserved kid should be fed with preserved colostrum or other doe's colostrum. Kids improperly fed with colostrum are found with hunger, hypothermia and respiratory problems.

Unbalanced Diet and Nutrient Deficient Feed and Fodder

The grazing lands are either degraded or encroached leading to restriction on grazing. Nutrient deficient and unbalanced diets induce metabolic disease like pregnancy toxaemia, ruminal imbalance and ultimately leads to compromise in welfare as well as decreased production. Pregnant does with improper nutrition affects foetal growth, offspring vigour and decreased milk production after birth and mortality of young ones.

Poor Quality Water

Goats should be provided with clean and fresh drinking water with 24-hour availability. Goats require at least 18 litre of water daily, it may vary with season, lactation and forage consumed. Less availability of water or reduced water intake cause less feed consumption which in result affect body weight gain. It is generally seen that ponds are major source of water for various flock in rural areas, goats drinking water from ponds were found to be infected with parasitic disease.

Grazing Management

Goats should be grazed on well-maintained pasture lands with rotation. Grazing should be avoided in extreme parts of day during summer. Seasonal movement, improper feed and parasitic infection affects weight gain in goats and cause mortality. Welfare issues during grazing are injury from barbed wires, penetration of hoof by nails, bruises on skin, eating plastic may cause choke.

Welfare Issues in Goat Breeding

Breeding is major aspect of sustainable livestock production, breeding is important for getting new progeny/young stock and products like milk. Breeding is also important for a species to sustain themselves in ecosystem. The welfare issues related to breeding are described below.

Indiscriminate Breeding

Breeding has been practiced from many years for animal products to gain income. Sometimes due to lack of knowledge farmers select animals of different breed (small females and large

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

males) for mating. This cause problems during parturition (dystocia) and goats suffer from severe stress.

Castration

Castration in male kid is practiced to make them less aggressive, to prevent unwanted mating and to avoid aversive flavour in meat. Castration can be performed by various methods like applying rubber band to scrotum, by burdizzo castrator and sometimes by surgical process. Although castration is practiced to improve welfare but process of castration induces severe pain. To avoid painful process surgical method should be adopted with use of anaesthesia and post operative care.

Welfare Issues in Health Management

Freedom from pain, injury and disease is one of the five freedoms. To achieve this freedom several measures should be adopted like vaccination against FMD, PPR and Enterotoxaemia, early disease diagnosis, timely and adequate treatment of disease. Welfare issues in health care are described below

Poor Prophylaxis

Prophylaxis simply means that measures adopted to prevent occurrence of disease. It can be achieved by use of antibiotics or vaccines. Lack of knowledge and more economic burden is major cause that prevents adoption of prophylaxis in extensively as well as intensively reared herds. Deworming, dipping and vaccination are the major prophylactic measures that should be adopted by goat rearers. Adoption of these measure helps to achieve freedom from pain injury and disease.

High Neonatal Mortality

Death of newly born kids is very common due to improper feeding of dam. Low nutritional status of dam during last month leads to pregnancy toxaemia which leads to stillbirth or mortality after birth. Improper management of kids during first week after parturition may leads to pneumonia, which cause mortality of kids. Neonatal mortality can be prevented by providing dams by good quality feed during advanced pregnancy, maintaining dams in clean and hygienic kidding shed during parturition and ensuring early colostrum feeding.

Other Welfare Issues

In this portion other welfare issues are discussed which are generally seen in goats

Tail Docking

Hind quarters of goats are generally warm and moist this attracts flies to lay egg there. When the eggs of flies hatch, maggots eat flesh of goats this cause severe pain to goats. To decrease the chances of flystrike and keep hind quarters cleaner (specially in fiber producing breeds), tail of goats is removed without proper surgical process and this cause severe pain to animal. To minimise the pain and improve the welfare it is suggested to avoid tail docking and adopt good managemental practices to avoid flystrike and if tail docking is adopted proper surgery including anaesthesia, analgesia and post-operative care should be method.

Clipping

Welfare issues in clipping is generally seen in fiber producing goats. Clipping is removal of hairs from skin of goat. Clipping can be done by hand clippers or machine clippers based upon number of animals and availability of resources. Goats are clipped twice a year and

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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famous fiber produced by goats is "pashmina". Goat herds which are extensively reared mainly depends upon hand clipping. The process of obtaining pashmina is very stressful and painful, in this metal comb with sharp teeth is combed in their hairs during moulting period(spring). This process of collection is welfare issue as it includes tying all four legs of goat and this process may take upto 1 hour. Improper handling and inability to move cause severe stress to goats. The sharp metallic teeths of comb cause injury to goats hence welfare of goats is compromised.

Transportation

Goats are transported from place to place for various purpose viz., grazing, slaughterhouses and marketing purposes. Flocks reared under extensive system travels by foot daily in search of quality grazing material. There are various modes of transportation that are by foot, road, rail and ships. Usually, common methods of transportation are by foot and road. Traditionally goats were transported by feet but with increasing commercialization transportation from road is increasing. During long transportation goats may suffer from severe discomfort due to lack of proper space, ventilation and feed and water. There should be proper space, ventilation and arrangement of feed and water for each animal during transportation. Transportation of sheep and goats is discussed in Chapter 6 of the Transport of Animals, Rules, 1978.Some norms related to transportation are provided in table 3.5.3

Table 4 Presenting Norms of Transportation by Road and Rail

Space requirement for goats by road		
Average body weight (Kg)		**Space requirement (m^2)**
Below 20		0.18
Between 20-25		0.20
Between 25-30		0.23
More than 30		0.28
Space requirement for goats by rail		
Broad Guage	Area of wagon less than 21.1 m^2	70 animals
	Area of wagon more than 21.1 m^2	100 animals
Meter Guage	Area of wagon less than 12.5 m^2	50 animals
	Area of wagon more than 12.5 m^2	60 animals
Narrow Guage	-	25 animals

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Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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CHAPTER – 6

Reproduction in Goats

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ABSTRACT

Goats are known to be first domesticated animals among ruminants. Goats are reared all over the world for meat, milk and fiber. India ranks second among globe in goat population with 148.88 million goats. There are 37 registered goat breeds in India which are contributing in different products. Goat is an additional source of income and provide nutritional security to small, marginal and landless farmers. Goats are hardy, low maintenance, multi-utility, and prolific animals which efficiently converts poor quality feed resources into useful nutritive products. The production in terms of meat and milk directly depends upon reproductive cycle. Reproduction is an important aspect of production; regular reproduction is necessary for maximum production. This chapter highlights basic as well as advanced technologies of goat reproduction. Starting from reproductive organs, estrus cycle, hormonal intervention in estrus cycle and estrus detection this chapter travels to advance technologies like Multiple ovulation and embryo transfer and artificial insemination through system of mating and measures of reproductive performance, gestation and parturition.

***Key words**: Reproduction, Goat, Estrus cycle, Reproductive biotechnology.*

INTRODUCTION

The term reproduction is defined as producing/giving birth to offspring. The capacity of species to reproduce is crucial for its existence. Reproduction is a series of events which starts from formation of gametes, reproductive behaviour, mating of gametes, gestation, parturition and terminates after viable offspring born. Reproduction is a complex process which is vital for all organisms.Goats are distinct species of family Bovidae which were domesticated earliest for milk, meat and fiber. The maximum population of small ruminants is found in developing countries because of their features like they require less feed, reproduce early and easy to manage. Understanding reproduction is essential for reproductive management since it affects many elements of goat productivity. High reproductive efficiency is desired for:

- Continuation of species
- Production of milk, meat and fiber
- Replacement of breeding stock

Role of male and female in reproduction is different, good quality parents are required for healthy and constructive offspring. Female plays an important role during reproductive cycles as well as after birth in terms of post-natal care and nourishment of young ones. In this chapter we will discuss bout major reproductive events and reproductive advancements.

Reproductive Organs and their Function

Male and female reproductive organs of goat are described in table 1.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Table 1. Reproductive organs of male and female along with functions

Female Reproductive Organ	
Name of Organ	***Functions***
Ovary	*contain ova and secrete female reproductive hormones (progesterone and estrogen)*
Oviduct	*collection of ova from ovary (infundibulum), fertilization (ampullary isthmic junction), transport embryo to uterus*
Uterus	*provide environment for foetal development, supports foetal development, transport foetus during birth*
Cervix	*gateway to uterus, transports spermatozoa, cervical plug make cervix impermeable to bacteria and spermatozoa during pregnancy*
Vagina	*exterior part of female reproductive tract, site of semen deposition during natural mating*
Vulva	*provide barrier and protection to female reproductive tract*
Male Reproductive Organ	
Name of Organ	***Functions***
Testes	*paired organ responsible for production of spermatozoa and testosterone hormone*
Scrotum	*muscular sac containing testes, helps in thermoregulation of testes*
Epididymis	*located in testes, storage and maturation of spermatozoa, matured spermatozoa stored in tail of epididymis*
Vas deferens	*join epididymis and urethra, also known as spermatic cord*
Assessory sex glands	*bulbo-urethral, prostate, seminal vesicle glands and the ampulla, these provide supportive secretions (fructose, alkali) to make semen*
Penis	*external genitalia, deposit semen in female reproductive tract*

Puberty and Age of Sexual Maturation

Puberty is defined as the age at which animal is capable of reproduction i.e., in females first ovulation and in male first spermatozoa in ejaculate. Puberty does not mean that animals are fit for reproduction. Age at which animal shows full reproductive capacity is considered as age of sexual maturity. Does attain puberty at age of 5-7 months. In most of goat breeds attaining puberty is associated with body weight, usually between 40-70% of mature body weight.

In buck puberty is associated with increase in testosterone secretion, spermatogenesis and mating behaviour, at the age of 8-10 weeks and body weight of 16-20 kg increase in testicular size starts. This is accompanied by the development of primary spermatocytes and an expansion of the seminiferous tubules. At 4 to 6 months of age, male undergo copulation with the ejection of viable spermatozoa, at this stage buck have live weight between 40 and 60 % of mature weight. However, it could take up to 15 months for a kid to attain complete reproductive capability.

Factors affecting puberty: Nutrition, genetic, environment, time of birth, breed, bodyweight. Nutrition is considered as significant factor which majorly affects the onset of puberty.

Critical body weight: It is considered as minimum desirable body weight of female at time of breeding to avoid abortion and growth retardation. Generally critical body weight is considered as two-third of mature body weight.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Estrus Cycle of Goat

Estrus cycle is reproductive cycle of female mammals (except primates) which is caused by hormonal change and prepares body for reproduction. Estrus cycle is number of days between two consecutive estrus (heat). The length of estrus in doe is 21 days. Estrus cycle is divided in 2 phases-

Follicular phase: growth of follicles, ovulation

Luteal phase: formation of corpus luteum

Another classification divide estrus in four phases namely proestrus, estrus, metestrus and diestrus. A discussion of estrus phase has been provided in Table 2.

Table 2. Phases of Goat Estrus Cycle

S.no	Stage	Length in days	Characters
01	Estrus	1-2	Females are ready for sexual receptivity Cervical and vaginal mucus discharge Hypermia and swelling in vulva Mucus become cloudy towards ovulation Ovulation occur during this phase
02	Metestrus	3-4	Formation of corpus luteum to maintain the pregnancy
03	Diestrus	5-18	Regression of corpus luteum initiates
04	Proestrus	19-21	Initiation of new follicular growth

Duration of estrus in doe is 24-48 hour. Age, breed, season, presence of buck also influences duration of estrus. Goats breeds producing fiber (angora) have shorter estrus (22 hr) than dairy goat breeds. Shorter estrus is observed at starting and end of breeding season, in first breeding season of does and in presence of buck. In many goat breeds two or more ova are released in estrus. Rate of ovulation increase with ageand it is generally higher in starting of breeding season, maximum rate of ovulation is observed at age of 3-6 years. Body weight, body condition and genotype also account to increase ovulation rate. It is found in different study that right ovary releases more ova than left ovary during estrus in goats. Season and nutritional level of animal are important environmental factor affecting rate of ovulation.

Detection of Estrus

Detection of estrus become important if mating is controlled or artificial insemination (AI) is adopted. Estrus can be detected through behavioural signs as well as some techniques when there is no one to observe the behavioural signs.

Behavioural Signs

Bleating, flagging of tail, swollen and red vulva, frequent urination, restlessness, mounting on other animals, mucus discharge from cervix. It is not necessary that every animal exhibit behavioural estrus signs. The best method of estrus detection is when female (doe) stands for being mounted. This is called as “standing heat”.

Estrus Detection Techniques

It is easy to detect estrus by behavioural signs in small ruminants (sheep and goats) than large ruminants (cattle and buffalo) as behavioural signs are more pronounced in small ruminants

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particularly in goat. In commercial farms where controlled mating or Artificial insemination is adopted, estrus detection is important for selective mating.

- Using teaser male: buck which is vasectomised.
- Using teaser male with marking harness: A harness is tied to male, whenever he mounts the female, it releases marking dye on rump of female.
- Using of aprons made of either leather or canvas are tied on male which prevent penetration of penis into vagina. Care should be taken as sometimes apron slips and penetration occurs which may lead to unwanted pregnancies.

Hormonal Intervention in Estrus Cycle

Estrus cycle of doe is regulated by various sequential hormonal intervention. Gonadotrophic releasing hormone (GnRH) control estrus cycle which is released by hypothalamus of brain. GnRH stimulates pituitary gland before onset of estrus, in response pituitary gland starts to increase secretion of Luteinising hormone(LH) and Follicular stimulating hormone(FSH). Both the hormones (FSH&LH) are responsible for follicular growth. LH stimulates the final maturation of the follicle containing the eggs (oocytes) and stimulates the follicle to produce the hormone estrogen. The hormone estrogen is responsible for visible heat behaviour. Rising concentration of estrogen hormone is responsible for LH surge. The mature follicles rupture by LH surge hence ovulation occurs and estrogen secretion from follicles ceases. After ovulation LH transforms follicle into corpus luteum(CL) which secrete hormone progesterone which is necessary to maintain pregnancy as well as it supresses the activity of pituitary and decreases the level of FSH & LH. In case if pregnancy not occur, CL is destructed by prostaglandin released by uterus. This cause decrease in level of progesterone hence initiates new reproductive cycle.

Mating Systems

After attaining sexual maturity both sexes show characteristic behaviour before mating, and try to mate. Smell, sight and noise are the common attractants. There is different type of mating practiced among India depending upon production systems-

Flock Mating: This method of mating is adopted by pastoralist system or extensive system in which fertile male is kept continuously with flock of female. In this system of mating heat detection is not necessary. In this mating system recording of mating date, sire, expected date of parturition are difficult to record unless breeding males are fitted with marking harness. Sometimes male mounts female as a normal behaviour this should not be confused with mating. Appropriate male to female ratio for flock mating is 1:20-25. Flock mating provides best result in terms of fertility when male female ratio kept appropriate, if male female ratio becomes unbalanced it may lead to over-exhaustion of male leading to compromise with body condition of male. Inbreeding and decrease in productivity has been observed in flocks practising flock mating if breeding males are not replaced in predefined period.

Pen Mating: In this method a sire is confined with group of females/individual females in pen or paddock. Continuous monitoring is essential in this type of mating, if assigned male can not perform well it should be changed. In this method marking harness are used for estimating the date of parturition.

Hand Mating: In this system of mating females in heat are identified and bring with male for mating. In this type of mating AM-PM method is used i.e., females detected with heat in afternoon are mated next day morning and females detected with heat in morning are mated

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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same day afternoon. Heat detection is very important in hand mating as mating only depends upon heat detection. This method is least efficient in terms of fertility as sire is only restricted with breeding of female.

Measures of Reproductive Performance

Reproductive performance majorly influences small ruminant production. Enhancement in production can be achieved by managing reproduction and breeding efficiently. Major reproductive performance considered in small ruminants are: age of puberty, age at first parturition, parturition interval, post-partum interval and fertility indices.

Age at Puberty: Age at puberty is not an obvious parameter which is same for all animals, it varies among individuals. There are many parameters which affects onset of puberty including genetic, nutritional and environmental. Age at puberty is considered as first behavioural estrus observed. Early puberty is desired so that animal starts production early.

Age at First Parturition: This can be easily recorded in flocks, it is the age at which female first parturates. Age at first parturition varies among flock and different production systems. It is observed that animals living in harsh environment parturate late.

Post-partum Interval: Post partum interval (PPI) is period between parturition to resumption of normal ovarian cyclicity and is major component of kidding interval. It has major role in production efficiency. In Somali goats it is estimated as 83.5 days (51-133). This trait is affected by nutrition, suckling, parity (number of times kidded) and breed. Generally ovarian cyclicity ceases after parturition as energy is utilized in milk production for offspring, this is called as lactational anestrus. Does parturated in dry season have longer PPI compared to those parturated in rainy season. Does in earlier parity takes more time to return in reproductive stage compared to older ones.

Parturition Interval: The interval between two successive parturition is called as parturition interval. In goat it is called as kidding interval. Average gestation period of goat is 150 days (147-152), but it may vary among breeds.Goats bred in the summer experienced longer gestation period than goats bred in the autumn. Gestation period decreases as parity increases. In normal environmental conditions tropical goats should parturate three times in every two years, for this realization kidding interval should not be exceed 8 months (245 days). Parturition interval is directly affected by post-partum interval, short parturition interval is desired for optimum reproductive performance hence accelerated kidding, early weaning and better nutritional supplementation can help in decreasing parturition interval.

Fertility: General definition of fertility is provided in form of formula

$$\frac{\textit{Number of does parturated}}{\textit{Number of does mated}}$$

Fertility depends upon age, disease, nutrition and season of mating. Supplementation during mating phase in females showed positive effects in number of ova released and embryo survival. This practice is termed as “flushing”. Fertility also depends upon age of doe; it increases with age upto certain age after that it declines with older age.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Litter Size: Litter size is number of offspring produced by animal in one birth. Litter size varies with breed. It is the combination of ovulation rate and embryo survival. Litter size increases with parity until fifth kidding. There is a positive correlation of litter size with age and parity. Litter size in does lies between 1.08-1.75 (1.38) while other research states that in sheep, the average litter size is 1.23, while for goats it is 1.47. One kg weight gain of does over population mean prior to mating results increase in litter size by 3.8%. Goats reared in pastoral system have lower litter size (one) due to negative selection.

Annual Productive Rate: The number of kids weaned per doe of reproductive age each year is what is termed as annual productive rate. Instead of using the litter size at weaning, some authors utilise the litter size at birth. The former is favoured because it takes into account the dam's capacity for mothering.
These traits either single or in combination can be used to judge the reproductive performance of doe.

Season of Breeding and Off-season Breeding
Goats are considered as spontaneous ovulating, seasonal polyestrus animal. Reproduction in goat is affected by various factors, it includes climate, latitude, breed, breeding system, physiological stage, presence of male and photoperiod. Goat reproduction is said to be seasonal in temperate regions, where breeding taking place in the autumn and winter with significant variations in seasonality between breeds and places. In tropical locales, goats are thought of being continuous breeders, however limited food supply frequently results in prolonged anoestrous and ovulatory periods as well as decreased fertility and prolificacy.

Goats reared in tropical regions display non-seasonality/weak seasonality in reproduction. In contrast goats of subtropical and temperate regions have a seasonal pattern of reproduction, ensuring that the kids are born in late winter and early spring in moderate to high latitudes, when pasture availability is at its best. Goats start ovulating in the late summer or early autumn because they are resistant to long days, and they become anoestric in the late winter or early spring. Male have a decline in spermatogenic activity around the same time of year. As a result, there is a seasonal pattern in mating and parturition, in the production of milk and meat, and in the distribution of prices. In the 1970s, 'out-of-season' breeding was started in order to facilitate spring mating and subsequent autumn births, thereby supplying meat and milk for the winter markets. Off-season breeding was aided by use of exogenous hormones like progesterone analogues, equine chorionic gonadotrophin (eCG), controlled lighting and exposure to male. The use of exogenous hormone allowed the development of artificial insemination(AI) and advanced reproductive technologies in goats. Multiple ovulation and embryo transfer were major technologies which evolved after introduction of off-season breeding concept. The advancement in reproductive technology like in-vivo embryo production and in-vitro maturation, in-vitro fertilization and in-vitro culture contributed majorly in genetic improvement of flocks but these are not universally applied.

Reproductive Biotechnology
Term Reproductive biotechnology here means the application of reproductive biology in livestock production. In livestock production, different techniques of reproductive biotechnology are used to improve the reproductive insufficiency of animals through estrus synchronization, artificial insemination, cloning, , embryo transfer, transgenesis and in-vitro fertilization.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Estrus Synchronization

Estrus synchronization is the technique of coordinating the reproductive cycle in animalsby strategically-timed administration of one or a combination of exogenous hormones such as prostaglandin, progesterone and gonadotropin-releasing hormone (GnRH). Reproductive efficiency of animals is improved by synchronizing the estrus cycle to cause the majority of goats to show standing heat around same time. This allows for more efficient breeding by artificial insemination and tighter kidding intervals, which creates a more uniform group of kids to market at time of weaning. Estrus in goat is synchronized for following reason:

- To practice artificial insemination or to reduce number of bucks to be kept
- To match time of kidding with feed availability
- Used as initial step for super-ovulating does for embryo transfer.
- To induce estrus in does which shows silent estrus

There are two techniques for estrus synchronization

a. Use of Exogenous Synthetic Hormones

Among reproductive hormones, progesterone is considered as organizer of estrus cycle. Manipulating the progesterone level of animal provide convenient mean of controlling estrus. Estrus synchronization techniques include artificial increase or decrease in progesterone dominance during luteal phase. There are two classes of hormones which are available for estrus synchronization, first one is progesterone or its synthetic analogues other is prostaglandin. Progestagens are responsible for extension of luteal phase. Vaginal pessaries, Y-shaped devices called as "Controlled Internal Drug Release"(CIDR) and implants are available which can be used in estrus synchronization. Vaginal pessaries are most commonly used among these aids. CIDR are silicone coated Y-shaped devices which are saturated with progesterone. Implants contain more potent synthetic progesterone analogue (Norgestomate), which can be applied on ear or inserted sub-cutaneous. The application of external progesterone is equal to life of corpus luteum. When exogeneous progesterone is removed it provokes release of GnRH, which stimulates release of FSH and LH leading to folliculogenesis, estrus and ovulation.

Prostaglandins are second class of hormone; it is used to supress the corpus luteum. $PGF_{2\alpha}$has luteolytic effect, synchronize estrus only when functional corpus luteum exists at time of administration. In most of the cases $PGF_{2\alpha}$ is administered twice 7 or 11 days apart to regress all functional corpus luteum.

b. Male effect

The buck can be used to stimulate estrus activity of does which have not been exposed to males from 3-4 weeks. After keeping male and female separate for 3-4 weeks, sudden introduction of male in group of females cause increased secretion of FSH and LH which cause ovulation after 2-3 days of introduction. Some females of group show late response, it may take 4-7 days to ovulate in such females. Highest frequency of estrus was seen within 3 days after introduction of buck in group of cyclic goats. Response to male introduction is affected by following factors:

- Within breedsbucks havingmore sexual activity induce estrus in more does.
- Bucks with higher libido induce estrus more effectively compared to males of low libido.
- Does with good level of nutrition responds better than nutritionally stressed does.
- The does respond better the longer the kids have been weaned from the does.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Artificial Insemination

Artificial is a reproductive technique in which semen is collected from male and introduced in female reproductive tract. Standard process of inseminating doe is lifting the doe by rear legs with front limbs on ground. The cervical opening is located with help of speculum and pen light, with visual control insemination pipette is passed into cervix where semen is deposited, if pipette cannotpass through the cervix semen can be deposited at 'os'/cervical opening.

Advantage of Artificial Insemination (AI)

- Ability to check semen quality before breeding
- Control of reproductive disease
- Eliminate aggressive behaviour of dam/sire during breeding
- Ability to produce more offspring
- Safety of animals as well as producers
- High potential of genetic improvement
- Frozen semen of superior animals from other part of world/country is easier to bring than animals.

Semen can be preserved in following ways depending upon utility

Fresh - When male is present in flock, fresh semen is used for insemination.

Refrigerated semen- In this technique the semen is chilled with semen extender. This semen is used when there is a single ram used among group of farmers located at small area. In this type of preservation semen is stored at -4°C and used within 24 hours of collection.

Frozen semen- In this method semen is collected and processed, after that it is stored in -96°C.

Thumb rule about preserved semen is that more the semen is damaged more deeper it should be deposited to achieve high fertility. Insemination of semen in vagina is successful for freshly collected semen while refrigerated and frozen semen should be deposited in intra-cervical or intra-uterine. In some animals it is difficult to penetrate cervix and deposit semen in uterus, in such cases either semen is deposited at cervical opening or more technically advanced techniques like intrauterine laparoscopic insemination is used.

Multiple Ovulation and Embryo Transfer

Technologies including Multiple ovulation and embryo transfer (MOET) are the fastest way of genetic improvement in sheep and goats. This technique comprise two steps first is super ovulation (production of more ova in reproductive cycle than normal) and other is embryo transfer. Genetically superior dams are selected and superovulation in induced using FSH or eCG hormones. FSH protocol is most commonly used for super ovulation, it includes synchronization of estrus using progesterone followed by administration of FSH. Once ova are released,dams are inseminated. Embryo transfer includes removal of ova (flushing) from donor and transfer to recipient. The estrus cycle of donor and recipient females are synchronized at same stage otherwise recipient not conceive the embryo.

MOET is not widespread used as its result varies from complete failure to completely successful irrespective of same protocol. Unpredictable results, high cost and surgical process for collection and transfer of embryo limited widespread use of MOET in goat improvement programmes.

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Pregnancy Detection and Gestation

Pregnancy detection is necessary to find whether animal successfully bred or not, as well as important for economic aspect. The tests that identify something that is only produced by a viable foetus, that is always present once the animal is pregnant and reached a specific stage are the most accurate. Pregnancy can be detected by following methods

Non-return to Estrus- Checking of does after 21 days of mating for visual signs of estrus is simplest way to check pregnancy, animals not showing estrus signs are considered as pregnant.

Progesterone Test- Progesterone is important hormone required to maintain pregnancy hence blood or milk progesterone level can be checked. Although progesterone is secreted by only ovaries in goat, estimation of progesterone after 19-24 days of mating provide 87% accuracy for pregnant animals.

Ultrasonography-Ultrasonography is a medical imaging technique which use high frequency waves to produce internal organ images. It is used to monitor the development of foetus. Intra-rectal ultrasonography for pregnancy detection can be done at 28-30 days while trans-abdominal ultrasonography can be done at 40 days after breeding.

Gestation period refers to time period from date of mating to date of parturition. In goats gestation period varies from 147 to 152 days. Gestation period depends upon following factors:

- ***Breed***- short breeds have shorter gestation period
- ***Nutrition level of doe***- poor nutrition shortens gestation
- ***Litter size***- does carrying twins have comparatively shorter gestation than does carrying singles
- ***Age of doe***- younger females have shorter gestation length

Parturition

Parturition is process of expulsion of foetus from uterus. In other words, it is act of giving birth in goats act of parturition is termed as Kidding.Twin birth are more rapid than single ones but time between delivery of twins varies from few minutes to hours.This process is initiated by several hormonal changes, in goats progesterone decreases before 24 hours of delivery with gradual increase in estrogen. The sudden change in hormonal activity is responsible for contraction of uterine muscles, after foetal and placental expulsion uterus shrinks to its normal size (involution). Signs like swelling of teats and udder, loosening of vulva can be noticed in females before 2 weeks of parturition.Parturition completes in three stages first is dilation of cervix, second is expulsion of foetus third is expulsion of placenta. The signs observed during these stages are described below-

Stage I- This stage starts 12 hours before expulsion of foetus. In this stage doe isolate herself from flock, become restless, scratches ground by paws, frequently sit and stand up, forces uterine content to dilate cervix, water bag appears or rupture and doe licks the fluid and roams around it.

Stage II- This stage lasts for 30-40 minutes, female lies in lateral side, contraction in abdominal muscles can be seen, mouth and forelimbs of foetus can be seen, this stage is completed by expulsion of foetus, when kid comes out dam lick off the membrane which uncovers the mouth and nose of kid and stimulates respiration.

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Stage III- Expulsion of placenta within 4-6 hours of birth, involution of uterus. Majority of does parturate without any assistance but some may need help.

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CHAPTER – 7

Herbal Remedies for Ailments in Goats

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ABSTRACT

Herbal medicines have been used to treat various diseases since antiquity. Indian peninsula harbours enormous plants and its rich biodiversity is known through nook and corner of the globe. Folklore or traditional medicines are bestowed with many pharmacological properties that have shown proven results in various instances. This has made scientist to take keen interest in exploring these Indian folklore systems. Knowing the how about of herbal medicine is the most sought for alternative to the allopathic medicine system which brings with them many undesired side effects along with the desired therapeutic effects. Also, the allopathic medicines are often out of reach of rural farmers rendering treatments difficult. Goat industry plays a pivotal role in socio-economic development, especially in country like India where half of the population are associated with agriculture and allied sector. Goat industry can be a boon to the socio-economic fabric of Indian population if reared scientifically as it requires little input. However, ailments limit their productivity and prevent the farmers from tapping their full potential. Folklores, here, can be seen as a solution to enhance the productivity as it is a cost-effective system where one can make use of the locally available resources to treat various ailment and hence, minimise the input and maximise the benefits. Aloe ferox, Bulbia latifolia, Acokanthera oppositifolia, Elephantorrhiza elephantia, Albacus setose, Gunerra perpensa, Centella coriacea, Cussonia spicata are some of the plants that have shown effective results against a plethora of internal and external parasites like helminths, ticks and mites in field conditions. Different parts of the plants such as, leaves, roots, tubers and barks are used for preparing the remedies. Plant parts are often prepared as decoction or infusion in order to administer to the disease affected animals. Decoction is the process of boiling part or the plant in question in water for a few minutes. It involves extracting polar compounds soluble in water and the high temperature so employed destroys the thermo labile toxic constituents that may be harmful for the subject. Plant extracts can be mixed with non- plant materials like epsom salts, flour, potassium permanganate, rock salt and oil cakes. Herbal recipes are employed to treat diseases like bloat, foot rot and food poisoning which are commonly encountered in goats. Cuminum cyminum Linn. (Zeera),Citrus limon (Linn.) Burm. (Nimbu), Tracchyspermum ammi (Linn.) Sprague (Ajwain) are reported to cure agalactia, tympanitis and constipation respectively. Azadirachta indica A. Juss. (Neem) cures bovicolasis, Allium sativum Linn. (Lahsun) cures diarrhoea, Cicer arietinum Linn. (Gram) cures dysentery, Trigonella foenum-graceum Linn. (Maithi) cures FMD, Brassica campestris Linn. (Sarson) cures foot rot, Ficus religiosa Linn. (Peepal) cures fracture, Buchanania lanzan Spreng (Chironji) cures hyperthermia, Azadirachta indica A. Juss (Neem) cures injury. Many solutions to the problems clanged to the livestock sector can be found in the nature itself. India, a melting plot of biodiversities is a paradise for the folklore system of medicine to prevail. However, this can be better put to use once they are documented. Documentation of traditional medicines will curtail half of the problems faced by the farmers worldwide.

***Keywords**: Herbal medicine, folklore, goat, ailments, decoction.*

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INTRODUCTION

Goat industry plays a pivotal role in rural settings where socio-economic development is at its initial stage and poverty has been creeping into the society owing to rural-urban disparity. In a country like India, where half of the population are associated with agriculture and allied sector, goat industry can be regarded as a tangible asset. Goat is often called as poor man's cow which unveils the fact that rearing goat requires minimum input. Goat industry can be a boon to the socio-economic fabric of Indian population if reared scientifically as it requires little initial cost. It's central in the present scenario as it can serve as an impetus to the dwindling economy which was hit hard by the dramatic pandemic. Not only it requires minimum labour and initial costs, it is quite beneficial from the perspective of human nutrition as it is rich in essential minerals and vitamins that are vital for human growth and development. Albeit, ailments limit their productivity and prevent the farmers from tapping their full potential and make them incur losses in their farming; thus, generating lesser income than usual. Folklores, here, can be seen as a solution to enhance the productivity as it is a cost-effective system where one can make use of the locally available resources to treat various ailments and hence, minimize the input and maximize the benefits. Indian folklore system has provided treatment for various diseases since antiquity. Indian history glorifies herbal medicinal system at large. Various Indian scriptures mention about traditional medicinal system of India. Atharva Veda is regarded as a repository of traditional medicine which also includes prescription for animals. Charak samhita, the treatise on Indian medicine mentions about many herbal remedies. The peninsula harbours wide genera of flora that are bestowed with medicinal properties. Herbal recipes are bestowed with many pharmacological properties that have shown proven results in various instances. This has triggered scientists to take keen interest to explore these herbs and to use them for the benefit of the mankind across the length and breadth of the globe. Knowing the how about of herbal medicine is the most sought for alternative to the allopathic medicine system which brings with them many undesired side effects along with the desired therapeutic effects. Also, the allopathic medicines are often out of reach of rural farmers rendering treatments difficult. Herbal medicine is not only considered safe, but it is also cheap and often found in our vicinity.

Ailments in Goat that can be cured with Herbal Remedies

Agalactia

Agalactia is a condition marked by absence of milk in milk producing animals. Contagious agalactia is a highly infectious disease of sheep and goats which has been included in the List B of dangerous infections issued by the International Office International des Epizooties. The major causative agent of the disease in both sheep and goat is Mycoplasma agalactiae. While in goats, the disease can also be ascribed to Mycoplasma mycoides subsp. Mycoides large colony type (LC). Agalactia in goat can be cured with Zeera (*Cuminum cyminum* Linn.). *Cuminum cyminum* belongs to the family Apiaceae. For treating agalactia, 100g zeera is mixed with 200g of jiggery and given for 3-4 days.

Bloat (Tympanitis)

Bloat is a disease of ruminants which results either due to excessive production of gas or physical obstruction of the process of eructation of gas. It can also be defined as a clinical condition where rumen and reticulum are filled with gases of fermentation due to excessive intake of easily fermentable foods. Bloat or Tympanitis can be treated with a mixture containing nimbu (*Citrus limon* Linn. Burm. f.,) and babool (*Acacia nilotica* Linn. Wild. Ex Delile subsp. *indica* (Benth.)). Nimbu belongs to the family Rutaceae and babool belongs to

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the family Mimosaceae. The preparation is made by mixing 100 g of neem leaves and 100 g of babool leaves with baking soda. The mixture should be given daily for 3 days.

Constipation

Constipation can be defined as a pathological state where there is difficult or infrequent passage of hard faeces. Faeces become dry and hard and excessive straining is required for defecation. Constipation can be treated with a preparation containing ajwain (*Trachyspermum ammi* Linn. Sprague), pamar (*Cassia tora* Linn.), maithi (*Trigonella foenum-graceum* Linn.), kali mirch (*Piper nigrum* Linn.), zeera (*Cuminum cyminum* Linn.) and heng (*Ferula asafoetida* Linn.). Ajwain, zeera and heng belongs to family Apiceae. Pamar, maithi and kali mirch belongs to the families Caesalpiniaceae, Fabaceae and Piperaceae respectively. For treating a preparation is a made by mixing 50 g of T. ammi, 50 g of C. tora, 50g of T. foenum-graceum, 50g of P. nigrum, 50 g of C. cyminum, 10 g of F. Asafoetida and 50g of black salt in the form of pills. The pill is to be given for 5 days.

Bovicolasis

Bovicolasis is a highly infectious disease caused by Goat fur eaters, that is, Bovicola caprae, which are small wingless insects. Bovicolasis can be treated with neem (*Azadirachta indica* A. Juss.). Neem belongs to the family Meliaceae. Leaf paste of neem is rubbed over affected area for 3-4 days in order to obtain the desired therapeutic effect.

Diarrhoea

Diarrhoea can be defined as the process of frequent defecation of fluid or semi-fluid faeces. Diarrhoea can be treated with Lahsun (*Alium sativum* Linn.). Lahsun belongs to the family Liliaceae. For treating diarrhoea, 5-6 bulbs of lahsun can be fried in mustad oil and given for 3-4 days.

Dysentry

Dysentry is an intestinal infection that causes diarrhoea containing blood or mucus, stomach cramps, nausea, vomiting and fever. Dysentry can be treated with gram (*Cicer arietinum* Linn.). It belongs to the family Fabaceae. For treating dysentery 200g of gram flour is dissolved in butter milk and is given for 2-3 days.

Food Poisoning

In goat, food poisoning can be treated with Lahsun (*Alium sativum* Linn.). Lahsun belongs to the family Liliaceae. For treating food poisoning, three bulbs of *A. sativum* boiled in mustard oil as well as ash of cow dung cake dissolved in one litre of butter milk or curd is given.

Foot and Mouth Disease

Foot and mouth disease is an acute febrile highly contagious disease of cloven-footed animals which is characterised by vesicular eruptions in the epithelium of buccal cavity, tongue, nose, muzzle, feat, tear and udder lesions. However, lesions may also appear in the rumen pillar. Foot and mouth disease in Caprine species can be treated with maithi (*Trigonella foenum-graceum* Linn) and ajwain (*Trachyspermum ammi* Linn. Sprague). Maithi belongs to the family Fabaceae and Ajwain belongs to the family Apiaceae. For treating foot and mouth disease, fifty gram of *T. foenum-graceum* and 10g of *T. ammi* is mixed with 100g of jiggery in the form of balls. This should be administered to the affected goat for a period of 3 days to obtain the desired therapeutic results.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Foot rot
Foot rot is an infectious disease caused by *Spherophorus necrophorus* characterised by inflammation, necrosis and ulceration of the inter-digital spaces, coronary bands and posterior limbs resulting in lameness. Foot rot in goat can be treated with sarson (*Brassica campestris* Linn.). *Brassica campestris* belongs to the family Brassicaceae. For treating foot rot, ash of cycle tyre is mixed with mustard oil. The mixture is then applied over the lesion for a period of at least 2 days in order to get the desired pharmacological response and total healing of the foot rot lesions.

Fracture
A bone fracture is a full or partial break in the continuity of bone tissues leading to pain, swelling and immobility of the affected part. Fracture can be treated with Peepal leaves (*Ficus religiosa* Linn.). Peepal belongs to the family Moraceae. For treating fracture in goat, soft leaves of *Ficus religiosa* mixed with 250 g of jaggery is given.

Hyperthermia
Hyperthemia in common parlance is known as over-heating. It results due to retention of excess heat, a consequence due to disturbed thermoregulation and impeded heat elimination into the surrounding environment. Hyperthermia can be treated with chironji (*Buchanania lanzan* Spreng). Chironji belongs to the family Anacardiaceae. Decoction of 100g of Chironji is given once daily for a period of 3 days in order to treat hyperthermia in goats.

Injury
Injury can be defined as any physical damage to the body caused by violence or accident or fracture. Injuries in goat can be treated with neem (*Azadirachta indica* A. Juss). *Azadirachta indica* belongs to the family Meliaceae. For treating injuries in goat, edible lime and calcium powder or neem leaf paste is applied on the injured area in order to treat the injuries as neem has antiseptic property.

Mastitis
Mastitis is a term which refers to the inflammatory condition of the udder irrespective of the cause. It is characterised by physical, chemical and microbial changes in the glandular tissues of the udder. Mastitis in goat can be treated with heng (*Ferula asafoetida* Linn.) and neel (Indigofera tinctoria Linn.). Heng and neel belongs to the families Apiaceae and Fabaceae respectively. For treating mastitis, small quantity of *F. asafoetida* or *I. Tinctoria* dissolved in water and applied on teats.

Pharyngitis
Pharyngitis denotes inflammation of the pharyngeal mucosa and sub mucosa. The inflammatory process may extend to soft palate and tonsils leading to constriction of pharynx, known as ‘angina’ or ‘cyranche’. Pharyngitis in caprine species can be treated with a mixture containing ajwain (*Trachyspermum ammi* Linn.) and lahsun (*Allium sativum* Linn.) Ajwain and lahsun belongs to the families Apiaceae and Liliaceae respectively. For treating pharyngitis, 20g of ajwain and 3-4 bulbs of lahsun are mixed with jiggery and given to the goat affected with pharryngitis.

Rheumatism
Rheumatism is a febrile condition in which severe pain and disability to move is experienced due to involvement of muscle and joints. It is thought to be due to auto

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

immunity and hypersensivity. Rheumatism can be treated a preparation consisting of saunjana (*Moringa oleifera* Lamk), lahsun (*Allium sativum* Linn.) and patharchatta (*Boerhavia diffusa* Linn.). Saujana lahsun and patharchatta belongs to the families Moringaceae, Liliaceae and Nyctaginaceae respectively. For treating rheumatism, a paste of 100g of bark of saujana, 20g bulbs of lahsun and 50 g leaves of patharchatta is apllied on the swollen part of the joint in order to get the desired therapeutic effect.

Rhinitis

Rhinitis is the inflammation of nasal mucosa often spreading to all the air passage yielding serous or mucoid type of nasal discharge. Rhinitis can be treated with a paste consisting of gongchi (*Abrus precatorius* Linn.) and bazra (*Pennisetum typhoides* (Burm.f.) Staph. &Hubb.) Gongchi belongs to the family Fabaceae and bazra belongs to the family Poaceae. For treating rhinitis, seeds of gongchi are mixed in the flour of bazra. Then the above preparation is made in the form of ball and given to the goat in the form of ball.

Scabies

Scabies can be defined as skin eruptions which are produced by the Sarcoptes mites. Scabies can be treated with a mixture made up of neem (*Azadirachta indica* A. Juss) and nimbu (*Citrus limon* Linn.). Neem and nimbu belong to the families Meliaceae and Rutaceae respectively. Leaf paste of neem mixed with nimbu is applied on the parts affected with scabies as nimbu and neem both have antiseptic property.

Urinary Retention

Urinary retention is a condition in which urine cannot empty from the bladder. Urinary retention can be acute or develop very quickly, or it can be chronic and occur over a long time. Urinary retention can be treated with Aak (*Calotropis procera* (Ait) R.Br). Aak belongs to the family Asclepiadaceae. For treating urinary retention in goat, powder of 100g root of *Calotropis* dissolved in one litre of butter milk is given to the goat suffering from urinary retention.

Volvulus

Volvulus is an acute obstruction of the intestine caused by twisting of its own axis or over another intestinal loop and its mesentery. This result into blood stasis in the wall or intestine involved. Volvulus can treat with neem (*Azadirachta indica* A. Juss.). Neem belongs to the family Meliaceae. Neem leaves mixed with salt are fed to the affected goat in order to treat volvulus.

Worms

Worms are many different invertebrate distantly related bilateral animals that typically have a long cylindrical tube-like body without limbs and eyes. Worms can be treated with genhu (*Triticum aestivum* Linn.). Genhu belongs to the family Poaceae. Several worms in goat can be expelled by feeding poultice of the Triticum to the affected goat.

Wound

Wound in common parlance can be defined as a break in the continuity of tissue caused by trauma. Wound can be treated with a mixture containing kainth (*Feronia limonia* Linn.), neem (*Azadirachta indica* A. Juss.) and arhar (*Cajanus cajan* Linn.). Kainth, neem and arhar belong to the families Rutaceae, Meliaceae and Fabaceae respectively. In order to treat wounds, the leaf paste of kainth, neem and arhar are applied on the affected area of the

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

wounded goat.

Body Inflammation
It is a condition characterized by general pain and difficulty. Body inflammation can be treated with *Anisomeles indica* (L.). *Animsomeles indica* belongs to the family Lamiaceae. Bogy inflammation in goat can be treated with leaf decoction.

Skin diseases
Skin diseases refer to any aliment in the skin, the largest organ of the body. Skin diseases are very frequently encountered in goats, especially reared under unhygienic conditions. Skin diseases can be treated with *Adiantum capillus-veneris* L. It belongs to the family Adiantaceae. Skin diseases in goat can be treated with plant paste of *A. capillus- veneris* and mustard oil.

Poisoning due to herbs
The plant powder of *Alangium salvifolium* (L.f.) Wangerin can be used as an antidote against poisonous herbs. It belongs to the family Cornaceae.

Maggots
Maggot is a soft-bodied grub that is the larva of many dipterous flies. About half of fly species produce larvae that can be categorised as maggots. Maggots can be treated with *Ailanthus excels* Roxb. It belongs to the family Simaroubaceae. Leaf decoction of the plant facilitates removal of maggots from wound. Also, the root paste of *Carisssa carandas* L. along with coconut oil can be used to treat maggots. *Carissa carandas* belongs to the family Apocynaceae.

Decreased Lactation.
Lactation is the process of secretion of milk by mammary glands. It occurs with the help of two hormones: prolactin and oxytocin. Lactation can be improved with the root paste of *Asparagus adscendens* Roxb. It belongs to the family Asparagaceae. Whole plant of *Convolvulus arvensis* L. facilitates lactation. It belongs to the family Convolvulaceae.

Paralysis
Paralysis also known as plegia is the loss of voluntary muscle function in one or more parts of the body as a result of damage to the nervous system. Root paste of *Azanza lampas* (Cav.) Alef. can be used to treat paralysis. *Ananza lampas* belongs to the family Malvaceae.

Abortion
Abortion is a procedure which terminates pregnancy. Stem bark paste of *Bridelia retusa* (L.) A. Juss. can be used to prevent abortion. *Bridelia retusa* belongs to the family Phyllanthaceae.

Brain diseases
The diseases pertaining to central nervous system and more particularly to the brain are called brain diseases. Leaves of *Chlorophytum tuberosum* (Roxb.) Baker is used to treat brain diseases. It belongs to the family Asparagaceae.

Fever
Fever can be definedas astate of elevated core temperature, which is often, but not

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

necessarily, part of the defensive responses to multicellular organisms (host) to the invasion of live (microorganisms) or inanimate matter recognised as pathogenic or alien by the host. The febrile response is a complex physiological response to disease, involving a cytokine-mediated rise in core temperature, generation of acute phase reactants, and activation of numerous physiological, endocrinological and immunological systems. The juice of bulbous root *Crinum latifolium* L. is used to treat fever. It belongs to the family Amaryllidaceae.

Snake bite

Fruit powder of *Sapindus laurifolus* Vahl can be used to treat snake bite. It belongs to the family Sapindaceae.

Herbal Plants Effective Against Parasites

Studies have documented that many medicinal plants are effective against internal and external parasites of goat. *Aloe ferox*, *Acokanthera oppositifolia*, *Elephantorrhixa elephantine, Albuca setose*, *Gunnera perpensa*, *Centella coriacea* and *Cussonia spicata* have shown effective results against a variety of helminths found in goat. *Aloe ferox*, *Acokanthera oppositifolia* and *Elephantorrhiza elephantine* have shown proven results against a wide variety of ticks found clanged to the body of caprine species. Also, *Aloe ferox* and *Elephantorrhiza elephantine* have shown effective results against a wide variety of mites found to be causing scbies in goat.

Preparation of Plants to Control Parasites

1) ***Aloe ferox:*** Leaves of the plant are crushed and juice is applied to the skin or mixed with drinking water.
2) ***Elephantorrhiza elephantine:*** Roots of the plant are grinded and boiled in water for about 30 minutes until the water turns red. Dose: 300ml or spray in the animal.
3) ***Albuca setosa:*** The tuber of the plant *Albuca setosa* is crushed, boiled and dosed with a 500 ml bottle.
4) ***Acokanthera oppositifolia:*** Grind leaves, boil, cool and drench the animals. Dose with 1 litre bottle for adults and a 300 ml bottle for kids.
5) ***Centella coriacea:*** Bark of the plant is chopped and decoction is made. Decoction is sieved and approximately 500 ml is dosed.
6) ***Cussonia spicata:*** Bark of the plant *Cussonia spicata* is ground, shopped overnight and dosed at the rate of 300 ml.
7) ***Gunnera perpensa:*** The tuber is crushed, boiled and decoction is made. The decoction so made is dosed at 300 ml.
8) ***Agapanthus praecox:*** It is given in the form of infusion. The leaves of the plant Agapanthus praecox are ground and soaked in water for overnight. The preparation so formed is dosed at the rate of 500 ml.
9) ***Bulbine latifolia:*** It is prepared in the form of decoction. The leaves of the plant Bulbine latifolia are ground, boiled and applied to the skin or drenched with one litre of water.

Collection and Preservation of Herbal Drugs

Collection

Herbal plants should be collected during appropriate time and season. Any variation in these may rigorously affect the quantity and quality of biological constituents present in the herb in question. One should take utmost care that no part of the plant so collected for medicinal purpose should come in contact with soil. With respect to underground roots, the soil clanged to the roots should be removed at the earliest.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Once collection is done, these are subjected to preliminary processing, including elimination of undesirable materials and contaminants, washing (to remove excess soil), sorting and cutting. If more than one medicinal plant is collected, then they should be segregated immediately.

Time of Collection

Sl no.	Plant parts	Time of collection
1.	Bulbs	Late autumn
2.	Barks	Autumn (after leave fall) or Spring (before development of leaves)
3.	Roots and rhizomes	For annuals: shortly before flowering for biennials and perennials: Autumn and winter
4.	Leaves	Dry weather
5.	Flowers	Dry weather and middle of the day.
6.	Seeds and fruits	When fully grown, ripe or nearly ripe.

Primary Processing

Collected raw materials should be promptly unloaded and packed on arrival at processing unit. The plant material should be stored under refrigeration, in jars, in sandboxes or using enzymatic and other appropriate conservation measures immediately following harvest or collection. Caution must be taken not to use any preservative.

Drying

Medicinal plants can be dried in a number of ways:

1) In the open air
2) Under direct sunlight
3) In drying rooms and solar dryers
4) By indirect fire, lyophilisation, microwave or infra red device.
5) Vacuum drying
6) Spray dryer.

Preservation

Method of preservation is applied as per the requirements. The various preservation methods employed for preserving medicinal plants are:

Drying

It is most commonly applied method for preservation. Prompt removal of water and moisture content prevents the plant material from being degraded. It also minimizes the risk of external attack and dwindle the enzymatic process.

Freeze-drying

This method requires a relatively complicated apparatus and is much more expensive. Hence, it is fairly used as a routine method, but it is very important for drying heat-sensitive substances, e.g., antibiotics and proteins.

Stabilization

In order to avoid degradation of active constituents of the plant material, enzymes should be destroyed through a process known as stabilization. The most common method is a brief exposure of the plant material to ethanol vapour under pressure (0.5 atm). It is of great value

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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for the isolation of compounds that are very susceptible to enzymatic degradation

Fermentation
Fermentation is mostly employed to remove bitter or unpleasant tasting substances or to promote the formation of aromatic compounds with a pleasant smell. It is mainly applied to drugs used as spices or stimulants, e.g., vanilla, tea and cacao.

Storage of crude drugs
1) Storage facilities should be well aerated, dry and protected from light.
2) The floor should be tidy, without cracks and easy to clean.
3) Continuous in-process quality control measures should be implemented in order to eliminate standard materials, contaminants and foreign matter prior to and during the final stages of packing.
4) Packing material should be non-polluting, clean, dry and in undamaged condition.
5) Should be stored at appropriate temperature.
6) Wooden boxes and paper bags should not be used for storage of crude drugs.

CONCLUSION
Herbal medicines can be seen as a solution to the commotions being observed in the allopathic medicinal system which are loaded with numerous undesired side effects. However, safety and efficacy issues are a concern which requires extended studies directed at establishing safer herbal medicinal system. Proper documentation of the available data is a must in order to maximize benefits.

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CHAPTER – 8

Blue Tongue Disease in Goats

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ABSTRACT

Blue tongue disease (BTD) is a viral illness caused by the blue tongue virus (BTV) that affects domestic and wild ruminants, including goats. The disease is transmitted by Culicoides biting midges, which act as vectors for the virus. Clinical signs of blue tongue disease in goats include fever, oral lesions, excessive salivation, respiratory distress, lameness, and edema of the face and tongue. The disease can lead to significant economic losses and trade restrictions. BTD has a global distribution, with different serotypes prevalent in different regions. Control measures involve vaccination, vector control, and quarantine protocols. The pathogenesis of BTD involves interactions between the virus, host immune system, and target tissues. The virus replicates in lymph nodes and spreads to various organs, causing vascular damage and tissue inflammation. Understanding the pathogenesis is crucial for developing control strategies. Clinical signs include general manifestations such as fever, depression, anorexia, weight loss, and specific signs related to respiratory, musculoskeletal, and reproductive systems. Supportive care, including stress reduction, hydration, and symptomatic treatment with NSAIDs and antibiotics, is essential. Vector control is important for preventing disease spread. No specific treatment exists, and prevention focuses on vaccination and vector control strategies.

Keywords: *Blue tongue disease (BTD), Goat and Culicoides species*

INTRODUCTION

Blue tongue disease is a viral illness that primarily affects domestic and wild ruminants, including goat. It is caused by the blue tongue virus (BTV), which belongs to the genus Orbivirus within the family Reoviridae. Blue tongue disease is transmitted by biting midges of the Culicoides species, which act as vectors for the virus (Maan S, 2019). The disease is characterized by a range of clinical signs, including fever, oral lesions, excessive salivation, respiratory distress, lameness, and edema of the face and tongue. In severe cases, it can lead to significant economic losses due to mortality, decreased productivity, and restrictions on animal movement (Veronesi E, 2020). Blue tongue disease has a global distribution, with different serotypes of the virus prevalent in different regions. It primarily affects goat, but can also infect other ruminant species such as cattle, goats, and deer. The disease has a significant impact on the goat industry, causing losses in terms of reduced fertility, decreased weight gain, and decreased milk production. In addition, trade restrictions may be imposed on regions affected by the disease, affecting international movement of livestock (Savini G,2004). Efforts to control and prevent blue tongue disease involve vaccination programs, vector control measures, and strict quarantine protocols. Vaccines are available for specific serotypes and provide protection against the disease. Vector control measures focus on reducing the population of Culicoides midges through insecticides, environmental management, and monitoring of vector populations. Quarantine and movement restrictions help prevent the spread of the disease to unaffected areas (Mellor PS, 2000).

Epidemiology

Blue tongue disease (BTD) is an infectious viral disease that affects goat and other ruminants worldwide. The epidemiology of blue tongue disease involves a complex interplay of the virus, the vector, susceptible hosts, and environmental factors. The disease is primarily

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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transmitted by biting midges of the Culicoides species (figure-1), which serve as vectors for the virus (Mellor PS, 2008). The Culicoides midges acquire the blue tongue virus (BTV) by feeding on infected animals and then transmit it to susceptible hosts during subsequent blood meals. The transmission dynamics of BTD are influenced by factors such as vector abundance, viral strain, host density, climate, and landscape characteristics (Wilson AJ, 2008).

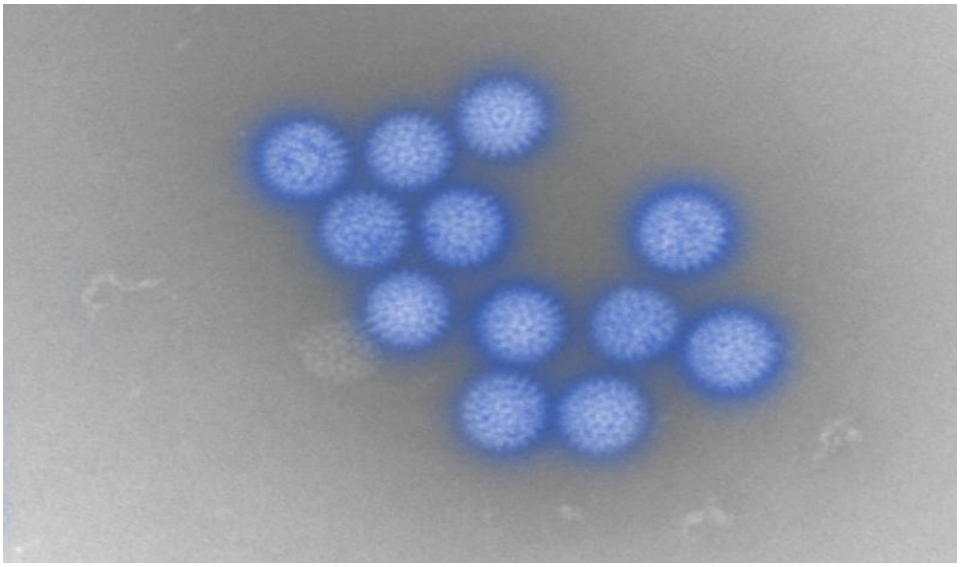

Fig. 1. Culicoides

The distribution of blue tongue disease is influenced by several factors, including the geographic range of the Culicoides vectors and the presence of susceptible ruminant populations. Different serotypes of the blue tongue virus are endemic in different regions of the world, and their prevalence may vary over time. The spread of BTV can occur through the movement of infected animals or the transport of infected Culicoides vectors. Climate conditions, particularly temperature and humidity, influence the activity and abundance of Culicoides midges, thus affecting the transmission dynamics of BTD (Purse BV, 2005).

Various studies have been conducted to understand the epidemiology of blue tongue disease and its transmission patterns. These studies have employed techniques such as molecular characterization of viral strains, serological surveys, vector surveillance, and mathematical modeling to elucidate the dynamics of BTD. The findings from these investigations have contributed to our understanding of the geographic distribution, seasonality, and risk factors associated with blue tongue disease (Carpenter S, 2011).

Pathogenesis

Blue tongue disease (BTD) in goat is caused by the blue tongue virus (BTV), a member of the Orbivirus genus. The pathogenesis of blue tongue disease involves a series of interactions between the virus, the host's immune system, and various target tissues. The initial entry of the virus occurs through the bite of infected Culicoides midges, which introduce the virus into the host's bloodstream. From there, the virus replicates in regional lymph nodes and spreads to other tissues, including the spleen, liver, and endothelial cells lining blood vessels (Ratinier M, 2011).

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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The primary target of BTV replication is the endothelium, leading to endothelial damage and subsequent vascular leakage. This vascular damage, along with the host's immune response, results in a range of clinical signs and pathologic changes. The immune response involves the production of neutralizing antibodies, which can limit the spread of the virus and contribute to the clearance of the infection (Verwoerd DW, 2004). However, the immune response can also lead to inflammation and tissue damage, particularly in organs such as the lungs, heart, and reproductive organs.

The pathogenesis of blue tongue disease can vary depending on the BTV serotype, host susceptibility, and other factors. Some strains of BTV may cause mild or subclinical infections, while others can lead to severe clinical disease and high mortality rates. Factors such as host genetics, viral strain pathogenicity, and host immune status play a role in the severity of the disease and its outcomes (Schwartz-Cornil I, 2012).

Understanding the pathogenesis of blue tongue disease is essential for developing effective control and prevention strategies. Research on the pathogenesis of BTD has utilized experimental infection models, histopathological examinations, viral characterization, and immune response studies to unravel the mechanisms underlying the disease. These investigations have contributed to our understanding of the cellular and molecular events involved in blue tongue disease and have paved the way for the development of vaccines and diagnostic tools (Mertens PPC, 2013).

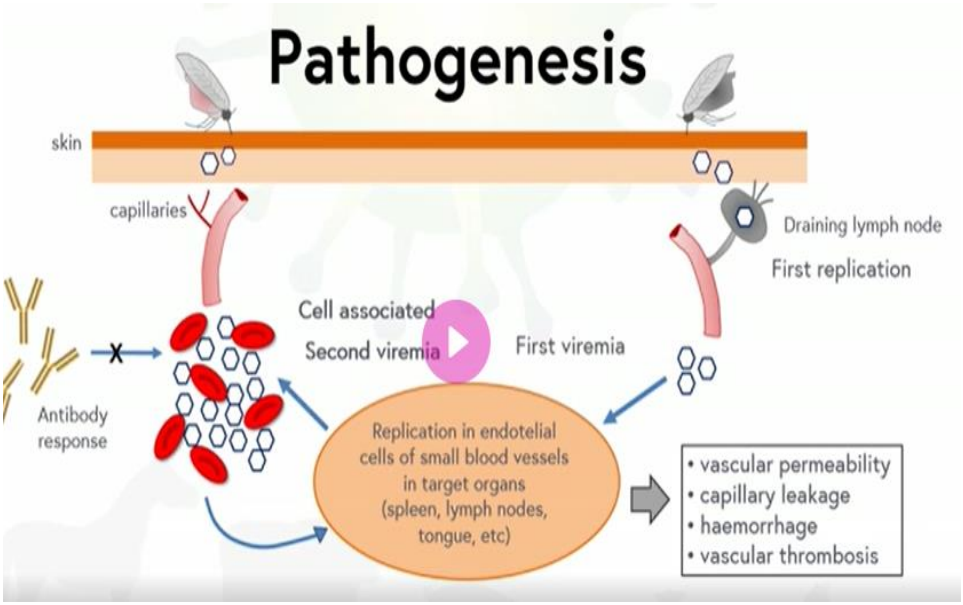

Fig. 2. Cycle of Culicoides

Clinical Signs

Blue tongue disease (BTD) in goat is characterized by a wide range of clinical signs that can vary in severity depending on the strain of the blue tongue virus (BTV), the immune status of the host, and other factors. Clinical signs typically appear within 5 to 20 days following infection and can include both general and specific manifestations (Mellor PS, 2000).

General Clinical Signs of Blue Tongue Disease

- Fever
- Depression

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Volume 3 Issue 1; 2023
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- Anorexia
- Ulcers in mouth (Fig. 4)
- Weight loss
- swelling and bluish tongue (Fig. 3)

1) Affected goat often exhibit reduced activity and may seek shade or cool areas due to discomfort caused by high body temperature (Purse BV, 2005).
2) In some cases, goat may show excessive salivation and nasal discharge(Figure-5). Edema, particularly in the head and neck regions, is a common finding due to vascular damage and fluid leakage. The presence of ulcers and erosions in the oral and nasal mucosa can also be observed (Gibbs EP, 1994).

Specific Clinical Signs of Various Systems and Organs

- Respiratory signs such as dyspnea, coughing, and increased respiratory rate may occur due to pulmonary edema and inflammation.
- Lameness and swelling of the limbs can be observed as a result of joint inflammation and accumulation of fluid.
- Reproductive signs can include infertility, abortion, and birth defects, as the virus can affect the placenta and fetal development.
- Additionally, affected goat may experience gastrointestinal disturbances, such as diarrhoea.

It is important to note that the clinical signs of blue tongue disease can overlap with those of other infectious diseases, making diagnosis based solely on clinical signs challenging. Confirmation of BTD requires laboratory testing, including serological and molecular techniques.

Fig. 3. Swelling and Bluish Tongue

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Fig. 4. Ulcers in Mouth

Fig. 5. Nasal Discharge

Treatment and Control Measures

There is no specific treatment for blue tongue disease (BTD) in goat, as it is a viral infection caused by the blue tongue virus (BTV). Therefore, management and supportive care are essential to help affected animals recover and reduce the impact of the disease. Treatment aims to alleviate clinical signs, prevent secondary infections, and provide supportive therapy.

Supportive Care

1) Providing a stress-free environment with access to clean water, shade, and appropriate nutrition to maintain the affected goat's overall health and immune function.
2) Ensuring adequate hydration is crucial, especially during periods of high fever or when oral lesions impair the animal's ability to eat or drink.

Symptomatic Treatment

1) The administration of non-steroidal anti-inflammatory drugs (NSAIDs) to reduce fever, alleviate pain, and decrease inflammation.
2) Additionally, broad-spectrum antibiotics may be prescribed to prevent or treat secondary bacterial infections that can occur due to compromised immune function and tissue damage.

Indian Journal of Livestock and Veterinary Research
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Prevention

1) Vector control plays a crucial role in preventing the spread of the disease. Measures such as reducing the population of Culicoides biting midges, which are the primary vectors of BTV, can help limit the transmission of the virus.
2) This can be achieved through insecticide application, habitat modification, and implementing vector control strategies recommended by veterinary authorities.

It is important to consult with a veterinarian for guidance on appropriate treatments and management practices specific to the situation and region affected by blue tongue disease. Vaccination strategies may also be available to provide protection against specific strains of the blue tongue virus in endemic areas (Savini G, 2008).

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CHAPTER – 9

Feeding Management of Goat

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ABSTRACT

A small ruminant production in India contributes to 3.4 and 4.8 % of total world milk and meat production, respectively. Small ruminants, such as goats and sheep's, are adapted to a wide range of climatic conditions, but their husbandry is more prominent in the harsh environments reared by the poor people. Small ruminants possess some unique characteristics as a better thermoregulation, resistance from diseases, durability in case of long-distance grazing and higher feed conversion efficiency. Approximately 65-70% cost of feed is used completely in goat rearing so that it will be performed economically as well as higher production and better reproduction.

Keywords: *Different Stage; Feed Resource; Feeding System; Goat; Nutritional Requirement*

INTRODUCTION

Goats generally produce milk more than a cow from the similar quantity of nutrients. The nutrient conversion efficiency of goat for the production of milk is 45.71 per cent, whereas a dairy cow average 37.11 per cent, Buffaloes 37.81 percent and Sheep 41.67 percent. It has been observed that goats are 4.04, 7.90, and 8.6 per cent superior to sheep, buffaloes, and cows in nutrient utilization, respectively. (Dairy Handbook (production), ICAR-NDRI, Karnal).

The goat uses more useless feeds for its maintenance than a cow and others animals. The secret of successful feeding is in deriving a cheap and efficient ration, while preparing a ration for goats, some factors such as availability, price, digestibility and palatability should be considered along with the rich nutritive quality of the feed and fodder. Abundant clean, fresh water, changed every morning and evening should be made available to goats at all times. Some of the most serious and deadly diseases of goats result from the drinking of dirty and contaminated water from shallow pools. Water troughs should be thoroughly washed out at least thrice in the month. Goats in milk require more water than dry goats and should be watered regularly at least three times a day.

Feeding Habits

Goats are very sensitive and vulnerable animals with peculiar dietary habits. By the means of their mobile upper lips and very prehensile tongue, goats are able to graze on very small grass and to browse on foliage not normally eaten by other domestic livestock.

Unlikely sheep and goats prefer to eat aromatic plants in areas with scarce food supply and can therefore penetrate deep into deserts. They are conscious about the cleanliness and like top change feed frequently. Feeds must be given clean and fresh, since goats will not eat anything that is dirty or foul-smelling. They don't eat *like* wet, stale or trampled fodder. Due to this reason, it is advisable to feed them in hay-racks or hang the feed in bundles from a peg

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in the wall. Double-sided portable hay-racks are the most suitable and convenient for stall feeding in all season. It is preferable to serve them small quantities at a time, when served in large quantity at a time; they waste a lot of it by trampling.

Feeding System

Feeding may cost high expense in goat rearing. Goats rise for milk and meat with need good quality feed in most situations and requires an optimum balance of many different nutrients to achieve maximum profitable income potentially. Most of the goats reared in villages are hardly provided with any grain, good green or dry fodder. They have to browse and graze to meet out their nutritional requirements; due to which their body growth and milk production is very low.

There is difference in feeding habit of goats from other farm animals, they response in different way to sweet, sour, bitter and salty feeds for acceptance and rejection. Goats produce more milk than cow with the same amount of nutrients. Goats can use more amounts of low-quality feeds for its maintenance than cow, buffalo and any other animals. Success in feeding can be achieved by formulating a nutritious and cost-effective ration.

Preparation of balanced ration requires consideration of factors *like* nutritive value, bulk, palatability and digestibility, local availability and their cost. Fresh and clean water should be made available free of choice all the times for goat feeding. Water trough should be washed at least for twice in a month. Dairy goats require more water as compared to meat goats so; care should be taken in this regard.

In general, goats are reared in four different feeding system is following as:-

Tethering

When grazing facilities are limited and one or two goats are to be kept then tethering is suitable. In this system, goat is tied with a rope of 3-5 meter and 35-50cm long peg. Peg is driven into the ground over a grazing area which permits the goat to browse over a bound area depending upon the length of the rope.

Change the location whenever necessary so that goat may get sufficient grass to meet out the own requirement. Provide a temporary portable shelter closely within reach of goat so that may turn to shelter in the extreme heat or heavy rains. (Rumosa Gwaze et al. 2009).

1) Goat has a strong dislike for rain and getting wet.
2) Goat should have tethered both in morning and evening.
3) Goat should be kept in the shelter in day time.

Advantages

1) It helps to keep the goat within the door.
2) Feeding goat is convenient or suitable.
3) Utilization of grass properly in the front or rear in the house.

Precaution: Graze goat on a plot which is surely known to be free from parasites.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Extensive System

Goats are generally reared under extensive system in which goat are allowed for grazing in the entire pasture for the whole season. This practice is quite prevalent in migratory, transhumance, free range, pasture and range grazing system. In this method feed cost is very low and goats play only a secondary role to crop or other livestock production. Rational grazing system is preferable practices in which the pasture land should be divided by temporary fences into several sections and the animals are shifted from one section to another section. By the time entire pasture is grazed, the first section will have sufficient grass coverage to provide second grazing.

Parasitic problem can be controlled to a great extent. Further, it helps to provide quality fodder in immature for most part of the year. In this system, it is more effective feeding to graze the kids first on a layer and then bring in does to finish up the feed left by kids. Moreover, intercropping of legume forages such as cowpea in Cenchrus cilians and Dolichos lablab legume pasture can increase the biomass yield per area by three to four times and improve nutritive value of forage. (Nampanzira, D.K. *et al.* 2015).

Limitation of Extensive System

1) Natural potential range of land is low due to long summer, erratic rains, light textured soil, deficient organic matter.
2) Marked fluctuations in availability of feed depending from region to region and season to season.
3) Poor nutritional availability to goats does not given enough opportunity to exhibit their genetic potential.

Advantages

1) Easy and convenient method of goat rearing.
2) Use of low resources for feeding.
3) Managemental advantage due to small sized flock of goats with farmers.
4) More economical than cattle in the respect of natural grazing or browsing.
5) Goat 2.5 times more economical than sheep on free range grazing in semi- arid regions
6) Increase fertility of soil by manure and urine excreted by goats.
7) No need shed due to trees on range lands.
8) Less expense occurs in goats rearing.
9) Capital expenses are less with the labour expenses.

Semi-intensive System

This system is combination of intensive and extensive system in which limited free range grazing and browsing is allowed with stall feeding. Goat of different farmers is grazed together for 4-6 hrs. a day, and then kept in stalls feeding where they are offered concentrate mixture, hay, dry fodder, tree leaves, green kitchen waste and crop residue depending upon the availability.

The level of nutrition is optimum or low but this system is superior to under extensive system resulting improvement in kidding rates, milk yield, body weight gains and quality of meat production. In this system the feed cost increased due to offered concentrate, dry fodder and some hay. In this context, the increasing grazing pressure and poor productivity of grazing lands the semi-intensive system is gaining more importance. (Nampanzira, D.K. *et al.* 2015).

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Advantage
1) Fulfill the nutrient requirement both from grazing and stall feeding.
2) Managing medium to large flock of 50-400 heads or above.
3) Utilizing cultivated forage during lean or scarcity period.
4) Harvesting good crop of kids for meat and milk.
5) Raising a profitable gain due to less labour input.

Intensive System

In this system goats are continuously kept under housing in confinement with limited access to land and provides with complete stall feeding on cultivated fodder, crop residues or straw and concentrates or compounded feeds. This system is also called Zero Grazing system. A medium sized flock of 50-200 oriented towards commercial milk production is suitable as well as 500 goats may be used of commercial purpose. It is also includes browsing on developed pasture for health and exercise purpose only and feeding completely in stalls on fresh fodder, straw and concentrates.

Production and consumption of balance feed mixtures as pellet or blocks based on maximum use of by-products is beneficial. It requires maximum labour and high capital investment with constitutes less than 5 % of the small ruminant production systems. This system is mostly beneficial for peri-urban areas driven by good market access to cater or hotel the demanding for meat. (Nampanzira, D.K. *et al.* 2015).

Advantage
1) Helps in close supervision and control over the all goats.
2) Dung in collected in one place and use as organic farming and produce Vermi-compost.
3) Less space is sufficient for the kept more number of animals.
4) Helps in reduce disease incidence with proper treatment.

Nutritional Requirement of Goats

A goat needs nutrients for the growth, reproduction, body maintenance, pregnancy and production of the various prospects such as meat, milk and wool or hair. Energy, protein, minerals and vitamins are the major nutrients and the nutrient varies on different stages of development and production. During the winter condition, goats should be offered the highest quality hay available. Ethers grazed or stall fed, goats should be supplemented with a concentrate feed when do not available contain the necessary nutrients to cover their nutritional demand.

Table 1. Nutrient Requirement For dairy goats

S. No.	Nutrient	Requirement
1.	Dry Matter	Temperate region: 5-6% of live weight
		Tropical region: 4-5% of live weight
		Meat type goats: – 2.5-3% of live weight
2.	Concentrate	
i.	For maintenance ration	250g per 50 kg body weight
ii.	For production ration	450g per 2.5 lit. milk yield per doe

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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iii.	For pregnancy ration	220g daily per doe for Last 2 month of gestation
iv.	Stud buck	400g daily
3.	Water	450- 680 gm./ day for a goat weighting 18-20 kg
4.	Dry matter: total water intake ratio	1:4 or 1:5

Source: Nutrient Requirements of Sheep, Goat and Rabbit, ICAR, New Delhi

Table 2. Macro and Micro elements requirement in Feeding of Goat

Macro elements (%)			Micro elements (mg)	
Calcium (Ca)	0.3-0.7		**Iron (Fe)**	50-1000
Phosphorus (P)	0.25-0.4		**Copper (Cu)**	10-80
Sodium (Na)	0.2		**Cobalt (Co)**	0.1-10
Potassium (K)	0.8-2.0		**Zinc (Zn)**	40-500
Chloride (Cl)	0.2-0.32		**Selenium (Se)**	0.1-3.0
Sulfur (S)	0.18		**Molybdenum (Mo)**	0.1-3.0
Magnesium (Mg)	0.4		**Iodine (I)**	0.5-50

Source: Nutrient Requirements of Sheep, Goat and Rabbit, ICAR, New Delhi

The nutrients needed may be divided into maintenance, production and pregnancy requirements.

a) Maintenance Ration

As goats have a higher BMR than cattle, their maintenance requirements are higher. The maintenance requirement thus calculated is 0·09 per cent digestible crude protein (DCP) and 0·09 per cent total digestible nutrients (TDN). For its size and weight, a goat can consume substantially more feed than cattle, Buffalo and sheep, *viz.* 6.5-11 per cent of its body weight in dry matter when compared with 2.5-3 per cent for cattle, buffalo and sheep. This means that the goat can prove its maintenance requirement and produce milk from forage alone.

b) Production Ration

Requirements for the production of 1 ltr. of milk with 3 % and 4.5 % fat is 43 gm of DCP and 200 g of starch equivalent (SE), and 60 g of DCP and 285 g of SE, respectively. The nutritional requirement of goat weighing 50 kg and yielding 2 liters of milk with 4% fat may be meet by feeding 400 g of concentrate mixture and 5 kg of berseem or lucerne. The balanced ration should have 12-15 % protein content for goat rearing.

The following concentrate mixtures may be used as a feed to goat:

Table 3. Different Economic Concentrate Mixture (%)

Ingredients	Type-1	Type-2	Type-3	Type-4	Type-5
Maize crushed	30	20	25	-25	30
Wheat bran	20	20	25	20	20
Barley	-	10	5	25	10
Oats	10	10	10	10	-
Gram(crushed)	10	10	15	10	20
Groundnut cake	20	20	10	10	10

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Gram/arhar chuni	10	10	5	10	10
Molasses	2	2	2	2	2
Common salt	0.3	0.3	0.3	0.3	0.3
Vit-A (g)	0.3	0.3	0.3	0.3	0.3
Vit-B2 (g)	0.3	0.3	0.3	0.3	0.3
Vit-D3 (g)	0.5	0.5	0.5	0.5	0.5
Mag. Sulphate	0.5	0.5	0.5	0.5	0.5
Phosphorus	2.4	2.4	2.4	2.4	2.4

Source: Dairy Handbook (production), ICAR-NDRI, Karnal.

c) Pregnancy Ration

The fetus growth in the last 2 months of pregnancy is going rapidly and the metabolic rate of the goat rises fast. During this period, the content of ration should be increased equivalent to the level of production ration. A week before her kidding, the Doe should be provided with more succulent type of feed and fodder. For 3 or 4 days after kidding, the level of ration should be lowered and more fibrous. This is necessary to minimize the shock to the goat's udder. After this time, the feeding should be done at a normal rate.

Table 4. Nutrient Requirement of Goats for Pregnancy

Live weight (kg)	DM intake (g)	Total ME (MJ)	DP (g)
20	816	8.54	49.8
25	950	10.04	58.6
30	1104	11.55	67.4
35	1240	12.97	75.6
40	1368	14.31	83.4

Source: Nutrient Requirements of Sheep, Goat and Rabbit, ICAR, New Delhi

Factor Affecting of Nutrition Requirements

Nutrition plays an essential role in goat farming systems. In developing countries, these systems are characterized by low input of poor-quality pastures that contribute to inadequate feeding and nutrition (Ben Salem and Smith 2008), and low productivity (Thomas and Rangnekar 2004). This is in turn aggravated by the goat rearing practice that is mainly characterized by tethering of indigenous breeds in natural pastures (Rumosa Gwaze *et al.* 2009).

Female goat (Doe) nursing twins or triplets' kid have grater nutritional requirements than goat nursing a single kid as well as kids, younger and bucks. Goats grazing very hilly pastures will have higher nutritional requirements than goats on plain pastures of same quality because they will expand more energy to gather feed. The following factors affecting of nutritional requirements: -

1) **Energy:** Energy comes primarily from carbohydrate liz. Sugars, starch and fiber and fats in the ration. Feed grains are the high energy liz. Maize, wheat, barley, soybean hull or meal and gluten feed. The main sources of grain for goat feed are pulses, wheat, maize rice, gram, pea, potato, molasses, agricultural by-products etc. Fat is efficiently used for energy, but usually added fat should be less than 5% of diet as it depresses ruminant fermentation.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

2) **Protein:** Crude Protein is the most important nutrient for the nutrition and cost effectiveness. Feed or concentrate are rich in protein with oilcakes liz. Cottonseed, soybean, mustard, linseed, groundnut, sesame etc. as well as wheat middling and corn gluten meal feed also. Protein is in the form of nitrogen and 1 gram nitrogen produces 6.25 gram microbial protein. Moreover, it's also helps to balance the ruminal bacteria and supply amino acids for protein synthesis in the animal's body. The level of protein is an Inadequate in the diet so that it is occurs negatively effect on animal growth rate, milk production, reproduction and disease resistance.

3) **Mineral Mixture**: Goats require many minerals for basic body function and optimum production. The requirements of major minerals as Calcium and Phosphorous in the ratio of 2:1 to 3:1 for maintenance according to body weight. Goat requires slightly larger quantities of calcium than sheep. The mineral mixture may be included in the concentrate ration at the rate of 1-2 percent.

4) **Salt:** Salt licks or lumps of rock salt of fairly good size should be hung up in some suitable place where the goats can easily get them. This is important as goats secrete a good amount of sodium and chloride ions in the milk.

5) **Vitamins and Antibiotics:** Goats particularly need some essential vitamins such as vitamin A, D and E. Vitamin A can be supplied by green forage and yellow maize; 1 kg of lush-green fodder will have provided 1500 IU. Vitamin D can be obtained by sunlight and Vitamin E is present in adequate amounts in normal rations. Synthetic vitamins A and D may be supplemented in the ration for growing kids. Feeding of aureomycin or terramycin in the form of medicinal increases the growth rate of young kids, reduced the incidence of scours and other infectious diseases and improves the general appearance of the kids.

Feeding of Different Stage of Goats

Feeding management of the young goats in critical to the overall success of the farm enterprise and regardless of the production system.

1. Feeding of Kids

Goat kids are raised either as replacement stock or for Meat (Goat meat called as Chevon) purpose. At the birth time, the digestive system of the young goat is almost similar to the pig and human. During these first stages of milk feeding, the abomasum and small intestine play an important role with respect to digestion and nutrition.

a) **Colostrum feeding of kids:** Colostrum is the first milk produced after kidding by goat, which contains rich in Immunoglobulin (Antibodies), Vitamin A, Mineral, Fat. The feeding of Colostrum serves as laxative aid in the excretion of the meconium lining of the digestive tract. It is providing as higher energy source for the newly born kids until its own immune system begins functioning at the stage of 3 week of age. The best Colostrum feeding time is 1 to 6 hours after birth. Colostrum should be fed 10% of kid body weight or 100 ml per kg live weight during the first 12 to 24 hours of life for optimum immunity.

b) **Feeding after birth to 3 months age:** After 3 days of kidding, the kids should be weaning from goats and the kids should be fed with their mother milk at 2-3 times a day. The milk feeding period last from birth to 3 weeks or as long as 5 months depending on

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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the production system. At the 2-4 weeks of age the young ones should be trained to eat green fodder and 1-2 months of age concentrate (creep feed) can be provided.

Table Feeding schedule for kid (After birth to 90 days)

Age of Kids	Doe milk	Creep feed (g)	Forage, green/day (g)
1-3 Days	Colostrum	-	-
4-14 Days	300ml 3 times	-	-
15-30 days	350 ml, 3 times	A little	A little
31-60 Days	400 ml, 2 times	10-150	*ad. lib.*
61-90 Days	200 ml. 2times	200-250	*ad. lib.*

Source: Pankaj Kumar Singh, 2017

c) Creep feeding of kids

Creep feed is allowed after 1-3 months of age @ 50-100 g/day with the purpose for their rapid growth. It should be containing 22% protein.

Feeding Schedule for goat (90 days to 12 months)

1) Grazing 8 hours per day
2) Concentrate @ 100-200gm/day with at least 16-18 % protein contains
3) Dry fodder *ad. lib.* for goats

d) Feeding of Breeding Does

In not sufficient of grazing condition goat may be supplemented concentrate 150-350 g/day with 16-18% Crude Protein (CP) depending upon the age, pregnancy and lactation. Flushing is usually practiced in does which the level of feed offered to breeding does. Most probably energy is increased one month prior to breeding to increase body weight, ovulation rate and litter size. Flushing can be accomplished by moving breeding does to a lush nutritious pasture 3 to 4 weeks prior to the introduction of the bucks. Low to medium quality forage will meet requirement of dry doe and non-breeding bucks while forage is limited or low quality (less than 10% protein), weanlings and yearlings should be fed concentrate mixture.

Table 8 Feeding of Pregnant does

S. N.	First 4 months of pregnancy	Last 1 month of pregnancy
1.	4-5 hours per day in good quality pasture	4-5 hours per day in very good quality pasture
2.	supplemented 5 kg green fodder per day	Concentrate 250-350 g per day and 7 kg green fodder per day

Source: Nutrient Requirements of Sheep, Goat and Rabbit, ICAR, New Delhi

e) Feeding does at kidding

After parturition the ration of the doe may be gradually increased to provide the full ration in divided does 6-7 times in a day. A mixture of wheat bran and barely/oats/maize (1:1) is excellent.

f) Feeding Lactating does

The feeding of lactating does is most important for better milk performance and kid growth. The following rations may be recommended:-

1) 6-8 hours grazing+ 10 kg green fodder per day
2) 6-8 hours grazing+ 400 g concentrate per day
3) 6-8 hours grazing+ 800 g concentrate per day

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

g) Feeding non-pregnant/dry does

Dry goats do not need concentrate of good quality pasture is available. In poor grazing condition animals may be supplemented concentrate 150-200 g per day.

h) Feeding Bucks for breeding

Bucks are allowed to graze with does as a common practice and bucks get the same ration as the does. Bucks should be given 500 g Concentrate with facilities for separate feeding.

Balanced goat feed is the food which contains all nutrient ingredients in proper ratio and quantity to meet the demand of body in different stages of production. Every goat needs high quality nutritious food for healthy live and optimum production and reproduction. Raising a goat rearing, proving sufficient amount of green fodder, concentrate, grazing and water play a vital role. The composition of Ideal concentrate mixture as follows:-

Table 9 Ideal Concentrate Mixture for Different Stage/Purpose

Feed Ingredients	Goat kid (%)	Dairy Goat (%)	Meat Goat (%)	Pregnant Goat (%)
Gram	20	15	20	50
Maize/Broken Wheat	22	37	23	20
Sesame/groundnut cake	35	25	30	20
Rice/wheat bran	20	20	24	7
Minerals	2.5	2.5	2.5	2.5
Salt	0.5	0.5	0.5	0.5
Total	**100**			

Source: Pankaj Kumar Singh, 2017

i) Feeding of Young Stock

Performance of the adult flock depends on how they are reared when young age. Feeding schedule for kids should be such that a weekly growth rate of 600 g is obtained. The kids should be fed 56-112 g of colostrum 4-5 times a day, depending on birth weight, for 3 days. From the 4th day onwards, they may be fed the following ration schedule:-

Table 5. Ration Schedule according to Different Body Weight Stage

Body weight (kg)	Milk		*Concentrate mixture per day (gm)	Green fodder (lucerne/berseem) Kg
	Morning (ml)	Evening (ml)		
2.5	200	200	-	-
3.0	250	250	-	-
3.5	300	300	-	-
4.0	300	30	-	-
5.0	300	300	50	ad lib.
6.0	350	350	100	ad lib.
7.0	350	350	150	ad lib.
8.0	300	300	200	ad lib.
9.0	250	240	250	ad lib.
10.0	150	150	350	ad lib.
15.0	100	100	350	ad lib.
20.0	-	-	350	ad lib.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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25.0	-	-	350	1.5
30.0	-	-	350	2.0
40.0	-	-	350	2.5
50.0	-	-	350	4.0
60.0	-	-	350	5.0
70.0	-	-	350	5.5

Source: Animal Husbandry and Dairying
**Concentrate mixture should contain (in parts): Gram 20, maize 22, groundnut-cake 35, wheat bran 20, mineral mixture 2.5, and common salt 0.5.*

Feed Resource and Feeding

Goats are sensitive animals with peculiar feeding habits because goats are able to graze on very short grass due to having mobile upper lips and very prehensile tongue. Sheep and goats relish eating aromatic plants in area of scarce food supply, hence can penetrate deep into deserts. Goats are very fond of leguminous fodders. They do not relish fodder *like* sorghum/maize silage or straw but like leguminous hay. The goats are relishing some common green roughage*:* Lucerne, Berseem, Napier grass, cowpea, green pigeon pea, soybean, cauliflower and cabbage leaves, Shaftal, Senji, Methi, shrubs and weeds of various kind; and leaves of tree such as babul, Neem, Ber, Tamarind, and Peepal. Moreover, some dry fodder also likes such as pigeon pea, green gram, black gram, chick pea *etc* and lucerne/berseem hays.

Goats were maintained on grazing in harvested area, along with the roadside and other uncultivated/barren lands. The natural ability of goat to eat a wide variety of vegetation and wastage, that why it is a big motivating factor for small, marginal and landless laborers to rear few goats while stall feeding in goats is very limited.

CONCLUSION

Goats eat 4-5 times for their body weight and eat more of tree leaves and fodder and hence 40-50 % of green fodder should contain tree leaf fodder in roughages. The feeding management consist 65-70% proportional cost of rearing of the total cost of goat rearing. If proportion of feeding is correctly and completely given to goat so it will be good practice in goat rearing for better health, high milk production, more number of kids, improve reproduction and reduce incidence of diseases.

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CHAPTER – 10

Goat Behaviour in General

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ABSTRACT

Instead of grazing, goats prefer to browse among forages and legumes. They stand out among many other domestic ruminants because of their distinctive eating habits. When given free range, goats will graze and browse plants in a selective manner, but in confined or regulated environments, their propensity for browsing trees and shrubs increases. Goats tend to consume a variety of plants, frequently eating those that cattle and other livestock prefer not to eat. The production management idea of inter-species or rotational grazing is well suited to the goats' preferred eating habits. Goat food intake is thought to be inversely related to both water intake and the surrounding temperature. Although the amount of time it takes to digest feedstuffs and the digestibility of the percentage of ingested crude protein may actually rise, goats have a tendency to decrease their water intake in colder weather and subsequently reduce their feed intake. A sustained decrease in water intake should be avoided, as this can result in decreased urine output and an increase in the content of minerals and urea. Goat social behaviour is comparable to that of sheep, and horns likewise significantly influence caprine social standings. While goats also hide when they are young, they spend the first six weeks of their lives away from their nannies for a longer period of time than cows do. Because adult male goats are expected to charge individuals who cross their territory, behavioural issues are less frequently recorded in these animals.

Keywords: *Behaviours, Behavioural problems, Browsing, Ethogram, Social Behaviours.*

INTRODUCTION

It is believed that the first animal (10 000 YBP) to be domesticated for economic purposes was the goat *(Capra hircus).* Following domestication, physical variation among breeds and types started. Goats have shown themselves to be incredibly adaptable creatures, and the majority of them are found in emerging Asia, Africa, and South American nations. Goats give their owners a variety of essential goods and services, including milk, meat, skin, and hair (*Peacock, 1996*). One of our fundamental tenets is that animals should be allowed to behave in accordance with their natural instincts. Some of these behaviours, like those related to living outside and having access to natural foods, may seem obvious to goats.

Others are less so, such as the social organisation of goats or how they act at critical phases of their reproductive cycle, such as mating or childbirth. We must develop a fundamental understanding of some of these key behaviours if we are to offer the environments and management that allow goats to live happy, healthy lives while balancing that with meeting our own social, environmental, and economic demands. In addition to providing links to further resources and knowledge sources, this page introduces some important findings and information concerning goat behaviour. Whereas other livestock animals would not survive, goats have effectively adapted to desert, hilly, and tropical environments. This adaptability is because of their distinct behaviours in feeding, body physiology, and social behaviour.

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Feeding Behaviour of Goat (Behaviours of Grazing versus Browsing)

Grazing (head-down) and browsing (head-up).

Instead of grazing, goats prefer to browse among forages and legumes. They stand out among many other domestic ruminants because of their distinctive eating habits. When given free range, goats will graze and browse plants in a selective manner, but in confined or regulated environments, their propensity for browsing trees and shrubs increases. Goats tend to consume a variety of plants, frequently eating those that cattle and other livestock prefer not to eat. The production management idea of inter-species or rotational grazing is well suited to the goats' preferred eating habits. Goat food intake is thought to be inversely related to both water intake and the surrounding temperature. Although the length of time it takes to digest feedstuffs and the digestibility of the percentage of crude protein ingested may actually rise, goats have a tendency to decrease their water intake in colder weather and thus reduce their feed intake. Water consumption reductions that last for an extended period of time should be avoided since they can result in decreased urine production and higher concentrations of minerals and urea. Goats are reputed to be able to discern between the flavours of bitter, salty, sweet, and sour foods. Their tendency to browse on bark, leaves, shoots, shrubs, and branches—which may have a more bitter flavour than grasses, forbs, and general pasture—is thought to be the reason for their better tolerance for bitter-tasting feeds. Additionally, goats are very skilled at differentiating between sweets.

Seasons and Sexual Activity

Goats are spontaneously ovulating, polyestrous animals that breed at their highest levels in the autumn as the days get shorter. Melatonin output from the pineal gland rises as the day length shortens, stimulating pulsatile GnRH release from the brain. In short-day breeders, hypothalamic GnRH secretion stimulates the anterior pituitary's release of luteinizing hormone (LH) and follicle-stimulating hormone (FSH) and the development of follicles, which initiates the hypothalamic-pituitary-gonadal axis. The majority of goats breed between late August and mid-March, with September through November often being the best time to witness breeding activity. At the start and conclusion of the season, silent heats, in which ovulation occurs without being accompanied by typical estrus behaviours, are frequent. The doe enters heat as the light and temperature decrease. The entire flock of does frequently enters into heat within eight days after the buck's entrance at the start of the season. Obviously, there is a lot of diversity based on breed. For example, French Alpine goats may still be in anestrus in April, May, and June while Angora goats rarely go into heat before September. During breeding season, estrous cycles can vary in length from 18 to 24 days, with 21 days being the typical norm. Variation is caused by individual and breed variations. For instance, older does could have shorter cycles. Pygmy goats frequently cycle for 24 days.

In many cases, a group of female goats' beginning of puberty and estrus is accelerated by the doe's more overt sexual behaviour when the male is around. Estrus lasts for 32 to 40 hours on average in a doe, but she can only stand for 12 to 24 hours (Angoras: 22 hours). According to the classification of goats as spontaneous ovulators, ovulation will take place between 30 and 36 hours following the commencement of heat. Prior to mating, both male and female goats engage in considerable sexual and wooing behaviour that is influenced by pheromones, which are chemical attractants in bodily secretions that can be detected by the opposing sex. A doe that is open to sexual activity will become more interested in the buck due to his scent glands' aroma. Estrus is a common reproductive cycle in female animals, characterised by unease, tail switching, bleating, frequent urination, mucus discharge, and standing for buck

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mounting. Breeders and farmers must closely monitor these signs for successful breeding and reproduction.

Signals from Sight, Sound and Scent

Bucks use smell, sight, and sound as vital clues to find females who are in heat. Olfactory (smell) signals, particularly those pertaining to sexual and maternal behaviour, are more significant in goat flocks than they are in sheep flocks. "The buck effect" (also known as the "male effect" among sheep) is a phenomenon that occurs when males are introduced into a flock of seasonally anestrus females. This phenomenon leads the females to secrete luteinizing hormone and cause synchronised ovulation (Gelez and Fabre-Nys, 2004).

One of the primary indicators of a goat's identity and, particularly with regard to reproductive state, is how frequently they urinate. They also have tail glands and pedal glands that release smell signals. In response to non-volatile odours (pheromones), male goats engage in flehmen behaviour around females. Many animals exhibit this behaviour, which involves folding back the top lip and closing the nostril to expose the front teeth. This makes it easier for non-volatile substances (pheromones) to travel from the oral cavity to the vomeronasal (Jacobson's) organ, which in turn triggers normal reproductive activity (Ladewig and Hart, 1980).

Another significant way that adults and their children form bonds is through smell. Mothers actively lick their newborns as soon as they are born, forming a link through smell recognition extremely quickly (Poindron et al., 2007a). If the doe is malnourished in the latter stages of pregnancy, this maternal recognition may not be as strong. The processes that determine the onset of maternal behaviour and bonding appear to be the same in both species, despite the fact that infants tend to hide during the first week of life, whereas lambs immediately follow their mothers (Poindron et al., 2007b). It's crucial to be aware of how important smell is in the early morning hours because disturbing this input can lead to rejection.

Social Interaction

Sheep are less aggressive than goats. Goats are more exploratory and reactive than sheep, who typically run from assailants when threatened (Miranda-de la Lamaa and Mattiellob, 2010). Goats also have a tendency to confront their attackers. According to Shackleton and Shank (1983), the shape and size of sheep or goat’s horns are strong predictors of social standing. The majority of ungulate species, including goats, exhibit high levels of social organisation, which improves defence against predators, foraging efficiency, access to sex partners, and successful rearing and protection of young (Miranda-de la Lamaa and Mattiellob, 2010).

Social Structure

Goats prefer a greater separation from other goats and have a more individualistic nature. Additionally, they exhibit separation anxiety in distinct ways, with goats exhibiting higher vocal rates and sheep displaying higher levels of locomotor activity. Although they are both herd-living ungulates that are born into organised social groupings, sheep and goats behave differently in social situations. If goats prefer greater individual separations while resting, this could help explain why there are fewer aggressive interactions when the laying area is separated into two levels. In order to lessen aggression and social stress among herds of goats, it would probably be a good idea to use resting sites on various levels or a number of

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distinct resting spots as opposed to a single large one. According to Fournier and Festa-Bianchet (1995), developing housing for goats should take into account the fact that they engage in confrontational encounters more frequently than other ungulates. Instead of focusing on the demand for physical space per se, legislation regarding space requirements should emphasise preferred individual distances and individual diversity in how space is used in social groups.

Goats dislike being left alone. They are not isolated beings, but gregarious ones. One goat always seems to take the lead when there are other goats present. This goat stands out since it is leading the group from the front. Because of their fierce loyalty to their leader, the other goats will not move until he or she does. The oldest doe typically serves as the leader. The herd queen, as she is known, there will be stress and chaos if the queen is killed and this will last until the remaining goats choose a new queen. This change in order might temporarily stress goats out, which can lead to unfavourable goat behaviour. Since goats are gregarious animals that are typically found in groups, it is advised against isolating them for very long. Once established, a group's social structure can persist for a long time. Within groups, there is a distinct, consistent, linear hierarchy, and the most hierarchical position frequently entails the most violent behaviour. When food is plentiful, dominant and subordinate animals have different diets, which vanish when forage is scarce. Age, body size, and horn size all play a role in group dominance. Surprisingly, those in the middle of the hierarchy typically exhibit the highest levels of productivity (Barraso et al., 2000). The average size of a group might range from 4 to 300 people! Under natural circumstances, the 'ecological niche'—the type of flora that surrounds a group—determines its size. The group size will be significantly larger in open savanna conditions than it would be in areas with more vegetation.

Stress Results from Isolation!

Goats are rarely found alone in their native habitat, so being forced to remain alone might be distressing (Kannan et al., 2002). The behaviour of the offspring of pregnant females, who are forced to be isolated, particularly during travel, may be affected for life (Duvaux-Ponter et al., 2003; Roussel et al., 2005). If pregnant women must be kept apart before giving birth, it is preferable to segregate them but still offer them the chance to smell, see, and hear other pregnant women in the same group (Miranda-de la Lamaa and Mattiellob, 2010).

Dominance Behaviour in Goat

Goats tend to exhibit dominance within a social grouping more than sheep do because they are more aggressive and inquisitive than sheep. When a goat wants to dominate another animal, it will drop its head and aim its horns in the targeted direction.

Resting Behaviour in Goat

Most often, goats lie on their sternums to rest. Goats only sleep about 5 hours out of 24 hours. In contrast to social interactions, the resting pattern of goats is more influenced by size than organisation. In social groups of goats, aggressiveness levels were not observed to be affected by space allowance per se by Loretz et al. (2004). However, the percentage of time spent resting fell when the space permitted was reduced from 2.0 to 1.0 m^2. The conditions for ensuring that the goats had enough rest were far from ideal. Instead of specifically altering the size of the laying spaces, it may be more important to increase the overall space allowance and personal space in order to decrease aggression and lengthen rest periods.

Indian Journal of Livestock and Veterinary Research
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Abnormal Behaviour in Goat

It may lead to abnormal repetitive behaviours, some of which may be harmful, like crib biting, extreme anger, and biting or rubbing oneself or others. Ample space, socialisation, and goat enrichment could help with some of these problems. Because adult male goats are expected to charge individuals who cross their territory, behavioural issues are less frequently recorded in these animals. Because of the closer resemblance between the maintenance circumstances in this group and those in a free-ranging environment, behavioural issues may actually be less common (as opposed to less commonly reported) in this group. Goat social behaviours may have been less affected by domestication than those of other species.

Self-Suckling

Goats can self-suckle if they have late-term abortions or if they become pregnant again after nursing. Given that the behaviour did not take place while the nanny was breastfeeding, the latter instance may shed light on the matter. Treatment entails social companionship that was steady prior to conception, environmental and behavioural enrichment, and perhaps some anti-anxiety drugs.

Stereotypic Behaviours

On the other hand, separated sheep tend to display flocking behaviour and may become anxious or distressed when alone. These distinct behaviours highlight the social nature of both goats and sheep, emphasizing their need for companionship and a sense of belonging within their respective groups.

SUMMARY

Goats are adapted to semiarid regions and are primarily grown in dry periods. They have a high demand for food, which can compromise their performance during dry periods. Goats graze in the morning and late afternoon, with quick consumption and longer regurgitation processes. They consume a large amount of food and return to the trough for smaller meals. Water consumption is lower in goats, as it is required for nutrient digestion and absorption. In field conditions, goats seek water during the hottest hours of the day, seeking it as heat dissipation. Different social interaction behaviours between goats are observed, showing signs of communication through sound, sight, and touch. The most common form of communication is touch, especially with their horns, forelimbs, and necks. These behaviours are more frequently observed in the afternoon. Social behaviour serves ecological purposes, such as better protection from predators, more efficient foraging, and ease of interactions related to sexual behaviours. However, competition for food or access to other resources can reduce harmony between animals. In intensive goat production systems, aggression levels are higher than those in semi-intensive and extensive systems. Goats in the study showed high anxiety for the hours that preceded food delivery, and the proximity between stalls contributed to aggressive behaviour. Grooming behaviour was more frequent at night due to the intense presence of ectoparasites. Goats use their horns, teeth, or hind limbs for grooming, but this can compromise oral hygiene and food intake. The bipedal posture confers advantages to goats when under grazing conditions, as they are agile compared to sheep and cattle. They are free from catching most endoparasites, developing less resistance to them. The frequency of other activities was higher in the afternoon for all genetic groups. Goats are also aware of stimuli, with the aware state being higher when provided with visual and acoustic stimuli. Abnormal behavior in goats can lead to harmful repetitive behaviors like crib-biting, extreme anger, and biting. Proper space, socialization, and enrichment can help address these issues. Domestication may have less affected goat social behaviours than other

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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species. Self-suckling may occur in goats due to late-term abortions or nursing, and treatment may involve social companionship, environmental enrichment, and anti-anxiety drugs. Separated sheep display flocking behavior, emphasizing their social nature and need for belonging within their groups.

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CHAPTER – 11

Contribution in Milk and Meat Production Management of Goat in Uttar Pradesh

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ABSTRACT

Goat farming is gate way to create your food and provide meat and milk products for your family. The up. Goat farming industry is growing rapidly as there is a growing demand for fresh goat meat and goat milk product in India.in India Goat population in the country in 2019 is 148.88 million showing an increase of 10.1% over the previous census. Contributing of total population of goat West Bengal 16.28, Utter Pradesh 14.48, Bihar 12.82 and Madhya Pradesh 11.06 respectively. Goat farming has been an integral part agriculture in U.P. for centuries the state is one India largest producers of goat milk and meat. Goat require less space than other livestock such as cow and buffalo and goat rearing require low cast input thus making it suitable as a source of livelihood for low-income people. U.P. has various goat well suitable for commercial and backyard farming the Barbari goat known for its hardiness and adoptability is one such breed that has gained immerse popularity in the regions. Another population breed is the Jamnapari which is highly valued for its production, they have going slender bodies and distinctive ears that curve outward at the tips their milk is high in solid content. The pantija breed originated from the eastern part of U.P. and Bihar. they are small but produce a good amount of meat per animal due to their muscular build and fast growth rate. Decide on the breed of goat went to rise barbari goat, Jamunapari goat pantija and Rohilkand are popular breeds in U.P. choose a breed that is well-suited for local climate and market demand. It required proper attention and knowledge to maintain their helth and productivity. It is crucial to provide a clean-living environment for the goat, which involves regular cleaning of the shed or house also insure enough space to for them to more around freely. Feeding management is another imported aspect of goat should always have access to clean drinking water and sufficient amount of nutritious food such as hay. Goat farming in U.P. has been advantages but it also come the biggest challenges is feeding quality breed stock at affordable price and another change is marking the products such as milk and meat farmers must establish relationship with buyers and find markets to sell their product fairly. The goat farming business is in creakingly poplar technological advancement and better management practice being maximum profit to the enterprise. starting goat farming is the most important factor in ensuring good profit in a short period goat farming has gained much momentum in recent years as goat are a good source of fiber, skin, and nutritious milk.

Key words: *Goat, U.P., Barbar, milk and meat, production, contribution and management etc.*

INTRODUCTION

Small ruminant production is a very significant component of livestock production throughout the world arid more especially developing countries like India. These small ruminants play an important role in improving the socio-economy of the farmer in particular and economy of our nation in general. Popularly known as the “poor man’s cows. The goat was the earliest ruminant domesticated around 9000 to 7000 B.C. When it provided milk, meat, hides, fiber and manure. On the basis of the archaeological evidence, the center of goat domestication extends over Iraq, Iran, Jordan, Turkey and Palestine around 7000B.C. The

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goat is a hollow –horned ruminant belonging to the mammalian order Artiodactyla, sub order Ruminantia, family Bovidae and either of the genera Capra or hemitragus. Goat which belong to the genus Capra has possibly been developed from the following 5 wield species (1) *Capra hicus*, the true goat including the benzoar (ii) *Capra ibex*, the ibexes (iii) *Capra caucasica*, the Caucasian tur (iv) *Capra pyrenaica*, the Spanish (v) *Capra falconeri*, the Markhor.

Goat in India is largely reared for chevon production and contributes largely to the livelihood of resource-poor households specifically in climatically disadvantageous regions, where crop production is always at risk (Singh *et al.* 2013). Goat farming is less capital intensive and thus suitable for a large number of rural populations. Productivity of indigenous goats is lower than their actual genetic potential, and attributed to low input system, lack of suitable breed and region-specific structural goat improvement programmed, poor adoption of technologies, depletion of grazing resources and an unorganized market (Singh *et al.* 2018). World-wide goat milk in 2018 has surpassed 18.71million tones (FAOSTAT 2018) and India with 6.17 million tons of milk is contributing 33% of global goat milk production. India, Sudan, Bangladesh, Pakistan, and France are the major goat milk producing countries with 53.12% global goat milk production Goats in India are predominately (>90%) reared under extensive management on community rangeland under low input and output production system. The goat population of India is 148.88 million (2nd highest after China) which has been increasing by 3.5% annually from 2007 to 2019 (DAHD 2019) despite. ~56% slaughter and ~15% mortality, thus, it has become one of the most inclusive species of livestock. India occupies the first position in global goat milk production (6.09 million tones) and in India goat is 3rd (3% of total milk) largest milk contributing species (DAHD 2019). The top five goat milk producing states are Rajasthan, Uttar Pradesh, Madhya Pradesh, Gujarat and Maharashtra accounting for 79.5% of total goat milk production. Milk productivity, however, remains static over the year *i.e.* about 0.46 kg/day/goat for the last decade. The estimated global dairy goat population was 218 million in the 2017 and there has been a continuous increase (Miller and Lu 2019). The 20th livestock census showed a 10.1% increase in population over 19th livestock census. Rajasthan, West Bengal, Uttar Pradesh, Bihar, Madhya Pradesh and Maharashtra are major goat population states accounting for 20.84, 16.28, 14.48, 12.82, 11.06 and 10.60%, respectively (DAHD 2019).

Table 1. Milk Composition of Different Dairy Animals

Parameter	Sheep	Goat	Buffalo	Cow	Camel
Protein (%)	4.50-6.60	2.80- 3.70	4.38	3.20-4.00	3.26
Fat (%)	(5.30-9.30) 6.99	(3.40-4.50) 4.07	7.73	(3.40-4.50) 4.09	3.80
Lactose (%)	3.90-4.90	3.90-4.80	4.79	4.60-4.90	4.30
Solid not fats (%)	12.00	8.90	9.50	9.00	10.36
Water (%)	82	83.20	83.18	87.80	86.50
Total solid (%)	18.50	12.50	18.00	13.80	14.00

Importance of Goat Milk

The protein, fat, solid not fat and total solids contents are much higher in sheep, cow and buffalo's milk as compared importance of goat milk with unique features for human health. Goat milk is more alkaline and cow milk is slightly acidic. Goat milk has a stronger goaty flavor than sheep and cow milk. The fat globule size in goat milk is much smaller, make it in homogenized state with naturally improved digestibility. Goat milk forms a finer curd than cow milk following acidification, which mimics the conditions in the stomach, making it

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more readily digested. Goat milk contains a higher proportion of medium-chain fatty acids, *i.e*. caproic, caprylic and capric which are known for anti-bacterial, antiviral, inhibit development and dissolve cholesterol deposits, and absorbed rapidly from the intestine (Shing field *et al.* 2008). Goat milk contains 4-5 times higher oligosaccharides than cow milk and 10 times higher than sheep milk and is associated with prebiotic and anti-infective, anti-inflammatory properties and stimulates gut bifid bacterium and lactobacilli (Martinez *et al.* 2005, Boehm and Stahl 2007). Goat milk is a rich source of conjugated linoleic acid (CLA), which helps in reducing oxidative stress, atherosclerosis, improves blood lipids profile and protects the growth of tumours of mannar. Gland and skin. Goat milk contains less lactose than cow milk (4.1 % vs 5.0 %). The size of casein micelles in goat milk is higher (100- 200 nm vs 60- 80 nm) than in cow milk. The concentration of α_{s1}- casein in goat milk is low, whereas high for β-casein than that of cow milk, which helps in easy digestion and reduce allergy city.

Table 2. Breed of Goat Suitable for Utter Pradesh

S.N.	Breed's name	Origin and Distribution	Characteristics	Performance
1.	**JAMUNAPARI**	It of is the biggest and most majestic goat breed of India. The breed has been extensively utilized to upgrade indigenous breeds for milk and meat (dual- purpose) and has been exported to neighboring countries for the same purposes. Its home is between Jamuna Ganges and Chambal rivers. Pure breed stock in Etawah district of U.P. the breed is distributed at Agra and Mathura apart from Morena districts of Madhya Pradesh.	There is a great variation in coat colour but they are generally white or light yellowish tan with brown spot on the neck and face, and occasionally patches of tan or black are found on the body. Best dual purpose, biggest and most majestic breed of Indian goat, most beautiful Indian goat creamy white body colour with shining hair, roman nose (parrot mouth appearance) and thick growth of hairs.	Dual purpose meat and milk (i) Milk: - Average daily yield varies from 1.5 to 2.0 kg per day with total lactation yield of about 200 kg. (ii) Kidding: - Usually doe kids once a year, giving birth to single in 57% while twins in 43% per cent cases. (iii) Meat: - Dressing percentage on pre-slaughter live- weight basis is about 45 percent at 6 months and 48 per cent at 9 months with a bone and meat ratio of 1:3.9.
2	**BARBARI**	The breed is a promising dairy type goat which has probably originated in the city of Barbera in British Somali land in East Africa. In India the breed is distributed at Etawah, Agra, and Mathura and Aligarh districts of U.P. and Bharatpur district of Rajasthan. In addition to being a	Small animals with compact body. Where is wide variation in coat colour, but white with small light brown patches is most common ear are short, tubular and erect. Both sexes twisted horns, medium in length and directed upward and backward. Origin barbera city (east africa), the colour of this breed is white with light brown patches. Dwarf breed highly suitable for stall feeding & generally	(i) Milk: - Daily milk yield average about 750 ml to 1,000 ml. Average lactation may be 130-200 kg's of milk in a lactation length of 150 days with a fat percentage of about 5. (ii) Kidding: - It may twice in a period of 12-15 months. Litter size single 25 percent twins 65 percent and triplets 10 percent.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

		good milker it is highly prolific and generally give birth to twin and triplets. It is a dwarf highly suited for stall – feeding condition and hence generally found in the cities.	found in cities so it is also known as city breed. Indian goat with maximum milk fat (5%).	
3.	**PANTJA**	Which is reared for meat and milk in Udham Singh Nagar and Nainital districts of Uttarakhand as well as adjacent Tarai area of Uttar Pradesh.	Pantja are medium sized goats reared mainly for meat purpose with average flock size of 7±2. However, the flock sizes as big as 35 to 62 have also been observed. The composition of the flock for does, bucks and kids being 48, 1 and 51 per cent, respectively. Traditionally, buckling have been castrated by incision method at about 10 day's age and hence Pantja bucks were not commonly seen with small flocks. People consider meat of Pantja wethers as highly delicious. The colour of the goats is brown/ fawn, getting lighter ventrally with stripe on face. They are very active but docile and morphologically resemble with deer. Pantja have small sized horns (about 10 cm), which are triangular, twisted, pointed at tip and oriented slightly upwards and backwards.	(i) Milk: - Average daily yield varies from 0.8 kg per day with total lactation yield of about 113.89 kg. ii) Kidding: - The age at sexual maturity of female ranged between 9 – 11 months and age at first kidding between 14-15 months. Majority of females deliver two kids (67%) per kidding, however, triple ting is also frequent in healthy goats. (iii) Meat: - Dressing percentage on pre-slaughter live- weight basis is about 45 percent at 6 months and 48 per cent at 9 months with a bone and meat ratio of 1:3.9.
4.	**ROHILKHANDI**	Native to Rohilkhand region of Uttar Pradesh, and is reared for meat and milk	Coat colour is predominantly black with star or patch on neck and face in some animals. Majority of animals are horned which are curved, and directed laterally and outwardly. Beard and wattles are absent in both sexes. Forehead is slightly convex. Tuft of hair (black or brown) is present in thigh region. Tail is bunchy.	Adult body weight ranges from 25 to 36kg in male and from 21 to 31kg in female. Twinning is common and triplets are frequently observed. Average litter size is 1.57. Daily milk yield ranges from 450 to 740g.

Reproductive Performance

Reproduction in the Male

The male goat (Buck) has exceptionally high libido (Sex desire). A well grown buck-kid be doe (The female) during his first season at an appropriate age of six months. However, the semen was less in volume and motility score was very low. The age has a significant effect

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

on the semen production. From records, it appears that semen volume and sperm motility were significantly higher in adults than in 9 months old males. The semen quality of 4-5 months old kids were inadequate for breeding, although their sexual libido was satisfactory. At the age of 18-24 months buck may be allowed to serve 25-30 does, and when they attain full maturity 50-60 does in a breeding season may be permitted to serve. Age of puberty different from the breed, climate factor, nutrition factors, and along with male reproductive hormone can modify puberty.

Table 3. Semen Characteristics and Other Attributes of Some Breeds

Attributes	JAMUNAPARI	BARBARI	PANTJA	ROHILKHANDI
Reaction time (sec)	22.7±1.19	30.60	42.05±.02	49.39±2.5
Volume (ml)	0.54±0.04	0.92±0.07	0.47±0.02	0.58±0.041
Sperm concentration (10^6/ml)	2289±38.23	2753±158	2234±162	3534±176
pH	6.42±0.003	6.59±0.01	6.47±0.16	6.41±0.17

Reproduction in the Females

The duration of oestrus is usually 24 to 48 hours but in certain breeds, for instance the Indian beetle, it may be as short as 18 hours on the average. Recurrence of estrus cycle is 18-21 days intervals unless pregnancy occurs. The gestation period is from 145 to 153 days (5 months). Indian goat commonly kid twice in one year and usually times in two years. Generally, the incidence of oestrus is highest from May to October. Sexual desire in female kids have been noticed at an early age of their 14 weeks. Body weight climate, nutrition and even presence of male has been found to modify age of puberty apart from breed characteristics. In one study at I.V.R.I. (1974) it has been observed that barbari nannies attain their puberty between 9-10 months whereas Anglo-Nubian takes about 15 months' time to reach puberty stage. For getting good results, goat should be breed at the age from 14 to 18 months and should kid for the first time when they are about two years of age. In general, although two kidding from a doe per year is theoretically feasible but in practices (Except Black Bengal goats two kidding are common) three kidding in two year is attained. Meat breeds commonly have a shorter kidding interval than milk breeds presumably because of the influence of the length of lactation. For example, goat in Indian and Malayasia the interval between kidding is 90-120 days but for pure bred and crossbred Anglo-Nubian goat it is 327 and 204 days respectively. The time of ovulation of goat is towards the end of estrus. Under ordinary conditions, the average life of goat is about 12 years. She should give milk for about 10 lactations. If kidding is taken once a year. A goat is at her prime when 5-7 years of age.

Sins of Heat

1) The doe (she goat) become restless, shakes its tail, dislikes to eat feed properly.
2) Sudden drop of milk –yield.
3) Swelling and slight redenning of the genital opening.
4) Mounting on the other goats irrespective of sex.

Feeding Management

Goat have special feeding habits as different from other ruminants. With the aid of their mobile upper lips and very prehensile tongues goat are able to graze on very short grass and to browse on foliage, which is not the common feed of other livestock's. Under extensive conditions, goats may be used to convert otherwise useless browse plants into milk and meat.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

The special feeding habits of goat enable them to meet their nutrient requirement in adverse feeding conditions in which quality and quantity of feed available are inadequate for other species. Under semi-intensive condition, supplementing grazing with harvested green fodder and concentrates becomes necessary. Under intensive system of confinement rearing. All the roughages and concentrate have provided. The amounts to be fed depend on body weight, age, physiological status and milk yield. About two-thirds of the energy requirements of mature goats should be meet through roughages. Half of the roughages should be leguminous (green Lucerne, berseem, peas or hay made out of them) and the rest half green grasses. Instead of green grasses tender tree leaves can also be given.

Dry Matter Intake

Goat have greater capacity for dry matter intake then cattle and large ruminants. However, there are big difference in the relative intakes between tropical and temperate goats. Dairy goats in temperature regions are observed to eat 5-6 per cent of live weight compared to 4-5 per cent by tropical goat. The meat type goats of tropical regions consume still less -2.5 to 3.0 per cent of live weight, when temperate breeds are reared in tropical regions, their DM intake seldom exceed 4.5 percent of their live weight. Dry matter intake increases with the increase in feed digestibility in to about 53 per cent.

Energy and Protein Requirements for Maintenance

Different workers have estimated the energy requirement for maintenance of goat and the values vary 365 to 581.3 kJ ME per kg W 0.75. Taking an average value of 413kj per day per kg W 0.75. The TDN and ME requirements for maintenance of goats with differing live weight has been estimated and presented. The protein requirement for maintenance estimations by various workers vary from 0.59 gm to 2.57 gm DCP per kg W0.75. On the basis of an average value of 1.82 gm DCP/kg W 0.75, the maintenance requirement for goats with different live weight have been calculated.

Table 4. Different Type Energy and Protein Requirements for Maintenance

Live weight (Kg)	Extensive			Semi-intensive			Intensive		
	TDN (kg)	ME (MJ)	DP(g)	TDN (kg)	ME (MJ)	DP(g)	TDN (kg)	ME (MJ)	DP(g)
10	0.15	2.32	10.2	0.48	2.78	10.2	0.21	4.00	10.2
15	0.21	3.15	13.92	0.25	3.78	13.9	0.29	4.41	13.9
20	0.26	3.91	17.2	0.31	4.69	17.2	0.36	5.47	17.2
25	0.30	4.62	20.3	0.36	5.54	20.3	0.42	6.47	20
30	0.35	5.30	23.3	0.42	6.36	23.3	0.49	7.42	23

Source: Adapted from Devendra, C, Feeding system for goats in the Humid and Sub humid tropes. Proc., Int. Symp. On Nutrition and systems of Goats feeding 12-15 May, 1981.

Energy and Protein Requirements for Milk Production

The requirement for milk production in goats are similar to cattle. The efficiency of utilization of ME for lactation has been estimated to be around 70 percent. The requirement per kg milk varies depending on the fat percentages. Give the requirements of energy, protein and some minerals for milk production at different levels of fat percent.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Table 5. The nutrient Requirements for Lactation for Goats

Milk fat %	TDN (gm)	ME (mj)	DP (gm)	Calcium (gm)	Phosphorus (gm)
3.5	301	4.53	47	0.8	0.7
4.0	322	4.87	52	0.9	0.7
4.5	340	5.15	59	0.9	0.7
5.0	361	5.45	66	1.0	0.7
5.5	380	5.73	73	1.1	0.7

Source: Adapted from Devendra, C, Feeding system for goats in the Humid and Sub humid tropes. Proc., Int. Symp. On Nutrition and systems of Goats feeding 12-15 May, 1981.

Table 6. Nutrient Requirements of Goats for Pregnancy

Live weight (Kg)	DM intake (gm)	Total ME (MJ)	DP (gm)
10	484	5.06	29.6
20	916	8.54	49.8
25	950	10.04	58.6
30	1104	11.55	67.4
35	1240	12.97	75.6

Source: Adapted from Devendra, C, Feeding system for goats in the Humid and Sub humid tropes. Proc., Int. Symp. On Nutrition and systems of Goats feeding 12-15 May, 1981.

Practical Feeding of Different Classes of Goats

Despite similarities in sheep and cattle, goat markedly from them in grazing habits, sensitivity to sweet, salty, bitter and sour taste in accepting or rejecting the feeds. Goat are more tolerant of eating feeds containing bitter principles and refuse any solid feed. In general goat feeding agrees with the expectations based on "universal" formula of feeding ruminants. However, it is noted that (i) a goat generally produces more milk than a cow from the same quantity of nutrients. The nutrients conversion efficiency for milk production of a dairy cow is on an average 38%, whereas for goat it ranges between 45-71%. It has been observed that goats were 4.04% superior to sheep. 7.90% to buffaloes and 8.60 % to cows in crude fiber utilization. A goat uses less feed for its maintenance than cow and a goat use more fodder for digestion and metabolism than a cow does. However, on the basis of limited work done at India and Veterinary Research Institute, National Dairy Research Institute, R.B.S. College at Agra, and various other Research institute of country and of the work done in foreign including NRC.

Feeding Kids: Kids must receive colostrum from the doe within one hour after birth and should continue for 5 days. After 5 days kids kids may be given whole milk at the rate of $1/6^{th}$ of their body weight for 30 days. The quantity of milk may be reduced to $1/8^{th}$ of body weight months and 1/10-1/20.from the second week onwards a palatable and easily digestible concentric mixture (starter ration) with 20-24 % DCP and 70% TDN and good quality fodder may be offered to the kids. Provide a good legume hay (or fresh green grass) and calf starters along with fresh water at three to four weeks of age. Equal parts of cracked maize, crushed oats, wheat bran and 10% linseed meal may be fed as the concentrate mixture. Rumen activity will develop quicker and kids will start chewing their cud by the time they are 3 to 4 weeks of age.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Feeding Growers: - Grower kids can be reared under intensive, semi-intensive or extensive system of feeding. Experimental evidence shows that under the intensive system kids grow faster and attain more weight at slaughter. Under semi-intensive system growth is intermediate. But economic analysis shows that in spite of lower growth rate, extensive system is for more economical. Supplementing inferior dry grass with subabul was found to increase DM intake, DM digestibility and weight gain in barbari bucks. Good quality roughage providing 9-10% DCP and 62-65% TDN will be adequate to provide average growth rate.

Feeding of Pregnant Goats: High quality roughages provide the basic nutrients needed during the last 6 to 8 weeks of gestation when 70-80 % gain in foetal mass is made. Liberal feeding of quality leguminous fodder and concentrate having 25 % protein should be offered between 400 to 500 gm depending upon the condition of doe should be fed. However, the concentrate allowance may be reduced to 0.2-0.3 kg during the last week of pregnancy.

Feeding of Lactating Goat: The ration for lactating does should contain high quality roughages like Lucerne, berseem and other cereal grasses through which it will receive not only fresh nutrients particularly of minerals, vitamins and protein but also the bulk needed for volatile fatty acids *viz*., acetic, propionic and butyric needed for high milk production. To supplements more nutrients particularly of energy, cereal grains at the rate of 350 gm for each litre of milk must be provided. The protein per cent varies from 14-16% the feed in two lots, at the time of morning and evening milking. Add 1% trace mineralized salt and 1% calcium-phosphorus mineral mixture to concentrate mixture. Molasses (5-7% of concentrate mixture) may be used to increase palatability and to reduce dustiness of feed.

Table 7. Different Type of Nutrients Requirement of Goats

S.N.	Nutrients	Requirement
I	Dry matter	2.5-3.0 % of live weight (meat goats) up to 8% live weight (milking goats)
II	Energy (a) For maintenance (b) For live weight gain (c) For milk production	 725.8g SE/100 kg live weight/day 3.0g SE/g Live weight gain 300 g SE/ kg milk
III	Protein (a) For maintenance (b) For milk production	 45-64g DCP /100 kg live weight 70g DCP /litre milk
IV	Water	450-680 g/day for a goat weighting 18-20 kg
V	Dry matter: Total water intake ratio	1:4
VI	Minerals (a) Calcium (b) Phoshorus	 147 mg/kg live weight 72 mg /kg live weight

Source: Devendra L. and M. Burns (1970), Goat production in the tropics, Tech. Comw. Bur, Anim Breed Genet, No.19, Comw,Agric, Bur ., Farnham Royal , UK.

Housing Management of Goats

Housing materials is enough for goats their optimum production and well-being. In our country small ruminant production system itself is characterized by low input and low output. Majority of the farmers are not able to afford well-constructed pucca houses for their animals.

1) The optimal environment condition in the shed should be a temperature of 13-27^{0}C,

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

relative humidity of 60-70 per cent, wind velocity of 5-8 km/hour and a medium level of solar radiation are reported to be ideal for these small ruminants.

2) Type of shed used depend on the system of rearing. Open type housing with a covered area and run space is generally enough. Chain links or any other locally available materials can fence the run space. The covered area is used for shelter of animals during night and adverse climate conditions.
3) Orientation of the long axis of the sheds in warm region should be north and south that will help to dry up the urine and faeces and to improve the sanitation. However east – west orientation will provide a cooler environment than north –south orientation for a comfortable house east-west orientation with generous provision for ventilation /air movement to dry the floor will be suitable.
4) Roofing materials and pattern under Indian conditions thatched roof is the most suitable one for its comfort and cheapness. Tiles or corrugated tin, aluminum or cement asbestos sheets can be used for organized farms for longer durability for minimizing recurring costs. Gable roofing is suitable is generally preferred in high rainfall regions. For small sheds lean to type roofing is sufficient. The length of the overhang be 75cm -1 meter.
5) Dimension of the shelter there is no restriction for the length of the shelter, however breadth of shed should not exceed 12 meters, optimum breadth being 8 meters height of caves recommended is 2.5 meters and height at ridge 3.5 meters. The height of chain link used for open space may be 2 to 2.5 meters.
6) Floor space the provision floor space which includes closed space and open space is highly essential for optimum growth of animals. Following are the recommended space requirement for Indian conditions.

Table 8. Space Allowance for Housing of Goats

Types of Goats	Requirement of space in sq. m		Feeding space (cm)	Watering space (cm)
	Closed	Open		
Buck	1.5 to 2.0	3 to 4	50	40
Doe	1.0 to 1.5	2 to 3	50	40
Kids	0.4 to 0.5	0.8 to 1.0	35	30
Dairy does	1.5 to 2.0	3 to 4	50	40
Adult	1.5	3.0	50	40

Types of Goat Rearing System

1) Extensive system
2) Semi-intensive system
3) Intensive system

1) **Extensive system-** This system is mainly practiced in large tracts of Deccan Plateau where there are hills and large areas of land unable to be cultivated. Goats are taken out of grazing by women and children in the morning and brought back in the afternoon. This is the cheapest system and practiced over all parts of India where grazing land is available. This is also practiced by nomadic tribes. Advantages of this system are that it is cheap and provides the production and disposal process simultaneously. The disadvantages are mainly that the animals raised on the system are poor producers besides having poor genetic capabilities, and are exposed to continuous stress.

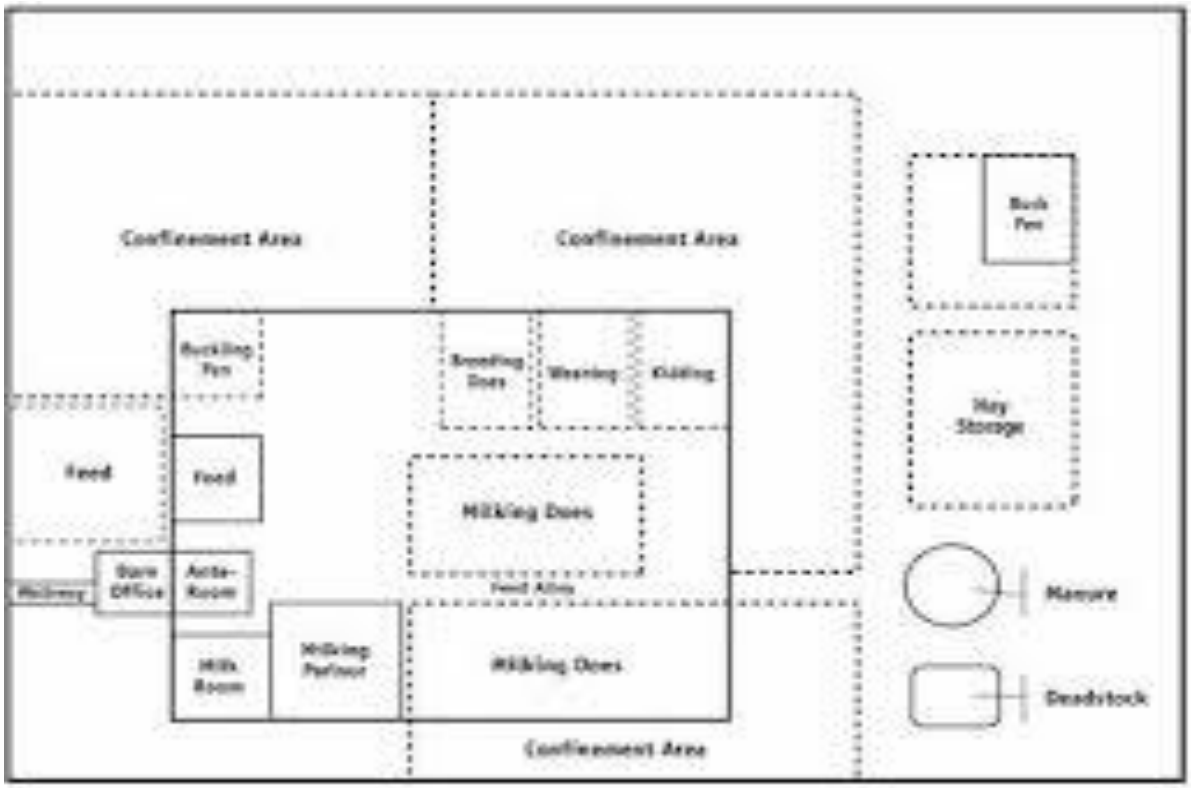
Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

2) **Semi-intensive system**- This system is widely practiced by small and marginal farmers and village poor. Goats are left to graze/browse on the crop residue when the same has been harvested. The advantages of this system are increased fertility of the land by droppings and urine of these animals, control of wasteful habits, good growth rate, easier management and possible increased crop yields.

   Goat keepers keep herds of goats which they take to other farmers' fields when a crop has been cut. The farmers pay them in cash or kind for the manure and urine they drop in the field while grazing. A modified form of this system is tethering where the animal is held by a rope about 2-3 meters long, and other end being tied to a tree or post. The animal grazes and browses in the area accessible through the length of the rope. This system is popular with farmers who keep only a few goats. It permits utilization of grass, fodder and bushes in a limited area and keeps a control on the animal and saves labour.

3) **Intensive system**- Goats are confined in specialized houses. This system requires labour and accurate knowledge of production. Feed and water is brought to the animal. This system offers the greatest protection for the animals from both predators and environmental conditions. This housing system is expensive to construct and may only recommended in commercial settings with high output.

Provision of Simple Shade with Low Cost



Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Routine Operation

1) **Handling: -** Goats are seldom difficult to handle and frequently learn to come for and milking when called. For an ideal handling it is preferable to hold them with neck or head collars.
2) **Castration**: - it is done at the age of 2-4 weeks although castration at later stage is successful. For this method the Burdizzo's castrator is used. After castration there may be swelling of the testis which become normal within 2or 3 days.
3) **Dehorning:** - Dehorning is done to avoid keeping and polled goats together. It is practiced with in one week of birth by using caustic potash.
4) **Marking the Goats: -** Three means for marking are ear-tattooing, ear tagging and ear-notching which should be carried out with –in one week after kidding.
5) **Tethering or Staking out the goat: -** where there are only one or two goats being raised. A running tether has a long staked at both ends where the tether is attached with some kind of ring. This is the most popular and dry land holders and women, children, disabled and old can easily be entrusted with the work of goat keeping.
6) **Exercise paddock for stall fed goats: -** When goats are reared under constant confinement either as for research work or for some other reasons, it is of utmost

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

importance to provide the exercise paddock. An enclosure measuring 12m X 18m is adequate for 100 to 125 goats.

Table 9. Common Diseases of Goat

Disease	Symptoms	Prevention & Treatment
Mastitis	Enlarged hot, painful udder, fever milk watery with flakes of food.	Improve hygiene application of antibiotics
Foot rot	Lameness hoof will look as if it is rotten and it will smell bad signs of pain is seen if pressed.	Trimming, soaking in bath of water with $CuSo_4$
Brucellosis	Abortion in late pregnancy retention of placenta and mrtritis in bucks infertility orchitis and swollen joint are seen.	Isolation of infected animals Vaccination blood testing and culling of positive animals.
Internal Parasites	Loss of weight reduction in milk yield Diarrhoea anemia.	Good quality food and clean water proper medication.
External Parasites	Restless ness scratching loss of weight reduction in milk yield.	Application of proper chemical as a dust, spay or a dip
Poisoning	Unsteadiness followed by dullness and unconsciousness great pain and vomiting convulsion and eventual death.	Keeping goat away from poisonous plants and chemicals immediate treatment.
Bloat	Distended abdomen on left side respiratory difficulty restlessness	Too much fresh green grass should be avoided a cup of mineral oil may bring relief. In acute cases removal of gas by making puncture is needed.

Table 10. Vaccination Schedule of Goats

Months	Vaccine	Adult goat	Kids (Above 6 months)
January	Contagious pleuro pneumonia (C.C.P.P.)	0.2ml I/Dermal	0.2ml I/Dermal
March	Haemorrhagic septicaemia (H.S.)	5 ml S/c	2.5ml S/c
April	Goat pox	5 ml S/c	2.5ml S/c
May	Entero toxaemia (FMD)	5 ml S/c	5ml S/c
June	Rinderpest	1 ml S/c	1ml S/c
July	Black quarter	5 ml S/c	2.5ml S/c
August	FMD	5 ml S/c	0.5ml S/c
September	Enterotoxaemia	5 ml S/c	2.5ml S/c

CONCLUSION

In recent past, demand of goat milk has emerged due to its usage in making a lot of nutraceutical and pharmaceutical supplement besides in making many processed or functional food. It has created huge opportunity for farmers to become an entrepreneur and earn manifold, simultaneously providing a lot of raw materials for dairy industries and varying degrees of satisfaction to consumers. Development of goat based dairy sector will require focused efforts on genetic improvement of dairy breed and policy support to commercial farms to encourage entrepreneurs to invest in this sector. It may be concluded from the

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

present investigation that in general the goat is better suited for milk production. Their potentialities for further higher production by proper breeding, feeding and scientific management practices are generally ignored by the local farmers. Housing system mainly depend on the available resources and the environmental condition.

Now-a-days building materials and designs for goat housing are aimed at lower cost. For the best outcome in animal housing, the producers, building suppliers, livestock specialists, and regulatory agencies must adopt a rational and integrated approach for goat housing design that provides for health, management and husbandry, material and construction technology, energy and pollution, and economic considerations. Thus, the success in overcoming on these obstacles' extension activities should be undertaken to educate and encourage the goat keepers for scientific management of goats and increasing the milk production which can offer immense opportunity for income and employment generation to landless, poor and weaker section of society

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Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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CHAPTER – 12

Feeding and Nutritional Management of Goats

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ABSTRACT

Feeding and nutritional management are crucial aspects of goat farming, essential for ensuring optimal growth, health, and productivity in goats. This summary provides an overview of the key considerations and strategies related to goat feeding and nutritional management, focusing on current practices and emerging trends. Goats have unique nutritional requirements that vary based on factors such as age, breed, physiological status, and production goals. While goats traditionally rely on pasture and browsing forages, supplementary feeding becomes necessary in intensive or confined production systems. Supplementary feeds can include concentrates, roughages, by-products, and mineral supplements. Understanding the nutritional composition of feeds is essential for formulating balanced rations. Feed quality assessment, including proximate analysis and evaluation of anti-nutritional factors, helps determine the suitability of feeds for goats. Proper feed formulation ensures the availability of essential nutrients, such as energy, protein, minerals, and vitamins, necessary for growth, reproduction, and milk production. Recent research has contributed to innovative feeding strategies for goats. Precision feeding, based on individual animal requirements, optimizes nutrient utilization and minimizes feed wastage. Additionally, agro-industrial by-products like crop residues and oilcakes are explored as cost-effective and sustainable feed options. Feeding management practices, including feeding frequency, water availability, and feeding systems, also impact goat performance. Adhering to appropriate feeding schedules, providing clean water, and implementing efficient feeding systems enhance feed intake, digestion, and overall animal productivity. Nutritional management involves addressing specific challenges and deficiencies. Micronutrient supplementation, such as balanced mineral mixtures and vitamins, prevents deficiencies that affect goat health and productivity. Implementing targeted deworming programs and monitoring forage quality contribute to optimal nutritional management. In conclusion, effective feeding and nutritional management practices are vital for successful goat rearing. Understanding nutritional requirements, feed composition, and emerging feeding strategies enables farmers to optimize productivity, improve animal health, and contribute to sustainable agricultural practices.

Key words *-Feed formulation, Feeding management, Goat nutrition, Nutritional requirements, Sustainable goat production*

INTRODUCTION

Feeding is often the most significant expense in goat production. Whether goats are raised for meat or milk, providing them with good-quality feed is crucial for maximizing profit potential. It is essential to achieve an optimum balance of various nutrients to support their growth and productivity. In many village settings, goats are often not provided with grain or good-quality fodder. Instead, they rely on browsing and grazing to meet their nutritional requirements. Unfortunately, this can result in slow body growth and low milk production. However, with proper management and feeding practices, goats can respond well and yield better results, similar to other valuable animals.

Goats have unique feeding habits compared to other farm animals. They exhibit different preferences for sweet, sour, bitter, or salty feeds, which may affect their acceptance or rejection of certain feeds. Goats require a higher amount of feed compared to larger animals, with a daily intake of about 4-5% of their body weight. Their smaller stomach capacity

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suggests dividing their daily feed into multiple meals. The nutritional requirements of goats are influenced by factors such as age, breed, physiological status, and production goals. Young kids have high protein and energy requirements for growth, while adult goats require maintenance and production-specific nutrients. Breed variations contribute to differences in nutrient requirements based on body size, metabolism, and production traits. Physiological status, such as pregnancy and lactation, increases nutrient demands for fetal development, milk production, and maternal maintenance. Production goals, such as meat, milk, or fiber production, further influence nutrient requirements.

The Bureau of Indian Standards (BIS) provides guidelines for the nutrient composition of feeds for goats, ensuring the provision of essential nutrients at appropriate levels. These standards define recommended levels of energy, protein, minerals, and vitamins based on the specific stage of goat development. Compliance with BIS standards is essential for formulating balanced rations that support optimal growth, reproduction, and productivity in goats. Feeding strategies for goats vary depending on their stage of development. Breeding does can be supplemented with a concentrate mixture if grazing conditions are poor, while pregnant does require additional energy to support fetal growth. Feeding practices change during kidding time, lactation, and for non-pregnant does and bucks. Feeding kids involves colostrum feeding immediately after birth and gradually introducing them to solid feeds. Goats can be fed using different feeding systems, such as tethering, intensive or zero-grazing, extensive or range system, and semi-intensive system. Each system has its advantages and considerations in terms of cost, labor, and nutritional provision. Water is essential for goats, and they require fresh and clean water.

Goats generally drink up to three to four times the amount of dry food they consume, and providing slightly warm water can encourage them to drink more. Feed sources for goats include pasture, browsing forages, tree leaves, grasses, legume fodders, cereal fodders, and dry feeds. Advanced feeding strategies in goat feeding include phase feeding, split sex feeding, dynamic feeding, and the use of feed additives. Phase feeding adjusts the diet based on specific nutritional requirements at different stages of growth or production. Split sex feeding recognizes the distinct nutritional needs of male and female goats. Dynamic feeding adapts the diet to changing nutritional demands, and feed additives enhance performance and health.

In summary, understanding the feeding habits and nutritional requirements of goats is crucial for their optimal growth, reproduction, and productivity. Implementing appropriate feeding strategies and providing balanced diets based on scientific guidelines and individual needs can contribute to the overall health and well-being of goats.

Feeding Habits of Goats

The goat is an efficient ruminant that obtains around 80% of its nutritional needs through browsing, which means feeding on leaves and plants. Goats can effectively utilize coarse fiber feed to produce energy. They consume a higher amount of feed compared to larger animals, with a daily intake of about 4-5% of their body weight. Providing a slightly higher level of protein in their diet can be beneficial for goats. Due to their smaller stomach capacity, goats may benefit from having their daily feed divided into 3-4 meals. Their mobile upper lip and prehensile tongue allow them to graze on very short grass and browse on foliage that other livestock may not typically eat. Goats have a higher basal metabolic rate compared to cattle, which means they require more feed for maintenance. However, it is important to note

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that the cost of feed and labor per unit of production tends to be higher for goats compared to other livestock. Goats are known to be swift eaters and have a wide-ranging palate. However, they have specific preferences and dislikes when it comes to their feed. They avoid wet, stale, or foul-smelling feeds and tend to waste a significant amount of feed by trampling on it. Goats particularly relish leguminous fodders such as Lucerne, berseem, green arhar, cowpea, methi, and soybean, more than non-leguminous fodders like sorghum, maize, oats, and bajra. They also enjoy consuming various shrubs, weeds, and leaves from trees such as babul, neem, subabul, ber, and tamarind. However, they generally have little interest in silage or straw as feed options. At birth, a goat's rumen is undeveloped.

Factors Influencing Nutritional Requirements

Goats exhibit unique nutritional requirements influenced by various factors such as age, breed, physiological status, and production goals. Age-related differences exist due to the changing metabolic demands during growth, reproduction, and maintenance. Young kids have high protein and energy requirements for growth, while adult goats require maintenance and production-specific nutrients. Breed variations contribute to differences in body size, metabolism, and production traits, leading to variations in nutrient requirements. Physiological status, including pregnancy and lactation, increases nutrient demands for fetal development, milk production, and maternal maintenance. Production goals, such as meat, milk, or fiber production, further influence nutrient requirements.

BIS Standards and Nutrient Requirement for Goat

The Bureau of Indian Standards (BIS) establishes guidelines for the nutrient composition of feeds for goats. These standards ensure the provision of essential nutrients at appropriate levels to meet the animals' physiological needs. BIS standards define the recommended levels of energy, protein, minerals, and vitamins based on the specific stage of goat development. Compliance with BIS standards are crucial for formulating balanced rations that support optimal growth, reproduction, and productivity in goats.

Nutrient	Stage of Development	Recommended Level (per kg of feed)
Energy	Growing kids	2,800 - 3,000 kcal
	Adult maintenance	2,200 - 2,500 kcal
	Lactating does	2,800 - 3,500 kcal
Protein	Growing kids	16 - 18%
	Adult maintenance	10 - 12%
	Lactating does	14 - 16%
Minerals	Calcium	0.6 - 1.2%
	Phosphorus	0.3 - 0.6%
	Sodium	0.2 - 0.4%
	Potassium	0.6 - 1.0%
	Magnesium	0.2 - 0.4%
Vitamins	Vitamin A	10,000 - 15,000 IU
	Vitamin D	2,000 - 4,000 IU
	Vitamin E	20 - 40 IU
	Vitamin B12	2 - 4 mcg

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Nutritional Requirement of Goat

Sr.	Nutrient	Requirement
1	Dry matter	For dairy goats
	In temperate region	5-6% of live weight
	In tropical region	4-5% of live weight
	For meat type goats	2.5-3% of live weight
2	Concentrate	
	For maintenance ration	250g for every 50 kg body weight
	For production ration	450g for every 2.5 lit. milk/ doe
	For pregnancy ration	During last 2 month of gestation 220g daily/ doe
	Stud buck	400g daily.
3	Water	450- 680 g/ day for a goat weighting 18-20 kg
4	Dry matter: total water intake ratio	1:4

Feeding Does in Different Stages

Feeding Breeding Does

If there is abundant pasture available, there is no need to supplement with a concentrate mixture. In poor grazing conditions, breeding does can be supplemented with a concentrate mixture ranging from 150 to 350 grams per animal per day, depending on their age. The concentrate mixture used for adult does should have a digestible crude protein level of 12%.

Feeding Does During the First Four Months of Pregnancy

Pregnant does should have access to good quality pasture for 4-5 hours per day. Their ration should be supplemented with 5 kilograms of available green fodder per head per day.

Feeding Does During the Last One Month of Pregnancy

During this period, fetal growth increases significantly, and lack of sufficient energy in the feed can lead to pregnancy toxaemia in does. Does should be allowed in high-quality pasture for 4-5 hours per day. In addition to grazing, does should be fed with a concentrate mixture of 250-350 grams per animal per day. Their ration should be supplemented with 7 kilograms of available green fodder per head per day.

Feeding Does at Kidding Time

As kidding time approaches or immediately after kidding, the grain allowance should be reduced, and good quality dry roughage should be fed free-choice. It is preferable to feed lightly on the day of parturition but provide plenty of clean, cool water. Soon after kidding, the doe should be given a small amount of slightly warm water. The doe's ration can be gradually increased after parturition, and she should receive the full ration in divided doses six to seven times a day. Bulky and laxative feedstuffs can be included in the ration during the first few days, and a mixture of wheat bran and barley, oats, or maize at a 1:1 proportion is recommended.

Feeding Lactating Does

Lactating does require an adequate diet to support milk production. Recommended rations include 6-8 hours of grazing combined with 10 kilograms of cultivated green fodder per day, or 6-8 hours of grazing with 400 grams of concentrate mixture per day, or 6-8 hours of grazing with 800 grams of good quality legume hay per day.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Feeding Non-Pregnant Does

If there is sufficient pasture available, there is no need to supplement with a concentrate mixture. In poor grazing conditions, non-pregnant does can be supplemented with 150-200 grams of concentrate per animal per day.

Feeding Bucks for Breeding

Bucks are usually allowed to graze with does, and their nutritional requirements are typically met through this practice. If separate feeding facilities are available, the buck can be given half a kilogram of a concentrate mixture consisting of oats or barley, maize, and wheat.

Feeding Kids

Feeding from Birth to Three Months of Age

Immediately after birth, kids should be fed with colostrum, which is the first milk produced by the dam. Up to 3 days of age, the dam and kids should be kept together to allow frequent access to milk. From 3 days to the weaning period, kids should be fed with milk 2 to 3 times a day. At around 2 weeks of age, kids should be introduced to eating green roughages.At one month of age, kids can be provided with a concentrate mixture known as creep feed.

Colostrum Feeding of Kids

Colostrum feeding is crucial for limiting kid losses. Kids should be allowed to suckle their dam for the first three to four days to receive an adequate amount of colostrum. If dam's colostrum is unavailable, cow colostrum can be used as a substitute. Colostrum should be given at a rate of 100 millilitres per kilogram of live weight. Colostrum can be preserved using propionic acid or formaldehyde, ensuring it is stored in a cool place.

Creep Feeding for Kids

Creep feeding can begin at one month of age and continue until 2-3 months of age. The purpose of creep feeding is to provide additional nutrients for rapid growth. The recommended quantity of creep feed is 50-100 grams per animal per day, containing 22% protein. Antibiotics like oxytetracycline or chlortetracycline can be mixed in the feed at a rate of 15 to 25 milligrams per kilogram of feed.

Feeding after Three Months to Twelve Months of Age

During the day, goats should graze in the pasture for approximately 8 hours. They can eat grass and other plants to meet their nutritional needs. However, to ensure they receive enough nutrients, they may require additional feed in the form of a concentrate mixture. This can be given at a rate of 100-200 grams per animal per day, and the concentrate should contain a protein content of 16-18%. In the summer months or on rainy days when grazing is limited, goats should be provided with dry fodder during the night. This helps ensure they have access to food even when pasture is not available. Dry fodder can include hay or other dried plant materials.

Feeding Systems of Goats

Tethering

Tethering is a feeding system used when there is limited grazing space and only one or two goats are being kept. In this system, the goat is tied with a rope that is typically 3-5 meters in length. This allows the goat to browse and eat grass within a limited area. It is important to change the location of the tethered goat regularly to ensure they have access to enough grass to meet their nutritional needs. Additionally, a temporary or portable shelter should be

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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provided nearby so that the goat can seek shelter during extreme weather conditions. Tethering is a practical and cost-effective way to utilize available grass resources and can be suitable for rearing goats with limited resources.

The Intensive or Zero-Grazing System

The intensive or zero-grazing system involves keeping goats in stalls or enclosed areas and providing them with cultivated fodders, both fresh and conserved, as well as concentrates to meet their nutritional requirements. This system ensures that goats receive optimal nutrition, leading to improved performance in terms of growth, milk yield, reproductive performance, and twinning percentage. However, implementing the intensive system requires higher investments in labor and capital, limits exercise opportunities for goats, and can make heat detection more challenging.

The Extensive or Range System

The extensive or range system of goat rearing involves small farmers and landless laborers taking their goats and sheep on long journeys in search of food and water. This method allows goats to browse for approximately 8-9 hours a day. The advantages of this system are its ease and convenience, low resource requirements, and low capital and labor expenses.

Additionally, it contributes to soil fertility through the animals' manure and urine, and helps control weeds. However, the limitations include the low natural potential of range lands, which have extreme weather conditions and less nutritious soil. Feed availability also fluctuates across regions and seasons, resulting in limited nutritional resources for the animals and restricting productivity.

The Semi-intensive System

The semi-intensive system of goat rearing combines aspects of both intensive and extensive systems. In this system, goats are allowed to graze for 4-6 hours and then kept in stalls where they are provided with roughage and concentrate mixture, depending on availability. The performance of goats in this system depends on the quality and quantity of feeds provided through limited browsing and supplementary feeding. Compared to the extensive system, the semi-intensive system offers a higher level of nutrition for the goats.

Water Requirement

Goats require fresh and clean water. They will not drink water that is dirty or contaminated unless they are extremely thirsty. It is important to prevent goats from defecating in the water, as this can lead to infections caused by coccidia and other internal parasites. Goats generally drink up to three to four times the amount of dry food they consume. During winter, providing slightly warm water can encourage goats to drink more. Additionally, goats drink approximately 3.5 liters of water for every liters of milk they produce.

Feed Sources for Goats

Goats are natural browsers and can efficiently utilize a wide range of forage resources. Pasture and browsing forages form the foundation of goat diets, providing a diverse array of nutrients and roughage. Browsing allows goats to selectively consume leaves, twigs, and shrubs, meeting their nutritional requirements. where natural forage resources are limited, supplementary feeding becomes necessary to meet goats' nutritional needs. Supplementary feeds include concentrates, roughages, by-products, and mineral supplements.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Common Feed Resources for Goat

Tree Leaves	Babul, Subabul, Mango, Pipal, Neem
Grasses	Para, Guinea grass
Legume Fodders	Berseem, Lucern, Cowpea
Cereal fodder	Maize, Jowar, Oats
Dry Feed	Cereal Straw, Legume Straw, gram husk

Advanced Feeding Strategies in Goat Feeding

Phase Feeding: Phase feeding is a feeding strategy that involves adjusting the diet of goats based on their specific nutritional requirements at different stages of growth or production. It aims to provide the right balance of nutrients during each phase, such as the early growth phase, pregnancy, lactation, or maintenance phase. By tailoring the diet to meet the specific needs of the goats at different stages, phase feeding helps optimize growth, reproduction, and overall health.

Split Sex Feeding: Split sex feeding is a feeding strategy that recognizes the distinct nutritional requirements of male and female goats. It involves providing separate diets or adjusting the nutrient composition of the feed for males and females to meet their specific needs. This strategy ensures that the nutritional requirements for growth, reproduction, and maintenance are met efficiently, leading to better performance and health in both male and female goats.

Dynamic Feeding: Dynamic feeding is a flexible feeding approach that takes into account the changing nutritional needs of goats based on factors like body weight, growth rate, pregnancy, lactation, and environmental conditions. It involves adjusting the quantity and composition of the feed regularly to meet the changing demands of the goats. By dynamically adapting the feeding program, goat farmers can optimize nutrient intake, prevent undernutrition or overfeeding, and promote optimal growth and production.

Feed Additives: Feed additives are substances added to the goat's diet to enhance performance, health, and overall well-being. These additives can include probiotics, prebiotics, enzymes, vitamins, minerals, and other supplements. Probiotics and prebiotics improve gut health and digestion, while enzymes enhance nutrient utilization. Vitamins and minerals play crucial roles in various metabolic processes. By incorporating feed additives into the diet, goat farmers can support the goats' physiological functions, improve nutrient absorption, and boost immunity.

CONCLUSION

Overall, understanding the feeding habits, nutritional requirements, and feeding strategies in goat rearing is essential for goat farmers to achieve optimal performance, reproduction, and health in their herds, contributing to the sustainable and profitable management of goat farming enterprises.

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CHAPTER – 13

Goat Housing and Facilities: Enhancing Welfare and Productivity through Design Considerations

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ABSTRACT

Goat housing and facilities play a vital role in ensuring the welfare and productivity of these animals. This abstract provides an overview of the key considerations in designing goat housing systems and highlights their impact on animal welfare and productivity. Effective goat housing design involves factors such as space allocation, ventilation, lighting, flooring, and layout. Providing adequate space is crucial to prevent overcrowding and allow goats to exhibit natural behaviors. Ventilation systems maintain good air quality, regulate temperature, and reduce the risk of respiratory issues. Proper lighting conditions support normal physiological functions and reproductive management. The choice of flooring material influences comfort, hygiene, and hoof health, while the layout of housing structures facilitates efficient workflow and functional areas for feeding, watering, and bedding. The welfare implications of housing and facilities are significant. Well-designed systems enable goats to express natural behaviors, reducing stress levels and improving overall well-being. Access to clean water, balanced feed, and suitable bedding materials is essential for proper nutrition, hydration, and rest. Enrichment materials and structures promote mental stimulation, physical activity, and social interactions. Adequate space and ventilation minimize the occurrence of respiratory diseases and parasitic infestations. In terms of productivity, an optimal housing environment positively influences feed intake, growth rates, reproductive performance, milk yield, and meat quality. Proper ventilation and temperature control contribute to efficient nutrient utilization and prevent heat stress and respiratory issues. Well-designed feeding and watering systems ensure access to balanced nutrition, supporting growth and milk production. Additionally, appropriate housing design assists in the management of kidding, reducing mortality rates and promoting the health of newborns. In conclusion, the design of housing and facilities for goats should prioritize both animal welfare and productivity. Considerations such as space allocation, ventilation, lighting, flooring, and layout are crucial for creating a suitable environment. By understanding the impact of housing on goat welfare and productivity, practitioners can optimize goat management practices and improve the overall well-being and productivity of these valuable animals.

Keywords- *Design considerations, Goat housing, Productivity, Ventilation, Welfare.*

INTRODUCTION

Goat housing and facilities are vital components of successful goat management systems. The design and construction of suitable housing systems significantly impact both the welfare and productivity of goats. Well-designed housing not only provides goats with a comfortable and secure environment but also allows them to exhibit natural behaviors, minimizes stress, and promotes overall well-being. Moreover, proper housing conditions contribute to optimal growth, reproduction, milk production, and meat quality. One of the key considerations in goat housing design is space allocation. Providing adequate space is crucial to prevent overcrowding and enable goats to engage in their natural behaviors, such as lying down, moving, and socializing. Insufficient space can lead to stress, aggression, and various health issues. Proper space allocation involves grouping and separation of goats based on factors like age, size, and behavior. Additionally, the provision of exercise areas and outdoor access allows goats to engage in physical activity and explore their surroundings, which positively

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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impacts their overall well-being. Ventilation is another critical aspect of goat housing design. Good ventilation ensures proper air exchange, regulates temperature, and reduces the risk of respiratory issues. Stagnant air, high humidity, and poor air quality can lead to respiratory diseases and decreased productivity. Effective ventilation systems can be achieved through a combination of natural ventilation, such as windows and openings, and mechanical ventilation, including fans and air exchange systems. Determining appropriate ventilation rates based on goat density, ambient temperature, and airflow requirements is essential for maintaining optimal air quality within the housing system. Proper lighting conditions within goat housing also play a significant role in goat welfare and productivity. Goats, like other animals, have specific lighting requirements to support normal physiological functions and reproductive management. The natural lighting provides important cues for circadian rhythms and influences goat behavior and reproduction. In cases where natural lighting is insufficient, the provision of artificial lighting can help maintain appropriate lighting schedules and promote optimal performance. The choice of flooring material is another critical consideration in goat housing design. The flooring should provide comfort, promote hoof health, and be easy to clean and maintain. Different flooring materials have varying characteristics, such as traction, drainage, and durability. Proper flooring reduces the risk of hoof problems and improves overall goat comfort and hygiene. In addition to the above factors, the layout of housing structures and the organization of functional areas are important aspects of goat housing design. A well-designed layout facilitates efficient workflow and ensures the availability of functional areas for feeding, watering, and bedding. Optimizing the layout minimizes labor requirements, improves accessibility for management tasks, and enhances overall operational efficiency. Moreover, the site selection for goat housing and the environmental conditions play a significant role. Goats do not thrive on marshy or swampy ground, and grazing areas should be free from pits and shallow pools, as goats can contract parasitic infections mainly from such places. Housing aims to protect animals from harsh and uneven climates as well as environmental stress. The physical surroundings of goats form their environment, which could be a microenvironment immediately surrounding the animal or a macroenvironment, which refers to the broader area in which the animal inhabits. Proper combinations of various meteorological components, such as temperature, humidity, precipitation, winds, and sunlight, are necessary to provide the needed comfort to goats. In the era of changing climates and unpredictable rainfall patterns, new diseases have emerged in the animal production system. Controlled housing could be a potential solution to these problems, although its installation cost may be expensive. Currently, there is a lack of systematic studies on goat housing, particularly in regions like India. Therefore, the basic idea is to adjust different meteorological components and bring them within the range that makes goats feel pleasant and comfortable.

Important Points to be Considered in Goat Housing

1) **Proper site selection**: Goat housing should be constructed on a dry and elevated area to prevent flooding and waterlogging, ensuring the safety and well-being of the goats.
2) **Maintaining dry floors**: The flooring of the goat house should be kept dry at all times to minimize the risk of moisture-related diseases and promote a hygienic environment.
3) **Adequate ventilation and lighting**: Goat housing should be designed to allow sufficient light and air circulation. Proper ventilation helps control temperature and humidity levels, reducing the risk of respiratory issues and creating a comfortable living space.In general, a width of 2.5 to 3 meters is considered suitable for comfortable accommodation of goats. However, under Indian conditions, it is recommended to limit the width to a maximum of 20 feet (approximately 6 meters). While there are no specific restrictions on the length of

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the goat housing, it is advisable to create partitions at intervals of 30 feet (approximately 9 meters).

4) **Moisture control**: It is crucial to keep the goat house free from dampness and prevent rainwater from entering. Moist conditions can contribute to the development of various diseases, so maintaining a dry environment is essential.
5) **Suitable construction materials**: Walls made of concrete or bamboo poles provide strength and stability to the goat house. These materials offer durability and protection from external elements.
6) **Comfortable and spacious housing**: Goat housing should be designed to provide enough room for the goats to rest comfortably. Sufficient space allows them to exhibit natural behaviors and reduces stress.
7) **Regular cleaning and waste management**: Regular cleaning of the goat house is essential to maintain cleanliness and hygiene. Proper waste management helps prevent the accumulation of filth and minimizes the risk of diseases.
8) **Seasonal care**: Extra care should be taken during the rainy season and winter to protect goats from cold and wet conditions. Pneumonia can be a significant concern during these periods, so appropriate measures should be taken to provide adequate shelter and protection.

Orientation

Orientation is a crucial factor in the design of goat sheds, particularly concerning ventilation. Optimal shed design ensures proper air circulation while providing goats with protection from direct sunlight. An east-to-west orientation is generally preferred as it allows for a balanced distribution of warmth and coolness during winter days. This orientation allows goats to benefit from adequate sunlight in the morning while shielding them from excessive exposure during the day. The free movement of air in the shed prevents dampness and minimizes the proliferation of parasites and worms, thus contributing to the overall health of the goats. It is important to note, however, that proper vaccination protocols for goats should still be strictly followed to ensure their well-being.

Ventilation

Proper ventilation is critical for maintaining an optimal interior temperature of 28 to 30°C within the goat shed. In high-temperature environments exceeding 30°C, if goats are unable to dissipate heat effectively, they tend to eat less, resulting in decreased productivity. Additionally, inadequate ventilation leading to excessive warmth and humidity can contribute to the onset of pneumonia among the goats. Sudden fluctuations in temperature also pose a risk. Therefore, it is essential to design the shed with sufficient height and incorporate openings in the roof or walls to facilitate proper air circulation and ventilation. This ensures a comfortable and healthy environment for the goats, promoting their overall well-being and productivity.

Lighting

Lighting plays a significant role in goat housing, influencing various aspects of their health and well-being. Proper lighting helps regulate the circadian rhythm, ensuring a consistent day-night cycle. It also affects reproduction, as appropriate photoperiods stimulate hormone secretion and enhance breeding performance. Lighting conditions impact growth, bone development, and milk production in goats. Moreover, adequate illumination promotes normal behavior, reduces stress, and supports overall welfare. Therefore, optimizing lighting

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conditions in goat housing is crucial for their physiological processes, reproductive performance, growth, milk production, and overall health.

Roof

The roof of the goat house serves as protection against sunlight and rain. There are different roof styles to choose from, such as shed, gable, or modified gable. The slope of the roof is important for draining rainwater, with thatched roofs requiring a steeper slope compared to iron sheeting. In areas with high rainfall, a greater slope is beneficial. The roof should be waterproof and have sufficient overhang to prevent rain from entering. Proper ventilation is crucial for maintaining the health of the animals. A higher roof encourages air movement, but it is more prone to damage in strong winds. Adding a roof vent can help improve ventilation. Roofs can be made of various materials, including iron sheets, grass/bushes, wood, stone/brick, or earth, depending on factors such as the farming system, material availability, and climate.

Flooring

When it comes to flooring, it is important to consider both durability and comfort for goats. Mud flooring is a preferred and cost-effective option. However, cement flooring has gained popularity due to its ease of cleaning and ability to prevent the presence of parasites commonly found in mud beds. Elevated flooring, while beneficial for labor efficiency and cleanliness, can be expensive. It is a viable choice for those with a larger budget and seeking guidance from experienced goat farmers for their farm setup. In terms of floor type, packed earth, concrete, or slatted floors are commonly used.

1) **Packed earth** or concrete floors should have a slight slope of about 5% (1:20) to ensure proper drainage. Raised platforms along the longest wall of the barn provide goats with an elevated resting area, away from manure and urine.
2) **Slatted floors**, known for their hygiene benefits, have a lower occurrence of diseases. However, their cost restricts their use to larger farms. Slatted floors should be raised approximately 1-1.5 meters above ground level to facilitate easy cleaning and dung collection. The gap between the slats should measure 1.4 to 1.6 cm, allowing fecal matter to pass through while ensuring secure footing for the animals. It is important to note that newborn and young goats should not be placed on slatted floors.In tropical and subtropical regions, raised, slatted floors offer several advantages. They eliminate the need for bedding, prevent disease and parasite infestation by allowing waste to drop through, require less labor for maintenance, remain relatively dry and clean, reduce space requirements, facilitate easy collection of manure for fertilization or sale, and enhance ventilation for the animals during hot weather.However, it is worth mentioning that the main drawback of raised, slatted floors is their high construction cost. While materials like bamboo may be cheaper than wood, they may not provide the same level of secure footing. Commercial wood is generally preferred over bamboo due to its strength and durability. It is crucial to consider factors such as cost, ease of installation, and safety when selecting flooring materials for slatted floors. Additionally, inadequate gap width or poor maintenance of existing slatted floors can lead to leg and foot problems in goats.
3) For a more hygienic approach, **pucca flooring** is highly recommended. Breeding and dry stock can be maintained with some bedding material on a pucca floor. Regular cleaning with disinfectant, either on a daily or weekly basis, is advisable. However, it is important to note that hoof problems may arise with this type of flooring.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Types of Sheds in an Organized Goat Farm

1) **General Flock Shed:** The flock shed is designed to house ewes or does specifically for breeding purposes. It is recommended that the shed dimensions be 15 meters in length, 4 meters in width, and 3 meters in height, providing sufficient space for up to 60 ewes or does. To ensure durability and hygiene, the shed should have a three-meter height and a floor constructed with brick-on-edge. In regions prone to low lying areas and heavy rainfall, it is preferable to elevate the floors. In temperate regions, strong wood can be used as an alternative material for the floors.

2) **Shelter for Bucks:** Bucks should be housed separately to avoid potential fights, especially during the breeding season. It is recommended to provide a single stall with dimensions of 2.5 meters by 2.0 meters. The stall should include the necessary fittings for food and water.

Space for Goats in Stanchions and Confinement

When keeping goats in stanchions, each stanchion should measure 0.75 meters in width and 1.2 meters in length. For goats confined in pens for longer periods, a minimum floor space of 2 square meters should be provided.

1) **Kidding Sheds:** These sheds are designed as maternity rooms specifically for pregnant ewes or does, ensuring individual housing for each animal. The dimensions of the shed are recommended to be 1.5 meters in length, 1.2 meters in width, and 3.0 meters in height. To facilitate feeding, a manger for holding feed and hay, as well as a bucket for water, should be provided within the shed.It is essential to create a draught-free environment in these maternity sheds to protect the animals from drafts and extreme weather conditions. In cold climates, additional measures should be taken to provide warmth to the newborns. This can include installing a warming device, such as a room heater, in the maternity pens to ensure the newborns are protected from the cold during winter.
2) **Exercise Paddock for Stall-fed Goats:** An enclosure measuring 12 meters by 18 meters is sufficient for 100 to 125 goats. The exercise paddock should be well-fenced with sturdy woven wires, particularly closer to the bottom to prevent escapes. It is advisable to make the exercise paddocks larger than the enclosures and provide some shade trees if the goats will be continuously confined. Use extra-strong woven wire since goats tend to climb fences and rub against them. Avoid using barbed wire to prevent injury to the udder and teats. For exercise, provide a box measuring 1 meter by 1 meter and 60 centimeters in height, along with a stationary steel drum or a log measuring 30 centimeters by 2.4 centimeters.
3) **Segregation Shed:** In the case of a large herd, it is highly desirable to have a small segregation shed with dimensions of approximately 3.6 meters by 5 meters. This shed should be located in a remote corner of the farm and equipped with a well-fenced yard. It should be divided into two or three sections, and each stall and yard should have separate watering arrangements.
4) **Hay Racks:** To minimize waste, hay racks are beneficial for feeding goats. The bars of the hay racks should be spaced no more than 5 centimeters apart. Additionally, a wooden board should be fixed about 15 centimeters below the rack to catch any hay that falls while the goat is feeding.

Indian Journal of Livestock and Veterinary Research
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Feeding and Watering Space Requirement

Type of animal	Space per animal (cm)	Width of manger/ water trough (cm)	Depth of manger/water trough (cm)	Height of inner wall of manger/ water trough (cm)
Adult goat	40 - 50	50	30	35
Kids	30 - 35	50	20	25

Recommended Space Requirements for Indian Conditions

Age groups	Covered space (sq.m)	Opened space (sq.m)
Up to 3 months	0.2-0.25	0.4-0.5
3 months to 6 months	0.5-0.75	1.0-1.5
6 months to 12 months	0.75-1.0	1.5-2.0
Adult animal	1.5	3.0
Male, Pregnant or lactating ewe/doe	1.5-2.0	3.0- 4.0

CONCLUSION

Goat housing and facilities are crucial for successful goat management. Designing housing systems that consider factors such as space allocation, ventilation, lighting, flooring, and layout is essential to provide goats with a comfortable and functional environment that promotes their well-being and productivity. Furthermore, selecting appropriate sites and adapting to environmental conditions contribute to the overall adaptability and resilience of goats. Continued research and studies are necessary to advance scientific understanding and develop cost-effective solutions for goat housing, particularly in regions facing climate change and emerging challenges.

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CHAPTER – 14

Advances in Artificial Insemination and Cryopreservation Techniques of Goat Semen: A Comprehensive Overview

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ABSTRACT

The goat is referred to as the "poor man's cow" since goat farming has proven to be an important contributor to the growth of rural farmers. Cryopreservation of semen and artificial insemination serve as key processes to improve the progeny's genetic potential. These methods have revolutionized goat breeding practices, providing several advantages in terms of genetic advancement, disease prevention, reproductive success, and financial efficiency. In contrast to other animals, such as the bull, freezing the semen in bucks is quite challenging. Despite the widespread use of artificial insemination in many species, including goats, there are still certain challenges, particularly when using frozen semen. Egg yolk is traditionally utilized in the preparation of semen extender, which coagulates due to the presence of egg yolk-coagulating enzymes secreted by the bulbourethral gland of a goat. As a result, several issues arise during the cryopreservation of goat semen. Hence, various problems are faced during the cryopreservation of goat semen. Cryopreservation protocols which are optimized for one species may not be suitable for another species. However, challenges such as maintaining sperm viability during cryopreservation and the need for specialized protocols warrant ongoing research and advancements in the field. Overall, artificial insemination and cryopreservation represent valuable tools in goat breeding programs, supporting the sustainable development and genetic advancement of goat populations worldwide. Therefore, we need to study the species-specific cryopreservation protocols so that the cryo survivability and post-thaw motility of semen can be enhanced. This review aims to explore information regarding artificial insemination in goats, the effects of factors present in the seminal plasma of goats advances in semen preservation, and the scope of new extenders and additives enhancing the quality of goat semen.

Keywords: *Artificial insemination, Buck semen, Cryopreservation.*

INTRODUCTION

Goat farming has a promising future as goat farming plays an important role in the socio-economic development of poor farmers. Goats can easily adapt to adverse climatic conditions and nutritional deficiencies. According to 20th livestock census, the total goat population in the country is 148.88 million in 2019. Total goats have increased by 10.14% over the previous Livestock Census (2012). About 27.8% of the total livestock is contributed by goats. However, the number of bucks is less in comparison to the does. The female goat population is 116.78 million which has increased by 19.71 % in comparison to the previous livestock census. The male population was 32.10 million in 2019 vs 37.62 million in 2012 which has decreased by 14.65 %. The highest number of goats is found in Rajasthan followed by West Bengal and Uttar Pradesh. The low male-to-female ratio in the goat population also become the biggest problem due to indiscriminate slaughter of the male goat and early castration of the male kids (Khandoker et al., 2011). Breeding bucks are fewer in number in comparison to the number of females. Small flock owners depend entirely on large flock owners, who typically keep breeding males because they do not maintain breeding males themselves (Goel and Kharche, 2016). Detection of superior breeding buck is challenging for goat farmers (Tajonar et al., 2022). Cryopreservation is also a difficult process which is done by keeping in

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my mind many factors essential for the survival of sperm of specific species. Proper knowledge should be required to understand the physiology and requirements of a sperm cell. Various factors like temperature, ice crystal formation, osmotic balance, etc. affect sperm cryo survivability. Even though goat sperm and sperm from other domestic species have many similarities, including the use of the same kind of cryopreservation media, cryoprotectants, and freezing and thawing rates to preserve these sperm, goat sperm requires special consideration to maximize the post-thawing viability (Purdy, 2006). Goat semen contains an egg yolk coagulating lecithinase enzyme which can affect the semen quality. Cryopreservation of high-quality goat semen (Ranjan et al., 2022) and artificial insemination (AI) is the need of the hour to preserve the superior germplasm. The current chapter comprehensively analyses the significant facts about cryopreservation advancements and artificial insemination in goats.

Artificial Insemination in Goat Reproduction

Goats are short-day breeders. During summer, the ovaries of anestrous does develop follicles and secrete estradiol when stimulated with luteinizing hormone (LH). It appears that prolactin fluctuations are unrelated to the seasonality of mating in sheep and goats, even though follicular activity fluctuates annually in synchrony with circannual fluctuations in prolactin production and day length. Low progesterone (P4) increases the size of the largest follicles and the age of the oldest ovulatory follicles. Embryos resulting from the ovulation of older and younger follicles in the same doe do not differ in their ability to survive (Hafez and Hafez, 2013). In the case of does, the length of estrus is 36- 48 hours with an estrous cycle of 18-21 days (Fatet et al., 2011). Estrus signs are more obvious in does than in ewes. They show symptoms like restlessness, off fed, frequent bleating, frequent micturition, flagging of the tail, etc. The vulvar mucosa of the estrus does become pink in color, swollen and moist. The majority of goat breeds ovulate 24 to 36 hours following the start of estrus. Therefore, it is highly recommended that farmers should bring does after 24 to 30 hours of heat symptoms (Dhara et al., 2023). Sometimes, if the farmers are not able to notice the exact time of heat symptoms, then double insemination is also advised.

Methods of Artificial Insemination

There are various kinds of techniques for artificial insemination in small ruminants; vaginal, cervical, laparoscopic intrauterine, and transcervical intrauterine insemination. Out of all the techniques, Sohnrey and Holtz, (2005) found that transcervical intrauterine insemination leads to 71 % conception whereas another researcher Nuti, 2007 reported that the conception rate was 40-80% in the cervical insemination method. Vaginal insemination is most commonly used for liquid or chilled semen but not with frozen semen. The conception rate is low in this method if frozen semen is being used. The cervical or intracervical method is the most popular and economical method used at the field level. In this method, semen is inseminated in the cervix. It is preferred for every kind of semen liquid fresh semen/ frozen semen.

Steps for Artificial Insemination in Doe

1) Firstly, take the proper history of the animal, ask about the heat symptoms and proper timings of discharge, last pregnancy, and mating.
2) Do the physical examination of the animal by yourself by noting the heat signs like swelling of vaginal mucous membrane and discharge.
3) Confirmation of estrus is done using a vaginal speculum. For this, the hind legs of the doe are lifted at 45° angle and the vaginal speculum is inserted.

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4) After confirmation of estrus, the AI gun should be loaded with semen straw.
5) Straw is taken out from the liquid nitrogen cylinder and placed in a thawing unit at 37° C for 30 seconds for the thawing of semen.
6) After thawing, semen straw is wiped properly and loaded in an artificial insemination gun.
7) Clean the vulva and perineal region of the doe to maintain the sterile environment inside the reproductive tract otherwise, it adversely affects the conception rate and can also lead to infection in the animal.
8) Insert a vaginal speculum lubricated with a non-spermicidal lubricant to know the exact position of the cervix and its external opening. A light source can be used in case the opening is not visible.
9) Insert an AI gun in the cervical opening and deposit the semen in the cervix.
10) Remove the gun and speculum slowly and keep the animal in the same position so that there will be no backflow of semen.

SEMEN HANDLING

Biochemical Characteristics of Semen

The cryopreservation process poses a negative impact on the spermatozoa by causing changes in ultrastructural, biochemical, and functional properties resulting in the reduction of post-thaw sperm attributes and fertility. Goat semen is not compatible to be diluted in egg yolk and milk diluents, as harmful effects of egg yolk extenders have been noticed by Roy (1957) and with milk, by Nunes et al. (1982). Roy (1957) found out that there is an egg yolk coagulating enzyme (EYCE) in the seminal plasma of buck semen which is secreted by the bulbourethral gland. This enzyme was found to coagulate the egg yolk portion of tris egg yolk citrate dilutor. Semen quality was found unaffected when seminal plasma was removed before the semen extension. The amounts of the hydrolysates, which vary with pH, temperature, seminal plasma concentration, season of semen generation, and breed of fowl providing the egg yolk, influence the toxicity of EYCE. Sperm survival following storage at 48° C was higher for ejaculated goat spermatozoa that had been washed once before being diluted than for unwashed spermatozoa (Roy, 1957; Iritani et al., 1961). Similarly, Nunes et al. (1982) discovered a protein (SBUIII) from the goat bulbourethral gland that reduced the survival of chilled or frozen goat sperm diluted in milk-based media. Pellicer-Rubio et al. (1997) later reported induction of acrosome reaction and subsequent cell death of spermatozoa incubated in milk medium at 37° C. Seminal plasma is removed before the extension of buck semen in the egg yolk extender. Pellicer-Rubio and Combarnous (1998) proposed some alternative extenders containing lipid-free cow milk, a triglyceride-free diluent containing milk protein casein or using milk from species other than dairy cows or adding BUSgp60 lipase inhibitors in the extender to prevent the negative interactions between the seminal plasma contents and egg yolk contents. Iritani et al. (1961) identified EYCE as phospholipase A and found out that it acts as a catalyst that hydrolyzes egg yolk lecithin into fatty acids and lysolecithin. This hydrolysate is toxic to the sperm as it leads to acrosomal reaction (Upreti et al., 1999), and chromatin decondensation (Sawyer and Brown, 1995) due to the increase in fusogenicity of the sperm membranes. All these changes are toxic to the sperm cell and decrease the cryo survivability of spermatozoa. SBUIII also known as bulbourethral gland glycoprotein lipase (BUSgp60), is a 55-60 kDa compound that causes hydrolysis of plasma membrane triglycerides and triglycerides in skim milk that result in fatty acid production. An egg yolk extender leads to the production of lysolecithin and milk triglycerides leads to the formation of oleic acid that is reported to be harmful to sperm (Pellicer-Rubio et al., 1997). The addition of the SBUIII to washed sperm cells was

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detrimental to sperm viability in the milk diluent, whereas SBUIII did not affect spermatozoa diluted in Krebs-Ringer-Phosphate-Glucose KRPG solution. Researchers suggested that an enzyme from BUS would either react with a milk component or, in the opposite situation an enzyme from milk would react with an SBU component to produce a substance that is lethal to spermatozoa. (Leboeuf et al., 2000).

Semen Freezing in Goat

Washing of buck semen is done immediately to remove the seminal plasma after collection. Removal of seminal plasma before the extension of semen in the egg yolk extenders or milk diluents increases the quality and cryo survivability of spermatozoa. Cells are washed either once or twice, each for 10–15 min at 550–950 × g (Nunes et al., 1982; Ritar and Salamon, 1982). The presence of vesicular gland secretions during the breeding season, which are absent during the nonbreeding season, was hypothesized to somewhat limit the detrimental effect of bulbourethral gland secretion (Nunes et al., 1982). Corteel (1974) reported that washing semen increases the quality of semen in washed groups in comparison to control. The same was observed by other researchers (Ritar and Salamon, 1982, Memon et al., 1985) in egg yolk-based extenders. Moreover, the recovery after thawing of washed spermatozoa was similar to non-washed cells, but washing markedly improved survival during incubation at 37° C for 6 h, especially when egg yolk 1.5% and 6% was present (Ritar and Salamon, 1982). As centrifugation or washing causes damage to the sperm plasma membrane, Ritar and Salamon (1982) suggested that the number of washings can be reduced by dilution of the semen at a higher rate 1:20 and the efficiency of washing can be increased by a high dilution ratio. Goat sperm can be cryopreserved in egg yolk and milk-free media, but this work was performed on cauda epididymal sperm, not ejaculated cells (Kundu et al., 2001, 2002).

Diluents

The aim to use a cryopreservation diluent is to provide the sperm cells with sources of energy, protect the cells from temperature changes, and maintain a befitting environment for the spermatozoa to survive. In general, a cryopreservation diluent contains ingredients like a non-penetrating cryoprotectant (milk or egg yolk), a penetrating cryoprotectant (glycerol, ethylene glycol, or dimethyl sulfoxide), a buffer (Tris), one or more sugars (glucose, lactose, raffinose, saccharose, or trehalose), salts (sodium citrate, citric acid) and antibiotics (penicillin, streptomycin) (Evans and Maxwell, 1987). Several diluents have been examined for freezing goat semen such as reconstituted skim cow milk, sodium citrate–glucose–yolk, lactose–yolk, saccharose– EDTA.CaNa-yolk, raffinose-yolk, Spermasol-yolk, IVT-yolk, tris-yolk, and test-2 yolk (Leboeuf et al., 2000). However, for Goat semen cryopreservation, a non-fat dried skim milk diluent (Corteel, 1974) or a Tris–glucose diluent (Salamon and Ritar, 1982) has been recommended. Corteel (1974) added 14% glycerol-containing skim milk in three steps at 10-min intervals, leading to a 7% final concentration. In another experiment, Ritar and Salamon (1982) added glycerolated tris-based diluent to the non-washed semen in a single step at 30°C and the final concentrations were made 4% and 2% for glycerol and egg yolk respectively in the diluted semen (Evans and Maxwell, 1987). Azawi et al. (1993) evaluated the effect of extension of semen in six different diluents- egg yolk citrate (YC), egg yolk fructose phosphate (YFP), egg yolk citrate fructose glycine (YGC), egg yolk cow skim milk (YSKM), Illinois variable temperature extender (IVT), egg yolk tris fructose (YTF). YTF and IVT diluents were found to be better in comparison to other diluents up to 120 hours of preservation. Individual motility (21.7%, 18.5%), percentage of live sperm (24.1%, 20.0%), and sperm damage (33.4%, 31.7%) were greater for YTF and IVT in comparison to

Indian Journal of Livestock and Veterinary Research
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other diluents. They also concluded that changes occurring due to harmful interaction between egg yolk and seminal plasma enzymes can be avoided by using YTF and IVT extender with 10% egg yolk. Kalyani et al. (2015) studied the cryopreservation of extended Black Bengal buck semen in Tris-egg yolk citric acid-glucose-glycerol (TEYCGG) extender containing 4 different levels (2.5, 5, 7.5, 10%) of egg-yolk. It was reported that 10% egg yolk gave the highest percentage of abnormal sperm in post-thaw semen. Semen attributes like post-thaw viability, and acrosomal integrity (%) of sperm were highest in the 2.5% egg-yolk extender than extender containing 5% and 7.5% egg yolk. It was concluded that the Tris-egg yolk citrate-glucose-glycerol extender having 2.5% egg yolk level (v/v) was successful to preserve the Black Bengal buck semen. On the other hand, Priyadharsini et al. (2011) reported that 10% egg yolk was better than 20% egg yolk in Jakhrana goat semen regarding seminal attributes like functional membrane integrity and intactness of acrosome. Evans and Maxwell (1987) proposed the use of a low concentration (2%) of egg yolk to protect the buck sperm from cold shock. Singh et al. (2016) assessed the effect of Tris-egg yolk-citrate-fructose-glycerol (TEYCFG) extender containing 4 different concentrations (2.5, 5, 7.5, and 10%) of egg-yolk on post-thaw black Bengal buck (*Capra hircus*) semen. Results were in agreement with Kalyani et al. (2015) as an extender with 2.5% egg yolk was found to be better in comparison to other egg-yolk concentrations. Also, 10% egg yolk caused the highest abnormalities in spermatozoa. The comparative analysis of extenders that contained egg yolk at high concentrations hindered the seminal parameters, indicating that egg yolk may contain some harmful components that are capable of reducing sperm motility at high concentrations Singh et al., 2016). Salmani et al. (2014) compared the effect of different concentrations of soy lecithin (SL, 0.5%, 1%, 1.5%, 2%, and 2.5% w/v) and 15% (v/v) egg yolk-based extender (TR-EY). It was found that the soya bean lecithin 1% and 1.5% extender gave higher post-thaw kinetic compared to the conventional tris egg yolk extender. Moreover, Soya lecithin can also eliminate the negative interaction of egg yolk and seminal plasma proteins. Another researcher Sarıozkan et al. (2010) suggested the use of a commercial extender containing soya bean lecithin (Bioxcell) with or without washing of semen before cryopreservation. Centrifugation was recommended to be avoiding reducing the chances of injury to the sperm cell. Bovine serum albumin and low-density lipoproteins are also being used nowadays. Ali Al-Ahmad et al., 2008) used LDL in goat semen and found that the results were equal to egg yolk extenders. (Bajuk et al., 2018) suggested 300-kDa cutoff semi-permeable cellulose tubing as an alternative method to egg yolk in goat semen cryopreservation.

Additives

Nowadays a lot of additives are also being added during the time of semen processing for research purposes. Various antioxidants, antioxidant preservatives, motility enhancers, targeted antioxidants, etc. are in trend in the research field. Vitamin E, vitamin C, Butylated hydroxytoluene, cholesterol-loaded cyclodextrins, resveratrol, melatonin, pentoxifylline, glutathione peroxidase, mitoquinone, curcumin, etc. are being studied. Atessahin et al. (2008) evaluate the post-thaw quality of goat semen for the effect of various concentrations of taurine (25, 50, 75 mM), trehalose (25, 50, 75 mM), and cysteine (5, 10, 15 mM) against control having no additives. Cysteine worked better at 10 and 15 mM, taurine at 25 mM, and trehalose at 50 and 75 mM. Bucak et al. (2009) carried out a study on Angora goat semen using antioxidants hypotaurine and cysteamine. Sperm motility, morphology, and functional membrane integrity were improved in comparison to the control samples without any additives. BHT improved the post-thaw seminal attributes in the frozen semen of Boer goats (Memon et al., 2011). Another study carried out by Rahmatzadeh et al. (2017) also suggested good results using BHT in Mahabadi goats during the non-breeding season. A combination of

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

additives is also being tried by researchers. Daramola et al. (2017) tried pyridoxine in combination with vitamin E, vitamin C, or melatonin in West African Dwarf goat's semen and reported improved viability and reduced oxidative stress in post-thaw semen.

CONCLUSION

Cryopreservation and artificial insemination in goats are continually improving. Despite the difficulty of freezing semen, numerous studies have proposed substitute extenders that use innovative substances rather than egg yolk and milk that have produced superior outcomes. The majority of researches have advised using an extender with a lower egg yolk content (1.5-2%) to preserve goat sperm. The AI personnel need to be given appropriate training in goat insemination. Further research should be done to identify a straightforward, quick, affordable, and user-friendly technique for processing goat semen. An increase in artificial insemination at the field level will result from enhanced semen preservation since it will make more superior-quality semen available.

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Indian Journal of Livestock and Veterinary Research
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CHAPTER – 15

Advances and Innovations in Goat Reproductive Management: A Comprehensive Review

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ABSTRACT

The successful goat farming industry in India relies substantially on adequate goat reproductive management. The reproductive management of goat is crucial for effective genetic improvement, higher productivity, disease control programme, best possible use of resources, and long-term financial viability. Additionally, it also ensures food security, supports overall agricultural economy and promotes long-term viable goat farming operations. Reproductive management can be implemented in goat farms using controlled breeding program, providing adequate balanced nutrition to both male and female goats, frequently evaluating the body condition, comprehensive implementation of herd health program to control and prevent diseases, accurate estrus detection of female goats, buck management, periodically assessing reproductive health of doe and bucks and record keeping of all reproductive events (date of estrus detection, date of breeding , pregnancy diagnosis of goat, date of kidding, and survival rates of kid). Absence of reproductive management leads to overpopulation, increase the susceptibility to diseases, inbreeding, unwanted pregnancies, increases the chances of early embryonic death and reduces the productivity of goat farm. However some limitation also exist in reproductive management of goats such as seasonality of goats, difficulty in estrus detection, complexity in estrus synchronizing, susceptibility of goats to several reproductive disorders such as hormonal imbalances, cystic ovaries, uterine infections, pseudo-pregnancy (cloud burst) and dystocia, limited access to superior genetics (semen from desirable sires and high-quality bucks), limited reproductive lifespan of goats (4-7 years), inadequate infrastructure, resources and lack of skilled personnel are the constraints in reproductive management of goats. It can be concluded that reproductive management is important for increasing the productivity and reduces the risk of reproductive disorders of the herd at goat farm.

Keywords: *Goat, reproductive management, overpopulation, inbreeding, pseudo-pregnancy*

INTRODUCTION

Goat rearing provides livelihood opportunities to a large number of people, especially in rural areas. It is an important source of income for small and marginal farmers, landless laborers, and women, as goats require minimal investment and can be reared alongside other farming activities (Escareño *et al*., 2011). Due to that, Goats are known as "the poor man's cow" in India because they require less space and resources compared to larger livestock (Luo *et al*., 2019). The successful goat farming industry in India relies substantially on adequate goat reproductive management. Reproductive management includes both male and female goats in the herd. It is important for an increase in the productivity of the herd and management of disease control.

Accurate estrus detection, constant reproductive health assessment of doe and bucks and record keeping, etc. are few strategies used in the goat farm for reproductive management. Difficulty in estrus detection, seasonality of goats, complication in estrus synchronizing, vulnerability of various reproductive disorders (pseudo-pregnancy, uterine infections, and cystic ovaries and dystocia), and inadequate access to superior bucks are the limitations in goat reproductive management.

Indian Journal of Livestock and Veterinary Research
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Significance of Goat Reproductive Management

The reproductive management of goats is crucial for effective genetic improvement, higher productivity, disease control program, best possible use of resources, and long-term financial viability. Additionally, it also ensures food security, supports the overall agricultural economy, and promotes long-term viable goat farming operations.

Strategies for Effective Reproductive Management of Goats

For effective reproductive management, the strategies should be applied to both male and female goats of the herd. This could be achieved by a controlled breeding program, providing adequate balanced ration to both male and female goats, frequently evaluating the body condition, comprehensive implementation of herd health program to control, control and prevention of diseases, accurate estrus detection of female goats, buck management, periodically assessing reproductive health of doe and bucks and record keeping of all reproductive events (date of estrus detection, date of breeding, pregnancy diagnosis of goat, date of kidding, and survival rates of kid). The absence of reproductive management leads to overpopulation, increase susceptibility to diseases, inbreeding, unwanted pregnancies, increases the chances of early embryonic death, and reduces the productivity of goat farms.

Reproductive Management of Buck

The buck is crucial for high levels of reproductive and productive efficiency in goat herds (Ridler *et al*., 2012). To increase the effectiveness and reproductive performance of male goats, a variety of systems, practices, and interventions are used in the reproductive management of the male (Luo *et al*., 2019). These are the few following crucial points given below.

Age and Maturity: Bucks should reach sexual maturity before being used for breeding. The younger bucks give dead immature sperms which are not able to fertilize the ovum. The age of sexual maturity varies between breeds, but it is generally recommended to wait until bucks are at least 7 to 9 months old before breeding them.

Physical Examination and Breeding Soundness Evaluation: Before using a buck for breeding, it is essential to conduct a thorough physical examination to ensure the reproductive health of the buck. The breeding bucks should be free from reproductive diseases. Since semen concentration can be decreased by either excessive feeding (fattening) or by inadequate feeding over an extended period with an evident gain or decrease in weight, it is advised to check the buck's physical condition before mounting (Delgadillo et al., 2021). The breeding soundness evaluation can be done by assessment of bucks' body condition, reproductive organs, and overall health. For ensuring bucks fertility including semen quality and libido breeding soundness evaluations should be done on regular intervals of time. This evaluation helps to identify any potential issues on an early basis, and their timely replacement and allows mating to higher-ranking males (Wang et al., 2015)

Nutrition and health management of bucks: Providing a well-balanced diet is crucial for the reproductive health of bucks. Balanced nutrition that is rich in proteins, minerals (zinc, selenium), and vitamins (Vit A, C, and E) is essential for libido, semen quality, volume, sperm concentration, and initial progressive motility (Guan et al., 2014). Adequate access to clean drinking water plays an essential role in disease control. Regular vaccinations and deworming are necessary for bucks to prevent diseases that could reduce their reproductive ability.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Exercise and Housing: Bucks should have access to sufficient exercise and space for their well-being. Providing a clean and well-ventilated housing facility with appropriate fencing and shelter is essential. Overcrowding can lead to stress and decrease reproductive performance.

Breeding Management: The management of breeding bucks is important for the genetic improvement of the goat herd. It is important to maintain an appropriate buck-to-doe ratio to ensure successful mating. A ratio of 1 buck per 25-30 does is generally recommended.

Management of Bucks in Breeding Season: The photoperiod (daylight hours), which influences seasonal variations in libido, seminal quality, and testicular size, has an impact on the reproductive activity of bucks (Maroto-Morales et al., 2016). Buck's breeding season can be chosen according to management objectives and the breed's natural reproductive cycle. According to Zarazaga et al. (2010), the reproductive activity of male goats can be induced by light or melatonin implants during the long days of the seasonal anestrus. This stimulation increases plasma testosterone levels which increases the libido and semen quality of the bucks.

Record Keeping: Maintain accurate records of breeding dates, buck performance, and breeding outcomes to monitor and evaluate reproductive efficiency.

Reproductive Management of Goats

Reproductive management of goats involves various practices to optimize breeding efficiency, enhance reproductive performance, and ensure successful reproduction. There are few following points given below for the reproductive management of goats.

Management of doe in the breeding season and estrus synchronizations: Most goats are seasonal breeders, and their reproductive activity is influenced by the length of daylight. Dairy goats are typically bred in the fall for spring kidding. The breeding season of the does should be determined based on the breed and climate. For the breeding, healthy, disease resistance, and genetically superior does and bucks should be chosen. The appropriate buck-to-doe ratios should be maintained in the herd to avoid overbreeding and ensure optimal fertility. Hypothalamic-pituitary-gonadal axis has a key role in the regulation of pituitary gonadotropins and cyclicity of estrus. Gonadotropin (FSH and LH) acts on the gonad through the peripheral blood circulation, they control the reproductive process by affecting the exocrine glands (Luo et al., 2019). PGF2α or its analogues have a luteolytic function and can be used for estrus synchronizations of does. Administration of two injections of PGF2α or its analogues, 11 days apart in cycling female goats can induce estrus (Ishwar and Memon, 1996). For a treatment regimen of 11 days, which is shorter than the luteal phase (16 days), oestrus length and ovulation could be inhibited or delayed due to the presence of a functional corpus luteus at the end of the progestative treatment. Thus cloprostenol is needed to induce lysis of the corpus luteum (Swelum et al., 2015). Best fertility after AI was obtained after one intramuscular injection of 50 μg 2 days before sponge removal. It was found that intravaginal sponges fluorogestone acetate (FGA) short-term 5 d and long-term 11 d PGF2α +eCG treatments, as well as 5 d GnRH+PGF2α 5 d treatment, provide accurate oestrus synchronization and fertility after natural mating in lactating goats during the transition period. In terms of synchronizing oestrus and ovulation, the combined 11-day FGA+PGF2+eCG treatment was effective, however, it was also associated with a significant

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

rate of aberrant ovarian response (Martemucci and D'Alessandro, 2011). According to Zarazaga et al. (2009), melatonin implants can be used to promote out-of-season cycling in does. The introduction of sexually active bucks in the goat flock can also induce oestrus behavior and ovulation in seasonally anoestrus does (Martínez-Alfaro et al. 2014).

Nutrition: Provide balanced nutrition to maintain good body condition in both bucks and does. Adequate nutrition is crucial for optimal reproductive performance. Ensure access to clean water, quality forage, and a well-balanced diet that meets the specific nutrient requirements of goats during different reproductive stages. According to Robertson et al. (2020), vitamin and mineral (Zn and Mn) deficiency can lead to reducing conception rate.

Estrus Detection and Breeding Management of Goats: Monitoring the signs of estrus (heat) in does can be used to determine the optimal breeding time. Before breeding does should be dewormed and vaccinated properly as per recommended schedules to maintain herd health. Restlessness, mounting other does, swollen vulva, clear vulvar discharge, and wagging of tails are the common heat signs expressed by the doe. Teaser bucks are more helpful to identify does in heat efficiently. There are two primary breeding methods used in goat reproduction. One of them is natural mating and another is artificial insemination method. Another is the artificial insemination method which can be used for disease control of venereal diseases (trichomoniasis and campylobacteriosis), genetic selection, and breed improvement. Artificial insemination could be done with the use of either fresh or frozen semen from high-quality bucks. In natural mating, bucks are allowed to mate naturally with the doe in heat. Insemination should be done either by artificial insemination or through natural breeding by introducing bucks may be carried out once or twice after 24 hours of oestrus detection (Leboeuf et al., 2008). Adequate mating opportunities should be ensured along with preventing injuries or exhaustion in buck or doe.

Pregnancy Care and Kidding Management: Normally the pregnancy diagnosis is performed around 30-35 days after breeding. From the date of confirmation of pregnancy, proper care should be given to the pregnant goat up to kidding. During pregnancy, proper nutrition should be provided to goats including increased energy and protein requirements. Monitoring of the does should be done for any signs of illness or distress. Prepare a clean and comfortable kidding area for the does to give birth. Monitor does closely during the kidding process and assist if necessary. Newborn kids should receive colostrum within the first few hours for passive immunity. Proper tag, weight, and birth details records of each kid can ensure easy management.

Reproductive Health Management and Postpartum Care: For reproductive herd management a comprehensive herd health program, including vaccination schedules, and parasite control, should be implemented. After kidding, any signs of reproductive complications (retained placenta or metritis) in does should be monitored. The provision of proper nutrition, including adequate forage and concentrate feed can support lactation and postpartum recovery. Pseudopregnancy can also reduce fertility in goats that occurs due to the presence of persistent corpus luteum in the absence of pregnancy. According to Fatet et al. (2011), the occurrence of pseudopregnancy in goats is reported between 3% and 20%. The probability of fetal loss increases with a low body condition score (>2) at mating (Robertson et al., 2020). Embryonic and fetal losses, nutritional deficiency, diseases (brucellosis and bluetongue), and dystocia also adversely affect the reproductive health of goats and these

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

factors should be eliminated to restore goat fertility (Aldomy *et al*., 2009; Robertson *et al*., 2020).

Drawbacks Associated with Lack of Reproductive Management

Reproductive management plays a crucial role in the overall productivity and profitability of goat herds. However, the absence of effective reproductive management practices leads to several disadvantages and hinders the success of a goat farming operation. Some of the key drawbacks associated with the lack of reproductive management in goat herds are given below

Uncontrolled Breeding: In the absence of reproductive management, goats may engage in uncontrolled breeding. This can result in an overpopulation of goats within the herd, exceeding the carrying capacity of the available resources. Overpopulation can lead to increased competition for food, water, and shelter, ultimately compromising the overall health and welfare of the goats.

Reduced Genetic Improvement: Reproductive management is essential for implementing selective breeding strategies aimed at improving the genetic traits of the herd. Without proper management, there is a lack of control over mating choices and the ability to optimize desirable traits such as milk production, growth rate, and disease resistance. This can result in stagnation or even regression of the herd's genetic potential over time.

Increased Disease Spread: The absence of reproductive management can contribute to the increased spread of diseases within goat herds. Uncontrolled breeding can lead to the introduction of infected animals into the herd, potentially transmitting diseases to healthy individuals. Moreover, without proper monitoring and control measures, the identification and containment of infectious diseases become challenging, posing a significant risk to the entire herd's health.

Inefficient Resource Utilization: Reproductive management allows for better planning and utilization of available resources such as grazing land, feeding resources, and facilities. Without management practices like controlled breeding, it becomes difficult to optimize resource allocation based on the specific needs of the herd. This can result in inefficient resource utilization, leading to wastage and increased production costs.

Limited Productivity and Profitability: Effective reproductive management is closely linked to improved productivity and profitability in goat farming. The absence of such management practices can hinder the achievement of reproductive targets, including high conception rates and optimal kidding intervals. This, in turn, leads to decreased productivity in terms of milk production, meat yield, and offspring quality. Reduced productivity ultimately affects the profitability of the goat farming enterprise.

Constraints in goat reproductive management

Some limitations also exist in the reproductive management of goats such as seasonality of goats, difficulty in estrus detection, complexity in estrus synchronizing, susceptibility of goats to several reproductive disorders such as hormonal imbalances, cystic ovaries, uterine infections, pseudo-pregnancy (cloud burst) and dystocia, limited access to superior genetics (semen from desirable sires and high-quality bucks), the limited reproductive lifespan of goats (4-7 years), inadequate infrastructure, resources and lack of skilled personnel are the constraints in reproductive management of goats.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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CONCLUSION

It can be concluded that reproductive management is important for increasing productivity and reducing the risk of reproductive disorders in goat herds.

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Goat Production & Management

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Management of Goat Diseases Using Ethnoveterinary Practices

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ABSTRACT

Small ruminants especially goat plays a significant role in the livelihood and economies of rural farmers. The goat is considered as "poor man's cow". They can be maintained easily in small areas, adapt easily to all agroecological zones, are very resistant and source of income for poor families. Small ruminant health problems still represent a major constraint which is commonly treated using drugs. However, to manage the health of small ruminants, the use of chemical drugs is also limiting due to the high cost and the development of pathogen resistance in animals. Diseases affect the productivity and fertility of animals which affects the economy of poor farmers. Several bacterial, viral, parasitic, reproductive system-related diseases and other diseases hinder the growth and immunity of goats. Frequently found bacterial diseases in goats comprise haemorrhagic septicaemia (H.S.), black quarter (B.Q.), anthrax, foot rot etc.; viral diseases include Peste des Petits Ruminants (PPR), Foot and Mouth Disease (FMD) etc; and parasitic diseases including both ectoparasitic and endoparasitic diseases. Reproductive diseases include prolapse, retained placenta, anoestrous, infertility etc. Other recurrently occurring disease conditions include bloat, wound, agalactia, cough, toxicities etc. Ethnoveterinary medicine is indigenous knowledge used in the treatment of diseases that should be passed on from one generation to another so that it is not forgotten and can be well documented. The use of medicinal plants to treat small ruminant diseases is the most promising alternative due to the low cost of treatment, easy availability and accessibility in rural areas for resource-limited farmers. Traditional healing practices have been applied for centuries and eventually evolved as ethno-veterinary practices. Medicinal plants are generally used in combination with other plants, and/or other substances to treat the illness. Medicinal plants possess several activities ranging from anthelmintic properties, antimicrobial, anti-inflammatory, analgesic, purgative, anti-oedema to immunomodulation. Thus, the use of medicinal plants plays a significant role in meeting small ruminant healthcare needs. Although, the rapid socio-economic changes and lack of interest of young people have led to a decline in Ethnoveterinary knowledge. But it is an integral part of cultural heritage that is required to be saved and propagated further. In veterinary practice, specifically for goats, it is the prime requisite. It is also essential for the growth of the herbal drug industry and the socio-economic growth of the country.

Keywords: *Goats, diseases, Ethnoveterinary medicine, medicinal plants.*

INTRODUCTION

Goats play a significant role in the socio-economic activities of people by providing food and income to small and landless farmers (Peacock, 2005). In India, there are almost 37 registered goat breeds reared in different agro-climatic zones (ICAR-NBAGR), mostly reared for milk, meat and manure. Goat milk is consumed as a cheap and easily digestible product. Male goats are reared for meat. Goat manure is good for increasing the fertility of the soil. Secondarily, goats play an important role in social, cultural and religious functions in different countries. Goats are extremely hardy and thrive in all agro-ecological zones (Tchetan *et al.*, 2020). However, the goat rearers face a number of problems and losses mainly due to diseases in the flock and animal mortality. Allopathic drugs are costly for the common man. Furthermore, resistance to too many drugs has been reported in small ruminants leading to a resurgence of interest in the use of herbal medicines to control and treat diseases and parasites in small ruminants. There is also a general belief that natural

Indian Journal of Livestock and Veterinary Research
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products are safer and more harmonious with biological systems (Erasto, 2003). Hence, most goat rearers and livestock keepers use traditional ethnoveterinary medicines as they are found to be cheaper, safe and easily available in rural surroundings. The practices and remedies used by the people based on knowledge gained through the experiences and observations of the previous generations are considered as ethnoveterinary approach (Kumar, 2002).

Diseases affect the productivity and fertility of animals which affects the economy of poor farmers. Several bacterial, viral, parasitic, reproductive system-related diseases, genetic/metabolic/nutritional/management-related diseases and other diseases hinder the growth and immunity of goats. Frequently found bacterial diseases in goats comprise anthrax, black quarter (B.Q.), haemorrhagic septicaemia (H.S.), foot rot etc.; viral diseases include Peste des Petits Ruminants (PPR), Foot and Mouth Disease (FMD) etc. and parasitic diseases including both ectoparasitic and endoparasitic diseases. Reproductive diseases include prolapse, retained placenta, anoestrous, infertility etc. Other recurrently occurring disease conditions include indigestion, bloat, diarrhoea, constipation, pneumonia, cough, agalactia, mastitis, wound, fracture, toxicities etc. (Khadda *et al.*, 2018b).

Goat farmers use a wide variety of indigenous plants, minerals and locally available products to cure their goats under the geo-agro climatic conditions (Khadda *et al.*, 2018b). Standard methods for administering ethnoveterinary medicines are adding the medicine to feed and drinking water, drenching, spraying/washing an animal with a medicinal infusion, applying a powdered medicine, fumigation, skin application, anal application and vaginal application (Najma *et al*., 2015).

Role of Ethnoveterinary Medicine (EVM)

According to the World Health Organisation (WHO), at least 80% of people in developing countries depend largely on traditional medicine for the control and treatment of various diseases affecting both human beings and animals (Iqbal *et al*., 2005). Ethnoveterinary medicine (EVM) is a system that is based on traditional knowledge, folk beliefs, skills, methods and practices used for treating diseases and keeping animals healthy. The traditional veterinary indigenous knowledge like all other traditional knowledge system is handed down orally from generation to generation and it may disappear because of rapid environmental, socioeconomic and technological changes. So, it should be well documented (McCorkle, 1995; Manoj *et al*., 2012). Increased attention on ethnoveterinary medicine (EVM) is because of their easy accessibility, preparation and administration at little or no cost at all (Iqbal *et al*., 2005). The ethnoveterinary practices cover every area of veterinary specialization and all livestock species.

Animal health could be managed traditionally via EVM practices which are a mode of identifying, using and integrating local knowledge, associated skills and custom procedures created by people to maintain the health of animals (Jarakabande, 2002). The use of medicinal plants to treat small ruminant diseases is the most promising alternative due to the low cost of treatment, easy availability and accessibility in rural areas for resource-limited farmers. Medicinal plants possess several activities ranging from anthelmintic properties, antimicrobial, anti-inflammatory, analgesic, purgative, anti-oedema to immunomodulation. Medicinal plants are generally used in combination with other plants, and/or other substances to treat the ailments. The most common forms of ethnoveterinary medicine are powders, poultices, infusion, ointment, tincture, decoction, cold ware extract and fumigation

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

(ShriBalaji and Chakravarthi, 2010). EVM differs not only from region to region but also among and within communities.

The ethnoveterinary practices concerning traditional herbal remedies for treating animal diseases are crucial for several reasons: (a) to provide effective and cheaper treatment alternatives; (b) to foster the sustainable use of local medicinal plant resources in animal care and then to contribute to rural development policies; (c) to decrease the abuse of antibiotics by being complementary to the use of pharmaceuticals that is detrimental to the quality of animal food products; (d) to promote local bio-cultural heritage; and (e) to prevent development of antimicrobial resistance which is a global matter of concern (f) to investigate the link between human and veterinary plant uses to possibly assess the origin of herbal practices (Aziz *et al*., 2020). Cost, inaccessibility and several side effects associated with the allopathic animal health care system have encouraged constant dependence on such traditional herbal treatment practices in the area of treatment. Ethnoveterinary practices are often cheap, safe, tested with time by people and based on local resources providing useful alternatives to animal health care (Kumar, 2002). Thus, the use of ethnoveterinary practices plays a significant role in meeting small ruminant healthcare needs.

Common Diseases and Health Problems in Goats

Inadequate knowledge regarding animal rearing like housing, spacing, sanitation, feeding practices, ventilation & hygiene in rural areas leads to several ailments in animals. Diseases not only affect the immunity of animals but also reduce the efficacy of production & cause loss to the farmers. Improper vaccination, contaminated pasture, poor management practices, overcrowding and mixing of both healthy & diseased animals in the same grazing land further lead to the occurrence and spread of diseases (Khadda *et al*., 2018b).

Goats are usually exposed to vulnerable diseases and harsh conditions due to the nonchalant attitudes of the farmers where they leave their goats to scavenge freely without proper monitoring. Sometimes, goats are subjected to extreme starvation with little or no concern for their well-being. It incurs an increase in production cost and reduces production rate, which directly or indirectly affects the quantity and quality of animal products causing a great loss to the farmer (Bukar & Isa, 2023). Various organisms like bacteria, fungi, parasites, protozoa, rickettsia and viruses cause several goat diseases. Further, the availability of low-quality feeds and poor management practices can predispose goats to metabolic disorders, which further cause losses due to reduced productivity and death (Unigwe *et al*., 2016). A sound management practice for keeping animals healthy should be practiced and the basic knowledge about diseases on goat production deems necessary leading to optimum production. The bacterial diseases found in goats include anthrax, haemorrhagic septicaemia, black quarter, brucellosis, enterotoxaemia, mastitis, foot rot, etc. Viral diseases like Peste des Petits Ruminants (PPR), goat pox, foot and mouth disease, contagious ecthyma and viral pneumonia are commonly observed in goats. Mycotic diseases such as dermatophytosis and rickettsial infections like conjunctivitis are common causes of goat mortality in rural areas. Numerous endoparasites (like gastrointestinal nematodes, flukes, and tapeworm infestation) and ectoparasites cause less mortality but can cause severe depression in the growth and reproductive performance of goats (Nath *et al*., 2014). Reproductive disorders in goats comprise of conditions like anoestrous, retention of placenta, prolapsed uterus etc. Other ailments which affect the growth in goats are diarrhoea, tympanitis, wound/injury, indigestion, agalactia. Snake bite and plant poisoning are also prevalent during goat management. The productivity of goats is affected due to increased incidence of diseases and

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

poor management practices. In view of the diseases prevalent in goats, there is a need to create awareness regarding the various diseases found in goats in designing appropriate preventive measures to minimize the risk of diseases in goat production and management.

Ethnoveterinary Practices in the Management of Goat Diseases

Antimicrobial resistance is a recent worldwide issue that invites immediate public attention. Indiscriminate use of antibiotics, the shooting cost of veterinary inputs and the presence of drug residues in milk and meat are the main reasons for antibiotic resistance. There is certainly an exigent need to combat the global threat of antimicrobial resistance in humans and animals. With the emergence of allopathy, the use of herbal medicine for health care dwindled during the last half of the century. Generally, allopathic medications are used to treat diseases of animals, but they have many side effects pertaining to its dose, site of administration, drug interaction & anaphylactic reactions. Therefore, herbal treatment of diseases is one of the substitutes to surmount these problems as well as there is less chance of toxicity, easy availability and also economical. There is an abundance of plant species in the Indian subcontinent having medicinal values which can be exploited for the treatment of several commonly found goat diseases (Khadda *et al*., 2018b). Therefore, this article seeks to make an attempt to treat some common diseases of goats using ethnoveterinary practices. Commonly occurring diseases in goats can be grouped into the following category along with the use of ethnoveterinary practices for treatment as follows: a) Viral b) Bacterial c) Parasitic d) Reproductive disorders and e) Other common ailments.

a. Viral Diseases

Foot and Mouth Disease

The medicinal plants used for curing FMD in goats comprise of *Ficus racemose, Nicotiana tabacum, Semecarpus anacardium, Terminalia tomentosa* (Misra and Das, 1998) and whole plant of *Tinospora cordifolia* (Rastogi *et al*., 2015). Neem (*Azadirachta indica*) leaves are boiled in water and cooled. This water is used to wash the hooves having FMD lesions for 3-4 days. Turpentine oil and camphor mixture is applied on the affected part after washing with lukewarm water (Khadda *et al*., 2018a). 50 g *Trigonella foenum-graecum,* 10 g *Trachyspermum ammi* and 100 g jaggery in the forms of balls are given for 3 days (Shrivastava *et al*., 2012). *Semecarpus anacardium* with coriander & hing mixed in buttermilk given to eat for improvement in signs (Pranjale and Dube, 2015). Juice of crushed *Vigna radiate* seeds mixed with coriander & given to drink to heal FMD lesions (Pranjale and Dube, 2015).

Peste des Petits Ruminants (PPR)

There are limited herbal treatments available for PPR. Still, roots of *Aconogonon molle* after boiling in the water in solution form along with molasses are fed orally for its cure (Khan *et al*., 2021).

Goat Pox

Seeds of *Phaseolus vulgaris* after boiling in the water are fed to cure goat pox (Khan *et al*., 2021). Extracts of *Acacia arabica* and *Eugenia jambolana* leaves inhibit goat pox virus replication *in vitro* (Bhanuprakash *et al*., 2008).

Pneumonia, Fever and Cold

For the treatment of fever, cold, pneumonia or any other respiratory problem following ethnoveterinary practices are used to treat goats. Turmeric (*Curcuma longa*) powder (10 g)

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

mixed with jaggery is given to goats for 3 days. Paste prepared from 10g turmeric, 10g ajwain (*Trachyspermum ammi)* and 10-15g Sprague black salt fed twice a day for 2-3 days to cure the ailment. Tulsi (*Ocimum sanctum*) leaves are provided twice a day for 2-3 days. Chirayita (*Swertia chirata*) leaves and pepper (*Piper longum*) decoction is drenched twice a day to the diseased animal (Khadda *et al*., 2018a). *Piper nigrum* seeds are also used for cough, cold and fever (Rastogi *et al*., 2015). Oil extracted from the heated bulb of *Allium sativum* is dropped in the nose for the treatment of pneumonia (Pranjale and Dube, 2015). Crushed roots of *Abrus precatorius* are used to treat cough, cold and pneumonia (Somvanshi *et al*., 2016).

b. Bacterial Diseases

Haemorrhagic septicaemia (H.S.)

Rhizome powder of *Curcuma longa* is given with water to drink (Pranjale and Dube, 2015). *Allium sativum* (Garlic) bulb is used in the treatment of H.S. cases (Rastogi *et al*., 2015). *Arisaema tortuosum* rhizome is crushed to extract the juice and fed to animals. The soup of powdered *Capsicum annuum* fruit is fed to animals orally. Crushed leaves of *Flacourtia indica* mixed with water, filtrated and fed orally. Leaves of *Solanum incanum* are chopped and mixed with water and then sieved to administer intranasally. *Pueraria tuberose* tuber extract, *Cayratia trifolia* and *Cassytha filliformis* whole plant paste are externally applied on the affected neck (Mishra *et al*., 2015).

Black Quarter (B.Q.)

Aegle marmelos, Cassia fistula, Azadirachta indica, Datura metel and *Semecarpus anacardium* are used to treat black quarter in animals (Misra and Das, 1998). Solution prepared from *Momordica diocia* grinded rhizome and tobacco leaves added water to it and given this solution to drink (Pranjale and Dube, 2015). Leaves and bark of *Bourreria orbicularis, Boscia coriacea, Acalypha indica* and *Cadaba rotundifolia* are used individually to cure B.Q. (Mishra *et al*., 2015). Crushed roots and leaves of *Agapanthus praecox*; the whole plant of *Sarcophyte sanguinea*; crushed bark of *Olea europaea africana* are separately soaked with water and administered orally (Mthi *et al*., 2018). Soon after being diagnosed with B.Q, the juice obtained from grinding the bark of *Ailanthus excelsa* and the garlic juice are mixed and applied externally on the affected part (Rao and Varma, 2008).

Enterotoxaemia

To treat enterotoxaemia problems, mashed uncooked roots of *Aconogonon molle* are given orally (Khan *et al*., 2021). The punctured fruit of *Semecarpus anacardium* is rubbed on the mouth of a goat suffering from enterotoxaemia (Misra and Das, 1998).

Mastitis

Small quantity of *Ferula asafoetida* or *Indigofera tinctoria* dissolved in water and applied on teats to reduce the inflammation (Shrivastava *et al*., 2012). *Vitex negundo* root juice (Bansal, 2013); paste of *Coriander sativum* leaves; leaf mucilage of *Aloe vera* (7 days); paste of *Cuminum cyminum* seeds (once a day) and *Lepidium sativum* seed poultice applied (10 days) externally (Somvanshi *et al*., 2016). *Curcuma domestica* (Haridra) rhizome and *Piper nigrum* seeds are also used in the treatment of mastitis (Rastogi *et al*., 2015).

Foot Rot

To overcome the problem of foot rot, paste of *Clerodendrum phlomoidis* leaves is applied to hooves rot (Bansal, 2013). Application of ash of cycle tyre mixed with mustard oil (*Brassica*

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

campestris) for 3-5 days is also practiced (Shrivastava *et al*., 2012). *Dolichos biflorus* leaf juice is used externally on affected hooves to cure foot rot. Paste prepared from handful leaves of *Eclipta prostrata* along with the same quantity of *Ocimum sanctum* leaves is applied externally once a day on affected hooves till cured. The fruit pulp of *Tamarindus indica* is boiled and applied slightly hot to control foot rot (Rao and Varma, 2008).

c. Parasitic Diseases

Parasites limit goat productivity by reducing fertility, causing skin irritation and sucking blood, ultimately leading to death (Molefe *et al*., 2012). Gastrointestinal parasites such as *Haemonchus contortus* and *Fasciola hepatica* are major endoparasites of concern in small ruminants (Vatta & Lindberg, 2006). Ectoparasites such as ticks, lice and mites are also prevalent in goats because of inappropriate housing and lack of adequate veterinary services (Mungube *et al*., 2006). For commercially available drugs, parasites have developed resistance which accelerated the use of medicinal plants as treatment alternatives (Erasto, 2003).

Internal Parasites

20 ml juice obtained from leaves and bark of bakain (*Melia azedarach*) drenched for 3-4 days in goats. Decoction of leaves, flower and bark of neem (*Azadirachta indica*) for 3 days (Khadda *et al*., 2018a; Rathore and Amarawat, 2020); dry leaves of gular (*Ficus glomerata*) and Banyan tree (*Ficus benghalensis*) @ 200- 250 g for 5-7 days (Khadda *et al*., 2018a); *Aloe ferox* leaves infusion work as anthelminthic in goats (Sanhokwe *et al*., 2016). A poultice of *Triticum aestivum* is fed for an effective cure (Shrivastava *et al*., 2012). *Calotropis procera* gynostegium blended in spread milk given to goats, once a day for 3 days (Rathore and Amarawat, 2020). Roots of *Mucuna prurita* (Misra and Das, 1998) and *Picrorhiza kurroa* (Rastogi *et al*., 2015) are administered orally to kill gastro-intestinal worms. *Dioscorea deltoidea* tuber juice (about 5-7 teaspoons twice a day) is given to treat roundworms, red powder obtained from *Mallotus philippensis* fruits is used to expel Threadworms and Ascaris and *Carissa caranta* root mixed with pericarp of mango (*Mangifera indica*) in water is used as wormicide (Mishra *et al*., 2015).

External Parasites

Tobacco (*Nicotiana tabacum*) leaves soaked in water and mixed with mustard oil and salt for application on skin (Khadda *et al*., 2018a). *Aloe vera* leaf juice (infusion) is applied externally to control ticks, lice and mites (Rao and Varma, 2008; Sanhokwe *et al*., 2016). Seed powder of *Annona squamosa* (7 days), *Nicotiana tabaccum* leaf juice used for 3 days (Somvanshi *et al*., 2016), corn powder (*Acorus calamus)* mixed with coconut oil (twice daily) (Rao and Varma, 2008), paste prepared by mixing an equal amount of leaves of *Clerodendrum phlomoidis* with leaves of neem (*Azadirachta indica*) applied externally help to control ectoparasites (Bansal, 2013).

d. Reproductive Disorders

Anestrous Problem

Anoestrus is one of the most commonly occurring reproductive problems affecting productivity and economics to a great extent. Goat keepers use several traditional herbs to treat anestrous. Leaves of *Ficus benghalensis* (Banyan tree), *Ficus religiosa* (Pipal), *Mangifera indica* (Mango) and *Azadirachta indica* (Neem) mixed with each other and fed early in the morning for 5-7 days to solve the anestrous problem. Supplementation of *Cicer arietinum* (Bengal gram) soaked in water (@100-150 g/ day for 3-5 days) induces heat. 200 g

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

sprouted *Triticum aestivum* (Wheat) fed to goats (for 5-6 days continuously) to induce heat. Bolus made from pigeon droppings and jaggery once a day and sprouted wheat @ 200 g are fed for 5-6 days (Khadda *et al*., 2018a).

Prolapse

Roots of *Curcuma longa* (Haldi) are cooked in ghee (fed orally) and cooked roots of *Dipsacus inermis* (Pilha) are used to cure uterine prolapse (Khan *et al*., 2021). The extract of *Gloriosa superba* tuber is applied to the uterus and *Leptadenia pyrotechnica* infusion is given to the uterus prolapsed. (Bansal, 2013).

Retention of Placenta

Retention of placenta is the major post parturient problems. Most of the goat keepers use decoction prepared from dry *Zingiber officinale* (40-50g, Ginger), *Trachyspermum ammi* (40-50g), green leaves of *Bambusa vulgaris* (40-50g, Bamboo) and 200g molasses, and drench this thrice a day to overcome the problem of retention of placenta. Similarly, leaves of *Oryza sativa* (Paddy) and *Saccharum officinarum* (Sugarcane) fed with jaggery; 50g *Sesamum indicum* (Sesame) powder with jaggery; buds of *Calendula officinalis* (Marigold); decoction prepared from outer bark of *Syzygium jambos* (Jamun, thrice a day) and *Abelmoschus esculentus* leaves are very effective herbs for expulsion of placenta after kidding (Khadda *et al*., 2018a).

e. Other Common Ailments

Diarrhoea/dysenter

Powdered pods of *Cosmostigma racemosa* mixed with curd are given orally twice a day to goats suffering from gastroenteritis (Bansal, 2013). Powders of internal bark of jamun (*Syzygium jambos*), mango (*Mangifera indica*) @ 2 tea spoons per day for 2 days; pomegranate leaves (*Punica granatum*) or tea leaves (*Camellia sinensis*) or falsa bark (*Grewia asiatica*) or banana flowers (*Musa paradisiaca*) are used for diarrhoea cure (Khadda *et al*., 2018a). Decoction of 25 g seed powder of *Trachyspermum ammi* and 50 g shake salt (Rathore and Amarawat, 2020), bark decoction of *Delonix elata* or *Xanthium strumarium* (Bansal, 2013), *Foeniculum vulgare* (Saunf) seeds or *Mangifera indica* (Amra) bark or *Mucuna pruriens* (Kaunch) leaves or *Picrorhiza kurroa* (Kutki) roots are offered orally to treat dysentery and diarrhoea in goats (Rastogi *et al*., 2015).

Bloat (Tympanitis)

A mixture prepared by asafoetida (2-3 g), chirayata (10 g), ajwain (10-15 g) and black salt (10-15 g) in lukewarm water. Drenching of linseed (*Linum usitatissimum*, 100 ml) oil, dry powder of ginger (*Zingiber officinale*, 5 g) and asafoetida (2.5 g) as a mixture. Common salt (40-50 g) and ajwain (10 g) are mixed together, given orally (Khadda *et al*., 2018b). 100 g leaves of *Citrus limon* and *Acacia nilotica* with baking soda are given daily for 3 days for tympanitis treatment (Shrivastava *et al*., 2012). Roots of *Aristolochia bracteolate*, once (Rao and Raman, 2008), half teaspoon seed oil of *Ricinus communis* or decoction of *Boswellia serrata* bark (Rathore and Amarawat, 2020) or *Cassia auriculata* leaves with jaggery are given to cure tympanitis (Bansal, 2013).

Open Wound/Injury/Maggoted Wound

Deodar (*Cendrus deodara*) oil, or paste prepared from neem leaves after roasting in a pan and mixed with mustard oil, or for foul ulcers and wounds, sprinkling of Katha (*Acacia katechu*) powder on the injured part to check bleeding or boiling of neem leaves in water and washing of wound after cooling on the wounded area (Khadda *et al*., 2018a). Edible lime and calcium

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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powder or neem leaf (*Azadirachta indica*) paste is applied on the injured part. Leaf paste of *Feronia limonia* or *Azadirachta indica* or *Cajanus cajan* is applied on the wound (Shrivastava *et al*., 2012). *Xanthium strumarium* leaf juice is used externally for wound healing and maggots in wounds (Bansal, 2013). *Vitex negundo* leaf juice is used externally for wound healing (Bansal, 2013; Somvanshi *et al*., 2016).

Indigestion

The herbal treatments for indigestion are using crushed leaves and inflorescence of bhang (*Cannabis indica*) for 2 days, feeding of a paste prepared from powder of methi (*Trigonella foenum*) seeds, garlic clove (*Allium sativum*), neem leaves, black salt and jaggery, twice a day for 3-4 days. Asafoetida (2.5 g), black salt (50 g) and ajwain (50 g) administered orally (Khadda *et al*., 2018a). *Zingiber officinale* (Ginger) rhizome, or *Azadirachta indica* leaves, or *Coriandrum sativum* (Coriander) seed oil, or *Curcuma domestica* (Haridra) rhizome are used to treat constipation and indigestion (Rastogi *et al*., 2015).

Agalactia

Roots of *Asparagus racemosus* are crushed, mixed with water and given to enhance milk yield (Somvanshi *et al*., 2016). 100g zeera (*Cuminum cyminum*) with 200g jaggery is given for 3-4 days to treat agalactia (Shrivastava *et al*., 2012).

Snake Bite

To deal with the cases of snake bite feed *Aristolochia indica* leaves once (Rao and Raman, 2008). *Allium sativum* (Garlic) leaves and bulbs are also used to treat snake bite (Rastogi *et al*., 2015).

Plant Poisoning

Lassi (Buttermilk) and leaf paste of Dhania (*Coriandrum sativum*) are fed thrice a day in case of plant poisoning. Sometimes, drenching of sour lassi mixed with mustard oil and aonla (*Emblica officinalis*) water is also practiced (Khadda *et al*., 2018a). Young leaves of *Calotropis gigantea are* fed once to get relief from HCN poisons (Rao and Raman, 2008).

CONCLUSION

In Asian and African countries, 80% of the population depends on indigenous practices for their primary healthcare needs. Ethnoveterinary practices have immense contemporary relevance.

In veterinary practice, specifically for goats, it is the prime requisite. It can be concluded that there are numerous goat diseases that could be cured easily using enormous ethnoveterinary practices for goat management. This area needs to be explored more in terms of its efficacy, clinical testing and proper documentation and dosage in goats.

Improved awareness concerning conservation issues are required. It is also essential for the growth of the herbal drug industry and the socio-economic growth of the country. Several field projects and in-depth studies can be helpful to exploit the application of ethnoveterinary medicine using selected practices either alone or by blending them with outside technologies.

Ethnoveterinary practices have economic differences, but their cost-effectiveness makes them competent in rural areas and especially goat rearers.

Indian Journal of Livestock and Veterinary Research
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Indian Journal of Livestock and Veterinary Research
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CHAPTER 17

Nutritional Characteristics of Goat Milk

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ABSTRACT

Although dairy cows generate the majority of the world's milk, particularly in industrialised nations, goat milk is consumed by more people globally than milk from any other species. Humans have historically consumed goat milk for nutritional purposes. Goat milk is different from cow or human milk in that it has higher protein and fat digestibility, is more alkaline, has greater buffering power, and has certain therapeutic benefits for human nutrition. Taking into account its total solid, fat, protein, lactose, mineral, and vitamin contents, goat milk has a variety of effects on human health. Along with improving the physical and sensory qualities of dairy products, goat milk lipids also improve digestion due to their high concentration of short- and medium-chain fatty acids and small fat globule size. The primary carbohydrate in all milk species is lactose, and goat milk has less of it than the other goat milk rich in oligosaccharides is important in its protective function of intestinal flora against pathogens and in brain and nervous system development. Along with having higher concentrations of specific minerals, goat milk also has higher mineral bioavailability than other species milk such as cow milk. The higher vitamin A content may be the most important difference among the other vitamins in goat milk compared to cow milk. Along with the numerous health benefits of goat milk, the advantages of goat breeding—including cheaper animal costs, a reduction in feed and water requirements, and a tendency to not need the same specialised housing as larger livestock—are motivations for advancing goat milk production around the world. A useful nutritional supply of calcium, phosphorus, and animal protein is goat milk, especially in nations where meat intake is minimal. Infants and anyone with cow milk allergies benefit greatly from goat milk as well. Such distinctive qualities of goat milk help ensure the future viability of the dairy goat sector.

Keywords: *Goat milk composition, Nutrition, Physiochemical characteristics, Therapeutic effect.*

INTRODUCTION

India occupies second position in terms of goat population. In 2019, there were 148.88 million goats in the country, an increase of 10.1% from the previous census. Goats make up about 27.8% of all livestock (Annual Report, 2022-23). Goats are primarily produced in India for three things: milk, meat, and breeding. The demand for milk and milk products is rising in the country as a result of the constantly growing human population. Goats are an essential part of the livestock sector because they can survive in difficult conditions, making them appropriate for small-scale, landless producers. Goats have a lot of characteristics that are advantageous for small communities, including low production costs, quick generation times, minimal feed requirements, and the ability to consistently produce tiny amounts of milk that are acceptable for immediate family consumption (Haenlein, 2004). Goat milk contains protein, fat, carbohydrate, vitamin and mineral. The calcium and phosphate that goat milk provides are two of the most significant nutritional contributions. According to Jenness (1980) and Getaneh *et al*. (2016), goat milk has concentrations of 1.2 g calcium and 1 g phosphate per litre, which are comparable to those found in cow milk. With only one-fourth as much calcium and one-sixth as much phosphate, human milk has substantially lower concentrations of these elements. The calcium and phosphorus in goat milk are absorbed by the human child, giving it a significant excess of Ca and P in ratio to energy (Getaneh *et al*.,

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2016). Goat milk's high buffering capacity may be helpful in the treatment of stomach ulcers (Park, 1994). Patients with cow milk allergies have been advised to switch to goat milk. According to Park (1994), 40–100% of people who are allergic to cow milk proteins can consume goat milk. The fact that this milk digests easily may be due in part to the smaller size of the fat globules. Goat milk products are rich in calcium, phosphate, fat, and protein. According to Getaneh et al., 2016, its composition varies depending on things like nutrition, breed, environment, and management. Goat milk appears to have features that make it excellent for treating or preventing a number of medical disorders due to its improved digestibility, optimal fatty acid composition, and amount of bioactive substances. The primary function of milk proteins is to provide young mammals with amino acids and nitrogen, and they are a significant source of dietary proteins for adults. The production of micelles is one of the particular roles played by intact milk proteins. Additionally, milk proteins are physiologically significant; they aid in the absorption of a number of critical nutrients, including vitamins and trace elements, and they contain a group of proteins that serve a protective function (Brule *et al*., 1982). The most complete food known to man, goat's milk is a healthy, highly compatible natural food. Because of its tremendous nutritional value, it can essentially replace a meal.

Composition of goat milk

The fundamental nutrient makeup of goat milk is comparable to that of cow milk, notwithstanding some species-specific variances. The food, breed, animals within the breed, parity, environmental factors, feeding and management factors, season, location, and lactation stage all affect the content of goat milk (Park and Haenlein, 2007). Caprine milk typically includes 12.2% total solids, which are made up of 3.8% fat, 3.5% protein, 4.1% lactose, and 0.8% ash, meaning that it is higher in fat, protein, and ash than cow milk and lower in lactose.It is well recognised that there are considerable seasonal and lactational fluctuations in the composition and quantity of goat milk. The milk's fat, total solids, and protein contents are high in the first two to three months of lactation, drop quickly to their lowest levels, then start to rise as lactation progresses. As a result, there is an inverse link between milk yield and percentage.

Protein

According to Ceballos *et al*. (2009), goat has 30 to 35 g/L of total protein, 80 g/L of which is casein and 20 g/L is whey. High levels of casein and the structure of the casein micelle, a wide variety of bioactive peptides within these fractions, as well as minor proteins and non-protein fractions containing amino acids, nucleotides, and nucleosides, all help to distinguish the protein in goat milk from other sources of protein. Many of the physical qualities and health advantages of goat milk are determined by its protein composition.Many people experience allergic reactions to the lactalbumin in cow's milk, which is a major issue, especially for young children. Due to the two proteins' different structural characteristics, these people frequently can ingest goat milk without experiencing this reaction. Trypsin completely hydrolyzed 96% of goat casein in vitro, compared to just 76–90% of cow casein, according to Jasinska (1995). Similarly, human gastric and duodenal acids break down goat milk substantially more quickly than they do cow milk (Almaas *et al*. 2006).

Fat

Butterfat is the name for the suspended globules of fat that are present in milk and may be viewed using low power microscopes. Goat's milk derives many of its most distinctive properties from its lipid fraction (Getaneh *et al*., 2016). According to Jenness (1980), goat

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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milk has a high concentration of short- and medium-chain fatty acids (MCFA). Goat milk is much higher in butyric (C4:0), caproic (C6:0), caprylic (C8:0), capric (C10:0), lauric (C12:0), myristic (C14:0), palmitic (C16:0) and the essential omega-3 linolenic (C18:2) acids, whereas it has lower content of the longer chain fatty acids stearic (C18:0) and oleic acid (C18:1) (Nunej-Sanchez *et al*. 2016).Goat milk fat globules are typically less than 3.5 m in size and are distinguished by their high homogeneity, which offers lipases with more fat surface area for improved digestion (Chandan *et al*. 1992).Cow's milk normally includes 14 to 17 mg of cholesterol per 100 grammes of milk, however goat's milk is more frequently documented at 11 to 25 mg per 100 grammes of milk, suggesting that goat's milk appears to offer a distinct contrast in terms of cholesterol when compared to cow's milk. Additionally, a variety of clinical disorders, such as hyperlipoproteinemia, infant malnutrition, intestinal resection, epilepsy, cystic fibrosis, coronary bypass, and gallstones, have benefited from the use of capric and caprylic acids due to their distinct metabolic ability to provide direct energy rather than being stored in adipose tissues (Haenlein 2004).

Amino acids

Amino acids are a component of proteins as well. With the exception of having less cysteine than cow or human milk, goat milk has a similar amino acid profile (Silanikove *et al*. 2010). The body may produce taurine, an important amino acid, from cysteine and methionine. Due to its cardiovascular advantages, such as controlling blood pressure, as well as its roles in eyesight, cerebral functions, detoxification, and fatty acid assimilation, taurine is also advantageous for adults. Taurine may be helpful in reducing muscular tiredness and increasing exercise capacity during workouts, according to recent findings in animal research (Silanikove *et al*. 2010).

Carbohydrate

According to Horackoval *et al*. (2014), lactose is the main carbohydrate found in goat milk. In the mammary gland, where the milk protein lactalbumin plays a significant role, it is produced from glucose and galactose (Park *et al*., 2007). Because it facilitates vitamin D absorption and intestinal absorption of calcium, magnesium, and phosphorous, lactose is a useful nutrient (Ceballos *et al*., 2009). Goat milk also contains trace amounts of oligosaccharides, glycopeptides, glycoproteins, and nucleotides. According to Horackoval *et al*. (2014), goat milk contains a significant amount of lactose-derived oligosaccharides. Due to their prebiotic and anti-infective qualities, milk oligosaccharides are regarded to be advantageous for human nutrition (Kunz *et al*., 2000).

Minerals and Vitamins

Between 0.70 and 0.85%, goat milk has a greater mineral content than either human or cow milk (Silanikove *et al*. 2010). In comparison to human milk, goat milk has notably high levels of calcium and phosphorus. It also has higher levels of potassium, magnesium, and chloride than cow milk. When compared to human milk, goat milk has a lower iron concentration and a greater zinc and iodine content. However, goat milk has a higher iron bioavailability than cow milk because the higher nucleotide content promotes better absorption in the stomach (Raynal-Ljutovac *et al*. 2008). Due to the high MCFA content or soluble protein ratio in goat milk (Zenebe *et al*. 2014), the selenium concentration in goat milk is higher than that in cow milk (Ednie *et al*. 2015) and is more bioavailable. For instance, goat cheese retains the majority of its zinc and manganese because they coexist with casein, whereas varying amounts of calcium, magnesium, and phosphorus are found in the soluble phase (33%, 66%, and 39%, respectively), and are therefore not retained in the curd (Park *et al*. 2007). The salt

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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balance in goat milk is a determining factor in the retention of minerals in the curd during cheese making. The mineral content of goat milk varies slightly depending on the breed, nutrition, individual animal, and lactation stage, although not significantly. Goat milk has unusually high concentrations of vitamins A and B, but is completely devoid of -carotene since it is converted to retinol (Park *et al*., 2007; Raynal ljutovac *etal*., 2008). The reason goat milk is whiter than cow milk is because beta-carotene is converted to retinol (Park *et al*., 2007). Goat milk is less vitamin E, folic acid, and vitamin B12 than cow milk, which might cause "goat milk anaemia" if extra amounts of these minerals are not present in the diet (Park *et al*. 2007).For a human infant, goat milk includes excessive amounts of thiamine, riboflavin, and pantothenic acid (vitamin B). As a result, infants that are exclusively fed goat milk are overloaded with both these minerals and vitamins.

Nutritional Value of Goat Milk

Even while goat milk production accounts for a minor portion of the global milk supply, it is economically significant in nations where the climate is unsuitable for rearing cattle (Tziboula-Clarke, 2003).

Raw goat's milk is the second-best feeding option after mother's milk in terms of comfort for children who have trouble digesting cow's milk, even if they are sensitive to cow or other animals' milk. Since goat's milk and human milk are actually quite comparable, kids who drink goat's milk report feeling fuller between meals and sleeping through the night (Park, 2007).

Table – 1 Average Composition of Goat Milk

Nutrient	Goat milk (%)
Fat	3.8
Solid not fat	8.68
Lactose	4.08
Total Protein	2.90
Casein	2.47
Vit A (IU/gram fat)	39.0
Vit B1 (µg/100ml)	68.0
Vit C (mg ascorbic acid)	2.00
Vit D (IU/gram fat)	0.70

Source: Getaneh et al., 2016

Functional Properties of Goat Milk

Goat Milk in Curing Dengue Fever

Compared to cow milk, goat milk has higher selenium (more than 27%) (Belewu and Adewole 2009). The fundamental issue with dengue fever is a selenium deficiency, which causes a drop in platelet count in the body. The virus that causes dengue is exclusively carried by infected mosquitoes. These viruses that cause fever in humans are transmitted through mosquito bites. These viruses enter the body's glands through the blood, where they replicate

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

and infect further organs and tissues. According to Kurane (2007), platelet count is primarily decreased during dengue fever. Since external sources of platelets cannot be used for transfusion, goat milk is primarily advised for dengue patients to maintain body fluid balance. Consuming goat milk enhances biliary secretion of cholesterol, lowering plasma cholesterol levels while maintaining the same levels of phospholipids, biliary acid, and lithogenicity (Lopez-Aliaga *et al*., 2010). According to Morgan *et al*. (2010), Se deficiency also causes irreversible cardiomyopathy.

Goat Milk in Brain Development

Sialic acid, which is found in colostrum and milk, is recognised as a crucial biological element that helps babies' immune systems and brains develop (Varki, 2008; Ednie *et al*., 2015; Formiga de Sousa *etal*., 2015). According to Claps *et al*. (2014), goat milk has a much greater sialiloligosaccharides concentration than milk from other ruminants. The total sialic acid concentration in milk may be influenced by a number of elements, such as species, feed management, and environmental circumstances.

Goat Milk as Prebiotics

Milk contains oligosaccharides or non-digestible sugars that can function as prebiotics. By encouraging the development of healthy gut bacteria and inhibiting the growth of harmful bacteria, prebiotics contribute to the maintenance of the digestive system's health. According to Martinez-Ferez *et al*. (2005), goat milk typically has 250 to 300 mg/l of oligosaccharides, which is 4-5 times more than the amount found in cow milk. According to research by Lara-Villoslada *et al*. (2006), the oligosaccharides in goat's milk help animals recover from colitis by reducing intestinal inflammation.

Goat Milk as Source of Antioxidant Peptides

Researchers' interest in antioxidant peptides increased as a result of their ability to delay or prevent oxidative food deterioration and hence extend shelf life. In-vitro hydrolysis of goat milk proteins by enzymes or fermentation by lactic acid bacteria can produce powerful antioxidant peptides (Ahmed *etal*. 2015). According to Gobba *et al*. (2014), these antioxidant peptides have excellent iron chelation, radical scavenging, and polyunsaturated fatty acid autooxidation inhibition properties.

Goat Milk as Antimicrobial Agent

Goat milk contains oligosaccharides that serve as anti-inflammatory scavenger receptors for a variety of pathogens, an inhibitor of Escherichia coli heat-stable enterotoxin, and a blocker of leukocyte-endothelial cell contact (Boehm and Stahl, 2007). According to Van-Immerseel *et al*. (2004), medium chain fatty acids have been found to exhibit antibacterial effect against gram-negative bacteria. Goat milk is broken down by the digestive enzyme pepsin to produce peptides that are antibacterial and effective against gram-negative bacteria (Park, 2009). In comparison to fermented cow milk, fermented goat milk also demonstrates antibacterial activity against Serratia marcesens (Slacanac *et al*., 2004).

Immunological Properties

T-lymphocytes (T-cells), Natural Killer (NK) cells, and B-lymphocytes (B-cells) are the key players in the innate and adaptive immune response, however many other types of cells are also involved. Although immunoglobulins (Ig) have a similar structural make-up, there are small structural variations across the five main immunological classes (IgG, IgM, IgA, IgD, and IgE). IgG and IgA make up the majority of serum immunoglobulins. Almost all

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

biological processes involve goat milk, which also has anti-inflammatory and antioxidant effects on the body. This is crucial since oxidation has been related to the emergence of numerous diseases, including cancer, and inflammation is the body's primary response to infection (Shea *et al*., 2004).

CONCLUSION

Goat milk production and consumption have recently increased on a global scale as more people, particularly in affluent countries, are becoming aware of its benefits. Goats are typically raised in rangelands in semi-desert and subtropical climates, where there is sufficient forage and water availability, and their milk is recognised to have more nutritional value than that of other species. Goats have the capacity to generate milk for human use that is of good composition and quality. These elements of milk include lactose, fat, protein, ash, vitamins, and enzymes. Despite the fact that goats are known to be able to produce milk with a high nutritional content. Additionally, it offers therapeutic benefits for people and is a healthy alternative to cow's milk that may be easier to digest, especially for kids and people with sensitive stomachs to other animals' milk. Because it lacks folic acid and can result in anaemia in infants under one-year olds, goat milk is not advised for them.

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CHAPTER 18

Nutritional Strategy in Goat

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ABSTRACT

Requirement of demand of daily needful animal origin product increasing. Due to shortages of feed and fodder, essential to utilized the crop residues in goat ration because of increasing population of goat. Goat is poor man's cow because it provided supplementary income and livelihood to millions of resource poor farmers and landless labourers of rural India. Nutrient requirement as water, carbohydrates, fats, protein, minerals and vitamins essential for daily metabolic activity. Water is universal nutrient and ratio between dry matter intake and water consumption is 1:1.2, dry matter and the other nutrients in the dry matter are important for animals. Average dry matter requirement of goat is 4% of body weight. Energy is used for maintenance and for fuelling the processes of growth and production which derived from the breakdown of several nutrients including fat, protein and carbohydrates. Fibre provides bulk to the diet which help to increases rumination rate and salivation for better production. Proteins containing needed for the growth and various metabolic process. Macronutrients are the most important nutrients for animal reproduction and should be given top priority. Micronutrients are required for proper cellular metabolism, growth, and maintenance, as well as animal fertility and health. For a variety of metabolic activities, including reproduction and growth, adequate nutritional supplementation and absorption are essential. Formulate the ration and feeding of the to the various stages of goat from kid to adult stage as per their requirement in terms of mainly DMI, DCP and TDN (gm) for maintenance, growth, lactation, pregnancy and breeding.

Keywords*: Goat, nutrients, macronutrients, micronutrients, reproduction, water*

INTRODUCTION

Worldwide demand for animal-origin foods (milk, meat and eggs) is increasing tremendously in recent years and will continue to increase shortly. More so in Asia, where the demands for livestock products are anticipated to outstrip the current production levels, and the demands are projected to grow two to threefold by 2050 (Devendra and Leng, 2011). To achieve these targeted levels of production, efficient feeding of livestock is necessary as feed is the major driver of livestock production.

The goat is important livestock species for the nourishment of rural poor people in India and other countries. Goat raring plays an important role in providing subsidiary income and livelihood to millions of landless labourers, marginal farmers, and small farmers. As per the 20th Livestock Census (2019), the goat population of India is 148.88 million which constitutes 27.74% of the total livestock population and contributes about 3% of total milk production and 14.25% of total meat production in the country.

Goats mostly thrive on grazing natural grasses as well as browsing on shrubs and various tree leaves. These feed resources are characterized by low digestibility, low ME, and low CP besides poor availability of minerals and vitamins. Moreover, there is a scarcity of grazing

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land due to the ever-growing human population, industrialization, deforestation, etc. Hence there is a need to adopt the scientific feeding of goats and making utilization of various non-conventional feed resources for reducing the unit cost of production. The source of green fodder in India is from cultivation of agricultural land, forest and fallow lands. Currently, the area available for fodder cultivation is decreasing, emphasizing the need for efficient utilization of available feed and fodder resources. There is a deficiency of 44% for concentrate feed ingredients, 35.6% for green fodders, and 10.95% for dry roughages in India (IGFRI, 2015).

Crop residues are bulky and contain more than 18 per cent crude fiber. Crop residues comprise straws and stovers obtained after harvesting the crops. These crop residues have for a long time been a major source of food for animals and will continue to be so for the foreseeable future. Though crop residues are the largest feed resource in the country, their use and development have not received proper recognition due to their bulkiness, poor nutrient density and high transport costs.

This importance of crop residues will continue to grow due to a deficit in feed resources and a rising demand for livestock feed, which cannot be fulfilled by green fodder alone. The crop residues are usually consumed by large ruminants but small ruminants like goats are reluctant to consume them. Several attempts have been made by researchers to improve the nutritive value, digestibility, and utilization of low-cost feed by various processing methods.

The daily feed intake of goats ranges from 3-4% of body weight (dry matter/head/day). The daily feed intake is influenced by body weight, % of dry matter in the feeds eaten (12-35% in forages, 86-92% in hays and concentrates), palatability, and physiological stage of the goats (growth, pregnancy, and lactation).

Basic Information of Goat as Livestock in the Country

Role in Rural Economy

Among all species of farm animals, Goats have the widest ecological range and have been poor people‟s most reliable livelihood resource since their domestication during Neolithic Revolution about 10 millennia ago. Goat plays a significant role in providing supplementary income and livelihood to millions of resource poor farmers and landless labourers of rural India. Small ruminant rearing ensures self-employment and acts as a cushion in distress situations like drought and famine.

Role in Entrepreneurship

In last few years, goat production in the country gained momentum in the form of a commercially viable enterprise as evidenced by the increasing interest of young entrepreneurs to develop knowledge and skill in this species. In many small-herd dairy goat enterprises, not all must be milked, so meat is often the main product. Along with meat, the sale of breeding stock from small herds of dairy goats may be an important income source.

This versatility allows the producer to plan and operate a more stable economic production unit. In some parts of the world, all breeds may be raised for fiber, meat, and milk and cheese production. Kids of all breeds can be used for meat. However, meat goat carcasses are generally leaner and more muscular than dairy goat carcasses.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Role in the Global Scenario

India ranks on top in goat population. The demand for meat, milk and fiber is increasing progressively and expected to further rise in future given the sizable increase in per capita income and health consciousness of people. Worldwide consumers are preferring products that are "clean, green and ethical". As such goat producers are shifting to husbandry practices that do not compromise the welfare of animals. Medicinal properties of goat milk increased the interest of society to use it as a therapeutic health food nutraceutical; moreover, biotechnologists are focusing on designer milk for human health.

Role in Nutrition and Health

Goats possess distinct social, economic and biological advantages. They can be maintained on a limited area and can sustain on wide variety of vegetation in varied agro-climatic conditions. Goat meat (chevon) is one of most preferred meat type by consumers in several countries including India. The goat milk is easily digestible due to smaller size of fat globules and serves as a ready source of family nutrition. In India, both demand and production of goat meat have shown steady increase during the last decade and despite the rising 3 production trend, country would need to double the number of goats to meet the projected requirement of goat meat for the growing human population in the coming decades.

Goat Nutrition

The principles involved in goat nutrition are mostly concerned with the determination or the establishment of the materials that the animal needs for it to live, grow, reproduce and produce. The adage that we are what we eat is equally applicable to other higher animals, including goats. Chemically, the goat and its products such as milk are constituted of water, carbohydrates, fat, protein, minerals (ash) and very minute quantities of vitamins The goat's body and milk are mainly made of water, although in the animal the proportion of water varies with age. The kid contains about 80% water but this falls to about 50% in the adult goat.

Nutrient Requirement

After the establishment of the role of nutrients the next important area of goat nutrition is to determine the amounts of these nutrients that the animal needs daily in order for it to maintain itself and to produce. Nutrient requirements are determined by the demand of the body for nutrients depending on its physiological state. For goats at the growing stage there is a consistent increasing demand for nutrients both for maintenance and growth. On the other hand, for reproducing goats the demand for nutrients is lowest at the dry/mating period and increases through gestation until it reaches a maximum at peak lactation. Nutrient requirement data have been determined with the view to satisfying these demands. Several factors influence the requirement for water, dry matter and the other nutrients in the dry matter.

Dry Matter Intake

Dry matter intake (DMI) tends to increase with increasing dietary protein level but decrease with increasing energy density. The energy density of the ration, milk yield and body weight are the variables used to best predict the DMI of goats. Average dry matter intake of meat goat is 3-5%, lactating dairy goats are 4-6% of body weight. This means that goats have a faster turnover rate and shorter retention time compared to dairy cows. High-producing, lactating goats consume nearly twice as much feed per unit of body weight compared to

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lactating cows. DMI peaks between 8 to 12 weeks postpartum. Dry matter intake is affected by parity and breed

Dry matter, energy and protein requirements vary according to the:

1) **Type of goat:** The requirements of meat goats are less than those for dairy goats. On average, the dry matter requirement of adult meat goats (1.9- 3.8% of body weight) is about 15% less than for adult dairy and dual-purpose goats (24.9% of body weight). Large breeds of goats need more nutrients to maintain the body and therefore their total requirements are higher than small breeds.
2) **Physiological status:** Goats in late gestation and those lactating require more nutrients than non-lactating ones.
3) **Rate of growth:** For a given breed of goat the bigger the body weight and faster the rate of growth the higher the nutrient requirement.

Function and Sources of Nutrients

There are five major groups of nutrients in food needed by goats. These are Water, Energy (derived from carbohydrates and fats), Protein, Minerals (ash) and Vitamins.

Water

Goats need water for normal body functions and for the production of milk. The body and milk are composed principally of water. Thus water is needed to maintain the turgidity of the cells and hence the integrity of the animal. Body processes such as digestion, the transportation of other nutrients and oxygen around the body and the excretion of carbon dioxide and other waste products all use water as the medium. Water also plays an important role in cooling the animal in hot conditions.

Goats should have free-choice access to clean, fresh water at all times. A mature animal will consume between three-fourths to one and one-half gallons of water per day. Water requirements and intake increase greatly during late gestation and during lactation. Water requirements increase substantially when environmental temperatures rise above 70^0 F and decline with very cold environmental temperatures. An animal's nutrient requirements will increase if it has to consume cold water during cold weather. Rain, dew and snowfall may dramatically decrease free-choice water intake.

Inadequate water intake can cause various health problems. In addition, water and feed intake are positively correlated, meaning that the more feed goats eat, the more water they need. Producers should use common sense when providing water (Schoenian, 2003). Goats get water from three sources i.e. water in the food eaten, free water consumed and metabolic water (water produced in the body tissues from the burning of nutrients to produce energy).

Water functions in the animal body in a number of ways:

1) Helps to digest food
2) Regulates body temperature
3) Lubricates tissue
4) Transports waste from the body

Water Requirement

Goats need water for the functions mentioned earlier. On average a 20-kg goat requires about 700 ml of water per day. However, the amount consumed is dependent on the prevailing

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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temperature, the amount of water in the food and the physiological status. More water is consumed on a hot day than on a cool day. Lactating goats need more water than non-lactating ones, and the greater the dry matter consumed the higher the water requirement. The ratio between dry matter intake and free water consumption is 1:1.2. In winter, taking the chill off of the water will encourage higher intakes. Goats drink about 3.5 L of water for every litre of milk produced.

Table 1: Recommended Water Consumption Rates for Goats

Category of goat	Water consumption per/head/day
Weaners	4-6 litres
Adult dry goat	5-7 litres
Doe with kid	5-10 litres

**These figures for water consumption could double if the temperature exceeds 40°C.*

Energy

Energy is not considered a nutrient, but can be derived from the breakdown of several nutrients including fat, protein, and both simple and complex carbohydrates. Energy is the basis of the whole existence of the goat. Energy is used for maintenance and for fuelling the processes of growth production of the offspring and milk. Sugars, starches (found in grains) and fibre (cellulose) are the carbohydrates that convert into volatile fatty acids (energy) by rumen flora (beneficial bacteria). Normal goat diet (browse, forbs, and grasses) is high in cellulose and requires digestion by rumen flora to be converted into energy. Fresh pastures and young plants may have highly digestible fibre and provide high energy compared to older plants. Higher energy levels come from lower fibre feeds. Energy is represented as total Goats and their Nutrition Introduction digestible energy (%TDN) in feed analysis reports. form of hay or pasture to avoid high energy-related problems. Maintain at least 12% crude fibre in the diet. Energy requirements for different physiological stages -- maintenance, pregnancy, lactation and growth vary. The maintenance requirement for energy remains the same for most goats except dairy kids; they require 21% energy higher than the average. It is important to feed high-energy rations at the time of breeding, late gestation and lactation. Lactating does have the highest energy demand.

The carbohydrates are derived from storage carbohydrates (starch) in the plant cells (potato, cereal grains and their mill by-products) and from the cellulose (fiber) in the plant cell wall. It is essential to evaluate the efficiency and overall performance of a feed or ration referred to as the total digestible nutrients (TDN). TDN is a broad term used to express the energy value of a feed or ration. The percentage of TDN is the most widely used method of evaluating feed for energy. As a rule, the greater the TDN is in a ration, the greater the rate of gain will be in the animal.

Fiber

Adequate fiber and/or quality forage promotes good health and better performance. Fiber adds bulk to the diet and keeps the rumen properly functioning, as it increases rumination and salivation. The rumen of sheep and goats functions best when the daily diet includes a high concentration of slowly degradable fibre ingredients known as roughage. Extended chewing of the fibrous material helps to keep the acidity in the rumen within a range that benefits the fiber-digesting microbes. This is commonly known as the cud-chewing process. The digestive interaction of fiber stimulates the muscles in the wall of the rumen to contract and expand, which essentially stirs up the material in the rumen. These forage products include

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

any type of hay, silage, or fresh forage. Cottonseed and soybean hulls often are utilized as a form of fiber in feed rations.

Fats

Fats can also be a source of energy for goats. Goats do consume some amount of fats while browsing. Excess energy produced by carbohydrates is stored in the form of fat, especially around internal organs. The stored fat in the body is used during high energy needs, especially the lactation period. Supplying fats may not be a cost-effective idea for goat production.

Protein

Proteins perform diverse functions in the body. They are constituents of milk, hair, skin, and hooves, as well as hormones and enzymes that drive chemical reactions in the cells of the animal. They are the principal entities in muscles and hence are a determinant of growth. Proteins are needed for the growth of foetuses too.

Proteins are digested and broken down into amino acids and are eventually absorbed in the small intestine. Those amino acids are building blocks for body proteins (muscles). The rumen plays a major role in breaking down consumed protein into bacterial protein through bacterial fermentation. Feeds like forages, hays, pellets (alfalfa), barley, peas, corn, oats, distilled grains and meals (soybean, cottonseed meals) are common sources of protein for goat rationing. The protein requirements are higher during growth (kids), milk synthesis (lactation), and mohair growth. Producers may need to supplement protein sometimes during the year, especially in late fall or winter. It is very important for a commercial goat operation to do cost-effective rationing as proteins can be an expensive feed ingredient. Good quality hay does not need much protein supplement for goats.

Goats ingest proteins in two forms true proteins and non-protein nitrogen. True proteins are derived from both animal sources, (e.g. fish meal, meat meal, milk) and plant sources (e.g. meals of oil bearing seeds, brewers' grain and forages). Forage legumes are a cheap source of protein for goats. Non-protein nitrogen is used for the production of microorganism protein in the stomach of the goat. Good sources of non-protein nitrogen are urea and poultry litter. Foods that are high in proteins and storage carbohydrates are generally called concentrates.

Minerals

Twelve of the mineral elements in the goat's body are essential. Seven of these are called macro-minerals and the rest called micro-minerals. The macro-minerals are needed in relatively large amounts, while the micro-minerals are needed only in minute quantities.

Macro minerals includes calcium, phosphorus, magnesium, sodium, potassium, sulfur and chlorides are required at 0.1% or more in the diet of goat. Persistent mineral deficiency may result in stunted growth, loss of appetite, loss of hair or dull sheen of the coat and reduced fertility. It should be noted that these symptoms are not exclusive to mineral deficiency. It should be noted also that too much of any mineral in the food might cause toxicity.

1) **Calcium (Ca):** The major biological function of calcium is for bones. Bones contain 99% of the calcium in body. Calcium is also necessary for muscle contraction, nerve conduction, and blood clotting. The main deficiency symptoms are seen in the skeletal system. Bones can become soft and weak and may be deformed resulting in lameness.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

This condition is called rickets or osteomalacia. Major common dietary sources of calcium include limestone and dicalcium phosphate.

2) **Phosphorus (P):** Approximately 80% of the body's phosphorus is found in bones, with the remainder in the blood and other tissues. In addition to skeletal structural functions, phosphorus is essential in energy metabolism, and acid-base balance, and is a constituent of enzymes and genetic material. The major symptoms of phosphorus deficiency include reduced growth, listlessness, unkempt appearance, depressed fertility, pica. Sources of phosphorus include protein supplements, cereal byproducts, mineral supplements, and dicalcium phosphate.
3) **Sodium (Na), Potassium (K) and Chloride (Cl):** These minerals function as electrolytes in the body. Electrolytes are mineral ions, carrying a positive or negative charge that the body uses for osmotic balance, pH balance, and water movement. They are also essential in transmission of nerve impulses. Salt provides both sodium and chloride. Most forages have adequate levels of potassium.
4) **Sulfur (S):** The major biological function of sulfur is as a component of sulfur-containing amino acids. Therefore, sulfur is important in protein synthesis, milk and hair production, enzymes, hormones, hemoglobin, and connective tissue, and is a component of the vitamins biotin and thiamine. The major deficiency symptoms include poor animal performance, hair loss, excessive salivation, tearing of eyes, and weakness. Sulfur-containing mineral blocks are often used.
5) **Magnesium (Mg):** Magnesium is found in bones (60 to 70% of that in the body), liver, muscle, and blood. It is required for normal skeletal development, and nervous and muscular system functions, as well as for enzyme systems. It is also closely associated with metabolism of calcium and phosphorus. In ruminants, a major magnesium deficiency disease is grass tetany, often seen on fast-growing, lush, cool-season pastures. A major supplemental source of magnesium is magnesium oxide.

Microminerals usually supplemented in goat rations are iron, copper, cobalt, manganese, zinc, iodine, selenium, molybdenum, and others required at the part per million (ppm) level. Goats obtain minerals from the food they eat. These may be minerals occurring naturally in the feeding stuffs or mineral supplement added to the food or provided as free choice or as salt lick.

1) **Iron (Fe):** The major function of iron is as a component of haemoglobin, required for oxygen transport. It is also a component of certain enzymes. The major iron deficiency symptom is anemia. Soil contamination on forages can provide significant levels of dietary iron. Iron sulfate is a common means of adding iron to the diet.
2) **Copper (Cu):** Copper is essential in formation of red blood cells, hair pigmentation, connective tissue, and enzymes. It is also important in normal immune system function and nerve conduction. Young goats may experience progressive incoordination and paralysis, especially in the rear legs. High dietary molybdenum can depress absorption of copper and cause a deficiency. There should be at least four times as much copper as molybdenum in the diet.
3) **Cobalt (Co):** The only well-accepted biological function of cobalt is as a component of vitamin B12. Rumen microbes utilize cobalt for growth and produce vitamin B12. Most natural feedstuffs contain adequate levels of cobalt
4) **Zinc (Zn):** Zinc is found in all animal tissue and is required by the immune system and for normal skin growth. Zinc is also essential for male reproduction. The bran and germ of cereals contain high levels of zinc.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

5) **Manganese (Mn):** Manganese is important for bone formation, reproduction, and enzyme functioning. It is unusual to have a manganese deficiency.
6) **Selenium (Se):** Selenium functions with vitamin E as an antioxidant, protecting cell membranes from oxidation. Selenium also affects reproduction, metabolism of copper, cadmium, mercury, sulfur, and vitamin E. Most plants that are not grown in selenium deficient soils will have adequate selenium levels. It is more effective to provide selenium supplementation through feed.
7) **Molybdenum (Mo):** Molybdenum deficiencies are very rare. Toxicity occurs above 3 ppm due to reduced copper absorption, resulting in a copper deficiency. Molybdenum (as ammonium tetrathiomolybdate) is often used to treat copper toxicity in animals.
8) **Iodine (I):** The only proven biological function of iodine is as a component of thyroid hormones that regulate energy metabolism and reproductive function.

Table 2. Acceptable Quantity of Macro and Microminerals in a Goat's Diet

Macrominerals (%)	Macrominerals (ppm)
Calcium (Ca) 0.3-0.8	Iron (Fe) 50-1000
Phosphorus (P) 0.25-0.4	Copper (Cu) 10-80
Sodium (Na) 0.2	Cobalt (Co) 0.1-10
Potassium (K) 0.8-2.0	Zinc (Zn) 40-50
Chloride (Cl) 0.2	Manganese (Mn) 0.1-3
Sulfur (S) 0.2-0.32	Selenium (Se) 0.1-3
Magnesium (Mg) 0.18-0.4	Molybdenum (Mo) 0.1-3
	Iodine (I) 0.5-50

Source: ICAR, 2013

Vitamins

Goats need vitamins for maintenance as well as proper functioning of their physiological systems. Feeding of fat soluble vitamins (A, D, E, K) must be insured in a goat's diet due to its inability to make these vitamins. Most of the vitamins are also synthesized in the rumen of the adult goat by the microorganisms.for metabolism. Vitamin C is essential for the immune system to work efficiently. Vitamins are nutrients that take part in various body chemical reactions that are essential for the well-being of the animal. The vitamins important in goat nutrition include A, B_1, B_2, B_6, B_{12}, C, D_2, D_3, E and K.

1) **Vitamin A:** It synthesized from carotene, the pigment that gives grass and hay their green color. As long as sufficient green feed is consumed, vitamin A intake will be adequate. Vitamin A is often supplied to animals not consuming green forage such as in winter months. Many mineral and vitamin supplements contain vitamin A.
2) **Vitamin D**: It is called the sunshine vitamin because animals can synthesize the vitamin with the help of the sun. Ultraviolet light in sunshine converts pre-vitamin D found in the skin to a pro-vitamin D form that is used by the animals. Vitamin D is normally present in mineral supplements and often added to complete feeds.
3) **Vitamin E:** Functions as an antioxidant in conjunction with the mineral selenium. The requirements for one can be partially met by the other. Thus, vitamin E is very important in areas with marginal or deficient levels of selenium. Green grass and green sun-cured hay have high levels of vitamin E. Most mineral supplements and complete feeds contain vitamin E, especially in areas that are deficient in selenium.
4) **Vitamin K:** It is required by animals and functions in the clotting of blood. Vitamin K is produced by bacteria in the digestive tract and absorbed. Generally, goats do not need to be supplemented with vitamin K.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Table 3. General Vitamin Requirements of Goats

Vitamin	Level
A	11.000 IU/Kg of feed
D	4,400 IU/Kg of feed
E	176 IU/Kg of feed
K	A properly functioning rumen can synthesize adequate levels

Source: ICAR. 2013

Principles of Feeding of Goats

The basic concepts of the need for nutrients for body processes as outlined above are not peculiar or limited to goats only but are generally applicable to other higher animals. The application, though, of the concepts to the feeding of goats and animals like sheep and cattle is different from that of humans, pigs and poultry. Goats, sheep and cattle belong to a group of animals called ruminants. Ruminants are animals that can utilize effectively roughage and forages for maintenance, and depending on the source and quality of the forage also for some level of production. Ruminants have this ability to utilize roughage and forages because they are endowed with a digestive tract (gut) that includes a special type of complex stomach, unlike humans, pigs and poultry that have simple stomach. Even within the group ruminants, goats are known to have higher digestive efficiency for cellulose than cattle and sheep.

Concentrate Feeding

Concentrates are a good and quick source of energy, particularly since some portions bypass the reticulon-rumen and get digested quickly in the small intestine. Late pregnant and lactating does and young growing kids that need high energy do benefit from concentrate foods. however, concentrate foods could have serious implications for goat production; goats can suffer and die from acid poisoning as a result of feeding large quantities of concentrate. This occurs because the VFAs are produced at a faster rate than they can be absorbed. Additionally, because there is little saliva produced when concentrates are consumed there are insufficient saliva salts to buffer the acid in the reticulo-rumen. Goat producers should therefore limit the amount of concentrates fed to the animals. It is generally recommended that the proportion of concentrate in the diet should be between 30 and 40 per cent on a dry matter basis, except in feedlot where concentrate could form the bulk of the diet. In feedlots it is also advisable to feed some good quality and palatable roughage or forage (e.g. good hay, peanut haulm, sweet potato tops or leucaena and other forage legumes) either before or with the concentrate.

Feeding Different Classes of Goats

A. Nutrition for Kids

Kids must nurse their mothers (does) in the first 8 hours of their life to consume colostrum at a minimum rate of 10-20% of their body weight, preferably within 2-3 hours after birth. Colostrum contains vitamins and antibodies that will save kids from many diseases including enterotoxaemia and tetanus. Kids born as twins and triplets may need supplementation of colostrum fostered from other high producing does and even cows. Extra colostrum from high producing does with dead kids can be stored in the freezer. It is not recommended to thaw frozen colostrum in a microwave or on high heat as this would possibly denature the nutrients. Thawing at room temperature is all it takes. Replacement kids should stay with their milking mothers for as long a period as possible. Early weaning of replacement kids can leave them undernourished and will have a detrimental effect on their production potential.

1. Feeding from birth to three months of age

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Immediately after birth feed the young ones with colostrum. Up to 3 days of birth keep dam and young ones together for 2-3 days for frequent access to milk. After 3 days and up to weaning feed the kids with milk at 2 to 3 times a day. At about 2 weeks of age the young ones should be trained to eat green roughages. At one month of age the young ones should be provided with the concentrate mixture (Creep feed).

a. Colostrum feeding of kids

The kid should be allowed to suck its dam for the first three or four days so that they can get a good amount of colostrum. Colostrum feeding is a main factor in limiting kid losses. Cow colostrum is also efficient for kids. Colostrum is given at the rate of 100 ml per kg live weight. Colostrum can be preserved with 1-1.5% (vol/wt) propionic acid or 0.1% formaldehyde. Propionic acid is preferred for preservation as it keeps the pH value low. The chemically treated colostrum is kept in a cool place to ensure better quality.

b. Creep feeding for Kids

Creep feeding is a method of providing feed for the kids only. This creep feed may be started from one month of age and up to 2-4 months of age. The main purpose of creep feeding is to give more nutrients for their rapid growth. The general quantity to be given to the kids is 50 – 100 gm/animal/day and contain 22 per cent protein.

Table 4. Feeding amount to newborn kids

Age of kids	Grain Feeds (Gram per day)	Quality fodder
From 2 weeks to 1 month	Little	Little
2 months	30-60	As much as goats can feed
3 months	60-100	As much as goats can feed
4 months	100-150	As much as goats can feed

Table 5. Composition of Ideal Creep Feed

Ingredients	Level (%)
Maize	40
Ground nut cake	30
Wheat bran	10
Molasses	13
Mineral and Vitamin mixture	5
Salt	2

Table 6. Feeding kid from birth to 90 days

Age of kids	Dam's milk or cow milk (ml)	Creep feed (grams)	Forage, green/day (gm)
1-3 days	Colostrum-300 ml, 3 feedings	-	-
4-14days	350 ml, 3 feedings	-	-
15-30 days	350 ml, 3 feedings	A little	A little
31-60 days	400 ml, 2 feedings	100-150	Free choice
61-90 days	200 ml, 2 feedings	200-250	Free choice

B. Feeding after 3 months to 12 Months of Age

During the active growth period, a grower ration having 10-11% DCP and 62-64% TDN with 25% DM from good quality roughages can meet the requirement. Supplementation of

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

concentrate mixture @ 150 – 200 g/animal/day with protein of 16-18 per cent. The following concentrate mixture may have fed during the growing period

Table 7. Composition of concentrate mixture

Ingredients	Level (%)
Maize	30
Ground Gram	13
Wheat bran	30
GNC	20
Molasses	5
Mineral & Vitamin mixture	1
Salt	1

Finisher Ration: Ration providing 5 - 6 % DCP and 60 - 65 % TDN is quite satisfactory for finishing period.

C. Nutrient Requirement for Maintenance

Table 8. Nutrient Requirement for Maintenance in Adult Goat

BW (Kg)	DMI (g)	DM % BW	DCP (g)	TDN (g)	Ca (g)	P (g)
15	500	3.3	23	240	1.1	0.7
20	625	3.1	29	295	1.3	0.9
25	730	2.9	34	350	1.6	1.1
30	830	2.8	39	400	1.8	1.2
35	940	2.7	44	450	2.1	1.4
40	1040	2.6	48	500	2.3	1.5
45	1125	2.5	53	540	2.5	1.7
50	1230	2.4	57	590	2.7	1.8
55	1315	2.4	62	630	2.9	1.9
60	1410	2.3	66	675	3.1	2.1

C. Feeding Pregnant Doe: Pregnant females need feed to support the growth of the foetus. They shouldn't be fed to become too fat. females that are too fat will have trouble kidding.

Table 9. Nutrient Requirement of Pregnant Does

BW (Kg)	DMI (g)	DM % BW	DCP (g)	TDN (g)	Ca (g)	P (g)
15	700	4.7	42	385	2.1	1.4
20	865	4.3	52	475	2.6	1.7
25	1025	4.1	62	564	3.1	2.1
30	1170	3.9	71	645	3.5	2.3
35	1320	3.8	80	725	4.0	2.7
40	1460	3.6	88	802	4.4	2.9
45	1590	3.5	96	875	4.8	3.2
50	1725	3.4	104	984	5.2	3.5
55	1850	3.4	112	1018	5.5	3.7
60	1975	3.6	120	1086	5.9	3.9

Source: Ranjhan, 1998

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

D. Feeding Lactating Doe

The lactating doe has very high nutrient requirements. The requirement of these classes of animals is similar to females in late pregnancy. Their rations should generally contain 14–16% crude protein. They have high requirements for milk production. They should receive the level of concentration should be higher for high milk producers. An allowance of concentrates at the rate of one-third of the amount of milk produced is necessary.

Table 10. Nutrient Requirements of Lactating Doe

BW (Kg)	Milk Yield (Kg)	DMI (g)	DM % BW	DCP (g)	TDN (g)	Ca (g)	P (g)
20	0.5	865	4.3	51	468	4.3	2.9
	1.0	1185	5.9	74	640	5.9	3.9
25	0.5	968	3.9	56	523	4.8	3.2
	1.0	1290	5.2	79	695	6.4	4.3
30	0.5	1060	3.5	61	573	5.3	3.5
	1.0	1380	4.6	84	745	6.9	4.6
35	0.5	1155	3.3	66	623	5.8	3.9
	1.0	1470	4.2	89	795	7.3	4.9
40	0.5	1245	3.1	70	673	6.2	4.1
	1.0	1565	3.9	93	845	7.8	5.2
45	0.5	1320	2.9	75	713	6.6	4.4
	1.0	1640	3.6	98	885	8.2	5.3
50	0.5	1410	2.8	79	763	7.0	4.7
	1.0	1730	3.5	102	935	8.6	5.7
55	0.5	1490	2.7	84	803	7.4	4.9
	1.0	1805	3.3	107	975	9.0	6.0
60	0.5	1570	2.6	88	848	7.8	5.2
	1.0	1890	3.1	111	1020	9.4	6.3

Source: Ranjhan, 1998

E. Feeding Bucks/Breeding Males

Adult males used for breeding need to be well-fed to maintain their body condition for mating. Breeding males need to be supplemented beginning two weeks before the start of breeding. They should not become too fat and fed @ 3 to 3.5 % of live weight. Ration providing 4 to 6 % DCP and 50 - 60 % TDN with sufficient mineral and vitamins will maintain normal health and fertility. The supply of good pasture is enough when not used for breeding.

F. Dry Breeding Females

A dry female that has recently been weaned from her kids can be maintained on good quality pasture or fed good quality hay depending on her body condition at weaning. Flushing is the practice of feeding the doe so that she starts to gain weight about two weeks before breeding. Flushing may increase the kidding percentage and embryo survival.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Table 11. Feeding Schedule for Different Categories of Goats

Category of goat	Approximate body weight (kg)	Quantity to be fed per day	
		Concentrate (g)	Green fodder (kg)
Growing (6-12 months)	15-20	300-400	1-2
Adult goats	25-30	200-300	2-3
Breeding bucks	30-40	400-500	3-5

G. Dry Period Feeding

During the far-off dry period (4 to 5 weeks), goats can be fed good quality hay (9 to 11% protein). During the last 3 to 4 weeks, both energy and protein need to be supplemented. Feed ½ to 1 kg of grain ration to adapt the rumen to the higher grain feeding during lactation and help avoid complications with ketosis.

H. Common Feeds and Fodder for Goats

1) Tree leaves, shrubs, herbs *i.e*. Pipal, beri, mango, anjan, jharberi, babool, neem etc.
2) Grasses *e.g*. anjan, sawai, kankauwa etc.
3) Vegetable wastes *i.e*. tops of carrot, turnip, reddish, leaves of cauliflower, cabbage, mustard and empty pods of peas.
4) Cultivated fodders and their hays
    a) Leguminous - Peas, Cowpea, Berseem, Lucerne *etc*.
    b) Cereals - Maize, Oats, Jowar etc.
5) Pods and berries of Babul, Gular, Jharberi *etc*.
6) Dry feeds - Dry pods of subabool, cereal straw, leguminous straw, gram husk, gram waste.

CONCLUSION

Goat pollution increased by 10.1% over the previous census. Due to shortfall of feed and fodder with increasing goat population required proper knowledge of raw feed ingredients for utilization in goat as grower, finisher concentrate feed with low cost formulation for maximum production. Cultivation of perineal fodder variety need for future for healthy flock. Utilization of agriculture wastages, poor quality dry roughages and non-biodegradable fibre converting to easily digestible for production in terms of meat, milk by action of various chemical and biological treatment for various developing stages of goat.

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CHAPTER 19

Goat Management: Before and After Parturition

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ABSTRACT

Goat is usually referred to as the "Cow of the poor". It is a multipurpose small and viable domestic animal. Rearing of goat fits well with small and marginal farmers in their mixed farming. Goat has the ability to survive on little vegetation and grass. Goat farming suits India's climate and economic situation. Goats by nature are very tolerant of all kinds of weather and adapt to many different styles of housing, hence goat farming suits in the prevailing climatic changing situation of our area and it can be integrated with fish culture for better economic output.

***Keyword**: Pregnant doe, goat kid, Management, Parturition.*

INTRODUCTION

In India, goats play a significant role in the livestock sector for provide a valuable source of meat, milk, and fiber (Banerjee, 2004). The goat population in India is quite large, and there are various breeds of goats that are reared for different purposes. According to 20th livestock census conducting in 2019, India had a total goat population of over 148.88 million (Dept. of A.H.2019, GOI). This makes India the largest producer of goat in the world. The goat population has been steadily increasing over the years, reflecting the importance of goat production in the country. Goat production in India is mainly concentrated in rural and semi-rural areas, where a large number of small scale and marginal farmers rear goat as a source of income and livelihood. Goats are known for their ability to adapt to divers agro-climatic conditions and are often raised in mixed farming systems. The most widely reared goats breed in India includes the Jamunapari, Beetal, Sirohi, Osmanabadi, and Barbari.

These breeds are primarily raised for meat production. In certain regions, specific breeds like the Marwari, gujari, and pashmina goats are reared for their fine quality fiber. Goat is also reared for milk production, with certain breeds like Jamunapari, Beetal and Surti being known for their high milk yields. Goat production in India is predominantly undertaken by small scale farmers and tribal communities who rear goats in backyard or extensive systems. However, there is also a growing trend towards commercial goat farming where large farms are being set up with a focus on improve breed management, nutrition, and marketing (Shastry and Thomas, 2015).

Overall goat production in India is a vital sector of the livestock industry and provides a valuable source of income and livelihood for millions of farmers. Islam *et al*. (2016). Management refers to the practices and processing involved in overseeing and controlling the activities of individuals or group to achieve specific goals or objectives it involves various

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steps like planning, Organizing, leading and controlling resources to fulfilling desired outcomes management, (2023).

In context of goat farming management typically involve:

1) Planning or setting goals, establishing strategies, and making decisions about various aspects of the operations, such as breeding, nutrition, health care, marketing etc.
2) In organization there will be structuring the farm or business in a way that optimizes efficiency and effectiveness. This may involve tasks such as assigning responsibilities, developing schedules, and creating systems for record keeping and data management.
3) In leading it provide guidance to individuals or team involved in the operation. This includes effective communication and fostering a positive work environment.
4) Controlling it monitoring and evaluating the progress and performance of various aspect of operation this may involve tracking financial records, assessing animal health and productivity.

Care and Management of Pregnant Does Just Before Parturition

1) Pregnant Does

a) About 6-8 weeks before parturition female should be dried off for developing healthy fetus to keep good health and to maintain high milk yield during lactation stage.
b) Separate pasture area should be allowed and at least 450 g/day concentrate mixture should be fed to does.
c) For pregnant dam separate housing arrangements shall be made.
d) In last week before the parturition provide animal with adlib water and energy diet which should be less bulky.

Source: (Prasad, 2016)

2) Signs Approaching Parturition in Goat

a) Sunken look at tail and hip.
b) Udder enlarged, shiny and filled
c) Restlessness: Looking back and side and bleat slowly.
d) Great display of affection for keepers.

Source: (Prasad, 2016)

Care and Management of Doe Just After Kidding

Kids survival is greatly influenced by their early care and the setting in which they are born. (Peacock, 2005). Ample bedding should be provided, and the environment should be dry and tidy.

In order to prevent the spread of any sickness or infection to the kid and goat during birth, the kidding environment should be cleaned before kidding. (Blauw *et al.,* 2015). It is also recommended that the area be well spacious enough to minimize stress and overcrowding of the goats. (Rowe and East, 1997).

Kidding Shed

It is the place where advance pregnant doe will be shifted for kidding. Movable hurdles can be used for the preparation of pens. This should be spacious for kidding. It should be cleaned and disinfected thoroughly in order to prevent naval infection. 1.5m X1.2m X 3m spacing is required for manger and water trough. The pen should provide warm weather to kids in winter. During cold weather, thick bedding material is essential for the kids.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Table 1: Source: (Balsare and Singh, 1992)

Goat	Floor space (m^2)	Maximum animals per pen	Shed height (cm)	Feeding space per animal (cm)	Watering space/ animal (cm)
Kids	0.5-1	20-25	300 in dry 220 in heavy rainfall	30-35	3-5
Adult female	1-1.5	60	Same as above	40-50	4-5
Pregnant and lactating doe	2	8-10	Same as above	40-50	4-5
Adult male	2	1	Same as above	40-50	4-5

a) Provide dalia/bran mash, oat meal, ginger, salt, mineral mixture with jaggery palatable and soft in nature.
b) Wait and observe the discharge with placenta to fall down.
c) Wash the hind portion with disinfectant clean and dry cloth.
d) Offered concentrate mixture contain 15% DCP & 60% TDN @ 450 g/day.
e) Postpartum heat will be observed after 4 weeks but female should be rebred after 45 days.
f) Save parturient Does from cold & chilly weather.

Fig 1: Sirohi goat kid with his dam

Care and Management of Kids

a) Cleaning mucus: The mucus from nostrils and body of kids of cleaned by soft cloth just after kidding (artificial respiration initiation if needed).Birth weight may be recorded so that colostrums and milk feeding will be done accordingly.
b) Cutting of naval cord: Naval cord should be cut 2-3 cm away from the body and then apply iodine solution. If bleeding exists than seal with tincture Benzoine.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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c) Feeding of colostrums: Allow kids to suckle first milk (colostrums just after birth to provide antibodies, Vitamin A, D and minerals helps in cleaning meconium.
d) Weaning kids: Feeding of milk by nipple either from pail or bottle feeding.
e) Feeding of milk: Feeding of milk in first 2 weeks for 2-4 times, later on 2 times a day.

Table 2: Milk Feeding Schedule of KIDS SOURCE: (Shastry and Thomas, 2015)

Milk feeding @	$1/6^{th}$ of body weight	I^{st} month.
Milk feeding @	$1/8^{th}$ of body weight	2^{nd} month
Milk feeding @	$1/10^{th}$ of body weight	3^{rd} month

Fig 2: Sirohi goat kid feeding with goat starter feed

a) Disbudding: Horn buds are cauterized by KOH sticks at one week age.
b) Putting Identification mark: Marks the kids within first week by putting tagging number, to keep proper record management.
c) Castration of male kids: All the male kids except those to be kept for breeding must be castrated by Burdizzo's castrator at the age of 2 to 4 weeks age.
d) Deworming of kids: Deworming may be done after 1-2 months age.
e) Feeding of milk replacer: May be practice after 15 days age.
f) Feeding of starter ration: it should be started after 15 days age.
g) Cleanliness of kids and importance of bedding: Dry grasses, paddy, straw, sawdust etc, bedding which acts as insulation.
h) Washing of udder: For feeding 161colostrums and milk from dam by P.P. lotion.
i) Immediately after birth 5 ml Enteromycetin syrup for 3 days to prevent digestive infection.
j) Provide adlib fresh clean water to drink.
k) Vaccination schedule may be followed.

After the colostrum phase is through, kids can be reared naturally or artificially. The major component of the pre-weaning kids diet is milk, which can be given via bottles or self-feeders up until the second week and thereafter 2-3 times per day until weaning. Nipples and the bottle should always be kept spotlessly clean when milk is given via bottle. In the event that

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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breastfeeding is unsuccessful or to preserve the saleable milk, they can also be grown on milk replacement. (Naud and Vasseur, 2021).

Table 3: Feeding Schedule for KIDS SOURCE: Ranjhan, (2003)

Age of kids (days)	Body weight (Kg)	Number of feedings	Dams or cow milk (ml)	Green feed	Creep mixture
1-7	1-3	With dam	300	-	-
8-30	3-6	3	350	Free choice	Free choice
31-60	6-9	2	400	Free choice	100-150
60-90	9-12	2	200	Free choice	200-250

The optimal period to wean kids is up to three months old, although they can wean at any time up to six months old. Over milking should be avoided as it may result in poor stomach development. By two weeks, kids begin to nibble on fodder like hay or pasture grass, and by four weeks, they are eating solid foods. consumption of milk that has been supplemented or concentrated. Concentrate supplements mostly three weeks after delivery make up for the lack of milk consumption. It is preferable to give them 150 g of concentrate or 200 g of wheat bran when they are one to three months old in order to have a decent growth rate. Additionally, providing concentrate feeding before to weaning promotes weight gain after weaning since it moulds goats well for weaning and reduces weaning stress if leguminous fodder is available. (Naud and Vasseur, 2021).

Starter Ration

From 15 days of age following palatable and easily digestible kid starter be offered.

Table 3: Composition of Starter Mixture

Maize	22%
Gram	20%
Groundnut cake	35%
Wheat bran	20%
Mineral mix	2.5%
Common salt	0.5%
Total	100%

Starter mixture for kids must contain DCP-18-22%, TDN-72% and M. Cal. 2.5 – 2.9ME/kg. Source; Ranjan (2003)

Water Requirement

At weaning to promote the transition from liquid diet to a solid diet in kids, it is advisable that kids should have access to lukewarm and clean water (Sajilata *et al*., 2002).

Concentrates

Feeding of concentrate before weaning is crucial for the transition from milk fed kids which is usually occur between 1 and 3 weeks of age. A high quality (18-22% CP) and delicious kids starter is provided to kids at least twice daily (Greenwood, 1993). Feeding of goat kids adlib concentrates alone as opposed to mixing pellets with whole or rolled cereal grains, which increases weight gain and feed conversion ratio (Hadjipanayiotou, 1990). Before weaning kids should ingest a minimum of 250 gram/day feed to promote a smooth transition to a solid feed. (Zobel *et al*., 2020).

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Forages

For proper rumen development and function forage consumption is necessary at the time of weaning. The introduction of a high-quality forage to the kids diet should occur around the same time as the concentrates (*i.e.* between 1 and 3 week of age) and fed 3 times a day or adlib to promote feed intake. However, Lucerne hay should be avoided before the age of four months to lower risk of bloating. The hay supplied to kids should be leafy and cut at a young stage (Naud and Vasseur, 2021).

Health Management of Kids

The first advisable intervention is to dip or spray the umbilical cord of kids with a 5 to 10% iodine tincture disinfecting solution after birth to prevent navel infections and repeated at 24 hours if signs of redness persists. If it is too long, cut it to 8 to 10 cm in length before disinfecting it to prevent it from dragging on the bedding and collecting bacteria. The kids should also be supplemented with selenium and vitamin E at birth, for the prevention of white muscle disease. Ramirez-Bribiesca *et al*. (2005) revealed that giving newborn children from selenium-deficient goats 0.3 mg of selenium and 4.2 IU of vitamin E/kg of body weight at birth was enough to lower the death rate of children in their first two months of life when compared to the control therapy (60% vs. 24% mortality, respectively; $P < 0.01$).

To avoid illnesses like enterotoxaemia (Clostridium perfringens types C and D) and tetanus, which kids might catch at a young age, vaccination of dams and kid is also a crucial health care practice. It is advisable to vaccinate dams for these diseases in their last 3 to 4 weeks of gestation so that transfer of immunity to kids can occur through colostrum. Then, between the ages of three and six weeks and again between the months of two and four weeks, kids should receive the recommended vaccinations. The most prevalent cause of diarrhoea in goat kid is coccidiosis, and specific management advice is provided for this condition. (Ngongolo and Mmbaga, 2022). kids who with coccidiosis lose weight and occasionally pass away, which raises serious financial issues. (Foreyt, 1990; Ruiz *et al.,* 2012). Adding an anticoccidial medicine (coccidiostat; for example, decoquinate) to the kids' diet commencing at 15 to 30 days of age is advised for the management of coccidiosis in goat kids. Around weaning, it was shown that feeding dairy goat kids 1 mg of decoquinate/kg of kid body weight per day for 30 days was an effective way to avoid coccidiosis. (Mage *et al.,* 1995).

Disbudding of Kids

It is a common management practice done on commercial dairy goat farms to avoid injuries to other goats in the herd and handlers and to minimize risks of goats getting stuck in fences or between pen partitions. It is both stressful and painful for the kids (Hempstead *et al.,* 2017) and should be kept under control to reduce discomfort, mishaps, and consequences. Disbudding-related injuries (17%) were found to be the second highest cause of mortality on New Zealand dairy goat farms (Todd *et al*., 2019). Before the horn buds on children's horns get too big, disbudding is advised between the ages of 3 and 15 days. Heat cautery is the suggested and most used method for disbudding (Hempstead *et al.,* 2017). An electric or gas hot iron tool with a tip diameter of 19 to 25 mm can be used for cautious disbudding (Smith and Sherman, 2009). In order to remove the horn buds, a copper ring of cauterised tissue must form after 2 to 3 cycles of holding the hot iron tool against the horn buds. (Alvarez *et al.,* 2019). It was shown that removing the horn buds decreased the chance of infection. (Matthews and Dustan, 2019) as well as stop horn regrowth (Hempstead *et al.,* 2018c). After disbudding, this technique was demonstrated to cause an immediate cortisol spike lasting for 2 to 3 hours. (Alvarez and Gutierrez, 2010) additionally strong pain and stress-related

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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behavioural reactions (Alvarez *et al.,* 2009; Hempstead *et al.,* 2017). Additionally, goat kids that undergo cautery disbudding suffer tissue damage that results in huge, open lesions and scabs that are visible six weeks after the surgery. (Hempstead *et al.,* 2018a). wounds typically take between 35 and paste had more intense, prolonged pain perception. (Hempstead *et al.,* 2018b, e) and compared to kids who were disbudded by cautery, and had a greater blood cortisol levels one hour later. (Hempstead *et al.,* 2020). Caustic pastes also result in big scars that are visible for up to 6 weeks after application and produce red, open, and painful sores. (Hempstead *et al.,* 2018a).

Despite the fact that different disbudding techniques have different effects on pain, pain can be effectively managed. This means giving children the right pain medication, as prescribed by a veterinarian, to minimize the discomfort caused by disbudding. Examples include using a local or general anaesthetic, sedatives, or long-acting anti-inflammatory medication, such as meloxicam, for postoperative pain. (Naud and Vasseur, 2021).

Housing of Kids

To encourage comfort and to assess bedding moisture and depth daily, the kids should be given plenty of clean, dry bedding (such as straw or wood shavings). Infrequently changed bedding can increase the amount of ammonia accumulation, which can cause respiratory issues. To make management easier, kids should be kept in homogeneous groups of 15 to 25 kids who are the same age and weight. Smaller groupings are advised during the first two weeks of life to prevent competition and provide sufficient supervision of the kids. Goetsch *et al.* (2001) investigated the impact of keeping kids in single pens, pairs of pens, or groups of pens on pre- and postweaning growth and discovered that group size had no influence on ADG up to 12 weeks of age or during the 8-week preweaning period. From the age of two to twelve weeks, kids were given access to adlib concentrates and milk. This study suggests that when given enough resources (i.e., adlib feeding to reduce competition at feeding), kids should behave similarly in group and individual pens. The suggested kid feeder spacing is 15 cm/head to make sure that all kid may eat at the same time with no competition. The recommended floor space for kids is between 0.25 and 0.5 m2/head to minimise congestion. Last but not least, the nursery chamber should be kept apart from the adult goats and away from air exchanges that could contribute to the spread of infections. (Naud and Vasseur, 2021).

Weaning of Kids

As the kids switches from a liquid to a solid food, weaning may be a highly stressful time for the kids and frequently results in stunted development and poor wellbeing. Additionally, parallel alterations in endocrine and metabolic processes are involved, such as a fall in plasma levels of insulin, amino acids, and glucose. (Magistrelli *et al.,* 2007; Atef Aufy *et al.,* 2009). Appropriate weaning strategies must be followed to reduce unwanted effects Based on weight (i.e., 14–15 kg, or when children have gained 2-2.5 times as much weight as they did at birth), Age (i.e. 6 to 8 weeks old), Solid feed intake, which is defined as the daily consumption of hay and concentrates totaling 115–200 g or 30–500 g, respectively Palma and Galina (1995) observed that kids weaned later (at 15 kg) grew more quickly than those weaned earlier (at 10 kg), reaching their ideal reproductive weight (30 kg) 30 days before kids weaned earlier. Gokdal *et al.* (2017) noticed that kids weaned at 3 times their birth weight and kids weaned at 4 times their birth weight had equal growth performance up to breeding. Magistrelli *et al.* (2013) contrasted the effects of progressive weaning, which is performed by gradually lowering the amount of milk provided over 17 days, with 1 L/day fed

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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in the last 10 days, to the effects of unweaned kids of the same age. Growth performance, aberrant behaviours, or other physiological stress markers (such as plasma haptoglobin, ceruloplasmin) did not change between the 2 groups, indicating that the weaning approach was effective in reducing stress. However, the study only included a few male Saanen kids. Zobel *et al.* (2020) Weaning 3-month-old kids either suddenly or gradually by diluting milk or lowering the milk supply over 6 days has an impact on the kid's feed intake and behaviour, research found.

CONCLUSION

Proper care of a pregnant doe will also ensure the health of kid provided other factors are also necessarily taken care of conjointly. The delicate feature is to provide a good environment for the delivery of a kid avoiding any stressful condition. It is advisable to take the requisite care of the pregnant doe for a healthy and lucrative income in future from goat farming.

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Indian Journal of Livestock and Veterinary Research
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CHAPTER 20

Sustainable Genetic Improvement in Goat

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ABSTRACT

Goats have an important place in the Indian economy. There is a need for proper description and evaluation of existing genetic resources and need for their conservation. The chapter contains the observations on existing selection programmes and recommendations for an improved system to provide the knowledge required to adapt record keeping and progeny testing technology to the unique Indian environment. An animal's overall performance is mostly influenced by genetic potential acquired from its parents, as well as the environment, which includes nutrition, health, management, and other factors. This chapter covers a brief outline of traditional breeding methods for the selection of animals and their improvement.

Key words: *Goat, genetic, Progeny Test, Selection Schemes*

OBJECTIVES

1) Genetic improvement of goat breeds through selective breeding by propagation of superior male germplasm through artificial insemination
2) To introduce basic concepts of inheritance in animal breeding.
3) To identify the basic tools for attaining genetic improvement.
4) To describe methods for characterization and conservation of small ruminant genetic resources in India.
5) To describe selection methods for small ruminant improvement.
6) To describe crossbreeding methods for improvement of small ruminants in India.

INTRODUCTION

Goats are a major source of much needed protein through meat and milk. Above all, they are a source of livelihood for the millions of rural poor in the country. Considering the economic and social importance of small ruminants specially for the rural poor, there is a need for large-scale research and development investments in goats. It is necessary to understand the major trends in goat population in the country in relation to the economy and the efforts for goat improvement through research and development programmes in the various Five-Year Plans.

Goat (*Capra Hircus*)

General: Goat belongs to the

Phylum- *Chordeta* (Backbone),
Class- *Mammalia* (suckle their young),
Order- *Artiodactyla* (hooved even-toed)
Family- *Bovidae* (ruminants)
Genus- *Capra* (domestic and wild goat)

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Species- *Capra hircus*

The goat was earliest ruminants domesticated around 9000 to 7000 B. C. References are made to goat in early biblical literature when it provided milk, meat, hides, fibre and manures

Introduction to Genetic Concepts

The cell is the basic unit of life. At the center of the cell lies the nucleus, in which chromosomes are found. On these chromosomes are the genes which are the basic units of inheritance. Each animal species has a definite number of chromosomes arranged in pairs (called homologous pairs). goats have 30 pairs of chromosomes. Cells in the body are of two types, namely male and female somatic cells or sex cells, which are also called gametes. Male gametes are called sperm and female gametes are called eggs. The sperm and egg cells contain only one chromosome of each pair resulting in one-half the chromosome number (haploid) found in the somatic cells. When the sperm and egg unite, the full chromosome number (diploid) is achieved and the fertilized egg has all the genetic material needed for it to develop into a lamb or kid. Therefore, half of the genes each individual carries are contributed by either of the parents.

Table-1: Diploid Chromosome Number in Livestock

Sl. No.	Common Name	Genus and Species	Diploid Chromosome Number
1	Cat	*Felis catus*	38
2	Cattle	*Bos taurus, Bos indicus*	60
3	Dog	*Canis familiaris*	78
4	Donkey	*Equus asinus*	62
5	Goat	*Capra hircus*	60
6	Horse	*Equus caballus*	64
7	Human	*Homo sapiens*	46
8	Pig	*Sus scrofa*	38
9	Rabbit	*Oryctolagus cuniculus*	44
10	River buffalo	*Bubalus bubalis* (riverine type)	50
11	Swamp buffalo	*Bubalus bubalis* (swamp type)	48
12	Sheep	*Ovis aries*	54
13	Llama	*Lama glama*	74
14	Mule	(Hinny, hybrids of horse and ass)	63
15	African buffalo or Cape buffalo	*Syncerus caffer*	52

Goat Genetic Resources in India

Livestock population of the country has been estimated as 536.76 million spread over different states and UTs of India (***20th Livestock census-2019***). Goats contribute 27.73% to the total livestock population and are next to the cattle (36.04%). The population of Indian goat is 148.88 million (Livestock Census, 2019) which is 10.14% higher than population as per Livestock Census, 2012. Among the different states, Rajasthan has highest goat

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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population (20.84 million) followed by West Bengal and Uttar Pradesh, respectively. This increase in goat numbers in the country showed its popularity and usefulness due to their economic significance, low input resources, small generation interval, higher proliferation and adaptability to varied climatic conditions. India is a good repository of goat genetic resources consisting of 37 recognized breeds (Table 1) and a good number of non-descript population. Out of 37 breeds of goat, 8 breeds *viz*. Beetal, Gohilwadi, Jakhrana, Jamunapari, Kahmi, Mehsana, Surti and Zalawadi are of dairy type, producing more than 150 kg of milk on an average per lactation. More than 75% of the breeds (29/37) in the country are primarily meat producers. The dressing percentage of different breeds varies from 43 to 58.4%.

Different breeds have been developed in India to produce milk, meat and fibre through natural selection and have been adapted to diversified agro-climatic conditions based on their utility. There are only two breeds viz. Changthangi and Chegu which are pashmina producers. The pashmina produced by Changthangi goat is superior to that of Chegu in terms of fiber diameter and staple length, the important characteristics of Pashmina hair. More than half of the goat breeds in the country are early breeders, demonstrating early sexual maturity and first kidding at an age of less than 18 months. Primarily milch type breeds which are large in size are found in North and North-Western region of the country. The goat breeds found in southern and peninsular region of India are of dual purpose for milk and meat.

Table: 2: The different goat breeds of different regions have been listed as under

S.No.	Breed	Home Tract	Utility
I. NORTH TEMPERATE REGION			
1	Changthangi (Cashmiri goat)	Chnagtang (Ladakh), hills of Leh, Jammu and Kashmir	Pashmina, Meat
2.	Chegu (Cashmiri goat)	Lahul & Spiti, Himachal Pradesh	Pashmina, Meat
3.	Gaddi	Himachal Pradesh	Meat, fibre (long hair)
4.	Bhakarwali	Jammu and Kashmir	Meat, fibre
II. NORTH-WESTERN ARID AND SEMI ARID REGION			
5	Barbari	Uttar Pradesh and Rajasthan	Milk and Meat
6.	Beetal	Punjab	Milk and Meat
7.	Jamunapari	Uttar Pradesh	Milk and Meat
8.	Jakhrana	Rajasthan	Milk and Meat
9.	Kutchi	Gujarat	Milk and Meat
10.	Marwari	Rajasthan	Milk and Meat
11	Mehsana	Gujarat	Milk and Meat
12.	Gohilwadi	Gujarat	Milk, Meat and long hair
13	Sirohi	Rajasthan and Gujarat	Milk and Meat
14.	Surti	Gujarat	Milk and Meat
15	Zalawadi	Gujarat	Milk, Meat and long hair
16.	Pantja	Uttarakhand and Uttar Pradesh	Milk and Meat
17.	Kahmi	Gujarat	Milk and Meat
18.	Rohilkhandi	Uttar Pradesh	Milk and Meat
19.	Sojat	Rajasthan	Milk and Meat
20.	Karauli	Rajasthan	Milk and Meat
21.	Gujari	Rajasthan	Milk and Meat

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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III. SOUTHERNPENISULAR REGION			
22.	Malabari	Kerala	Meat and milk
23.	Attapady	Kerala	Meat and milk
24.	Osmanabadi	Maharashtra	Meat and milk
25	Sangamneri	Maharashtra	Meat and milk
26.	Konkan Kanyal	Maharashtra	Meat and milk
27.	Berari	Maharashtra	Meat and milk
28.	KanniAdu	Tamilnadu	Meat and milk
29.	Kodi Adu	Tamil Nadu	Meat and milk
30.	Salem Black	Tamil Nadu	Meat and milk
IV. EASTERN REGION			
31.	Black Bengal	West Bengal	Highly prolific meat breed
32.	Ganjam	Orissa	Highly prolific meat breed
33.	Teressa	Andaman & Nicobar	Meat
34.	Sumi-Ne	Nagaland	Meat
35.	Assam Hill	Assam and Meghalaya	Meat
36.	Bidri	Karnataka	Meat
37.	Nandidurga	Karnataka	Meat

Exotic Breed of Goat

The important exotic breeds of goats are as under.-

1) **Saanen:** Originated in the Saane and Simmental valleys of Switzerland. White or light cream colour body, have pendulous udder, produces about 100 kg milk per lactation. Legs short in comparison to body, ears erect pointing forward, bucks weigh about 80 kg and Does about 60kg.
2) **Alpine:** Originated in Nubia (Africa), large animals, long lagged and hardy, small ears and Roman nose, Bucks weigh 80 kg and Does 60kg
3) **Anglo Nubian:** The Development of this breed is exactly not known. This is one of the largest and heaviest breeds among all European breeds of goats, produces 3 kg milk daily.
4) **Toggenburg:** Originated in Toggenburg valley of Switzerland, very hardy and high milk producing breed, light brown to dark chocolate body colour. Small white ears pointing forward, white strips on both sides of face. Bucks weigh about 70 kg and Does about 60 kg.
5) **Boer:** It is from Southern Africa and exported to many countries. Mean adult body weight is about 30 kg with birth weight of 4.0 kg and produces about 1.4 kg milk per day.
6) **Angora Goat:** Originated in Angora region in Asia Minor (Turkey). It is most important goat breed for fibre (Mohair or Pashmina) production. The fibre produced by these goats is called Mohair. Bucks weigh 60 kg and Does 40 kg. Average yield of mohair is 3 kg annually.
7) **Orenberg:** Originated from local goats of kaazakhstan and later on improved by selection for quality of pashmina. The adult body weight is about 40 kg for does and 70 kg bucks. They produce pashmina fibres of 16 microns diameter and 5.5 cm in length of about 300 gm per year

Strategy for Genetic Improvement

Gap Analysis The per capita consumption of meat in developed/industrialized countries is much higher compared with developing countries. Consumption of meat in the USA is 124 kg per capita per year (340 g/day). The global average meat consumption is 38 kg per year

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

(104 g/day). Countries whose population consumes the least amount of meat are located isn Africa and Asia. The ten lowest-ranking countries in meat consumption consume 3–5 kg per capita per year. However, in case of India, it is much less in comparison to even African countries such as Ethiopia, where the average annual meat consumption per capita is estimated to be 8 kg/year as compared to India's per capita meat availability being only 4.94 kg per year. Thus, it is apparent that there exists a huge gap of meat availability between India (4.94 kg per year) and the global average of 38 kg per year. Analysed from the point of required nutrition, as per WHO standards, the daily requirement of protein is 63 gm per day. In average Indian diet conditions, 50.75 gm per day per person (approx.) for the vegetarian population, and about 55.25 gm per day per person (approx.) for the non-vegetarian population is available. Notwithstanding this, the average deficit of protein requirement is approximately 12.25 gm for vegetarian and 7.75 gm for non-vegetarian. Moreover, by 2050, it is expected that the population in India would increase by 34% and to fulfill the dietary recommended levels of the livestock products by Indian Council for Medical Research (ICMR) for a population of 1.7 billion people, the livestock sector should produce 186.2 million tons of milk, 18.7 million tons of meat and 306 billion eggs per annum. This means that the current level of production, the milk, meat and eggs would have to increase by 1.5, 3 and 4.7 times respectively. Fulfilling the feed demand of this huge livestock from same resource base of land and water is going to be a huge challenge. Therefore, rather than increasing the number of animals, improving the genetics through breed improvement programme might be a better strategy to address the required demand for animal protein. This becomes a greater challenge, as there exists a wide variation among Indian small ruminant breeds with respect to potential growth rates and mature weight which may be considered as a gap to fulfilling the meat demand as is clearly brought out in the charts above.

The 2 steps are:

1) Genetic improvement of identified indigenous descript breeds of sheep and goat through selective breeding for better yielding breed stock for meat, milk and wool.
2) Genetic improvement of non-descript breeds of sheep by germplasm from existing improved descript indigenous breeds

Culling as Flock Management Tool and Reasons of Culling from the Flock

Culling is defined as the removal of uneconomical, unproductive and surplus animals from the herd. Culling in goat flocks is an important tool for the development of a good flock. Culling should be stringent and used as a means of improving the genetic quality and productivity of a flock.

Flock size can be maintained by replacing culled goats doelings in the flock

1) Provides opportunity to make progress in the genetic potential for productivity and profitability.
2) Culling can also represent a substantial loss to the producer. The cost associated with rising of replacement stock.
3) It works out to 20 % of the overall operating expenses.

Breed Improvement Methods

Selection within a breed: Selection is usually done within cohorts within a flock, i.e., among animals of the same age which have been raised together. Genetic progress through selection depends on heritability, selection differential and generation interval.

Selection differential: The average superiority of the selected parents relative to their flock contemporaries. Fewer males are usually needed for breeding than females; therefore,

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

selection differential is generally higher for males. Sometimes selection differential can be very large, as it is possible to select very few males with exceptionally high performance for use through artificial insemination.

Heritability: Heritability (h2) refers to the degree of resemblance between relatives i.e. how much the progeny resemble its parents. Heritability (h2) is the most important genetic parameter on which different breeding strategies depend. It is useful to have an estimate of the heritability for the trait to be improved in order to predict the likely progress from selection. It is preferable if this estimate is made from the population considered for selection before selection starts. This, however, is usually difficult because of unavailability of appropriate records. Published estimates from a similar population kept under similar conditions would be valuable.

Table 3: Estimates of Heritability (h2) for Some Traits in Goats

Traits	Average h2	Range of h2
Milk yield (lactation)	0.38	0.20–0.53
Milk yield (test day)	0.21	0.14–0.31
Birth weight	0.18	0.03–0.43
Weaning weight	0.34	0.08–0.62
Six-month weight	0.21*	
12-month weight	0.33*	
Adult weight	0.39	0.11–0.72
Fleece weight	0.36	0.17–0.57
Fleece quality traits	0.49	0.13–0.72
Number of lambs at birth	0.14	0.00–0.49
Litter weight at birth	0.06	0.00–0.12
Goats six-month weight	0.23	0.10–0.71***
Goats 12-month weight	0.30**	0.13–0.60***
Goats birth weight	0.04**	0.05–0.68***
Three-month weight	0.16**	0.09–0.75 ***

*Source: (Weiner, 1994); *(Solomon, 2002 estimates for Horro sheep); ** (Horst and Mathur, 1991); ***Shrestha and Fahmy, 2007).*

Generation Interval

Generation interval is defined as the average age of the parents when their offspring or, more strictly, those offspring which are used to replace the parents, are born. The genetic changes which occur as a result of selection happen only when one generation is succeeded by the next. In goat the generation interval is affected by the age when the animals first start to breed. It is also influenced by the interval between successive parturitions and by the number of offspring born on each occasion which survive to breeding age. The earlier in the life of the parent its offspring are born, the closer parturitions follow each other and the more offspring per parturition, the sooner the number needed as replacements is reached. The generation interval for goats varies between 3 and 5 years.

SELECTION: Choose the parents for next generation. Criteria- **"keep the best & cull the poor"** Selection is of two kinds namely, natural and artificial selection. Again, the artificial selection is divided into different methods; they are Tandem method, Independent Culling Level and Selection Index or index selections**.**

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Natural Selection
The main force of natural selection is the survival of fittest in a particular environment. The survival is for the particular environment in which the population lives e.g., wild animals. In nature, the animals best adapted to their environment survived and produced the largest number of offspring.

Artificial Selection
It is the selection practiced by man. This can also be defined as the efforts of man to increase the frequency of desirable genes or combination of genes in his herd or flock by locating or saving those individuals with superior performance or that have the ability to produce superior performing offspring when mated with individuals from other lines or breeds.

Basis of Selection

Individual selection (Mass selection): When selection is done on the basis of breeding value of an individual animal estimated according to its own performance. This is used when the animal's performance is a measure of its genetic merit. This is also used for traits of high heritability where an animal's performance is an accurate guide as to how its progeny will perform.

Pedigree Selection: Selection on the basis of performance of the ancestors is called as pedigree selection. Pedigree selection is very useful when the traits selected are highly heritable. If a performance record of individual is available, the addition of pedigree information usually adds little to accuracy of estimates of breeding value of individual. Pedigree selection is especially useful for early selection of individuals as in case of selection of young buck for progeny testing**.**

Family Selection

Family represents a group of animals having common genetic relationship. Generally full sibs and half sibs are the most common collateral relatives, whose records are often used to estimate the breeding value. When individual's performance is also included in calculating the sibs average performance, it is called family selection. Family selection is very useful in case of traits with low heritability.

Performance of progenies: Goats can be selected on the basis of the performance of their own offspring. This is useful when the heritability of the trait is low, or where the trait can be measured only in one sex (milk production, for instance) or can be measured only after slaughter (carcass characteristics). To carry out a successful progeny testing scheme, a large enough number of offspring from each male may be required.

Genetic Selection: Genetic selection of animals is based on the breeding value. The BV of a goat can be estimated either on the basis of individual's own phenotypic performance or the performance of its relatives. The breeding value is known as ***estimated breeding value (EBV) or probable breeding value (PBV).***

Methods of Selection/ Multi-Trait Selection

Given by Hazal and Lush in 1942

1) **Tandem method:** It involves selection of only one trait at a time for selection till the satisfactory improvement is achieved. After satisfactory improvement of this trait a second trait is applied for improvement. It is least efficient method of selection and

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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genetic progress per unit of time is less. It is not suitable for the traits which have negative genetic correlation.

2) **Independence culling level:** Two or more traits are considered at a time and a minimum standard is fixed for each trait. If any animal fails to qualify the fixed to meet the minimum standard for any one trait will cull irrespective of their merit in other trait.
3) **Total Score-card/selection index method:** It is practiced for several traits simultaneously. It is best method of selection. Here; a score is given to each trait and score of all the traits are summed to a total score which is used as an index for selection of the animals under consideration. The animal has to achieve the total score to qualify for selection. In this method, an animal having poor performance in one trait may be selected if it is superior in another trait.

Methods of Mating

1. Hand Mating: In this system the females are allowed to mate one by one and buck not allowed mating more than three does in a day.

Merits

- This method ensured the expected time of kidding.
- This system allows the farmer to know that the animal has actually bred.
- This system reduces the risk of injuries to the animals.
- It is beneficial when mating older male with a younger female.
- It also improved the breeding efficiency of male, resulting in an increased number of females that can be bred in shorter period of time.

2. Pen Mating: In this mating system the does are divided into batches varying from 20 to 25 does. Males are turned in to the flock only during the night time and separated during day time.

Merits

- This system of mating prevents the disturbances to the does by the male during grazing hours.
- Males also given with enough rest and they can be fed properly.

3. Flock Mating/Pasture Mating: In this system males are allowed to run along with the females throughout the day and night.The buck may lose its most of its body reserves in chasing the doe and they may lose their body conditions.

Demerits

- The buck sometimes may develop attraction for particular doe in heat and serve it a number of times while other remains unattended resulting in empty does and low fertility rate.
- The ram/buck some time exhaust itself overnight by serving more than a dozen times and the last served ewes or does not receive optimum number of spermatozoa and remain unconceived.

4. Artificial Insemination

AI was introduced in goats in the 1970s, but it was not fully adopted in the initial stages, until it was discovered that the bulbo-urethral glands of bucks secrete a glycoprotein lipase which acts upon semen extenders (such as skimmed milk and egg yolk), producing substances which are toxic for sperm and reduce the fertility after AI (Corteel, 1977).

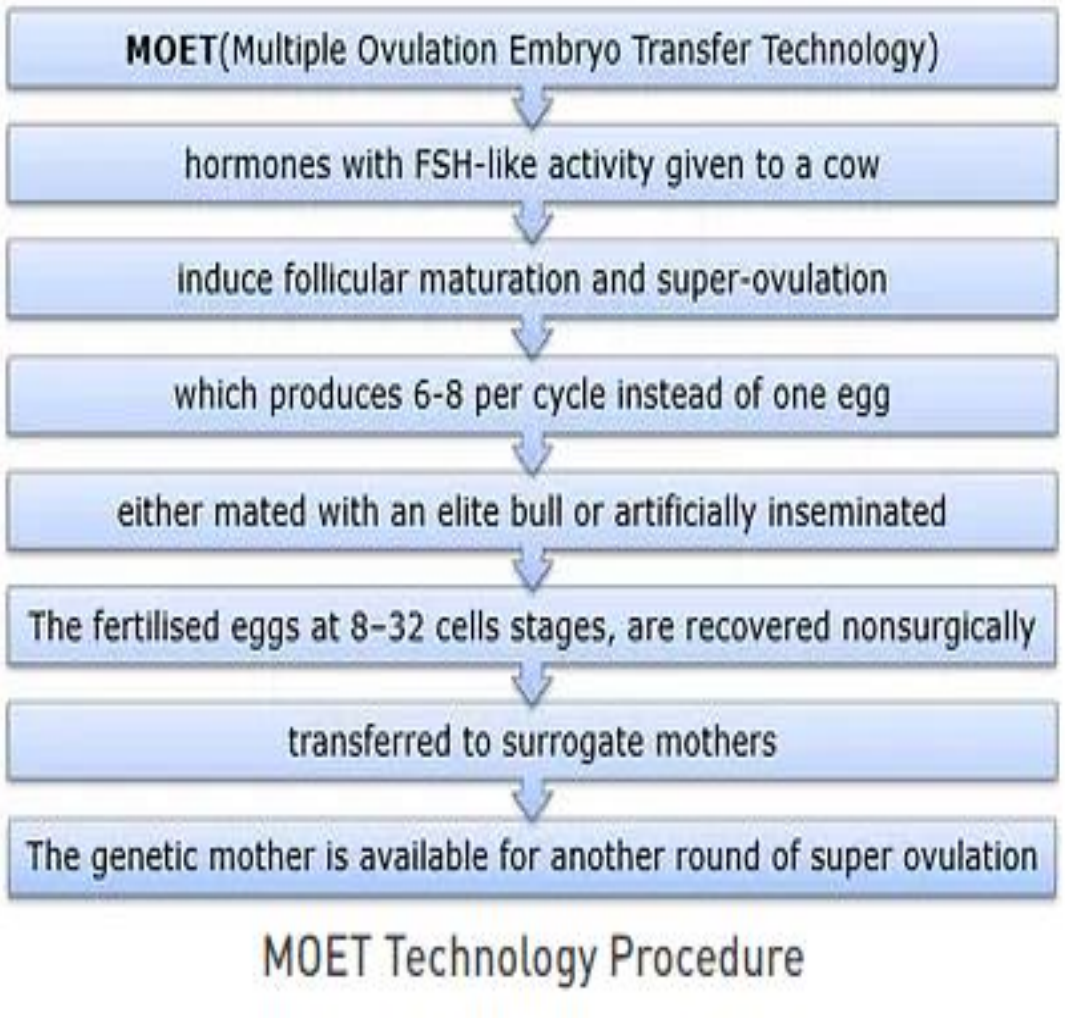
Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

In addition, AI has allowed for the implementation of the progeny-testing scheme prevalent particularly in dairy cattle production and which has had a major impact on the improvement of the herd by increasing the accuracy of selection despite the associated increase in generation interval. Artificial insemination offers the best means of distributing germplasm from nucleus breeding flock to many small flocks within each eco system.

5. Embryo Transfer Technology

MOET (Multiple Ovulation Embryo Transfer Technology) is a program for herd improvement in animals such as cattles, goat, sheep, rabbits, buffaloes, mares, etc.

The high-yielding female cow is injected with Follicle-stimulating hormones to induce follicular maturation and superovulation. This results in the release of 6-8 eggs per cycle instead of one. Now the female cow is either mated with an elite bull or artificially inseminated**.**



MOET Technology Procedure

6. Gamete and Embryo Cryopreservation

Embryo cryopreservation play crucial role conservation programmes aimed at maintaining genetic diversity and is an essential tool in conservation of genetic resources. It is also extremely advantageous in MOET programs and facilitates the exchange of genetic material across different regions/countries, with lower health risks (Paramio, 2010).

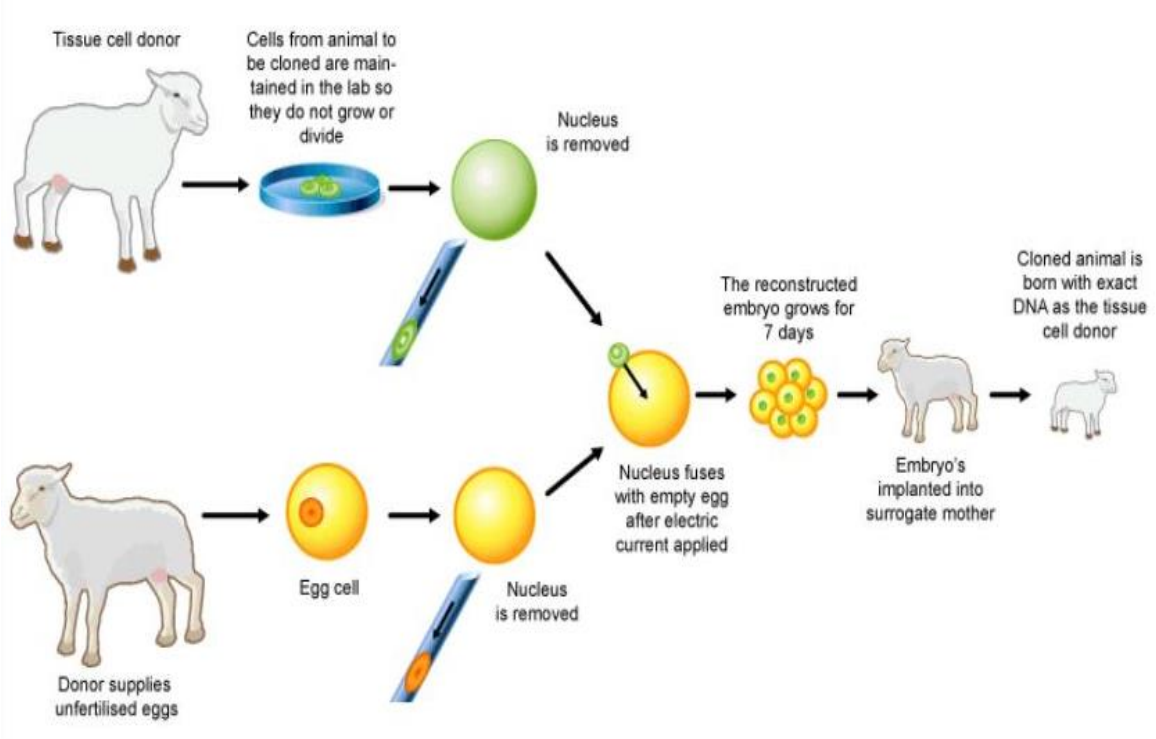
Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

7. Sexed Semen

The pre-determination of sex through artificial insemination with sexed semen is advantageous in terms of management and profitability, but its major benefit is in selection programs, especially in milk producing animals. In this case, it is possible to select a few outstanding does to be the dams of sires and inseminate them with Y-chromosome bearing sperm, thus increasing selection intensity in this path.

7. Nuclear Transfer or Cloning

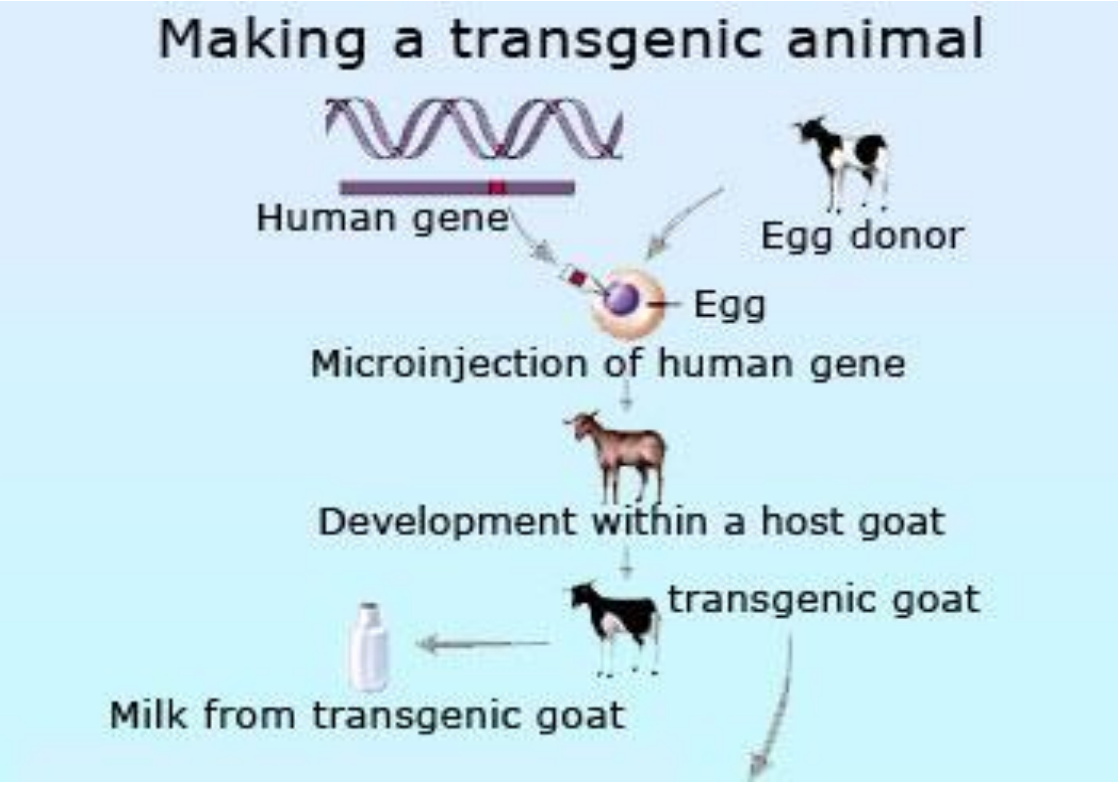
Cloning in simple terms is production of multiple and identical copies. Cloning Soon after the birth of a sheep cloned from an adult cell was revealed (Wilmut et al., 1997), cloning of goats was also reported by several authors (Yong and Yuqiang, 1998; Baguisi et al., 1999; Keefer et al., 2002), with nuclei from different cell lines being transferred into enucleated oocytes. This technology, however, still has a low efficiency and has been used only in conjunction with the production of genetically modified animals, while its application in breeding and conservation programs is of more limited interest.



Recombinant DNA technology

Today, the most sorted out and developing technologies are Information technology and Recombinant DNA technology. The use and applications of recombinant DNA technology has become a commonplace as new products from genetically modified plants, animals, and microbes have become available for human use. In the year 1997, **Dolly** made headlines as the first successfully cloned large mammal (sheep). Since then, there have been many similar advances in medicine, such as targeted cancer therapy; many advances in agriculture, such as transgenic insect-resistant crops, vitamin rich golden rice; and many advances in animal husbandry, such as growth hormones and transgenic animals (an animal that has received recombinant DNA). Most biotechnologists envision DNA technological applications as one of the new frontiers in science with tremendous growth and discovery potential.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4



CONCLUSION

India has a significant contribution to the world's goat both in numbers, production types and genetic variants (breeds/strains). Both the national economy as well as socio-economic growth of small and marginal farmers and landless laborer's is supported by the goat rearing. In spite of making an important contribution to rural agrarian economy, there are still many constraints in goat rearing especially related to feed and health which require immediate attention of the agencies implementing goat improvement programs. Although, large number of improvement programs primarily by the research institutes and state agricultural universities have been taken, the overall improvement has relatively seen small because of lack of proper linkage of these agencies with the central and state development agencies.

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Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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CHAPTER 21

Management of Goats During Natural Calamities

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ABSTRACT

Natural disasters are increasing over the last decade across the globe and in India. During such emergency events, management of animals is due to huge loss of infrastructure. The growing incidences of natural disasters pose a greater challenge to the livestock sector in this changing environment. The animals, particularly goats are affected by the various natural calamities such as flood, drought, cyclone etc., and their management primarily depends on the type and intensity of natural calamity which discussed in separate sections in this chapter. Though goats are affected by the natural calamities, they are beneficial in improving the livelihood of people affected owing to their multi-functionality through assistance in food and financial security. The support from government authorities along with mutual cooperation among the affected population is more essential in rebuilding the livelihood during the occurrence of natural disasters.

Keywords: *Cyclone, Drought, Flood, Goat, Natural disaster.*

INTRODUCTION

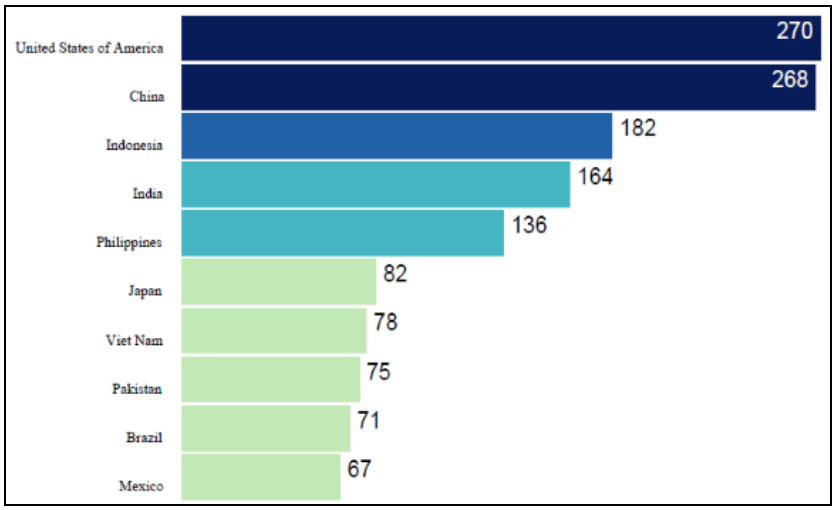
Natural calamities (such as earthquake, tsunami, drought, flood, cyclone etc.,) are considered as an emergency event that causes rapid and greater damage to the community. These macro-scale geographical events cause extensive mutilation of infrastructure along with loss of both human beings and animals. Over the last few years there has been unanticipated increase both intensity and number of natural calamities over the globe which is hindering the growth of several sectors. The occurrence of these events over the last decade has been depicted in fig-1 (EM-DAT, 2023). The impact of natural calamities is relatively higher in under-developed and developing countries (Botzen and Van Den Bergh, 2009) as it hinders the momentum of growth. These extreme events caused an estimated economic loss of 109.4 billion USD (based on EM-DAT international disaster data base) from 2013 – 2023 (EM-DAT, 2023) in India. In the last decade 25,674 died due to natural disasters and over 477.39 million humans affected by these events in India.

Occurrence of Natural Disasters from 2013 – 2023 ***(Source: EM-DAT, 2023)***

In our country, livestock farming especially with regards to goat rearing is in the hands of marginal to small farmers. Goats serve multipurpose such as meat, milk, skin and manure, thereby contribute to upliftment of the livelihood of smallholder farmers. Impoverished economic conditions, low risk bearing capability, less accessibility to financial institutions and poor scientific knowledge make these farmers more vulnerable during and/or after natural calamities. Due to an unexpected emergency the natural calamities cause an artificial surge in demand for natural resources resulting in shortage of good quality feed and potable water to animals. The contamination of feed and water resources make the animals more

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

prone for occurrence of infectious diseases. During natural calamities, the local community and the government authorities have to work in liaison for rapid relief of the population affected. Both central and state governments play a significant role in lessening the impact of natural calamities (Pattanayak, and Kumar, 2022). Nevertheless, the shortfall in assistance provided by the higher authorities may sometimes delay the rehabilitation of affected human and animal population. The management of animals particularly concerning goats has been discussed in the following sections.



Management of Goats during Natural Disaster

The unforeseen occurrences of natural disasters pose threat to human beings as well as animals. During any emergency events animals are more affected as most of the relief and rehabilitation programmes focus primarily on evacuation of affected human population. Livestock sector is the second most affected sector following crop production due to natural disasters which accounts for an estimated amount of 11 billion USD (36% of total loss due to natural disasters). Out of various natural disasters, major loss to livestock sector is caused from drought and floods which contribute to 44% and 39% of total loss to livestock sector, respectively (Qasim *et al*., 2017). The demand for animal production to ensure food security is increasing globally and at the same time the occurrence of natural disasters is also increasing. It is a greater challenge to have optimum production from animal sector in this changing climate scenario. Animals become more vulnerable during and/or after natural disasters due to less availability of feed resources and rise in incidences of infectious diseases. Besides, loss of valuable animal genetic resources is also a threat due to these emergency events. So, management of animals during natural disasters is of utmost importance.

Management of Goats during Drought

Drought is affecting the animals across the world, especially in tropical climate. It results in change in vegetation type and quality owing to low precipitation and reduced availability soil moisture. Though goats are drought resistant, they start losing their body condition and move into negative energy balance due to exhaustion of stored energy (Mpelasoka *et al*., 2008). In extreme conditions, death may also occur with youngest, weak and old being more susceptible. So, the management of goats during drought must ensure provision of balanced feed and good water supply as per the requirement of animals. It is difficult to answer all the issues with a single strategy; and hence, multiple strategies are required to manage the goats

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

during drought (Dida, 2021). Few set of approaches to handle the goats during drought condition are as follows (Dida, 2021: Islam *et al*., 2020):

1) Development of an early warning system is beneficial in preparing for drought mitigation.
2) Procurement of feed and fodder from surplus areas – Feed can be purchased from the abundant area and transported to the drought affected area. Purchase of concentrates is beneficial over dry grasses as less bulkiness of concentrates reduce the transportation cost.
3) Use of agro-industrial by-products – Agro-industrial by-products such as sugarcane bagasse, molasses, brewery by-products (Brewer's Spent Grain), and milling by-products can be used for feeding goats as they are highly economical.
4) Locally available unconventional feed sources can also be used as the goats efficiently utilize them.
5) Environmental stress along with nutritional stress makes the goats more susceptible for diseases. Planned deworming and vaccination ensure better herd immunity.
6) Special care to vulnerable animals – Young, weak and old animals are more vulnerable during drought condition and they cannot compete with the general herd while feeding. These animals have to be segregated and special care has to be given to ensure their well-being.
7) Distribution of feed from government institutes – Temporary shading areas can be built; feed and water can be provided by the government through local animal husbandry and allied bodies.
8) Reducing the stock density – During severe drought, the number of animals can be reduced by directly selling them in the market as this gives financial assistance the farmers' family and also reduce the risk of maintaining more number of animals.
9) Migration of animals to surplus area – If the drought has affected particular locality, the goats can be migrated to the other locations where the feed and water resources are abundant.
10) Policy makers may intervene and relax the rules and regulations on migration of animals. Besides, it is helpful to goat herders if few schemes are implemented to alleviate feed and water scarcity.
11) Propagation of fodder seeds and plantation of drought resistant fodder trees in public lands by the local governance and maintenance of emergency pasture may be helpful in severely drought affected areas.

Management of Goats during Floods

Floods have become more common in recent years causing extensive infrastructure damage, loss of agricultural production along with loss of human and animal lives. Animals are natural swimmers and can escape floods if they are let free; however, after flooding animals become more prone to infectious diseases due to contaminated feeds and drinking water. Commonly observed illnesses following flood in animals are dysentery, leptospirosis, tetanus, hepatitis and food poisoning (Kouadio *et al*., 2012). More often, there will be increase in fly and mosquito population following flood which increases the possibility of animals affected with vector-borne diseases. In addition, animals become more susceptible to foot infections if they have to stand in flood water for long period. In a study conducted at three flood affected districts (Srinagar, Pulwama, and Bandipora) of Jammu and Kashmir after 2014 floods, it was reported that majority of the farmers (39.58%) lost around 1 – 8 small ruminants. The major economics loss to the farmers was from loss of large ruminants, followed by small ruminants (Rasool *et al*., 2020). According to the report of department of sheep husbandry, Kashmir, around 79,855 small ruminants have died in the flood with an

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

estimated loss of 8.29 million USD (Rasool *et al*., 2020). In an another study, Sorathiya *et al*. (2016) reported flood to be one of the major constraint faced by goat keeping community - Ahir - in southern parts of Gujarat. The management of goats during floods has to be multi-strategic as like management during drought. Few general managemental strategies to safeguard goats during floods are given in the following points:

1) The goats have to be evacuated rapidly from the flood affected area and shifted to high altitudes.
2) The contamination of drinking water bodies from manure pits or sewage water has to be prevented.
3) The canals, ponds and other water bodies have to be checked for any obstructions and easy flow of flooded water is ensured.
4) The goats have to be vaccinated for endemic contagious diseases.
5) Construction of temporary shelters for animals with provision of feed and water is beneficial for the farmers.
6) In case of early forecast of flood, the goats have to be shifted to safer places.
7) Ensure proper veterinary assistance in the event of endemic outbreak of infectious diseases.

Management of Goats during Cyclones

The adverse effect of cyclones on livestock is similar to that of floods; however, it is possible to effectively predict cyclones much early adding to better preparedness of such mishaps. Geographically, coastal areas get more affected by these cyclones in comparison to inlands. In a survey conducted on Ahir goat herders in Gujarat, cyclone was reported as one of the notable constraints faced by the herders (Sorathiya *et al*., 2016). The incidence of infectious diseases especially with regards to parasitic infestations increases during and/or after cyclones. The incidence of mortality in sheep and goats due to *Haemonchus contortus* infestation increased after a cyclone in Botswana (Ramabu *et al*., 2018). The management of goats during cyclones is almost similar to management during flood occurrence and it is given in points in the following section:

1) Special shelters can be made at higher altitudes away from cyclonic area to accommodate goats during the occurrence.
2) Stocking of feed and fodder resources prior to cyclonic incidence.
3) Vaccination of goats against contagious diseases.
4) Ensure proper veterinary care for the vulnerable stock.

In other geographical/meteorological emergencies such as earthquake, tsunami, forest fires etc., the animals have to be evacuated from the place of mishap to avoid further suffering. The joint efforts from government organisations and local community might help in rapid recovery from these natural disasters.

Importance of Goats in Post-disaster Livelihood Recovery

Natural disasters have considerable impact on peoples' livelihood especially in developing and underdeveloped countries. Disasters substantially damage the rural economy as they destroy the farm land and livestock holdings of the farmers. The recovery from these unforeseen events takes a longer duration due to extensive loss to infrastructure. The livelihood recovery includes accessibility to both material and social resources necessary for sustenance of life. Goats can be helpful in such conditions to boost up the rural economy. They contribute to food security of the affected population and assist in uplifting their social status (Boogaard and Moyo, 2015). The government funded relief and rehabilitation

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

programmes should aim to improve the livelihood through livestock-based schemes. Besides, the developmental authorities and policy makers must work towards linking the small holders to mainstream market channels. In one such effort to alleviate the livelihood standards of affected population after 2015 earthquake in Nepal, the government and non-government organisations worked in unanimity with the local communities. They used goat-based aid-programmes to improve the livelihood which included distribution of goats, providing breeding males for mating purpose, financial assistance to livestock farmers, capacity building and training on management of goat housing and pasture land improvement (Karki *et al*., 2022). Considerable improvement in standard of living in affected areas is evident due to assistance from government and non-government organisations. Nonetheless, mutual cooperation from the affected population is eminent besides administrative assistance in speedy recovery from natural disasters.

CONCLUSION

Due to unpredicted occurrence of natural disasters, it is difficult to cope up with their devastating effects. The effect is more substantial in under-developed and developing countries and requires collective efforts from the local governance and affected community to hasten the speed of recovery. The relief and rehabilitation programs mainly focus on human beings and sometimes animals are neglected. The management of animals during and/or after natural disasters includes provision for shelter, good quality feed, fodder and potable water. Further, the incidence of infectious diseases flare-up after natural disasters and proper health management is also essential. The occurrence of natural disasters in beyond the scope of human beings; thus, proper preparedness to face the devastating effects of natural disasters is much necessary along with better early warning system.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the material discussed in this chapter.

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CHAPTER 22

Integrated Goat Farming

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ABSTRACT

India is rich in goat population and its genetic biodiversity. There are 37 recognized breeds of goats in India. It plays a vital role in the economy of landless and marginal farmers living in diverse climatic conditions of India. Goat is preferred over other livestock in wide range of agro climatic zones particularly in drought prone and tribal areas due to its inherent characteristics of better survival under scarce resources, poor quality fodder and better disease tolerance. The goat is often termed as 'poor man's cow' because of its substantial contribution in meeting their family's nutritional demand and monetary needs. Since ancient time livestock rearing has been recognized as an integral part of the agricultural sector, and it has been observed that combining livestock with other farming systems such as fisheries, horticulture, agro-forestry, etc. can be more productive and sustainable than specialized and intensive systems. This system of combining livestock with different farming systems is termed as integrated livestock farming system which helps in efficient utilization of natural resources and wastes/organic residues and also involves recycling of resources. In integrated goat farming goat is reared along with of other dairy animals, poultry, aquaculture, azolla and crop farming. Goat requires minimal capital investment for rearing and has very high commercial value in the market all the time. Thus an integrated goat rearing system can fulfill the multiple objectives of making farmers self-sufficient by ensuring the family members balance diet, improving living standard through maximizing the total income, providing employment, minimizing the risk and uncertainties of crop failure due to changing environmental conditions.

Keywords *– Employment, Goat rearing, Integration, Resource utilization*

INTRODUCTION

Nowadays livelihood security, food and water security as well as natural resource conservation and environment protection have emerged as major issues worldwide. It is accepted that the sustainable development is the only way to promote rational utilization of resources and protection of environment without hampering economic growth. Sustainable development can be promoted through sustainable agricultural practices which will help in addressing socioeconomic as well as environmental issues simultaneously. The growing demand for livestock products and feed grains increasing pressure on land and thus makes it more important to ensure the effective use of feed resources, including crop residues. An Integrated Farming System (IFS) is interdependent and interconnected production systems which is centered on a few crops, animals, and related subsidiary enterprises that maximize nutrient utilization and safeguards the environment as in this system nothing is wasted and the byproduct of one enterprise becomes the input for other. Crop residues can be used as animal feed, while livestock and livestock by-product are means of money generation. In this system byproduct utilization (manure) can enhance agricultural productivity by intensifying nutrients that improve soil fertility and reducing the use of chemical fertilizers. IFS are mainly oriented towards a zero-waste production system that will produce food, feed, fertilizer, and fuel. An integrated agricultural system enhances financial wellbeing of small

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Volume 3 Issue 1; 2023
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and marginal farmers, enhances their commitments towards social responsibilities like education and health care, as well as their ability to support themselves.

Integrated Goat Rearing

Goat plays a vital role in the economy of landless and marginal farmers living. It is preferred over other livestock in wide range of agro climatic zones particularly in drought prone and tribal areas due to its inherent characteristics of better performance under scarce resources, higher disease tolerance, survival on poor quality feed and fodder and better reproductive efficiency. Other than this it is easy for handling due to smaller size and highly prolific animal.

Goat is often termed as 'poor man's cow' because of its substantial contribution in meeting their family's nutritional demand and monetary needs. Goat rearing is considered as a revenue generating source for the rural youth and households. Thus, in rural areas goat keeping can fulfill the multiple objectives of making farmers self-sufficient by ensuring the family members nutritional demand, by improving living standard through maximizing the total income, providing employment, minimizing the risk and uncertainties of crop failure due to adverse environmental conditions. Apart from meat and milk, farmers also use their droppings as healthy manure as it rich in organic biomass, nitrogen, phosphorus and potassium. Similarly, urine of goats is also rich in both potash and nitrogen. Dawood *et al.,* 1996 recorded that in IFS 66% of the overall revenue was from the crop portion and 17% from the goat segment. The cost benefit ratio was 2.2 and 2.3, respectively, for crops and goat units. This indicates the viability of rearing goats as a complimentary enterprise to obtain additional economic returns for small farmers in the Cauvery delta district.

Table -1 Different Enterprises used in the Integrated Goat Farming

S. No	Combinations of different enterprises in IFS
1.	Crop + Goat + Backyard Poultry
2.	Crop + Goat + Cattle + Backyard Poultry
3.	Crop + Goat + Cattle
4.	Crop + Goat + Orange
5.	Crop + Cattle + Goat + Orange + Backyard Poultry
6.	Crop + Goat + Orange + Backyard poultry
7.	Crop+ Goat + poultry
8.	Goat + vegetable + pasture land
9.	Goat + fish farming + pasture land

Fish- Goat Farming Systems

Fish-livestock integrated farming systems is recognized as highly assured technology where predetermined quantum of livestock waste obtained by rearing the animals is applied in pond to raise the fish crop without any other additional supply of nutrients. For this system of rearing a low cost housing can be constructed near the pond embankment using locally available material like bamboo, wood and thatch etc., or raised house can be made inside the pond. Each adult goat excretes around 750 g / day.

Goat droppings have the benefits of direct application to fish ponds as pellets (around 1.0 cm size) in semi-dried condition covered with mucus floats on water and easily utilized by fishes. On the recycling of goat waste, the rohu and mrigal fish grow healthier and approximately

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

3.5 tonnes / ha / yr of fish can be produced by this method without any extra feed and chemical fertilizer. For this system of rearing a low cost housing can be constructed near the pond embankment using locally available material like bamboo, wood and thatch etc., or raised house can be made inside the pond.

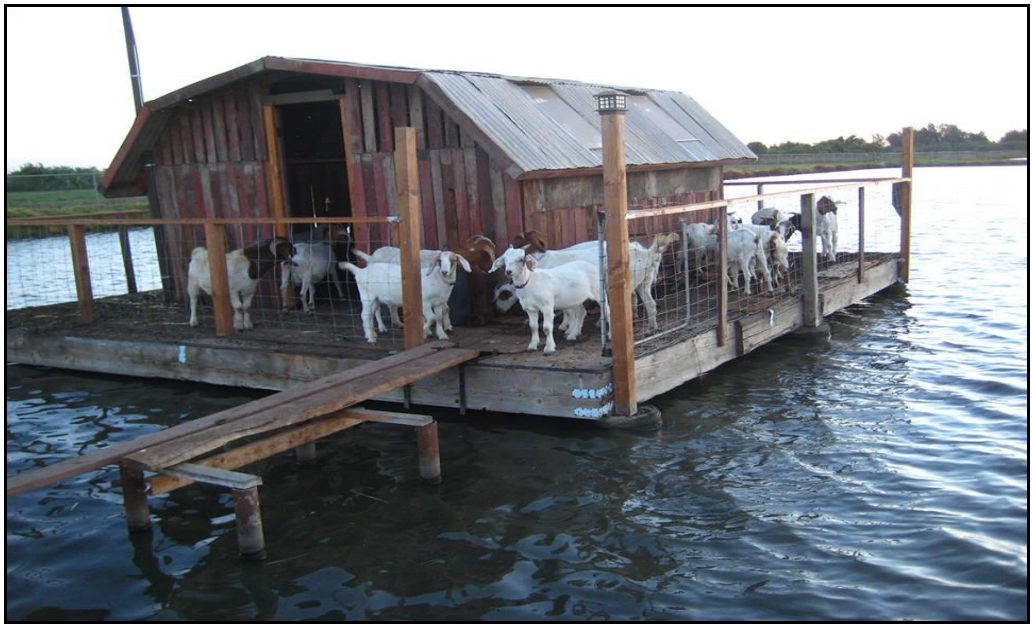

Fig.1. Integrated Fish- Goat Farming System

Integrated Farming System of Goat and crop in dryland area of Tamilnadu

A study was conducted by integrating crop and goat rearing in one hectare dryland considering small and marginal farmers of Tamilnadu. The goat unit comprised of twenty Tellicherry eves and one buck. The results of integrated farming, system were compared with the control and it was found that the gross income from the integrated farming system was Rs.12, 400/- and that of control was Rs.3, 697/-.

Among the income generated from integrated farming system, 57.4 % was from goat rearing along with this it generated additional employment by increasing 106 mandays (https://agritech.tnau.ac.in).

Fig.2. Integrated Farming System of Goat and crop in dryland area
(Source - https://agritech.tnau.ac.in)

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Agro Forestry and Goat Rearing

In agro forestry goats can be reared with trees like jackfruit, subabool and Gliricidia etc. the goats are fed with plant leaves. Agro forestry and rearing goat together may gives many benefits to the farmers as fallow land and dry land may be exclusively used for this project and in this the amount of water needed is very low.

In this method the goat dung and decomposed leaves can be used as fertilizer for agriculture this increases soil fertility. From Fifth year onwards farmers will get profit from well grown tree and along with that employment opportunity throughout the year.

Fig.3. Agro forestry and goat rearing
(Source - https://agritech.tnau.ac.in)

Agroforestry and Kennel Method of Goat Rearing

In one acre of land 5 % of land can be used to build fences and set up kennel method shed in the center and remaining land can be used for fodder production like hedge Lucerne, kollukattai grass, maize fodder, etc. Agathi, Soundal, Gliricidia trees can be planted in the boundary of land.

It is recommended to starts cultivating forage crops 3-4 months prior to the purchase of goat. For rearing goat in kennel method shed is constructed at a height of about 3 feet above ground level. For keeping one goat around 10 to 15 square feet of space is needed. Roof of shed can be made with coconut or palm leaf or tiles. Aluminum plates are kept on one side of the barn to feed and Water supply can be provided with automatic tool. A goat requires nearly 1-3 liters of water per day. In this system animals are fed with 1 to 2 kg of forage and 250 to 300 grams of tree leaves per day.

Integrated Farming System of Coffee and Goat to Maximize Farmers' Income

This farming System has excellent and sustainable prospects by integrating coffee and goat rearing farmers can improve production quality, productivity, and income by reducing production costs. Coffee farming and livestock business produces main products and intermediate products.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

The main product of coffee farming is coffee cherries, and the intermediate products are coffee pulp, leaves of cover crops, and grasses from coffee fields. The intermediate product of coffee farming can be used as fodder for goats. Likewise in goat farming main product is broiler goats. The intermediate product of goat farming is used as organic fertilizer in coffee farming.

Organic fertilizers derived from goat farming are divided into two: solid organic fertilizers of goat feces and liquid organic fertilizers of goat urine. It is observed that the revenue from the integration model generates 1.04% higher income than the actual income.

Integrated Goat – Poultry Farming System

Fig.4. Integrated Goat – Poultry Farming System

Benefits of Integrated Farming System

1) **Productivity improvement**: main benefits of maintaining IFS are to increase yield of different components in terms of per unit area or per unit of cost involved with it.
2) **Profitability:** by utilizing the by-product of one enterprise as a raw material for other components to reduce cost of cultivation/maintenance as well as enhancing soil fertility for sustainable production. It leads a higher cost benefit ratio by full utilization of byproducts. Due to effective use of land, plantation of perennial or annual fodder crops or combination of it can make availability of feed and fodder for animal throughout the year thus meeting fodder crisis.
3) **Sustainable growth in agriculture**: In long term by linking different components through effective utilization of available resources, provides an opportunity to regain potentiality of production. Effective recycling of waste material (crop residues and livestock wastes) helps to make a farm self-sufficient in terms of avoiding outside inputs like – fertilizers, agrochemicals, feeds, etc.
4) **Balanced Food:** Different enterprise in IFS supplies different nutrients which can fulfill the daily nutritional demand.
5) **Environment Friendly enterprise:** Effective recycling of waste material as raw materials for other enterprise in IFS models thus minimizes environment pollution.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

6) **Rounds the year income**: Due to maintenance of different enterprises with crops it provides income throughout the year.
7) **Adoption of new technology:** In IFS not only marginal and small farmer make sustainable production but resourceful farmers can also fully utilize the available technology to get greater benefit from it. Round the year income generation induces acceptance to adopt latest technology to get the work done easily with less time.
8) **Energy generation:** it can be utilized to generate biogas from organic wastes available in the system as an alternative energy source to reduce dependence on fossil fuel source. Some legume fodders can fix nitrogen in soil and thus helps in increasing soil fertility. By linking of agro-silviculture can avail fuel or timber without deterioration of other components and can solve the Fuel or Timber Crisis. This will also greatly help to keep forestation and preserving our natural ecosystem.
9) **Employment Generation:** IFS provide enough scope to employ family labor round the year and by combing different enterprises it would significantly increase the requirement of labor and would help in reducing the problems of underemployment to a great extent.

Constraints faced by Farmers in Integrated Livestock Production

In livestock production farmers faces problem due to veterinary services and it is also found that veterinary services are not available at door steps which increases the veterinary cost in terms of transportation charges because farmers have to take their animals to hospitals which are distantly located, Lack of artificial insemination facility, Problems in heat detection, lower conception rate through artificial insemination, and Repeat breeding were found as less prioritized constraints.

The high cost of feeds and fodder is also a major constraint to the farmers, inadequate knowledge about balanced feeding, and Inadequate availability of green and dry fodder (Sonpasare *et al.,* 2011). Non availability of Concentrate (Shishode *et al.,* 2009) also creates problem to the farmers'. Lack of organized marketing facility for selling the milk or live animal in case of goat, poor transportation facility, etc., are the problems which are majorly faced by farmers. All constraints related to livestock production are divided mainly into three subdivisions i.e. Production, Feeding and Marketing are listed in the Table-2 given below.

Table-2 Constraints related to Integrated Farming

Production Problems	Feeding Problems	Marketing Problems
• *Poor veterinary services* • *Lack of artificial insemination facility* • *Problems of heat detection* • *Lower conception rate through artificial insemination* • *Repeat breeding*	• *High cost of feeds and fodders* • *Inadequate knowledge about balanced feeding* • *Inadequate Green fodder* • *Inadequate Dry fodder* • *Inadequate Concentrate Non-availability for fodder cultivation*	• *Low price of products* • *Lack of storage facilities* • *Transportation problem* • *Lack of regulated market* • *Lack of market information*

CONCLUSION

For rational utilization of resources and environmental protection without hampering economic growth integrated Farming Systems plays important role. As in this system crops and livestock interact to create a synergy, nothing is wasted and the by-product of one system becomes the input for other and thus allows the maximum use of available resources. It increases crop yields by increasing soils biological activity and nutrient recycling, intensifies land use and increases profits therefore can help to reduce poverty and malnutrition and strengthen environmental sustainability.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

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CHAPTER 23

Managemental Practises of Kids

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ABSTRACT

Managing kids (young goats) is crucial in goat farming to ensure their optimal health, growth, and overall productivity. This comprehensive overview provides insights into key management practices involved in raising kids, highlighting their importance in the goat farming industry. The article covers various aspects, including nutrition management, housing management, healthcare management, feeding management, and weaning management. Each section discusses the practices involved, emphasizing the significance of proper nutrition, housing, healthcare, feeding, and weaning protocols in supporting the healthy development of kids. References from reputable sources are provided throughout the article to validate the information and guide further research. By implementing effective management practices, farmers can promote the well-being and success of kids in their herds, ultimately contributing to a sustainable and thriving goat farming operation.

Keywords: *Kids, management practices, nutrition management, housing management, healthcare management, feeding management, weaning management.*

INTRODUCTION

Kids (young goats) play a crucial role in the goat farming industry as they represent the future of the herd. Managing kids effectively is essential for their growth, health, and overall productivity. It involves implementing appropriate management practices from birth to ensure their well-being and set them on a path to reaching their full potential. By providing proper nutrition, healthcare, and a suitable environment, farmers can promote the healthy development of kids, enabling them to thrive and contribute positively to the herd. (Kumar et al., 2017) (Kourimska et al., 2020) (Mahmoud et al., 2021).

Proper nutrition management is crucial for ensuring the healthy growth and development of kids, or young goats, in the goat farming industry. Adequate nutrition plays a vital role in supporting their immune system, maximizing growth potential, and preventing nutritional deficiencies. It involves providing a balanced diet that meets their specific nutritional requirements at different stages of growth.

Care of New Born Kids

Clean the nostrils and remove the placental membranes sticking on the kid, by gently rubbing with dry cotton or rags. Holding the kids up by hind legs with head downward for few seconds, will aid in clearing the respiratory tract. The kid will get up and start walking within half an hour. Allow the doe to lick the kids dry. Immerse the end portion of umbilical cord in tincture iodine. Repeat this after 12 hours. The kid should get its first drink of colostrum within 30 minutes of birth. If the kids do not suck properly, the teats should be held by the

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

hand and pressed into their mouth. Once they have drawn a little of the milk, it will not be long before they take to the normal method of sucking (TNAU Argritech portal, 2022).

1) Take care of newborn kids by providing guard rails.
2) Treat / disinfect the naval cord with tincture of iodine as soon as it is cut with a sharp knife.
3) Protect the kids from extreme weather conditions, particularly during the first two months.
4) Dehorn the kids during first two weeks of age.
5) Male kids should be castrated for better quality meat production.
6) Vaccinate the kids as per the recommended schedule.
7) Wean the kids at the age of 8 weeks.

Fig. 1. New born kid

Feeding Management

Feeding management practices are crucial for ensuring the proper growth, health, and development of kids in goat farming. Implementing appropriate feeding practices helps meet their nutritional requirements and supports their overall well-being. Here are some key feeding management practices to consider when raising kids.

Colostrum Feeding: Providing adequate colostrum, which is the first milk produced by the dam, is essential for kids' immune system development and protection against diseases. It is important to ensure that kids receive sufficient colostrum within the first few hours after birth to acquire passive immunity (Khan et al., 2018).

Fig. 2. Colostrum Feeding

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Milk Replacers or Dam-Raised Milk: If dam-raised milk is not available, high-quality milk replacers specifically formulated for young goats can be used. These milk replacers should meet the nutritional requirements of kids, including essential nutrients such as proteins, fats, carbohydrates, vitamins, and minerals (Terrill et al., 2010). Following recommended guidelines for milk replacer preparation and feeding frequency is crucial to support proper growth and development.

Fig. 3. Feeding Milk Replacers

Introducing of Solid Feeds: Introducing solid feeds gradually alongside milk feeding helps kids transition to a solid diet. High-quality creep feeds or concentrates formulated for young goats should be offered starting from a few days of age. These feeds should be nutritionally balanced to provide essential nutrients for growth and development (Smith, 2020). Ensuring easy access to creep feed and monitoring their consumption supports their transition to solid food.

Forage Availability: Providing good-quality forage such as hay or pasture is important for the development of kids' rumen and their transition to a primarily forage-based diet. Access to fresh and clean forage encourages natural browsing behaviour and provides essential nutrients for growth and development (Terrill et al., 2010).

Fig. 4. Feeding Forage

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Water Availability: Ensuring a constant supply of clean and fresh water is essential for proper hydration and overall health. Kids should have access to water from a young age, and water sources should be easily accessible and regularly checked to maintain cleanliness (Smith, 2020).

Fig. 5. Water Availability

Feeding Management based on Age and Weight: Adjusting the feeding regimen based on the age and weight of the kids is crucial. Monitoring their growth and weight gain allows for appropriate adjustments in feed quantities to meet their increasing nutritional needs (Terrill et al., 2010). Regular weighing and consultation with a veterinarian or nutritionist can help determine the optimal feeding management approach.

NUTRITIONAL MANAGEMENT

For new born kids, colostrum intake within the first few hours of life is critical for acquiring passive immunity and protecting against diseases (Bhutto et al., 2019). Feeding kids with a high-quality milk replacer or pasteurized goat milk in appropriate quantities and at regular intervals helps meet their nutritional needs.

1) As they grow older, the transition to solid feed should be gradual, introducing creep feed and forage to stimulate rumen development and ensure a smooth weaning process (Ghasemi et al., 2020).
2) The nutritional composition of the diet should be balanced, providing an appropriate ratio of carbohydrates, proteins, fats, vitamins, and minerals. Formulating diets with proper energy and protein levels supports optimal growth and muscle development (Khan et al., 2020).
3) Additionally, providing access to clean and fresh water at all times is essential for maintaining hydration and ensuring proper digestion.
4) Regular monitoring of body condition scores and growth rates helps assess the effectiveness of the nutrition management program and make any necessary adjustments.
5) Consulting with a veterinarian or animal nutritionist can provide valuable guidance in formulating appropriate diets and ensuring optimal nutrition for kids (González-Martínez et al., 2018).

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Table 1: The Estimated Nutritional Requirements of Kids based on Age and Live Body Weight per Day

Age (weeks)	Dry Matter Intake (%)	Crude Protein (%)	Total Digestible Nutrients (TDN) (%)	Calcium (%)	Phosphorus (%)
1-2	15-20	18-20	75-80	0.8-1.2	0.4-0.6
3-8	10-15	16-18	70-75	0.6-1.0	0.4-0.6
9-12	8-12	14-16	65-70	0.4-0.8	0.3-0.5
13-16	6-10	12-14	60-65	0.3-0.6	0.3-0.5
17-20	4-8	10-12	55-60	0.2-0.5	0.2-0.4

Housing Management

Housing management practices play a vital role in providing a suitable environment for the well-being and growth of kids, or young goats, in the goat farming industry. A well-designed and maintained housing system ensures their protection from adverse weather conditions, reduces the risk of diseases, and promotes their overall comfort. Here are some key housing management practices to consider when raising kids.

Fig. 6. Bedding

Shelter: Providing adequate shelter is essential to protect kids from extreme weather conditions such as rain, wind, heat, and cold. The shelter should be well-ventilated to maintain good air circulation, preventing the buildup of moisture and harmful gases. It should also be spacious enough to allow for the free movement of kids. Implementing separate pens or areas for different age groups can help prevent injuries and
promote efficient management (Zabek et al., 2018).

Flooring: The flooring of the kid's housing should be clean, dry, and slip-resistant to ensure their safety and minimize the risk of injuries. Using materials such as concrete, rubber mats, or deep bedding with straw or wood shavings can provide a comfortable surface for the kids to rest and play. Regular cleaning and removal of waste are necessary to maintain hygiene and prevent the accumulation of pathogens (Ribeiro et al., 2015).

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Bedding: Providing suitable bedding material helps keep the kids clean, dry, and comfortable. Clean straw, wood shavings, or other suitable bedding materials can be used to create a soft and cosy resting area for the kids. Regularly monitoring and replacing bedding as needed is essential to maintain cleanliness and prevent the buildup of pathogens (Herskin et al., 2019).

Ventilation: Proper ventilation is crucial to maintain a healthy environment inside the housing facility. Good air exchange helps remove moisture, odors, and harmful gases, ensuring fresh and clean air for the kids. Implementing windows, vents, or fans can aid in controlling humidity levels and preventing respiratory issues (Nasri et al., 2018).

Separation: Separating kids based on age and size can help prevent injuries and facilitate targeted management practices. Providing separate areas or pens for younger kids and older ones allows for better control of their nutrition, healthcare, and social interactions. It also minimizes competition for resources and reduces the risk of diseases spreading among different age groups (Rosa et al., 2019).

Fencing: Secure fencing is necessary to prevent the escape of kids and protect them from predators. The fencing should be sturdy, with small enough gaps to prevent the kids from getting stuck or escaping. Regular maintenance and inspection of the fencing are important to ensure its effectiveness and safety (Ismail et al., 2016).

Fig. 7. Fencing

Implementing these housing management practices provides a conducive environment for the growth and well-being of kids, enabling them to thrive in the goat farming system. It is essential to consider the specific needs of kids, local climatic conditions, and the available resources when designing and managing their housing facilities. Consulting with experts or experienced farmers can provide valuable insights and guidance for implementing effective housing management practices (Hernández et al., 2017).

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Weaning Management

Weaning management practices are crucial for the successful transition of kids from a milk-based diet to solid food and the development of their independence. Proper weaning management ensures their nutritional needs are met, minimizes stress, and promotes healthy growth and development. Here are some key practices to consider during the weaning process.

1) Gradual weaning is recommended to allow kids to adapt to the dietary change gradually. This involves gradually reducing the amount of milk they receive while introducing solid feeds. It is important to monitor their response and adjust the weaning rate based on their individual progress (Hinch et al., 2015). This approach helps prevent abrupt nutritional changes and minimizes stress.
2) Introducing a balanced solid diet is essential during weaning.High-quality, nutritionally balanced concentrates or creep feeds designed specifically for young goats should be provided. These feeds should contain the necessary nutrients, including protein, energy, vitamins, and minerals, to support growth and development (Smith, 2020). Consultation with a nutritionist or veterinarian can help determine the appropriate diet composition and feeding regimen.
3) Ensuring access to clean water and good-quality forage is important during the weaning process. Kids should have access to fresh, clean water at all times to promote hydration and aid in digestion (Zobel et al., 2014). Providing good-quality forage, such as hay or pasture, encourages rumen development and helps transition them to a primarily forage-based diet (Marley et al., 2017).
4) Monitoring feed intake and growth is essential during weaning. Regularly monitoring kids' feed consumption and body weight allows for adjustments in their diet and helps identify any potential issues or health concerns. This helps ensure that their nutritional needs are being met and supports their growth and development (Herskin et al., 2017).
5) Minimizing stress during the weaning process is important for the well-being of the kids. Separating them from their dams gradually, providing a clean and comfortable environment, and minimizing any changes in their routine can help reduce stress levels (Herskin et al., 2017). A calm and quiet environment with minimal disruptions supports their adjustment to the weaning process.

Healthcare Management

Healthcare management practices play a crucial role in ensuring the well-being and disease prevention of kids, or young goats, in the goat farming industry. Implementing effective healthcare measures helps maintain their optimal health, promote growth, and reduce the risk of diseases. This involves a combination of proactive measures, routine health checks, and appropriate veterinary care.

- Vaccination is an important aspect of healthcare management for kids. Administering vaccines at the appropriate ages and following recommended vaccination schedules helps protect them against common diseases, such as enterotoxaemia, tetanus, and respiratory infections (Marley et al., 2020). Consultation with a veterinarian is essential to determine the specific vaccines required based on the local disease prevalence and vaccination protocols.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Table 2: Vaccination Schedule for Kids

Age (weeks)	Vaccinations
4-6	• *Clostridium perfringens* type C and D *Clostridium tetani* • *Escherichia coli* • *Pasteurella haemolytica* • *Mannheimia haemolytica* • *Haemophilus somnus*
8-10	• *Clostridium perfringens type C and D booster* • *Clostridium tetani booster* • *Escherichia coli booster* • *Pasteurella haemolytica booster* • *Mannheimia haemolytica booster* • *Haemophilus somnus booster*
12-14	• *Clostridium perfringens type C and D booster* • *Clostridium tetani booster* • *Escherichia coli booster* • *Pasteurella haemolytica booster* • *Mannheimia haemolytica booster* • *Haemophilus somnus booster*
16-18	• *Clostridium perfringens type C and D booster* • *Clostridium tetani booster* • *Escherichia coli booster* • *Pasteurella haemolytica booster* • *Mannheimia haemolytica booster* • *Haemophilus somnus booster*
20-22	• *Rabies* • *Caseous Lymphadenitis*

- Regular deworming is another critical healthcare practice to control internal parasites, which can negatively impact the health and growth of kids. An appropriate deworming program should be implemented based on the specific parasite species and local environmental conditions (Kaplan, 2019). Faecal examinations and consultation with a veterinarian can help identify parasite burdens and guide the selection of suitable deworming medications.

Table 3: Deworming Schedule for Kids

Age (weeks)	Deworming Treatment
2-4	First Deworming
4-6	Second Deworming
8-10	Third Deworming
12-14	Fourth Deworming
16-18	Fifth Deworming

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

- Maintaining good hygiene and sanitation practices is essential to prevent the spread of diseases among kids. Regular cleaning and disinfection of housing facilities, feeding equipment, and water sources help minimize the risk of bacterial and viral infections (Radostits et al., 2020). Providing clean and fresh drinking water, as well as maintaining proper sanitation in feeding areas, helps prevent the contamination of feed and water with pathogens.
- Observation and monitoring of kids' health on a regular basis is crucial for early detection of any signs of illness or abnormal behaviour. Prompt identification of sick kids allows for timely intervention and treatment, which can significantly improve their chances of recovery. Regular health checks, including physical examinations, temperature monitoring, and assessing appetite and behaviour, should be conducted by trained personnel or a veterinarian (Pugh et al., 2012).

In case of any health concerns or suspected illnesses, seeking veterinary advice and guidance is paramount. A veterinarian can provide accurate diagnoses, prescribe appropriate medications, and recommend additional preventive measures to address specific health issues in kids.

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Volume 3 Issue 1; 2023
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Indian Journal of Livestock and Veterinary Research
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CHAPTER 24

Feeding Behavior & Feed Management in Goat

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ABSTRACT

India occupies first position in terms of goat population and milk production. Chevon (goat meat) is most preferred and widely consumed meat in the country. Goats are multipurpose animal which can produce milk, meat, fiber, skin together. Compared to cow and other livestock farming, goat farming requires less space and additional facilities. They have a less demand of housing and other management. In small scale production they are also able to share their homes with their owners and his/her other livestock. Production costs like infrastructure, feeding and treatment are less. Goats can adopt themselves with almost all types of agro-climatic conditions and diseases are less in goats. Goat products like meat and milk has no religious taboo and highly accepted for consumption throughout the world. Goats are meticulous eaters and can tolerate more quantity of bitterness than other animals. Therefore, they can thrive on agricultural by-products, waste, and other such feed. In addition, they are stronger and thus can withstand all types of weather conditions Goat tongues are adapted for grazing and their upper lip is mobile. Therefore, they can graze on extremely short grasses, bushes, shrubs, and trees. The goats should be provided with leguminous fodder in addition to grains like pulses, wheat, maize, etc. They normally prefer fodder of leguminous crops to straw or maize silage. In addition, they need feed composed of at least 14 to 15% protein along with high mineral composition like iodized salt, bone meal, zinc oxide, ferrous carbonate, high- grade limestone, copper, and vitamins. The growers are given 100 gm per day of concentrate mixture through adult does and bucks are given concentrate ration of 200 to 250 grams per day. On average, each goat consumes 5 to 7 Kg of green fodder and a liter of water per day. Statistically speaking an acre of fodder is enough to feed 35 goats.

***Keywords**: Goat, agro-climatic, meticulous, grazing, protein, mineral, does and bucks.*

INTRODUCTION

Explanation of the term "**feed**" Feed can be defined as substance provided to animals to meet their daily requirement of nutrients for proper functioning and maintenance of their body (including growth and production).

Ration: Feed provided to animals in 24 hrs.

Diet: Feed provided in one time, is called diet.

Importance of Feed

1. To survive/ maintenance requirements.
2. Production of milk and kids.

Classification of Feed

There are two types of feed:

a) **Roughages**
b) **Concentrates**

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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a) **Roughages**: Roughages are bulky feeds containing relatively less digestible material i.e., crude fibre more than 18% and TDN less than 60%.

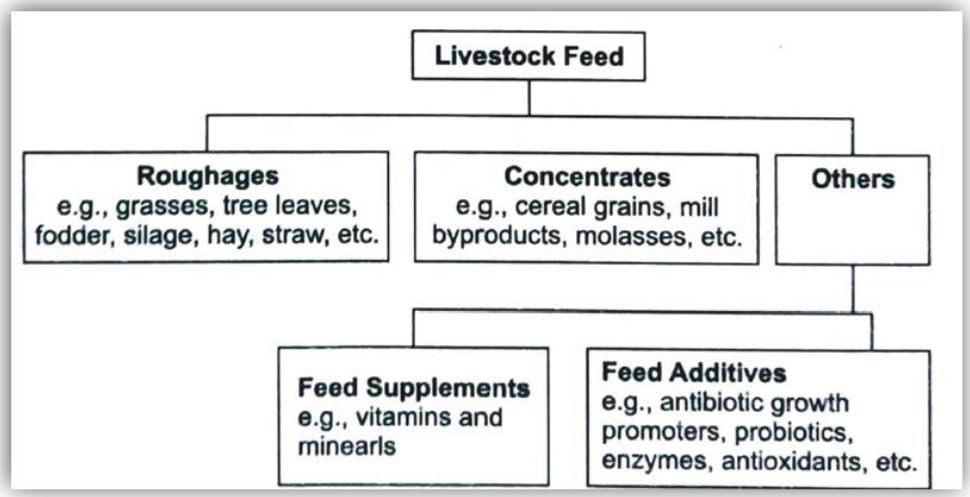
Types of Roughages

1) Dry fodder: Hay, Husk, Stover, Straw
2) Green fodder: Cultivated, Leguminous/Non-leguminous, Grasses
3) Tree leaves

b) **Concentrates:** Portion of feed that contains fibre less than 18% and TDN more than 60%. These occupy smaller portion of feed or simply it is a portion of feed that are eaten in less quantity by goats.

It includes:

1) Grains: Wheat, Barley, Jwar, Makka etc.
2) Grains By-products: Rice Bran, Wheat Bran, Dal Chuni etc.
3) Oil seed cakes: Cotton seed cake, Mustard seed cake, sunflower seed cake etc.
4) Pellets



Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Properties of Ideal Ration

The ideal ration should possess following properties:

1) Digestibility
2) Balanced
3) Palatability
4) Liberal feeding
5) Individual feeding
6) Much of green
7) Succulent
8) Fairly bulky
9) Enough of mineral matter
10) Fairly laxative
11) Variety of feeds
12) Maintain regularity in feeding
13) No sudden change to be made in the diet
14) Good quality of feed
15) Preparation of feed
16) Economical
17) Locally available
18) Fresh
19) Non-toxic

Feeding Management in Goats

There are three methods of feeding that are mainly practiced in goats:

1) Extensive Grazing
2) Semi-intensive
3) Intensive system or zero grazing-system
4) Tethering

1) **Extensive**: Raising the goat on entire pasture and leaving them there for the whole season grazing for rearing. In this method feed cost is very much less due to low input on feeding. This method is mainly practised in hilly/forest areas.
2) **Semi-intensive**: Grazing and browsing on pasture for five to six hours daily, with stall feeding available in the shed. The cost of feed was slightly higher using this strategy. This method is preferable since it satisfies dietary needs through both grazing and stall feeding. Flocks of fifty to three hundred and fifty goats, or more, are simple to oversee. During times of scarcity, we turn to our farmed fodder supply. Reduced labor costs and more profits result from raising kids for both meat and milk.
3) **Intensive system or zero grazing-system**: Considering the goats are confined indoors all the time and given very little opportunity to roam freely, this feeding method is often referred to as the "stall feeding" or "zero grazing" technique. Goats are not free to roam pastures under this arrangement. More time and money are needed to implement this management style. The benefit of this, however, is that the animals can be closely monitored and managed. This system centralizes the feces, which may then be recycled as fertilizer. More animals can be housed in the same area.
4) **Tethering**: When only one or two goats are needed for maintenance and there are limited grazing areas, tethering becomes an efficient solution.

Methods include:

1) A rope three to five meters in length is used to tie the animal to a peg 35 to 50 centimeters in length using a slip knot.
2) A peg is driven into the ground above the grazing area and the length of the rope determines how much of the area the goat can browse.
3) Move the area as needed to provide the goats access to enough grass to meet their dietary requirements. (In the event of extreme weather, such as a sudden rainfall or scorching heat, it is important to provide the animal with a temporary, ideally portable, shelter.)

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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In above three methods we find that sometimes goats raised under extensive system has to go very far to satisfy their hunger. This cause loss of energy which results in increased demand of nutrients by goat which ultimately leads to declining health as well as production.

Nutritional Requirement of Goats

Generally, goat can eat 2.5 - 4 % dry matter of their body weight which depends upon physical activity performed by them. Goats staying under stall feeding requires 2-3% dry matter where as goats under free range grazing requires 3-4 % of dry matter of based on their bodyweight. Production of goats in India very less than other countries, this due to lack of proper feeding and feeding managemental practices. Goats have different nutritional requirement at different stage of their life viz. kid, pregnant goat, dry goat, lactating goat and breeding buck. Not meeting the nutritional requirement will lead to decreased production in terms of milk, kid, meat and semen quality.

Requirements of feed based on age is shown in table on page

Stage of Goat	Roughages	Concentrates
Kid (3 months age)	500 grams to 1 kg	200 gm
3–6 months kid	1-2 kg	250 gm
6 months to 1 year old kid	2-3 kg	300 gm
Pregnant goat (15-20 days before kidding)	2-3 kg or free grazing	500 gm
Lactating goats	2-3 kg or free grazing	500 gm
Breeding Bucks	2-3 kg or free grazing	500 gm

Feeding of Pregnant Goats

Goats should be stopped milking in last 50 days of pregnancy and should be given extra 300-400 grams concentrate because maximum growth of foetus and increase in bodyweight of dam takes place at this time. If goats are not fed properly in last 50 days of pregnancy, then following consequences can occur:

1) Excessive weakness in the body of dam.
2) Lack of production of colostrum and milk after kidding.
3) Decreased birth weight of kids.

These consequences result in increased mortality of kid, slow increase in body weight and increased abortion.

Following feeding schedule should be followed for pregnant goats:

1. Under Intensive Feeding

Feed Component	Intensive System (with zero grazing)					
	2 Months		2-3.5 months		Above 3.5 months	
	Breed		Breed		Breed	
	Small	Large	Small	Large	Small	Large
Concentrates (Gm)	200	300	300	400	400	500
Dry Fodder (Gm)	400	600	400	600	500	800
Green Fodder (Gm)	1000	1200	1000	1200	1200	1500

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

2. Under Extensive Feeding

Feed Component	Semi-Intensive System (with 5-6 hrs. Grazing)					
	2 Months		2-3.5 months		Above 3.5 months	
	Breed		Breed		Breed	
	Small	Large	Small	Large	Small	Large
Concentrates (Gm)	200	250	250	350	300	400
Dry Fodder (Gm)	400	600	400	600	500	800
Green Fodder (Gm)	300	500	1000	600	5000	700

Point to keep in mind

1) Pregnant goats should not be left for grazing in wheat field after harvesting because at this time a weed named **Morella (*melilotus alba*)** is found in the field which causes abortion in goat.

Feeding Management of Kids

It is very essential for kids to drink colostrum after birth because it contains 4 times more protein than normal milk which provide energy. It also contains *immunoglobulin* which provides immunity to kid. Colostrum should be given to kids within 30 min. of birth because immunoglobulin count start decreasing. Kids should be given colostrum @ 10% of their body weight in 3-4 equal doses in 24 hrs.

Alternative of colostrum- 200 ml water + 300 ml milk + 1 egg (white portion only) + 10 ml castor oil + Vitamin A 1000 I.U.

Feeding of Milk

Age	Birth-7 days	8-15 days	15-30 days	30-60 days	60-90 days
Amount of milk	10% BW	15% BW	12% BW	7% BW	3% BW

Feeding of Concentrates

Kids starts nibbling grasses at the age of 15-20 days so we should provide them green fodder and grains *ad-libitum* which is essential for rumen development. Stop feeding milk at age of 90 days because at this age rumen is fully developed and they can digest all types of feed.

Feeding Schedule from birth to 3 months of age

Age	Per day gain in Body Weight					
	150 grams /days		100 grams /days		50 grams /days	
	Milk (ml)	Grain (gram)	Milk (ml)	Grain (gram)	Milk (ml)	Grain (gram)
Birth to 15 days	500	-	400		200	
15-30 days	800	120	600	75	300	40
1-2 months	700	175	500	110	260	60
2-3 months	400	300	300	200	150	100

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Feeding of Dry Goats

Dry goat just require feed to continue its life. A dry goat of weight 30 kg have following feeding requirements under intensive system:
Concentrates – 200 grams
Dry fodder – 500 grams
Green fodder – 500 grams

Feeding under Semi-Intensive System

Sr. no.	Daily grazing hours	Dry matter obtained from grazing	Concentrates	Season
1	3 hours	300 grams	250 grams	Summer
2	3-6 hours	300 - 600 grams	200 grams	Winter
3	More than 6 hours	More than 600 grams	150 grams	Rainy

Feeding of Breeding Buck

A buck whose body weight is 60 kg should have following feeding schedule:
Concentrates 400 – 500 grams
Dry fodder 1 – 1.5 kg
Green fodder 1 – 1.5 kg

Note: - During breeding season we should provide additional concentrates because at this time buck do not eat properly which can lead to weakness.

CONCLUSION

In India, goats play a significant role in providing milk, meat, fiber, and skin. They are adaptable animals that can thrive in various agro climatic conditions and coexist with other livestock. Goat feeding requires a balanced and diverse diet, including roughages and concentrates, with careful attention to their nutritional needs during different stages of life, especially pregnancy. Proper feeding and management are crucial for maximizing goat production and ensuring the health and growth of the animals. Additionally, colostrums are essential for newborn goats' immunity and should be administered promptly. By following good feeding practices and providing the necessary care, goats can be valuable assets for farmers and contribute to the country's agricultural productivity.

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Indian Journal of Livestock and Veterinary Research
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CHAPTER 25

Parasites and Goat Production: Unravelling the Impact on Management and Productivity

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ABSTRACT

The goat industry plays a vital role in meeting the surging worldwide demand for meat, milk, and fiber. However, parasitic infections pose significant challenges to the productivity and overall management of goat herds. This review article aims to explore the significance of parasites in goat production and management, shedding light on their impact on various aspects such as health, productivity, and economic sustainability. Goats are highly exposed to variety of parasitic infections including internal parasites (Trematodes, Cestodes, Nematodes), external parasites (Tick, Lice, Mite), protozoan parasites (Toxoplasma spp., Eimeria spp., Babesia spp., Theileria spp., Trypanosoma spp. etc.) and rickettsial infections (Anaplasma spp.). These parasites can cause a variety of health issues, including weight loss, anaemia, diarrhoea, reduced milk production, poor growth, fever, general weakness and even mortality in severe cases. Parasitic infections can directly impact the reproductive performance of goats. In females, high worm burdens and blood-sucking parasites can lead to decreased fertility, abortion, and reduced milk production. In males, parasites can affect sperm production and quality, leading to reduced breeding efficiency. In addition to that, genital myiasis can cause mating difficulties due to lesions. Scrotal sarcoptic mange reduces testicular mass, and besnoitiosis can affect the testes. Protozoa (Toxoplasma gondii,Neospora caninum,Trypanosoma cruzi etc.) have a harmful effect on the foetus, resulting in abortions, stillbirths, and decreased reproductive output in affected females. Additionally, they infect young kids, leading to higher neonatal mortality rates. Ectoparasites like lice or Przhevalskiana silenus severely damage the skin of goats, making their hair unsuitable for processing or decreasing its value. These parasites can also weaken the immune system of goats, making them more susceptible to secondary infections and have reduced resistance to other diseases, further exacerbating the health issues. The overall productivity and profitability of goat farming operations are adversely affected by the negative impact of parasitism. The economic implications of parasitic infections in goat production cannot be overlooked. Direct losses occur due to reduced productivity, increased mortality rates, and the cost of treatments. Indirect losses arise from the expenses associated with preventative measures, such as deworming protocols and biosecurity measures, as well as the impact on market value due to poor-quality products from infected animals. Effective management strategies are crucial for minimizing the impact of parasites in goat production. Integrated parasite management (IPM) approaches, including strategic deworming programs, pasture rotation, grazing management, and genetic selection for resistance, have shown promising results. Timely and accurate diagnosis of parasitic infections using appropriate diagnostic techniques allows for targeted treatment and prevention measures. Good husbandry practices such as maintaining clean and well-drained living environments, providing proper nutrition, and implementing quarantine protocols for incoming animals can help reduce parasite transmission and improve overall herd health. Sustainable control of parasitism requires a comprehensive understanding of local parasite epidemiology, including factors such as climate, geographical location, and farm management practices. Furthermore, promoting awareness and education among goat farmers regarding the importance of regular monitoring, appropriate deworming strategies, and the potential development of anthelmintic resistance is essential. In conclusion, parasites pose a significant challenge to goat production and management. Their detrimental effects on goat health, productivity, and economic sustainability necessitate the implementation of effective management strategies. By focusing on regular monitoring, strategic

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treatments, and comprehensive parasite control programs, goat farmers can minimize the negative impact of parasitic infestations, leading to improved herd health, productivity, and profitability.

***Keywords**: goat production, parasitic infections, health, productivity, economic sustainability, management strategies*

INTRODUCTION

In recent years, the global demand for goat meat and milk has experienced a significant upswing due to their nutritional value, low input requirements, and adaptability to diverse environments (Miller & Lu, 2019). They are reared for their meat, milk, fiber (such as cashmere and mohair), and hides, which contribute to food security, income generation, and rural development. Goats have emerged as valuable assets for small-scale farmers, contributing to sustainable livelihoods and poverty reduction in many regions (Devendra, 2013). However, various challenges, including parasitic infections, continue to impede the optimal productivity and overall success of goat production systems worldwide. Parasitic diseases pose a substantial threat to goat health and productivity, undermining the efforts of farmers and causing significant economic losses. These infections, caused by a range of internal and external parasites, can severely impact on growth, reproduction, and overall performance (Pilarczyket al., 2021). Moreover, the zoonotic potential of some parasites poses a risk to human health, further highlighting the importance of addressing these issues comprehensively (Utaakeret al., 2021). The intricate relationship between goats and parasites calls for a thorough understanding of their impact on management practices and productivity. Management strategies, including anthelmintic treatments, pasture management, and genetic selection, play a crucial role in combating parasite infections and enhancing goat performance (Arsenopouloset al., 2021). However, effective parasite control measures must strike a delicate balance to prevent the emergence of drug resistance and promote sustainable production practices. This review article summarized the parasites (internal and external parasites), their site of predilection, pathogenesis, clinical signs and drug of choice for treatment. This article also aims to explore the multifaceted aspects of parasites in goat production, focusing on the impact on management practices and productivity. Additionally, we will explore various management strategies employed globally to control parasite infections, assessing their effectiveness and sustainability. The article will also shed light on the economic implications of parasites in goat production and different methods for diagnosis of parasites. By understanding the magnitude of the problem, stakeholders can devise targeted interventions and allocate resources effectively to mitigate the negative consequences of parasitic infections. Ultimately, unravelling the complex interplay between parasites and goat production is vital for the development and implementation of sustainable and integrated management approaches. By synthesizing existing knowledge and identifying research gaps, this review article aims to provide a comprehensive overview of the impact of parasites on goat productivity, enabling farmers, researchers, and policymakers to make informed decisions to enhance animal health, welfare, and sustainable production in the face of parasitic challenges.

Types of Parasites Affecting Goats

Parasites are major constraints for sustainable and profitable animal production system. Broadly these parasites can be categorized into three major categories helminths, protozoa and arthropods. Helminths are further classified into trematodes (Flukes), cestodes (Tapeworms), nematodes (Roundworms).

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Table 1. Species of trematodes, cestodes and metacestode stage infecting the goat population and their Predilection site, pathogenesis and Drug of Choice

Species	Predilection site	Clinical sign/Pathogenesis	Drug of Choice / Preventive Measure
TREMATODES			
Fasciola (F.) *hepatica, F. gigantica*	Liver and Bile duct	**Acute form:** weakness, lack of appetite, Abdominal pain, Ascites, death. **Subacute form:** Pale mucous membrane, submandibular oedema, enlarged liver, Ascites. **Chronic form:** Loss of body weight, bottle jaw, Ascites, Anaemia, Hypoalbuminemia, pale mucous membrane, loss of weight.	Triclabendazole @10 mg/kg body weight orally.
Amphistomosis (*Paramphistomum cervi, Cotylophoron Cotylophoron, Gastrothylax crumenifer, Fischoederius elongatus, Fischoederius cobboldi*)	Rumen and Reticulum	Pronounced fluid foetid diarrhoea, soiling of hind quarters and tail with faeces, marked weakness, emaciation, anorexia, submandibular oedema, Death of the animal in about 5-10 days.	Oxyclozanide @18.7 mg/kg body wt. orally
Dicrocoelium dendriticum	Liver, Bile duct	Abdominal distention, painful liver, right upper abdominal pain, diarrhoea, constipation, and anaemia	Thiophenate @ 50 mg/kg body wt. Praziquantel @ 50 mg/kg body wt.
Schistosoma spindale	Mesenteric and portal veins	Frequent diarrhoea with blood and mucous, colic, weight loss and weakness, pale mucous membrane,	Tartar emetic @ 1.5 mg/kg body wt. (I/V)
CESTODE			
Moniezia expansa	Small intestine	Diarrhoea	Niclosamide @100 mg/kg body wt. Praziquantel @3.75 mg/kg body wt.
Avitellina centripunctata	Small intestine	Diarrhoea	Niclosamide @100 mg/kg body wt. Praziquantel @3.75 mg/kg body wt.
Thysanosoma actinioides	Bile duct, pancreatic duct and small intestine	Obstruct the flow of bile and pancreatic juice leading to digestive disorder and Unthriftiness	Bithionol @200 mg/kg body wt. Niclosamide @400-600 mg/kg body wt.
Stilesia hepatica	Bile duct	Obstruct the flow of bile	Niclosamide @100 mg/kg body wt. Praziquantel @3.75 mg/kg body wt.
Stilesia globipunctata	Small intestine	Severe nodule formation in the small intestine	Niclosamide @100 mg/kg body wt. Praziquantel @3.75

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			mg/kg body wt.
Thysaniezia giardia	Small intestine	diarrhoea	Bithionol @125-150 mg/kg body wt.
METACESTODE STAGE			
Coenurus cerebralis (Metacestode stage of *Taenia multiceps*)	Brain and Spinal cord	Fever, restlessness, Gid (Circling movement)	Cyst can be removed surgically
Hydatid cyst (Metacestode stage of *Echinococcus granulosus*)	Lung and Liver	Abdominal pain, nausea and vomiting are commonly seen when hydatids occur in the liver, If the lung is affected, clinical signs include chronic cough, chest pain and shortness of breath. Other signs depend on the location of the hydatid cysts and the pressure exerted on the surrounding tissues. Non-specific signs include anorexia, weight loss and weakness.	Surgical removal of cyst
Cysticercus tenuicollis (Metacestode stage of *Taenia hydatigena*)	Mesentery, greater omentum and serosal surface of organ	Unthriftiness, traumatic hepatitis	Oxfendazole, Surgery
Cysticercus ovis (Metacestode stage of *Taenia ovis*)	Muscle of heart, diaphragm and masseter	Do not exhibit any clinical sign	Surgical removal of cyst

Table 2. Species of nematodes infecting the goat population and their Predilection site, pathogenesis and Drug of Choice

Species	Predilection site	Clinical sign/Pathogenesis	Drug of Choice / Preventive Measure
Dictyocaulus filaria	Lung	Catarrhal parasitic bronchitis, Coughing	Diethyl carbamazine @50mg/kg body wt. orally for 7 days Levamisole @7.5mg/kg body wt. (S/C) Fenbendazole @2-5 mg/kg body wt. orally for 7 days Thiabendazole @100mg/kg body wt. orally
Protostrongylus rufescens	Bronchioles	Coughing	Similar to *Dictyocaulus filaria*
Muellerius capillaris	Lung parenchyma	Coughing	Similar to *Dictyocaulus filaria*
Trichostrongylus axei	Abomasum	Loose faeces, intermittent or black coloured diarrhoea	Albendazole, Fenbendazole, Febantel @5-7.5 mg/kg body wt orally. Levamisole @7.5mg/kg body wt. (S/C) Ivermectin @0.2 mg/kg body wt. (S/C) Closantel @10mg/kg body wt. orally.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

			Moxidectin @0.2mg/kg body wt. S/C or P.O.
Trichostrongylus colubriformis	Small intestine	Watery diarrhoea	*Similar to Trichostrongylus axei*
Haemonchus contortus	Abomasum	**Hyperacute:** severe anaemia, dark black coloured faeces with blood and sudden death **Acute:** Anaemia, hypoproteinaemia, oedema, bottle jaw, death **Chronic:** weak, unthrifty and emaciated	*Similar to Trichostrongylus axei*
Mecistocirrus digitatus	Abomasum	Diarrhoea, loss of body weight and production, partial anorexia, anaemia	*Similar to Trichostrongylus axei*
Ostertagiosis (*Ostertagia circumcinta, Ostertagia trifurcate*)	Abomasum	Diarrhoea, loss of body weight and production, partial anorexia, rough hair coat, slight anaemia, hypalbuminaemia and occasional death	*Similar to Trichostrongylus axei*
Cooperiosis (*Cooperia curticei*)	Small intestine	Soft faeces, diarrhoea, reduced food intake, slight hypalbuminaemia, emaciation, listlessness and weight loss	*Similar to Trichostrongylus axei*
Nematodirus battus, Nematodirus spathiger	Small intestine	Acute enteritis, severe dark green diarrhoea, dehydration, extreme thirst.	*Similar to Trichostrongylus axei*
Chabertia ovina	Large intestine	Diarrhoea containing blood and mucous, Anaemia, hypalbuminaemia	*Similar to Trichostrongylus axei*
Oesophagostomum columbianum	Large intestine	Severe dark green diarrhoea, weight loss, emaciation, prostration, Pimply gut.	*Similar to Trichostrongylus axei*
Bunostomum trigonocephalum	Small intestine	Anaemia, Bottle jaw, diarrhoea and dark red colour faeces	*Similar to Trichostrongylus axei*
Gaigeria pachyscelis	Small intestine	Anaemia, Bottle jaw, diarrhoea and dark red colour faeces	*Similar to Trichostrongylus axei*
Strongyloides papillosus	Small intestine	Anorexia, loss of weight, diarrhoea, moderate anaemia	Thiabendazole @50-75 mg/kg body wt. orally. Fenbendazole @50 mg/kg body wt. orally. Ivermectin @0.2 mg/kg body wt. (S/C or I/M)
Trichuris ovis	Cecum and colon	Diarrhoea, anorexia, and anaemia	Albendazole 7.5 mg/kg body wt. orally. Ivermectin @0.2 mg/kg body wt. (S/C) Levamisole @7.5mg/kg body wt. (S/C)

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Tab.3. Species of Protozoan and Rickettsial organism infecting the goat population and their Predilection site, pathogenesis and drug of Choice

Species	Predilection Site	Clinical sign/Pathogenesis	Drug of Choice / Preventive Measure
Babesia ovis, B. motasi	Blood	Fever, anaemia, icterus, and hemoglobinuria	Imidocarb dipropionate @1-2 mg/kg of body weight (I/M)., Diminazene aceturate @ 3.5 mg/kg of body weight (I/M).
Theileria hirci, T. ovis	Blood	High fever, marked enlargement of lymph nodes, jaundice, anaemia, atony of the rumen	Buparvaquone @ 2.5 mg/kg of body weight (I/M)
Trypanosoma vivax	Blood	Pale mucous membranes, enlarged lymph nodes, weakness, weight loss, opacity of the cornea, blindness, and abortion	Diminazene aceturate @ 7 mg/kg of body weight (I/M)
Eimeria (*E.*) *airlongi, E. caprina, E. ninakohlyakimvae, E. christenseni*	Intestinal tract	Mild diarrhoea to severe bloody diarrhoea	Sulphonamide (Sulphadimidine, sulphaguanidine, sulphaquinoxaline, sulphamethazine)
Giardia duodenalis	Gastrointestinal tract	Chronic diarrhoea	Fenbendazole, Albendazole
Cryptosporidium parvum	Gastrointestinal tract	diarrhoea	Nitazoxanide
Toxoplasma gondii	Muscles	Fever, diarrhoea, cough, dyspnoea, Abortion, icterus, seizures, and death	Goats vaccinated with the commercial Toxovac S48 live vaccine
Rickettsial Organism			
Anaplasma marginale, Anaplasma ovis	Blood	depression, debility, decreased milk production, weight loss, abortion and severe anaemia and jaundice in endemic areas	Oxytetracycline @10mg/kg body wt. (I/M)

Table 4. Species of arthropods infesting the goat population and their pathogenesis

Arthropod	Species	Predilection site	Pathogenesis	Drug of Choice / Preventive Measure
Lice	*Bovicola (B.) caprae, B. crassipes, B. Limbata, Linognathus (L.) stenopsis, L. africanus, Linognathus pedalis*	skin	Irritation, Loss of hair, weight loss, anaemia	Insecticide application
Mite	*Demodex caprae, Sarcoptes*	skin	Dermal papules and nodules, hair loss around the muzzle, eyes, and ears;	Insecticide application

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

	scabiei, psoroptes cuniculi, Chorioptes ovis, Chorioptest exanus		lesions on the inner thighs	
Flea	*Ctenocephalides felis, Ctenocephalides orientis*	Head and ears	Extreme annoyance, irritation, loss of hair, anaemia and loss of body weight	flumethrin (pour-on), deltamethrin (dipping)
Ticks	*Dermacentor* spp., *Amblyomma* spp., *Hyalomma* spp., *Rhipicephalus* spp., *Ixodes* spp.	Head and neck, Ears, Underbelly, Between toes and paw pads, Tail base, Inner thighs, Udder	Damage to the skin and hide, tick toxicosis, tick paralysis, anaemia, disease development through the transmission of various pathogens such as bacteria, viruses, and parasites	Insecticide application
Flies	*Oestrus ovis*	Dorsal turbinate bones, frontal sinuses	seromucous or purulent nasal discharge, frequent sneezing, incoordination and dyspnoea, false gid	Inj. Ivermectin, Inj. Doramectin, Eprinomectin (pour on)
	Gasterophilus haemorrhoidalis	Larvae migrate to the head sinuses	Discharge from nostrils, extensive shaking of the head, loss of appetite and grating of teeth	Ivermectin

Impact on Goat Health and Productivity

A. Effects of Parasite Infections on Growth and Weight Gain:

Parasite infections in goats and kids can have a significant impact on their growth and weight gain. Internal parasites, such as gastrointestinal worms (e.g., roundworms, tapeworms), can cause damage to the goat's digestive system, leading to poor nutrient absorption and decreased feed efficiency. This can result in reduced appetite, weight loss, and stunted growth (Hoste et al., 2005). Additionally, heavy parasite burdens can cause anaemia, further compromising the goat's overall health and growth potential. Further, *Eimeria* spp. (Andrews, 2013), *Cryptosporidium* spp. (Brito et al., 2014) or *Giardia* spp. (Peng et al., 2016) can infect young (<1-week-old) kids, ultimately resulting in increased neonatal mortality or, if affected kids survive, there is suboptimal growth rate and hence reduced meat production.

B. Impact on Reproductive Performance and Fertility

Parasite infections can also affect the reproductive performance and fertility of goats. In males, parasites can affect the quality and quantity of sperm, leading to reduced fertility. Genital myiosis in bucks might result in lesions that prevented mating (Taylor et al., 2007), scrotal sarcoptic mange could induce a decrease in testicular mass (Sarasa et al., 2011), and besnoitosis could impair testicular function (Oryanet al., 2011). In female goats, high parasite loads can disrupt the hormonal balance and interfere with the estrous cycle, leading to irregular or suppressed heat periods. This can result in decreased conception rates and fertility problems. For instance, decreased energy availability during the peri-conception period brought on by parasite illnesses may result in fewer ovulations or a higher incidence of embryonic deaths, both of which would result in lower kidding rates (Dobson et al., 2012). Furthermore, a decreased conception rate may occur in herds with animals that are in poor

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

health during the mating season. Additionally, protozoa, like as *Toxoplasma gondii* or *Neospora caninum*, have a direct fetopathogenic effect, causing abortions and/or stillbirths in susceptible does (Moreno et al., 2012; Porto et al., 2016). In cases of persistent infections, the same pathogens can also result in a long-term decrease in an animal's reproductive output (Silva et al., 2015). Additionally, general debilitation caused by parasite infections can lead to poor body condition, making it challenging for goats to conceive and carry pregnancies to term successfully. Last but not least, parasite infections may operate as a risk factor for pregnancy toxaemia, a serious metabolic disorder that affects pregnant does and can result in death in affected animals, abortion, or perinatal death of foetus(es)/new-born kids (Papadopoulos et al., 2013).

C. Influence on Milk Production and Quality

Parasite infections can have adverse effects on milk production and quality in dairy goats. Infected goats may experience decreased milk production due to the reduced nutrient absorption and overall health issues caused by parasites (Alberti et al., 2012). The presence of parasites in the digestive system can also lead to inflammation and damage to the mammary glands, affecting milk quality. Infected goats may have milk with lower fat and protein content, reduced lactose levels, and increased somatic cell counts, which can negatively impact the market value and usability of the milk (Alberti et al., 2012; 2014).

D. Effects of Parasitism in Fibre or Hide Production

The many ectoparasites that plague goats cause serious skin damage, making the animals' hair unfit for processing or decreasing its value. For example, *Przhevalskiana silenus* infested animals have holes on their hides, greatly lowering the market worth of the goods, whereas Mallophaga lice feed on the hair of the parasitized host (Taylor et al., 2007). Sarcoptic or demodectic mange is a serious skin condition in goats that can cause severe skin damage and hence reduced hide production in up to 10% of affected goats (Ghosh, 1997; Abebayehu and Kibrom, 2010). The synthesis of fiber may also be harmed by indirect effects: Infection with *Haemonchus contortus* decreases hair growth.

E. Relationship between Parasites and other Diseases

Parasite infections can weaken the immune system of goats, making them more susceptible to other diseases. Goats burdened with parasites may be more prone to bacterial or viral infections, respiratory diseases, and other parasitic infestations. The immune response of the goat can be compromised as parasites consume nutrients and cause inflammation, leaving the animal less capable of fighting off other pathogens (Mabbott, 2018). Therefore, controlling parasites is essential not only to address their direct impact but also to reduce the risk of other disease occurrences.

F. Economic losses associated with Parasite Infections

Parasite infections in goats can result in significant economic losses for goat farmers. Reduced growth rates, weight loss, and poor reproductive performance can lead to decreased market value for the goats (Devendra, 2013). In dairy operations, reduced milk production and compromised milk quality can impact the profitability of the enterprise (Zucaliet al., 2020). Additionally, the costs associated with veterinary treatments, medications, and management practices to control and prevent parasite infections can add up. Overall, parasite infections can have a substantial financial impact on goat farming operations (Charlier et al., 2020).

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Trends to Diagnose Goat Parasitism

The clinical manifestations in infected animals can vary depending on the parasite's preferred sites and nutritional needs. For instance, when the parasite disrupts the digestive tract, typical symptoms include diarrhoea, weight loss, a rough coat, depression, and loss of appetite. On the other hand, if the parasite infects the stomach or liver and feeds on blood, the common signs include anaemia, pale inner eyelid mucous membranes, and weight loss. Laboratory tests may reveal findings such as plasma protein depletion, reduced packed cell volume, and an elevated count of parasite eggs in the feces (Rizwan et al., 2023). Gastrointestinal parasite infection in goats is diagnosed through methods such as fecal egg count, fecal floatation, fecal sedimentation, and observation of clinical signs and physical examination, with fecal egg count providing an estimation of parasite burden but not identifying the parasite types.The diagnosis of blood protozoan and rickettsial organisms in goats involves observing clinical signs, which may provide initial indications, but requires confirmation through laboratory tests such as blood smear examination, where a stained blood smear is examined under a microscope to detect and identify blood parasites based on their characteristic morphology, such as *Babesia* spp., *Theileria* spp., *Anaplasma* spp., and *Trypanosoma* spp.A complete blood count (CBC) can provide valuable information about the overall health of the goat and identify potential indicators of blood parasitism.The diagnosis of ectoparasite infestation in goats involves observing clinical signs such as itching, scratching, hair loss, scabs, skin irritation, and the presence of visible parasites or eggs on the skin or hair, conducting a thorough physical examination to identify external parasites, taking skin scrapings to diagnose mite infestations, using the tape test to collect and identify certain mites or eggs, and visually identifying some ectoparasites, while being cautious about handling ticks due to their disease-transmitting potential(Taylor et al., 2007).In addition to that, serological tests for diagnosing parasitic infections involve detecting specific antibodies produced in response to the parasites, particularly useful for chronic infections, with common methods including ELISA for detecting antibodies in body fluids, IFA using fluorescently labeled antibodies to detect specific antibodies on microscope slides, Western Blot to identify specific antibodies against multiple parasite antigens, and Rapid Diagnostic Tests (RDTs) as point-of-care tests; they are valuable when parasites may not be present in the sample at the time of testing or when other methods have limitations, but they are not suitable for diagnosing acute infections, often requiring a combination of serological tests and other diagnostic methods for accuracy(Ndao, 2009).Molecular tests for the diagnosis of parasitic infections involve detecting and analyzing the genetic material (DNA or RNA) of the parasites, including Polymerase Chain Reaction (PCR) for amplifying specific DNA or RNA sequences, Real-time PCR (qPCR) for quantifying parasite load, Loop-mediated Isothermal Amplification (LAMP) for field settings, Nucleic Acid Hybridization for enhancing sensitivity, and DNA sequencing for identifying the exact species or strain of the parasite; these tests are highly sensitive and specific, essential in research, surveillance, and clinical settings when traditional diagnostic methods may not suffice or for accurate species identification in both human and animal populations(Ndao, 2009).

Management Strategies for Parasite Control

A. Anthelmintic treatments and Deworming Protocols:

Develop a deworming protocol specific to your goat herd. The protocol should consider the parasite species present, the local climate, and the age and health status of the goats. Administer anthelmintic treatments based on weight and follow the recommended dosing instructions. Rotate between different classes of dewormers to prevent the development of

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

resistance. Consider performing faecal egg count (FEC) tests to determine the need for deworming and to monitor the effectiveness of the treatment (Molento, 2009).

B. Pasture Management Techniques:
Rotational grazing is an effective method to manage parasites and maintain healthy pastures by moving goats regularly between smaller sections. This breaks the parasite life cycle and prevents overgrazing, allowing the pasture to recover. Resting pastures periodically disrupts the parasite's life cycle and reduces its overall impact. Reseeding with parasite-resistant forage species further strengthens the goats' natural defences against parasites. Harrowing the pastures exposes parasite eggs and larvae to sunlight, diminishing their viability. Lastly, implementing mixed species grazing can help reduce the risk of cross-contamination between different livestock species, contributing to a healthier environment for all animals involved (Molento, 2009).

C. Quarantine and Biosecurity:
To ensure the health and well-being of the goat herd, it is crucial to quarantine new animals upon arrival. Isolating and observing them for a period helps identify and treat any potential parasites before introducing them to the main herd, preventing the spread of infections. Minimizing contact between goats and other livestock species that might carry different parasites reduces the risk of cross-contamination, safeguarding the goats from additional health challenges. Additionally, regularly cleaning and disinfecting equipment like feeders and water troughs helps prevent parasite build-up and ensures a cleaner, safer environment for the goats (Molento, 2009).

D. Genetic selection for Resistance:
Select breeding stock with natural resistance or resilience to parasites. Some goat breeds or individual animals show inherent resistance to parasites, and breeding for these traits can help reduce susceptibility in future generations. Consider using performance data, such as fecal egg counts and growth rates, to assist in identifying goats with better resistance or resilience to parasites (Molento, 2009).

E. Integrated Pest Management Approaches:
Implement an integrated approach that combines multiple strategies, including pasture management, targeted deworming, and nutrition. Use strategic deworming based on faecal egg counts to determine which animals require treatment. Practice good herd health management, including nutrition optimization, stress reduction, and general animal welfare practices, to enhance the goats' natural defense mechanisms against parasites (Molento, 2009).

F. Alternative Control Methods:
Explore alternative control methods, such as herbal remedies or biological agents, under the guidance of a veterinarian or experienced consultant. Some herbal remedies or plant-based supplements may have potential anthelmintic properties, but their effectiveness can vary. Investigate the use of biological agents like nematophagous fungi or beneficial nematodes that can help control parasite populations in the environment. It’s important to note that alternative control methods may require further research and validation to determine their efficacy and safety in goat parasite control (Molento, 2009).

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Challenges and Limitations

A. Emergence of drug resistance in parasites:
One of the significant challenges in managing parasites, is the emergence of drug resistance. Over time, parasites can develop genetic mutations or acquire resistance genes from other organisms, rendering certain drugs ineffective. This resistance can occur due to several factors, including inadequate or improper use of drugs, incomplete treatment courses, or the overuse of specific drugs. Drug resistance can make it difficult to control and treat parasitic infections, leading to prolonged illnesses, increased healthcare costs, and potential public health threats(Molento, 2009).To address this challenge, it is crucial to employ strategies that minimize the development and spread of drug resistance. These strategies include:

Fecal Egg Counts (FECs): Start by performing regular fecal egg counts on your goats. This helps to identify which goats are shedding a significant number of eggs and need deworming.
Selective Treatment: Instead of treating all goats at once, selectively treat only those animals with high fecal egg counts or signs of clinical illness. This targeted approach ensures that only the most affected individuals receive treatment, reducing the overall selective pressure on the parasite population (Molento, 2009).

Refugia: Implementing refugia is crucial to maintaining a population of susceptible parasites in the environment. Refugia refers to the population of parasites that are not exposed to the deworming treatment. By leaving a proportion of goats untreated or underdosed, you allow susceptible parasites to survive and reproduce, diluting the resistant parasite genes in the population (Molento, 2009).

Rational drug use: Promoting appropriate and evidence-based use of drugs, including correct dosages and treatment durations, can help reduce the selective pressure that drives drug resistance (Molento, 2009).

Combination therapy: Using multiple drugs in combination can hinder the development of resistance. By attacking the parasites through different mechanisms, combination therapy makes it harder for parasites to develop resistance against all the drugs simultaneously (Molento, 2009).

Surveillance and monitoring: Regular monitoring of drug resistance patterns can help detect emerging resistance early. This information can guide treatment guidelines and interventions, ensuring effective management of parasitic infections (Molento, 2009).

Development of new drugs: Continued research and development of new drugs and treatment approaches are necessary to stay ahead of drug-resistant parasites. This includes exploring alternative treatment options and novel drug targets (Molento, 2009).

B. Environmental Concerns and Sustainable Practices:
Parasite management can have significant environmental implications, particularly when it involves the use of chemicals, such as pesticides or antiparasitic drugs. These substances can enter ecosystems and potentially cause harm to non-target organisms, disrupt ecological balances, and contribute to the development of pesticide resistance (Molento, 2009).To address environmental concerns and promote sustainable practices in parasite management, the following strategies can be employed:

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Integrated pest management (IPM): IPM emphasizes a holistic approach to pest and parasite control. It involves combining multiple strategies, such as biological control (using natural enemies), cultural practices (crop rotation, sanitation), and judicious use of pesticides or drugs. This approach minimizes the use of chemicals while maximizing effectiveness and minimizing environmental impacts (Molento, 2009).

Risk assessment: Conducting environmental risk assessments before using pesticides or drugs can help identify potential hazards and design appropriate mitigation measures. This includes considering factors like toxicity, persistence, and potential for bioaccumulation.

Alternative control methods: Exploring and promoting alternative methods of parasite control, such as biological control agents, biopesticides, or non-chemical interventions, can reduce reliance on chemical treatments and their associated environmental risks (Molento, 2009).

Education and awareness: Raising awareness among farmers, healthcare professionals, and the general public about the environmental impacts of parasite management practices is crucial. Promoting education and training programs can help disseminate information on sustainable practices and encourage responsible use of chemicals.

Zoonotic Potential and Public Health Implications

A. Zoonotic parasites associated with goats:
Goats can harbor various zoonotic parasites, which are capable of infecting humans and causing diseases. Some common zoonotic parasites associated with goats include: *Cryptosporidium* spp., *Echinococcus granulosus*, *Toxoplasma gondii*, *Giardia duodenalis* etc. (Utaaker et al., 2021).

B. Risk assessment and prevention strategies:
To minimize the zoonotic potential and public health implications linked to goat parasites, essential strategies include implementing good hygiene practices, ensuring proper food safety measures, managing water sources to prevent contamination, practicing environmental management to reduce faecal exposure, providing regular veterinary care and monitoring, and promoting public awareness and education about zoonotic risks and preventive measures (Utaaker et al., 2021).

Future Perspectives and Research Needs

A. Research gaps in parasite control in goat production:
Despite significant advancements in parasite control in goat production, several research gaps still exist. Some areas that require further attention and investigation include:

Drug resistance: Continued research is needed to understand the mechanisms of drug resistance in goat parasites and develop effective strategies to mitigate and manage resistance. Diagnostic tools: Development of accurate, cost-effective, and field-applicable diagnostic tools for detecting and monitoring parasite infections in goats is essential. This includes improving sensitivity and specificity, as well as the development of point-of-care tests.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Integrated parasite management: Further research is needed to evaluate and optimize integrated parasite management approaches that combine various control strategies, such as strategic deworming, pasture management, and alternative treatments.

Sustainable control methods: Research should focus on exploring and developing sustainable parasite control methods, including biological control agents, plant-based remedies, and novel non-chemical interventions.

B. Potential Advancements in Vaccines, Drug Development and Precision Farming:
Advancements in vaccines, drug development, and precision farming technologies hold promise for improving parasite control in goat production:

Vaccines: Research efforts should focus on developing vaccines against important goat parasites, including those with zoonotic potential. Vaccines can provide long-term protection, reduce the reliance on chemical treatments, and decrease the risk of drug resistance.

Drug development: Continued research is needed to identify new drug targets, develop novel antiparasitic drugs, and improve the efficacy of existing drugs. This includes exploring alternative drug delivery methods, combination therapies, and formulations that reduce treatment frequency.

Precision farming: The application of precision farming technologies, such as remote sensing, real-time monitoring, and data analytics, can enhance parasite management in goat production. These technologies enable early detection of infection, targeted treatment, and optimized management practices based on specific farm conditions.

C. Importance of Interdisciplinary Collaborations:
The importance of interdisciplinary collaborations in goat production and parasite control cannot be overstated. Collaborations between veterinarians and animal scientists allow for a better understanding of parasite biology and epidemiology, leading to more effective control strategies and improved animal health. Involving experts in microbiology and immunology aids in studying host-parasite interactions and developing vaccines to combat parasites and understand drug resistance mechanisms. Additionally, partnerships with agricultural economists help to assess the economic impact of parasites, enabling informed decision-making for cost-effective parasite management. Furthermore, engagement with environmental scientists ensures sustainable management practices that consider the environmental impact and conservation of natural resources, resulting in a holistic and comprehensive approach to parasite control in goat production.

CONCLUSION

A. Summary of Key Findings:
In conclusion, the management of parasites in goat production presents several challenges and limitations. The emergence of drug resistance in parasites poses a significant threat to effective treatment. Environmental concerns and sustainable practices are essential to minimize the impact of parasite control measures on ecosystems. Furthermore, the limitations of current management strategies, such as lack of access to treatments and diagnostic challenges, need to be addressed. Economic losses in goat production due to parasites can be quantified by considering reduced productivity, increased mortality rates, treatment costs, and additional management practices required. Zoonotic potential and public health implications

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

associated with goat parasites highlight the importance of considering the transmission of diseases from goats to humans. Zoonotic parasites commonly found in goats include *Cryptosporidium* spp., *Echinococcus granulosus*, *Toxoplasma gondii*, *Giardia duodenalis* etc. Risk assessment and prevention strategies, including good hygiene practices, proper food safety measures, water source management, and veterinary care, are necessary to minimize the zoonotic transmission of goat parasites. Future perspectives and research need in parasite control in goat production include addressing research gaps in drug resistance, diagnostic tools, integrated parasite management, and sustainable control methods. Advancements in vaccines, drug development, and precision farming technologies hold potential for improved parasite control. Interdisciplinary collaborations between veterinary and animal science, microbiology and immunology, agricultural economics, and environmental science are crucial to tackle the complex challenges of parasite management effectively.

B. Importance of addressing Parasite Infections for Sustainable Goat Production:
Addressing parasite infections is vital for sustainable goat production for several reasons. First, parasites can significantly impact goat productivity, leading to economic losses and reduced profitability for goat farmers. Second, zoonotic parasites pose a risk to public health, emphasizing the need to prevent human infections and protect consumers. Third, sustainable parasite management practices help reduce the environmental impact associated with the use of chemicals and ensure the long-term viability of goat production systems. By addressing parasite infections, farmers can improve goat health, productivity, and overall sustainability.

C. Recommendations for Improved Parasite Management:
To improve parasite management in goat production, the following recommendations are suggested:

Develop and promote integrated parasite management strategies that combine various control approaches, such as strategic deworming, pasture management, and alternative treatments.Invest in research and development for vaccines and new antiparasitic drugs, focusing on goat-specific parasites and those with zoonotic potential.Strengthen surveillance and monitoring systems to detect emerging drug resistance and promptly respond to changes in parasite prevalence.Improve access to effective treatments and diagnostic tools, particularly in regions with limited resources and healthcare services.Promote education and awareness programs among goat farmers, veterinarians, and the general public about the importance of parasite control, zoonotic risks, and proper hygiene practices.Encourage interdisciplinary collaborations between researchers, veterinarians, farmers, and policymakers to foster comprehensive and sustainable parasite management approaches.By implementing these recommendations, goat producers can mitigate the economic, public health, and environmental impacts of parasite infections, ultimately ensuring the long-term sustainability of goat production systems.

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Volume 3 Issue 1; 2023
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Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

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Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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CHAPTER 26

Goat Milk and its Functional Properties

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ABSTRACT

Goat milk is nutritionally almost similar to cow milk. Goat milk is an excellent source of vitamin A, high in digestible protein, lower levels of alpha-s_1-casein, contains slightly less lactose, and has more oligosaccharides carbohydrates than cow milk. Goat milk content sialic acid, to help fast brain development. It is packed with vitamins and minerals. It is easier to digestive because of lower content of fat. Goat milk is considered much closer to human milk than cow milk. Goat milk can be considered as an excellent dairy alternate to replace traditional dairy products and improve human health. Goat milk is nutritional benefits. Goat milk has high nutritional value, therapeutic value as a medicinal value and dietary characteristics.

Keywords*: goat milk, human health, chemical composition, functional properties*

INTRODUCTION

Goats were first domesticated animals among the all animals. According to archaeological data, there has been in an interdependent relationship with man and goat animal for up to 10,000 years (Ensminger and Parker, 1980). Goat milk is the commonly consumed in the world. In many countries, goat farming is the important from the economy point of the view; especially in the Mediterranean and Middle East region. Goat farming is well organized in many countries like France, Italy, Spain and Greece (Park and Haenlein, 2007). Goat milk is consumed about 65% to 72% in the world. Goat farming is an important in many countries from the economy point of the view. Commonly, goat is used for the meat purpose and it is also a source of milk for thousands of years (Boyazoglu *et al*., 2005). Goat milk is not well succussed because of its poor production and insufficient volume. Adaptation of goats in xerophytic area, high stress conditions and lower maintenance makes it an ideal animal for both landless and marginal farmers. So, goat is called "cow of poor man" (Iqbal *et al*., 2008). Goat milk is considered as an ideal food because it contains essential vitamin with minerals. It is also considered better for its digestibility and therapeutic values. Goat milk has creamy texture and rich in mineral and vitamin content. Goat milk is nutrionally health beneficial (Sandeep *et al*., 2021). Goat milk has been recommended as an alternative for cow and human milk (Zenebe *et al*., 2014). It has superior alkalinity, digestibility, buffering capacity, and some therapeutic benefits in medicine and human nutrition as compared to the cow and human milk (Coni *et al*., 1999). Lower concentration of fat present in goat milk is responsible for better digestively.

Presently, India holds 148.88 million goats which contribute 27.80% of total livestock population of India (20th livestock census, 2019). Goat is main contributors of dairy and livestock for rural people, more than any other mammalian farm animal, particularly in developing country. Home consumption is one of the major factors of goat milk demand. The second important aspect of demand for goat milk is the connoisseur interest in goat milk products especially preparation of cheeses and yoghurt in several developed as well as

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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developing countries. Another important aspect of demand for goat milk from the affliction of persons with cow milk allergies and other gastro-intestinal disorders. This demand is also growing because of a better awareness of problems with traditional medicinal treatments to such afflictions among the people, especially in developed countries.

Chemical Composition of Goat Milk

Goat milk composition is differed from the other species of animals like cow and buffalo milk. Goat milk contains 3.8% fat, 8.9 % SNF, 3.4% protein, 4.1% lactose, 0.8% ash (Park *et al*., 2007) and 87% water (Iqbal *et al*., 2008). Goat milk has a more mineral content than human or cow and buffalo milk, ranging from 0.70 to 0.85 percent (Silanikove *et al*., 2010). Goat milk content greater concentration of calcium and phosphorus than the human milk. It also content greater levels of potassium, magnesium, and chloride as compared to cow milk. The macro-mineral concentrations do not vary so widely, they vary based on the breed, nutrition, lactation stage, individual animal, and udder health (Park and Chukwu, 1988). Goat milk content more zinc and iodine and less iron content than the human milk. Chemical composition of the goat milk is varied from the many factors like diet, species, breed, individuals, season, feeding, stage of the lactation and environmental conditions.

Functional Properties of Goat Milk

Goat milk has many functional properties. Goat milk plays an important role in medicinal and therapeutic value. Goat milk is considered as an ideal food for all the ages and it contains essential vitamin and minerals. Goat milk contains low concentration of lactose, but high in protein, calcium, and proportion of digestible fatty acids as compared to the cow milk (Safdar *et al*., 2021; Zhao *et al*., 2019). Goat milk is important for prevention of cancer, cardiovascular disease, allergy and immunity boost up.

Important Functional Properties of Goat Milk

1) Better Digestible Fats

Fat is present in combination of triglyceride, diglycerides and monoglycerides. Fat is present in milk as oil-in-water type emulsion form. The size of fat globules in goat milk is approx. 1.5 to 2 µm while cow milk contains 2.5 to 3.5 µm diameter (Le Jaouen, 1981 and Kalantzopoulos, 1993). Due to lower size of fat globule, goat milk is considered as "self-homogenized" milk. The fat globule size of goat milk is smaller than the cow milk, so it is better for digest. The qualities of goat milk fat are very significant at differentiating the health qualities. Goat milk contains medium chain fatty acid like myristic acid. Medium chain fatty acid provided energy without being deposited in the fatty tissue of the body and it also play a role in decreasing cholesterol levels in human body. Present of smaller fat globule size in goat milk, combined with the lack of agglutinin, a protein that causes fat molecules to clump together. Goat milk contributes to the higher digestibility, and better tolerance for individuals with certain digestive disorders.

2) Lower in Lactose and Better for Lactose Intolerance People

The major carbohydrate present in goat milk is lactose. It is a disaccharide sugar and synthesized from one unit of glucose and one unit of galactose in the mammary gland (Kunz *et al*., 2000). Goat milk contains slightly lower lactose than the cow milk. Lactose intolerance is cause of deficiency of lactase enzymes which digests milk sugar. Patients suffering from lactose intolerance, to consume goat milk because of it has unhydrolyzed lactose passes to the large intestine. Consumption of goat milk is easy to digest because of

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

it contains soft curd formation. Some literature described the better digestibility of goat milk is responsible for lactose intolerance patient.

3) Better Digestible Proteins

Goat milk content protein that is nearly comparable to the cow milk. Amino acids are a element of the protein fraction. The protein present in goat milk is differentiated by its individual constituents, high levels of casein and structure of the casein micelle, the wide range of bioactive peptides within these fractions and minor proteins and non-protein fraction includes amino acids, nucleotides and nucleosides. The goat milk protein is considered to softer curd which helps to digestive health. Milk proteins contains ά-casein, β-casein and k-casein. Goat milk contains small amounts of άs-casein, but it contains higher content of β-casein and almost equal concentration of the k-casein as compared to the cow milk. The major protein contains of goat milk is β-casein. Goat milk contains less αs-casein and has more protein αs_2 than αs_1-casein (Mora Gutierrez *et al*., 1991) which is beneficial for the better digestively.

4) Less allergic Proteins

Proteins are essentials for the body functioning such as growth, development and repair of the body. Proteins are the known as the most common antigens. The level of $\acute{\alpha}s_1$ casein of goat milk is about 89% lower to the cow milk. So, goat milk is less allergic. Goat milk improve in colic, digestive disorders, asthma and eczema over the cow milk (McCullough, 2003). Goat milk has anti-allergy properties upon drinking when a similar trial in children with the cow milk protein allergies was taken. The drinking of cow milk has been significantly higher levels of inflammatory marker tumour necrosis factor-α than those who consumed the goat milk.

5) Better Anti-inflammatory Properties

Cow milk is responsible for the allergens due to present of protein fractions while goat milk is not allergens. Cow milk contains high fat as compared to the goat milk, which increases mucous build up. Goat milk has advantage that it is not causes the irritation in the gut, because presence of the smaller size of the fat globules. Goat milk plays important role in biological reactions. It possesses antioxidant activity and anti-inflammatory effect in the body.

6) Better Improvement of Heart

Cholesterol present lesser amount in goat and cow milk, are responsible for human health. Low-density lipoprotein (LDL) is also called bad cholesterol, it is transports cholesterol from the liver to the blood vessels. The "good" cholesterol high-density lipoprotein (HDL) which transports cholesterol from the vessels to the oxidative modification of LDL. Low density lipoprotein plays essential role in atherosclerosis progression. It was reported that antioxidants, which could inhibit the LDL oxidation, it should be effective in suppressing the atherosclerosis (Lindqvist, 2008). Goat milk protein are important source of the antihypertensive peptide, angiotensin converting enzyme (ACE) and inhibitory peptides properties. These are also beneficial for cardiovascular disease. Goat milk content lower level of the cholesterol as compared to the cow milk (Haenlein, 2004). The mineral and vitamin content of goat milk are higher to the cow milk (Park *et al*., 2007). Goat milk contains potassium. The high potassium content of goat milk reduces the blood pressure. It reduces the total cholesterol level and maintain adequate triglycerides and transaminases. This makes goat milk to prevent coronary heart diseases.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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7) Better Immunity Booster

Goat milk contains significant amount of the selenium. Therefore, goat milk are acts to immunity booster and able to protect from illness. Immunoglobulin (Ig) and immunological classes such as IgG, IgM, IgA, IgD and IgE are associated with a variety of biological properties. Several factors influence to immune health and nutrition in particular is main determinant of the body's immune response.

8) Better Anti-carcinogenic Properties

The goat milk has the ability to extract potential anticarcinogenic agents like beta-carotene, beta ionone and gossypol. It contains high conjugated linoleic acid (CLA) (Jirillo *et al*., 2010). Anticarcinogenic properties of goat milk is due to presence of conjugated linoleic acid have been supported against mammary and colon cancer (Liew *et al*., 1995). The conjugated linoleic acid has the properties to supress tumor development, anti-oxidative effect.

CONCLUSION

Goat milk plays important role in human health. Goat milk has high nutritional value than the other species of animals like cow and buffalo. It has ability to produce high quality milk of good composition and for the human consumption. Goat milk have high nutritional value and composition, various factors like feed, breed, udder size and shape, body weight etc. It also has medicinal value for human being and is healthy alternative to cow's milk. Goat milk is more easily digested than the cow milk, especially to children. There is limitation in goat milk, it lacks folic acid so goat milk does not recommend for infants under one year because it can cause anaemia. Goat milk is better to consume over the other species of milk. It may be concluded that, goat milk has high nutritional value, therapeutic value and dietary characteristics.

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Indian Journal of Livestock and Veterinary Research
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CHAPTER 27

An Overview of Goat Farming and Its Importance

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ABSTRACT

The goat has always been a very useful animal. It is due to goats' excellent ability to adapt to difficult mountain conditions, extreme weather, and low-value feed acceptance, as well as their versatile habits and high production considering their size, that goats are so successful. Many people rear goats for their livelihood and as a source of food. The animal is small and easy to handle by children and women, and it generates employment for unemployed rural workers. Goat milk is extremely nutritious containing protein, carbohydrates, fat, minerals, and vitamins. Just like cow's milk, goat milk is also used to make butter, yogurt, cheese, ice cream, and various other products.

***Key words**: Breed, milk, meat.*

INTRODUCTION

The goat was the earliest ruminant domesticated around 9000 to 7000 B.C. The goat is a multi-functional animal and plays a significant role in the economy and nutrition of landless, small, and marginal farmers in the country. Goat rearing is an enterprise that has been practiced by a large section of the population in rural areas. Goats are among the main meat-producing animals in India and have huge domestic demand. Goat rearing under intensive and semi-intensive systems for commercial production has been gaining momentum. Several commercial goat farms have been established in different regions of the country. A goat produces per year around 130 kg of dry manure which improves soil fertility through its nutrients (more than cow or buffalo manure) and by its residual effect on reducing soil pH. Annual production of goat manure, casings, and offal's was recorded in 1989 to the extent of 40,000 kg. the word manure refers to the mixture of animal excrements consisting of undigested feeds plus certain body wastes and bedding. Goat milk is extremely nutritious containing protein, carbohydrates, fat, minerals, and vitamins. Just like cow's milk, goat milk is also used to make butter, yogurt, cheese, ice cream, and various other products. The goat is one of the most versatile domestic animals in adaptation to arid and humid, tropical, and cold, desert and mountain conditions providing people with many important products, such as meat, milk, cashmere, mohair, skins, leather, draught and pack power, and manure for crops and gardens.

The growing interest in goat milk is not only focused on the sustenance of the poor and rural people with small land holdings and educating them of the value and acceptability of goat

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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milk, but also as an important "super" dairy food product with special medical, nutritional, biological, and immunological characteristics.

Top three Goat Milk Producing Nations in the World
1) India 5,000,000 metric tons of goat milk annually
2) Bangladesh 2,616,000 metric tons
3) Sudan 1,532,000 metric tons

Goat farming is becoming popular in Rural areas and towns of India nowadays as it involves minimum financial outlay and risk, but good profits. Goats can be raised in small areas of land as they require much less care and maintenance than other farm animals.

Goat farming can be combined with the rearing and breeding of other livestock such as sheep and cows. They are usually raised and bred to produce milk, meat, and leather either in a small or big scale. Different varieties or breeds of goat are good for milk production or for meat, leather.

Importance of Goats

1) The goat farming business requires little initial investment.
2) The small size of goats and their docile nature makes them easier to house and manage.
3) Goats are prolific breeders and reach sexual maturity at the age of 10-12 months. Their gestation period is short, and they begin giving milk at the age of 16-17 months. Triplets and quadruplets are very uncommon.
4) Compared to other livestock species, goat farming poses very little risk in drought-prone areas.
5) Mixed species grazing is ideal for goats. In addition to thorny bushes, weeds, crop residues, and agricultural by-products unsuitable for humans, the animal can thrive on a wide variety of thorny bushes, weeds, and agricultural by-products.
6) About 3% of the total milk produced in India is contributed by goats. Goat milk is used for making cheese and yogurt.
7) Goat is known as the poor's cow. Less housing and fewer management practices are required for goat rearing.
8) Goat meat is known as chevon. Its best quality is obtained from goats of 6-12 months of age. dressing percentage varies between 43-53%.

Indian Breeds of Goat

Temperate Himalayan regions breeds	Dry northern region breeds	Central region breeds	Southern breeds	Eastern region breeds
1. Kashmiri 2. Changthang 3. Gaddi 4. Chegu 5. Pahmina	1.Jamunapari 2. Barbari 3. Beetal	1.Marwari 2. Sirohi 3. Mehsana 4. Zalawadi 5. Belari 6. Kathiwari 7. Kutchi 8. Jhakaran	1. Surti 2. Osmanabadi 3. Malawari 4. Kannaiodu 5. Sangamneri	1. Ganjam 2. Assam hill 3. Black Bengal

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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1. **Breed:** Beetal
   Home Tract: Amritsar Gurdaspur and Ferojpur district of Punjab
   Body Feature: Large but smaller than Jamunapari, flat, curled, and drooping ears. Both sexes are horned, Males have beared, Lactation yield 150 to 190 kg., litter size Single 41 %, Twins- 53 %, triplets 6%
   Colour: Black (90%) and Brown (10%)
   Adult Body Weight: Male 50-62 Kg
   Female 35 – 40 Kg
   Used for: Meat and milk.

2. **Breed:** Jhakrana
   Home Tract: Nagpur distt.,
   Body Feature: Large, similar tobeetal, 2-3 kg. milk daily, lactation period 180-200 days
   Colour: Black with white spots on muzzle and ears
   Adult Body Weight: Male 55 Kg
   Female 45 Kg
   Used for: Meat and milk.

3. **Breed:** Barbari
   Home Tract: Agra, Aligarh, Mathura, Mainpuri & Etah districts of U.P.
   Body Feature: Small compact body, short , tubular and erect ears, twisted horns in both sexes, bucks (adult males) have thick and large beard.
   Colour: White with light brown patches
   Adult Body Weight: Male 40 Kg
   Female 24 Kg
   Used for: Meat and milk.

4. **Breed:** Osmanabadi
   Home Tract: Osmanabad disstt. (Maharashtra)
   Body Feature:large in size, 90% males horned, 0.5 to 1.5 kg. milk daily upto 120 days.
   Colour:73% black, rest brown, white or spotted females may be horned or polled
   Adult Body Weight: Male 34 Kg
   Female 32 Kg
   Used for: Meat and milk.

5. **Breed:** Black Bengal
   Home Tract: South Bengal and Nadia dist. Of west Bengal
   Body Feature: Small, upright, and pointed ears, twins or triplets births, horns and beards in both sexes.
   Colour: Black colour but also found in brown, grey and white
   Adult Body Weight: Male 32 Kg
   Female 20 Kg
   Used for: Excellent Meat and milk.

6. **Breed:** Chigu
   Home Tract: Lahaul and spiti valleys (H.P.), Chamoli, Uttarkashi and Pithoragarh distt.
   Body Feature: Medium sized, horns in both sexes, very similar to changthangi
   Colour: White mixed with greyish red
   Adult Body Weight: Male 36 Kg

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Female 25 Kg

Used for: Marked for pashmina production. Av. Prod. 120 gm Pashmina with 5.9 cm fibre.

7. **Breed:** Gaddi
   Home Tract: Kangra, kulu, Chamba, Bilaspur, Shimla, Kinnaur, Lahaul and Spiti (H.P.) Jammu hills, Dehradun, Nainital, Tehri garhwal and Chamoli, Uttrakhand
   Body Feature: Medium-sized, well-built body, able to move long distances, large horns in both sexes, medium long and drooping ears. Tough skin with coarse long hair measuring 7-10 inches.
   Colour:white, black-brown or a combination thereof
   Adult Body Weight: Male 27 Kg
   Female 25 Kg
   Used for: long hair, meat milk, draught, Fleece (long hair) Yield per clip 300 gm.

8. **Breed:** Jamunapari
   Home Tract: Its home is between jamuna, Ganegn and Chambal rivers.
   Body Feature: The typical character of the breed is highly convex nose line with a tuft of hair known as Roman nose or parrot mouth appearance. The ears are very long, flat, and drooping. Both sexes are horned with short and thin tail. Athick growth of hairs is present on the buttocks, known as feathers.
   Colour: There is a great variation in coat colour but they are generally white or light yellowish tan with light brown spots on the neck and face, and occasionally patches of tan or black are found on the body
   Adult Body Weight: Male 50-60 Kg
   Female 40-50 Kg
   Used for: Meat and milk.

Goat Feeding and Care

Feeding Habits of Goats

1) The goats can graze on very short grasses and tree leaves that other animals do not eat because their upper lips are mobile, and their tongues are prehensile (adapted for grasping).
2) The goat is a sensitive animal with peculiar feeding habits. They are 'fastidious about cleanliness and like frequent changes in the feed. It is imperative that goats are fed clean and fresh feed since they will not eat anything that smells foul or dirty. The fodder they dislike is wet, stale, or trampled.
3) Goats like to eat a variety of feeds.
4) Goats can feel sweet, salty, sour, and bitter tastes.
5) The feedacceptable to one goat, may not be acceptable to other goats.
6) Goats can tolerate bitter tastes.
7) A feed consumed by a goat at a definite time may be rejected at other times.
8) Rumen of the goats is not developed at birth. It may be fully developed 3 to 4 months after.
9) Different from sheep, goats like to eat aromatic feeds.
10) Goats like to eat the leaves of the bush and trees. If they are free to graze for 8 to 9 hours, they very well obtain a diet, sufficient for their maintenance and slow growth. For high milk yield, fast growth rate, for high yield of quality meat. They must be provided sufficient leguminous fodder and concentrate mixture.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

11) Goats are ruminants. They are very fond of leguminous fodders. They do not relish fodders like sorghum *(Sorghum vulgare* Pers) and maize *(lea mays* L.), silage, or straw. Goats do not relish hay prepared from forest grasses, even if cut in early stages, but very much relish hay prepared from leguminous crops: Some of the common green roughages liked by the goats are: lucerne *(Medicago sativa* L.), berseem *(Trifolium alexandrinum* Juslen.), Napier grass *(Penniselum purpureum* Schum.), green *arhar (Cajanus cajan* (L.) Millsp.), cowpea *(Vigna sinensis* (L.) Savi ex Hassk.), soybean *(GIyCiflemax-(L.)* Merr.), cabbage and *cauliflowerleaves;shajtal. senji. methi;* shrubs and weeds of different kinds; and leaves of trees such as *babul (Acacia arabica* WilJd), *neem (Azadirachta indica* A. Juss.), ber *(Ziziphus mauritiana* Lamk.), tamarind *(Tamarindus indica* L.) *andpipa/ (Ficus re/igiosa* L.). The common dry fodders liked by goats are straws of *arhar. urid (Phaseolus mungo* Roxb.), *mung (Phaseolus aureus* Roxb.), gram *(Cicer arietinum* L.), dry leaves of trees, and lucerne or berseem hays. The last two are popular and constitute the main forage crops for milch goats.
12) Feed provided to goats should be cheap, such as browsing (eating leaves of bush and trees) and agriculture and industrial wastes.
13) Goats have a better capacity to digest crude fiber.
14) The concentration of $NH_3$and total volatile fatty acids (TVFA) are highest in goats, least in buffalo, and intermediate in sheep.
15) Metabolic rate and production of thyroxin in goatsare higher as compared to that in sheep and cattle.
16) Meat goats need dry matter (DM) at the rate of 3% of their live weight. For milk production, goats need DM at the rate of 5-7% of their live weight. Goats can meet their requirements for maintenance and production only from good fodders and pasture. Concentrate mixture should be given to all pregnant, dry, and milking does and to young stock as they grow faster.
17) The average conversion efficiency of goats is higher (58%) than that of thecow (38%).
18) Goat milk is richer in minerals than cow milk. Concentrate mixture given to goats is usually mixed with mineral mixture at the rate of 2%. Besides this, salt should be provided separately for ad lib. Consumption.
19) Markets for goat meat are well established.
20) Goat is more tolerant to hot climate than other farm animals.

Nutrients Required

The nutrients needed may be divided into maintenance, production (for milk, meat and hair production) and pregnancy requirements.

Maintenance Ration

The maintenance requirements are related to surface area and basal metabolic rate. Goats have higher basal metabolic rate than cattle; therefore, their maintenance requirements are higher than those of cattle. The requirement by weight is calculated and an additional feed of about 25 to 30 per cent for maintenance is allowed. The maintenance requirement thus calculated is 0·09 per cent digestible crude protein (DCP) and 0·09 per cent total digestible nutrients (TDN).

It will be desirable to point out one interesting aspect. For its size the goat can consume substantially more feed than cattle or sheep, viz. 6·5 to 11 per cent of its body weight in dry matter when compared with 2·5 to 3 per cent for cattle or sheep. This means that the goat can satisfy its maintenance requirement and produce milk from forage alone.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Production Ration

Requirements for the production of 1 litre of milk with 3·0 per cent fat is 43 g of DCP and 200 g of starch equivalent (SE), whereas for the production of 1 litre of milk with 4·5 per cent fat it is 60 g of DCP and 285 g of SE. The nutritional requirements of a goat weighing 50 kg and yielding 2 litres of milk with 4 per cent fat may be met by feeding 400 g of concentrate mixture and 5 kg of Berseem or Lucerne. The ration should have 12 to 15 per cent protein content, depending on the amount of protein in their hay and in the milk produced.

Mineral Mixture

Minerals should be given as an essential part of the ration as they contribute to the building of the skeleton, physiological functions, and production of milk. The more important of these salts are calcium and phosphorus. The requirements of calcium and phosphorus for maintenance are 6·5 and 3·5 g, respectively, per 50 kg body weight. Goats require slightly larger quantities of calcium than sheep. The mineral mixture may be included in the concentrate ration at the rate of 0·2 per cent.

Common Salt

Lumps of rock salt are just the' thing for them. These lumps of salt, of fairly good size, should be hung up in some suitable place where goats can easily get at them, or else they may be kept in the manger. The provision of salt licks is very important for goats as they secrete a good amount of sodium and chloride ions in milk. The salt often helps to tone up the system and may even have some effect in removing worms from the body. Salt to the extent of 2 percent may also be mixed with the daily grain ration of goats.

Vitamins and Antibiotics

Goats need particularly vitamins A, D and E. The microbes in the rumen synthesize most of the other needed vitamins. Vitamin A can be supplied by feeding green forage and yellow maize. One kg of lush-green fodder will provide. Synthetic vitamins A and D may be included in the ration of growing kids. Feeding of aureomycin or terramycin increases the growth rate of young kids, reduces the incidence of scours and other infectious diseases and improves the general appearance of the kids.

Table 1: Composition of Mineral Mixture for a Goat to be added at the rate of 2% of the Concentrate Mixture

1.	Ground limestone (high grade	45 parts
2.	Bone meal (sterilized)	35 parts
3.	Iodised salt	20parts
4.	Copper sulphate	22 gms/ton of mineral mixture
5.	Ferrous carbonate	11/ton of mineral mixture
6.	Zinc oxide	11 gms/ton of mineral mixture

Table 2: Different types of Rations for Feeding Goats

	Class of goats	**DCP%**	**TDN%**	**Remark for ration feeding**
1.	Replacement stock	10-12	68-70	Adjust feeding to attain sexual maturity at one year's age
2.	Dry Doe	5-6	50	6 to 8 hrs of browsing is satisfactory

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

3.	Dry and pregnant does	15	60	Good pasture browsing + 200 gm Conc. Mix.
4.	Lactating pregnant does	15-16	50-60	Do+ 400 g Conc. Mix
5.	Lactating does	15-16	50-60	Do
6.	Bucks	6	50-60	Feed 3 to 3.5 of live weight

Feeding System

1) Tethering
2) Extensive
3) Semi-intensive
4) Intensive

Tethering: When grazing facilities are limited and one or two goats are to be kept then tethering is convenient.

Methods

- Animal is tied with a rope of 3 to 5 m in length with a slip knot to a peg of 35 to 50 cm long.
- Peg is driven into the ground over a grazing area which permits the goat to browse over a limited area depending upon the length of the rope.
- Change the location whenever necessary so that goats may get sufficient grass to meet the requirement.
- Provide a temporary or preferably portable shelter close by within reach of animal so that it may turn to it in the event of extreme heat or heavy rains.

Extensive System: it has been observed that when goats find opportunity to browse for about 8 to 9 hrs/day the goats can take care of their maintenance but rate of growth slows down. This system of rearing goats is common in India which includes migratory, transhumance, free range, pasture, and rang management of goats. Small farmers and landless labourers take their goats and sheep together walking long distance in search of feed and water. The size of flock is larger which may include animals of several farmers.

Semi intensive system this system is combination of intensive and extensive system in which limited free range grazing is called with stall feeding. Goats of different farmers are grazed together for 4 to 6 hour a day and then kept in stalls where they are offered tree leaves, hay, dry fodder, greens, kitchen wastes, crop residues and concentrate mixture depending upon the availability.

Therefore, the performance of goats depends upon the quality and quality of feeds made available through limited browsing and supplementing feeds in stalls. However, the level of nutrition is better than goats find in extensive systems.

Intensive system: This system includes two methods.

- Keeping goats in stalls and feeding them cultivated fodders (fresh and conserved) and concentrates to meet their requirements.
- Grazing of goats on development pasture permitting stocking rate of 16 to 60 goats per hectare depending upon the kind of grass level of fertilization, irrigation and legumes availability

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Goat Breeding Policy in India

In most of the states in India, non-descript and dwarf breeds of goats are being upgraded with larger breeds of the upper gadgetry or trans-gadgetry plains regions. Selection of parents before breeding is highly recommended and widely used. For selection, phenotype, pedigree records, and performance test methods of selection are used. Crossing between indigenous breeds and exotic dairy (Milch) and meat breed Angora is being used in Himachal Pradesh (H.P.) Maharashtra and Uttar Pradesh (U.P.) for crossing with local hairy breeds for production of mohair.

CONCLUSION

Goat is called poor's man cow. Goat farming can be easily in small level. Goat farming purpose for meat, milk and wool production. Goat farming has no need large investment & space. Goat maturity only 10 to 12 months. Goat milk is very nutritional for child and old human which is easily digestible that's why goat milk contribution is 3% of total milk production.

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CHAPTER 28

Insights of Goat Production in Tropics

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ABSTRACT

Goat population in India in 2019 is 148.88 million showing an increase of 10.1% over the previous census. Among the major states the goat population was increased in West Bengal (41.49%), Jharkhand (38.59%), Madhya Pradesh (38.07%), Karnataka (28.63%), Maharashtra (25.72%), Tamil Nadu (21.43%). The female population was 116.78 million during 2019, whereas in 2012 the female population was 97.56 million, indicated the total percentage change of 19.71%. The local breeds have developed more through genetic isolation and natural selection, however many of the breeds never been described. There is need to explore the potential of local breeds which are competent for commercial goat enterprise. The meat production in India has increased by 6.0 per cent as compared to previous year and 95% of goat meat produced is consumed locally and the per capita availability is far below the requirement. Thus, there is a considerable potential for developing goat production not only for meat for internal consumption but also for export. The protein content of goat is influenced by the breed, age, species, the location of muscles, feed, maintenance and management. Goat production is a livelihood activity for many in India. Commercial aspects of goat production are gaining interest due to changes in land utilization pattern, agriculture and socio-economic conditions. Sustaining livestock production has been an important consideration as livelihood activity for millions of small and marginal farmers. Thus, pragmatic approaches for increased and efficient goat production, processing and utilization have become more important for sustaining livestock production activities, particularly in the competitive environments. Most leading constraint in sustainable development of livestock sector is availability of feeds and fodders both in quantitative and qualitative terms. It is well recognized that, effective utilization of non-conventional crop residues as animal feed is an alternative way to overcome feed shortage for bulk eaters like ruminants. Apart from palatability and low bulk density, low nutritive value also restricts the utilization of crop residues as animal feed ingredients. The crop residues are usually consumed by large ruminants but small ruminants like goats are reluctant to consume it. Therefore, it is need to improve the nutritive value, digestibility and palatability of crop residues through different feed processing methods, before it is fed for better utilization. Several attempts have been made by the researchers to improve the nutritive value, digestibility and utilization of low-cost feed by various processing methods. Physical treatments include chopping, soaking, grinding, pelleting etc. The chemical methods include alkali, urea and ammonia treatment etc. The effective utilization of locally available feed resources is the key for economical goat rearing.

INTRODUCTION

Goats constitute about 15% of the total world population of domestic herbivores and occur in a multiplicity of forms over a wide range of environments in the tropics where they form an important source of meat, milk, hair and leather. Despite the importance of goats in the tropics, little attempt has been made there to breed them for performance, most breeds having developed through genetic isolation and natural selection rather than by design, so that their true potential has never been tested. Many breeds have never even been accurately described, particularly in regard to performance. Goats are like other ruminant animals in many ways but also are unique. They can digest fibrous feedstuffs, have only a minimal need for vitamins in their diet, and are very enterprising in surviving under harsh conditions. Goats are intelligent, inquisitive and very selective in what they can consume. Goats do not receive recognition to match their critical importance for lesser developed countries. Goats are very

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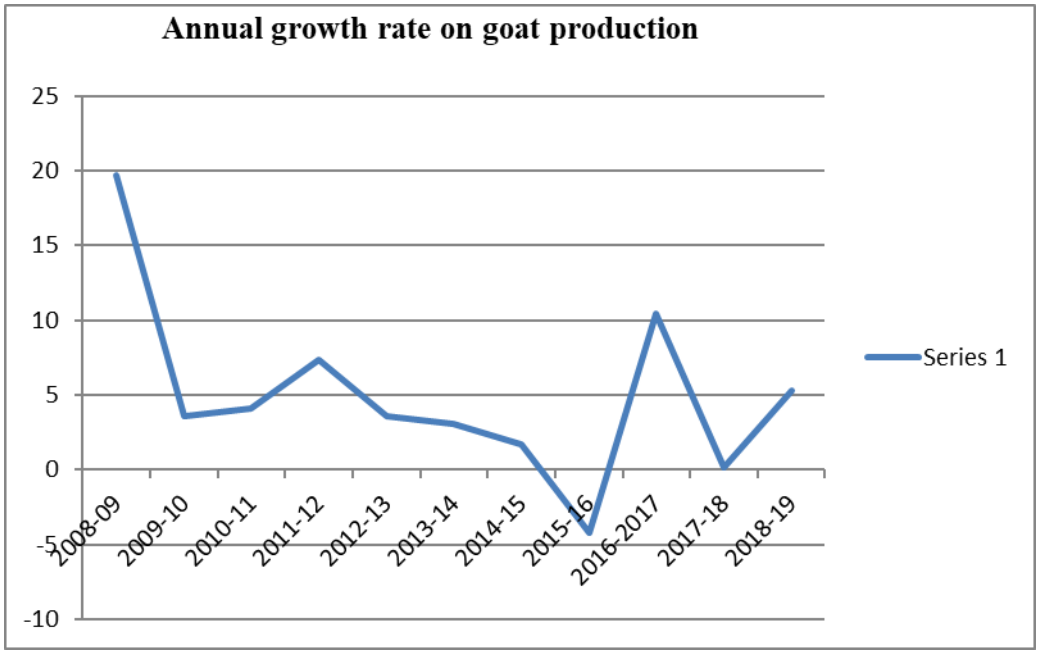
important in areas where feed resources are limited because they can consume a wide variety of plant species and parts and have a great ability to select a high-quality diet in these circumstances. Goats' milk has hypoallergenic and other medicinal properties.

Goat milk ranks fourth after cows', buffaloes' and sheep milk in terms of world milk production, although goats' milk production accounts only for 2.16% of the total world milk production. In the last decade, there has been an increased interest for goats' milk production and conversion to value-added products. In recent years, there has also been a renewed interest in goats' milk as an alternative milk source for people with cows' milk intolerance. Goat farming, because of its low capital investment and quick economic returns, has been integrated into flexible and vulnerable animal production systems. As a source of milk, meat, fiber, skin, hair, horns, manure and other valuable byproducts, goat husbandry calls for multifunctional management systems. These management systems range from extensive to the intensive with many combinations. It has been shown that goats are a uniquely successful earner of cash for small farmers or landless laborers. Goats are excellent at utilizing unfavorable marginal environments, and in better terrain can be integrated with crop production as an extra source of profit.



Asia had the largest goat population in the world compared with other continents which included 55.4% of world goat population. Goat populations are increasing mostly because of increasing worldwide demand for meat and milk. Goat population in Asia was 556 million. The most goat population in Asia existed in China, India, Pakistan, Bangladesh and Mongolia. Africa had 388 million goats and Nigeria, Sudan, Chad, Ethiopia and Kenya had the most population of goats. About 27.8% of the total livestock is contributed by goats FAO STAT (2018). Based on 20th livestock census the Goat population in India in 2019 is 148.88 million showing an increase of 10.1% over the previous census.

Among the major states the goat population was increased in West Bengal (41.49%), Jharkhand (38.59%), Madhya Pradesh (38.07%), Karnataka (28.63%), Maharashtra (25.72%), Tamil Nadu (21.43%) and Bihar (5.49%). Goat population was decreased in Odisha (-1.84%), Rajasthan (-3.81%) and Uttar Pradesh (-7.09%). As per 20th livestock

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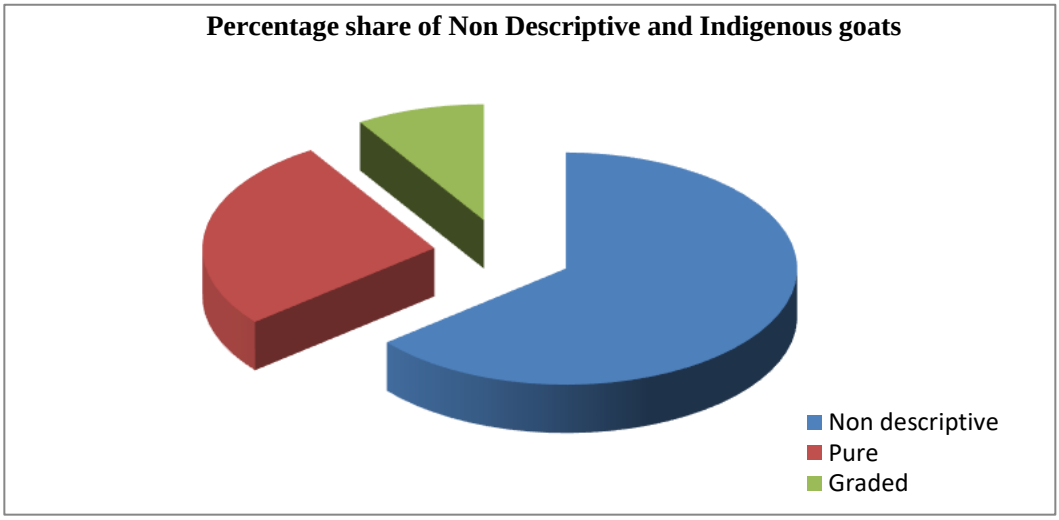
census female population was 116.78 million whereas in 2012 the female population was 97.56 million the total percentage change was 19.71. Total milch animals were 41.83 million in 2019 census and at 2012 the total milch animals were 36.25 million and the total percentage change was 15.38 while the total dry goats were 27.82 million while at 2012 census it was 25.31 million and the percentage change was around 9.95%. The male population decreased from 2019 to 2012 it was around 32.10 million in 2019 and 37.62 million in 2012 and the percentage change was -14.65% (Department of Animal Husbandry and Dairying 2019).



In many tropical countries, although goats are numerous little or no attention is paid to control of breeding or selection for performance. Local breeds have developed more through genetic isolation and natural selection and many of the breeds never been described. According to Devendra (1980a) there is presence of 22 breeds of goats, the majority of which are found in Pakistan, India and Bangladesh. There are 28 indigenous breeds of goats in India besides its Non-Descript animals as recognized by NBAGR.

The percentage share of indigenous breeds was 36.5% whereas, the percentage share for non-descript breeds were 63.5% with total no of animal population were found to be 5,43,23,290 and 9,45,61,496. The total no of goat population as per 20 livestock census was 14,88,84,786. Out of these breeds highest percentage is noticed in Black Bengal (18.6%) with total no. of animals 2,76,61,976 followed by Marwari 3.4% share with 50,41,776; Barbari (3.2%) with 47, 59,305; Osmanabadi 2.4% share with 35,97,071; Jamunapari 1.7% share with 25,55,965; Sirohi 1.3% share with 19,52,116; Kannaiadu 1.0% share with 14,45,588; Beetal 0.8% share with 12,34,760; Malabari 0.7% share with 11,04,305; Gaddi 0.5% share with 7,38,425; Jakhrana and Kutchi contribute 0.4% share with 6,55,582 and 5,84,538; Salem Black, Mehsana, Zalawadi and Kodi Adu contribute 0.3% share with 4,91,992, 4,22,509, 4,08,450 and 3,99,924; Gohilwadi and Surti contribute 0.2% share with 2,88,453and 2,31,194 and Ganjam, Changthangi, Sanganeri and Berari contribute 0.1% share with 2,11,478, 2,05,940, 1,63,091 and 84,823. Other goat breeds percentage share of population was not known like Attapadi Black, Pantja, Konka Kanyal, Teressa, Chegu and Sumi- Ne but the total no. of animal population was 31,182, 28,728, 16,892, 3,362, 2,356 and 1,509, respectively (NBAGR 2022).

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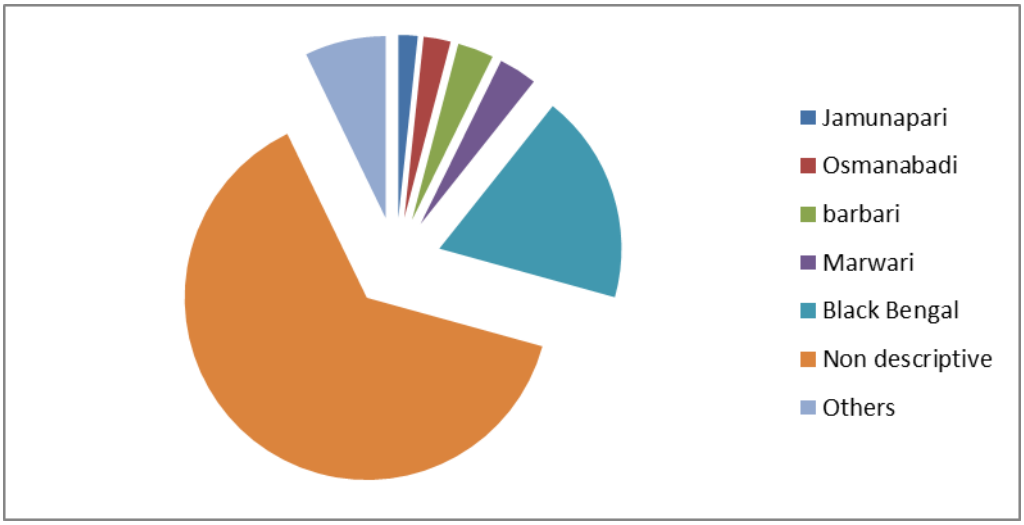

Goat meat is relished in all countries of Asia, Africa and Middle East where there is tradition for meat consumption from both sheep and goats, and in some countries such as plains of India, the goat is the major meat supplier. Goat rising is one of the important agricultural enterprises particularly in rural parts.

In India, the total number of goat population marginally increased from 140.54 million as per the 18th livestock census (2007) to 148.88 million in the 20th livestock census (2019). However, the total goat meat production in India has almost doubled from 4.0 million tonnes to 8.6 million tonnes during the same period. The meat production has increased by 6.0 per cent as compared to previous year. The top five meat producing states in India are Uttar Pradesh 15.1 per cent, Maharashtra 12.6 per cent, West Bengal 10.2 per cent, Andhra Pradesh 9.6 per cent and Telangana 9.3 per cent. They together contribute 56.8 per cent of total meat production of the country. The meat production showed a well-brought-up growth rate during the last decade. India has second highest goat population in the world. India's has seventh position in goat meat exporting country in the world. The share of goat meat exporting contribute is 1.34 percent in the world (APEDA-2019). The country over the last one decade the goat meat sector has transformed significantly from being a backyard activity to being one of the major agriculture-based industries.

This sector provides both the food (meat) and employment opportunities to a considerable proportion of the population. Goat farming has the potential to provide additional income to the farming community and unemployed masses in rural areas through creation of self-employment opportunities. Goat production is a popular activity among rural women at domestic level which helps in poverty alleviation. Goat production has been identified as a means of ensuring sustainable family income for both rural and urban (slum) dwellers as it needs low capital investment yet assures quick returns. In India, 95% of goat meat produced is consumed locally and the per capita availability is far below the requirement. Thus, there is a considerable potential for developing goat production not only for meat for internal consumption but also for export, for quality leather production in which India ranks high among the goat skin exporting countries.

Goat meat is consumed in more than 40 countries viz. Australia, Canada, Caribbean Islands, China, Dubai, Greece, Hong Kong, India, Italy, Japan, Malaysia, Mauritius, Mexico, New Zealand, Pakistan, Papua New Guinea, Portugal, Saudi Arabia, Singapore, South Africa,

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Volume 3 Issue 1; 2023
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South Korea, Switzerland, Taiwan, United States of America, Venezuela, Vietnam, / Argentina, France, Germany, Ireland, Spain, United Kingdom, Bulgaria, Poland, Romania, Republic of Kazakhstan, Russian Federation, Ukraine, Turkey and Egypt (Pinkerton, 1995). India having the second largest goat population in the World can play a vital role to exploit this market. Asia has the largest population of goats with 55% of world goat population, mostly in India (35.2%), China (29.3%) and Pakistan (12%) (Devendra, 2006). China has the highest consumption of goat meat, followed by India and Pakistan (Food and Agriculture Organisation, 2009). Goats of different ages can be used for human consumption (Devendra and Owen, 1983) and the younger animals were slaughtered at 8-12 wk or with 6-8 kg and the adult at 2 and 6 years of age weighing 20-30 kg).

The demand for increasingly urbanized population with higher incomes and changing food habits, India's goat meat production has been rising at an annual average of about 4 percent in recent years. The above figure shows that annual growth rate of goat meat production during the period 2007-08 to 2018-19. During 2016-17 the growth rate of goat meat production was reached at highest level. In comparison to the 2017-18, growth rate, the current growth rate of 2018-19 has shown a significant improvement in the goat meat production with the growth registered as 5.28.

Composition of Goat Meat

The chemical composition of goat meat is as follows: moisture 74.2-76%; protein 19-22.5%; fat 0.6-2.6% and ash 1.1%. Considering its high nutritional value and its greater unsaturated to saturated fatty acid ratio goat meat has the potential to improve the health of susceptible population without taking meat products out of their daily diet. Consumption of goat meat is becoming popular and is often available at the fine dining level (Giugliano D 2000). Possamai et al (2015) compared Saanen carcass quantitative and Longissimus dorsi chemical composition and found that the moisture % was 76.0%; protein 19.0% and fat 2.21%. Chaudhary et al (2015) found that the chemical composition (moisture, protein and fat were similar to that of Possamai et al (2015).

The main important scenario is factors affecting the goat meat production are breed and genetics; age and slaughter which are biological factors affecting goat. Preslaughter conditioning; own farm handling, transport and liarage condition, chilling, electric stimulation, carcass suspension and aging are some of important parameters affecting the quality of goat meat.

According to Mursheda et al. (2014) the moisture percentage of the goat breed is 76.66%. This study shows that the moisture content of the goat breed is 71.79. Abdullah and Musallam, (2007) stated that the energy level in goat meat diets affects the moisture content of 71.2% to 72.3%. Abdullah and Musallam, 2007 observed that moisture percentage is 76%. Dhanda et al. (1999) have reported that the moisture of Thoracic longissimus muscle of different genotype of goat were in the range of 70%-72%. Mursheda et al. (2014) the moisture percentage of sheep breeds is 72.01%. This study shows that the moisture content of sheep breed is 76.8135% which is higher than the recommended value. Water is one of the important components of meat that affects its look, texture and flavour, as well as determining its appeal or acceptability, level of freshness, and endurance (shelf-life). Because muscle protein has a hydrophilic nature, which acts as a binder of water molecules in meat (Judge et al., 1989), moisture in muscles has a significant association with meat protein.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Muscles contain roughly 75% water, with a range of 68-80%. When the meat's water content surpasses the typical threshold (75%), the meat's quality suffers.

Mursheda et al. (2014) the protein content of goat meat was found 24.54%. Variations in the protein content of meat can be influenced by breed, age, species, the location of muscles, feed, maintenance management (Judge M D et al., 1989). The protein influenced by the breed, age, species, the location of muscles, feed, maintenance and management. The protein content of sheep meat was found at 20.48% (Mursheda et al., 2014). This is due to the variety of breed, management and feeding practices of Bangladesh.

The ash content of the Mursheda et al., 2014 was found to be 1.1%. This is due to the variety of breed, management and feeding practices of Bangladesh. Ether extract shows that the ether extract of goat meat was found 5.6%, and the ether extract of sheep meat was 5.8%. This is due to the variety of breed, management and feeding practices of Bangladesh. Fatty acid profile of mutton and chevon: According to Anaeto et al. (2010) the same author, polyunsaturated fatty acids prevalent in goat meat, and the diet rich in unsaturated fatty acids is correlated with a reduced risk of stroke and coronary disease. Goat meat contains unsaturated fatty like elaidate (50.411%) which is higher than the sheep meat (0.362%) and saturated fatty acid like stearate (4.063%) is lower than the sheep meat (35.091%).

The goat production seems to be promising enterprise for sustainable livelihood of poor and marginal farmers, however most leading constraint in sustainable development of livestock sector is availability of feeds and fodders both in quantitative and qualitative terms. It is well recognized that, effective utilization of non conventional crop residues as animal feed is an alternative way to overcome feed shortage for bulk eaters like ruminants. Apart from palatability and low bulk density, low nutritive value also restricts the utilization of crop residues as animal feed ingredients. The crop residues are usually consumed by large ruminants but small ruminants like goats are reluctant to consume it. Therefore, it is need to improve the nutritive value, digestibility and palatability of crop residues through different feed processing methods, before it is fed for better utilization. Also there is need for commercial goat farming from the available resources in a judicious way.

CONCLUSION

The goat industry should transform into a commercial venture just like poultry and dairy industry from the traditional grazing system. The livestock farmers should be made aware about the importance of commercial goat rearing and also there is need to develop package of feeding practices for such farming from birth to marketable age.

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Indian Journal of Livestock and Veterinary Research
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CHAPTER 29

Recent Trends of Artificial Insemination (AI) of Goats

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ABSTRACT

A*rtificial insemination (AI) in goats is a widely used breeding technique that plays an important role in modern goat breeding programs. This method involves depositing highquality semen into the reproductive tract of female goats (goats) for fertilization and conception without natural mating. AI offers a number of benefits, including genetic enhancement, disease control, and improved reproductive efficiency. The history of AI in goats dates back to ancient times, but significant advances were made in the 20th century,leading to the widespread adoption of AI in the goat industry. Various AI techniques, such as intracervical insemination, intravaginal insemination, transcervical insemination, and endoscopic insemination, are used to meet breeding goals and challenges different. Successful implementation of AI requires technical expertise, the right equipment, and attention to factors such as estrus detection and sperm quality. Major area of goat cultivating is broad and breeding framework takes after uncontrolled common mating. For superior breeding administration, there ought to be adequate great quality stud billy.In any case, it is sad that due to need of breeding bucks, more than 30% estrus does stay without benefit. Preservation of predominant local billy semen and counterfeit insemination are (AI) vital apparatuses for the right administration of breeding arrangement, counting the capacity to check for negative choice. AI may be a portion of helped regenerative innovation (Craftsmanship) giving increase of hereditary make-up inpeople. AI in sheep and goat was to begin with described in detail in 1987. Universally, 0.5 million also are performed every year within the case of goats which is exceptionallyless compared with other creatures. Investigate on cryopreservation of goat semen and AI has been restricted to few investigate establishing, and AI is slightest practiced in field condition.*

Keywords*: AI (artificial insemination, billy, buck (male goat), estrus (heat period) Doe (female goat).*

INTRODUCTION TO ARTIFICIAL INSEMINATION (AI)

General Introduction: Goat farming plays a major role in the socio-profitable growth of small holder farmers in rural areas. Goats are easily adapted to hostile climatic and nutritional conditions. Within the changing livestock scenario, goat cultivating encompassesa promising future.

Goat cultivating plays an imperative part within the economy and dietarysecurity of landless, little and minimal ranchers. poor man's goat swarm can be kept up in arestricted zone and it can outlive on a broad diversity of plants in numerous agro-climatic conditions as well as on

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bushes and trees accessible beneath unfavourable natural conditions.

Artificial Insemination in Goats

Artificial insemination is a reproductive technique used in goats and other animals to improve genetics and achieve specific breeding goals. In this process, semen collected from a high-quality buck (male goat) is introduced into the reproductive tract of a doe (female goat) without natural mating. **A**rtificial insemination involves the process of transferring semen from a male animal to a female animal without natural mating taking place. This technique has revolutionized animal breeding, allowing for selective breeding and genetic improvement in goats and other animals. The process can be done in a diversity of ways and requires careful consideration to ensure successful insemination. **A**rtificial insemination is a technology in which semen collected from male animals is deposited into the female reproductive tract by AI service gun. At the right time and in the right place in the posterior reproductive tract. Artificial insemination should be done only when the goat is in heat.

HISTORY OF ARTIFICIAL INSEMINATION

Early Developments

Ancient Civilizations: There are historical records suggesting that AI was practiced in ancient civilizations like the Egyptians and Romans. They attempted to use various techniques, such as manually inserting semen into the reproductive tract of female animals.Italian scientist **Lazzaro Spallanzani** invented a method for artificial insemination in dogs in 1780 while researching animal reproduction. This was the first successful trial with artificial insemination in animals. In the 1700s, European naturalists and scientists, such as Spallanzani, began conducting experiments in artificial insemination in animals. These early efforts laid the groundwork for the development of modern AI techniques.

Advancements in the 20th Century

Early 1900s: Significant progress was made in the early 20th century with the discovery of the process of preserving semen through refrigeration and later through cryopreservation (freezing). This breakthrough allowed for the storage and transportation of semen over long distances, overcoming geographical limitations in animal breeding.

1920s-1930s: The first successful commercial application of AI in livestock occurred during this period, primarily in cattle breeding. In 1939 artificial insemination (AI) was launched in India at the Palace of Dairy farm in Mysore, even though the **AAI (Allahabad Agricultural Institute) in Allahabad** (U.P.) welcomed its first calf through artificial insemination in 1943. AI became more widely accepted as a practical and effective breeding tool for improving the genetics of herds.

Late 20th Century: AI technology continued to evolve with the introduction of new methods for semen collection, processing, and insemination. These developments led to increased success rates and wider adoption of AI in livestock breeding.

In 1942 AI was used in India at I.V.R.I Izatnagar, Bareilly, Uttar Pradesh

Modernization and Commercialization: As research and technology advanced, AI in goats became more refined, with better techniques for semen collection, processing, and insemination. The commercialization of AI services and the establishment of AI centres offering high-quality semen from genetically superior bucks further popularized its use.

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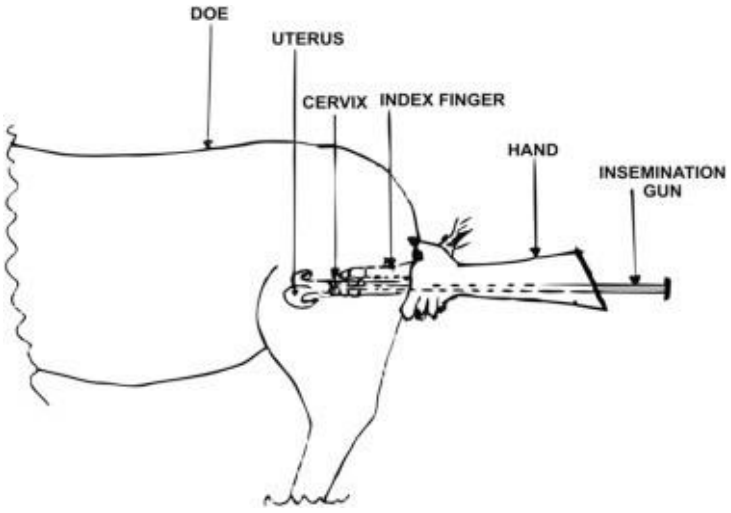
Current Status: Today, AI is a widely accepted and commonly used breeding tool in goat farming around the world. It continues to play an important role in genetic improvement, disease control and breeding of desirable traits in goat herds. Throughout its history, goat AI has undergone constant refinement and improvement, making it an indispensable tool for modern goat farmers looking to improve their genetic potential. transmission of the herd and achieve their breeding goals. The development of AI techniqueshas significantly contributed to the advancement of goat farming and the overall productivityof the goat industry.

Methods of Artificial Insemination in Goats

AI in goats is relatively easy to implement unlike other animals such as cattle. Insemination can be done by different methods such as vaginal AI, cervical/intracervical insemination and endoscopic AI.

1. Vaginal Artificial Insemination

Vaginal insemination is mainly used for fresh or frozen goat semen. In this method, semen is inserted into the vagina of estrus without striving to locate the cervix (no visual means used here). Vaginal insemination is Influential in females, when fresh semen is used directly; however, it gives low conception rate with chilled or frozen deer semen. Vaginal insemination also known as peri-cervical insemination. Vaginal insemination is suitable for doe's that are difficult to inseminate via cervical insemination or when cervical access is challenging. The semen is deposited into the vaginal vault, and sperm cells naturally ascend through the cervix into the uterus. The vaginal AI method involves inserting semen deep into the anterior end of the vagina without trying to locate the cervix. This strategy is viable for coordinate insemination with new sperm, but destitute comes about with delayed insemination (chilled or solidified).



Vaginal artificial insemination

2. Intracervical AI or Cervical Artificial Insemination

Cervical artificial insemination (AI) is a common and widely used method in goat breeding. This involves injecting semen straight into the uterus of a doe (female goat) by inserting an insemination rod or catheter through the cervix, a parochial opening at the bottom of the uterus. This procedure permits breeders to present semen into the reproductive tract without the required for normal mating and can be especially valuable for hereditary change and breeding monograph. Here's an clarification of the cervical artificial insemination handle in goats.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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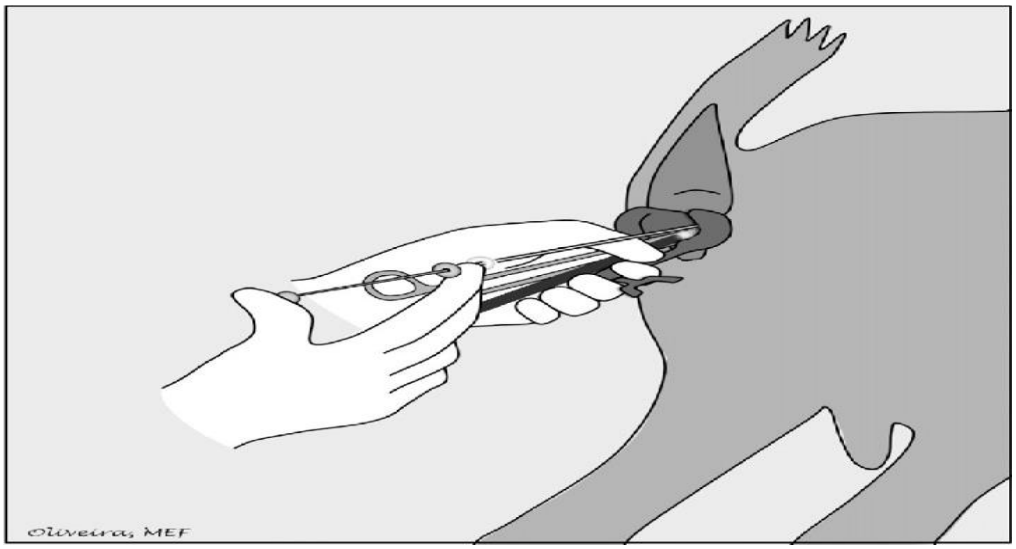
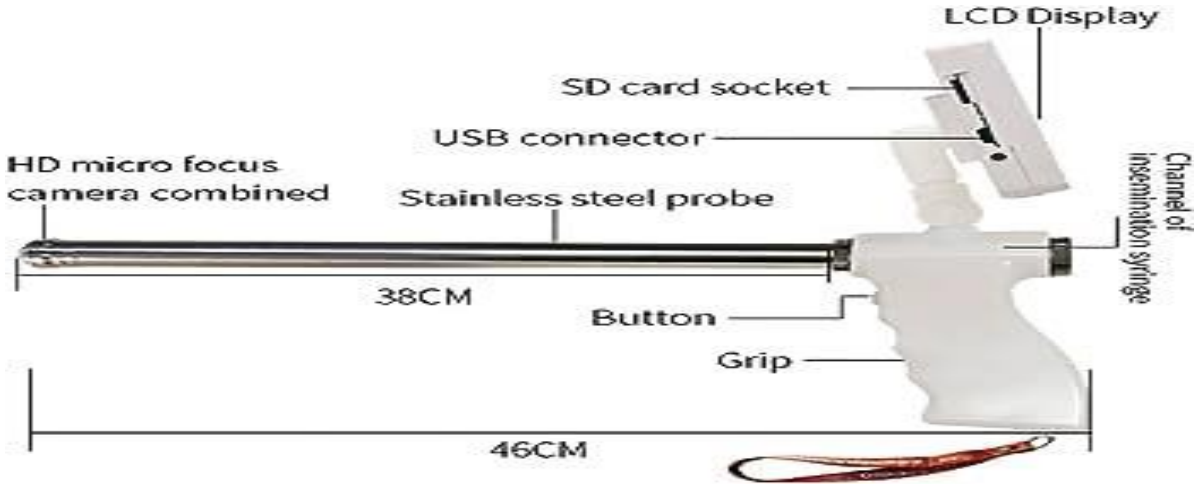


Cervical artificial insemination/ intracervical insemination

The procedure of cervical AI requires experience faculty and appropriate preparing to guarantee exact arrangement of semen and minimize any potential wounds to the regenerative tract. Cautious cleanliness and cleanliness amid the insemination prepare are basic to anticipate contaminations and maximize the chances of effective fertilization.

3. Endoscopic Artificial Insemination

Endoscopic artificial insemination (AI) in goats is an advanced reproductive technique that involves using an endoscope to visualize and guide the insemination process directly into the uterus of a female goat (doe). This method allows for precise placement of semen, enhancing the chances of successful fertilization and conception. Endoscopic AI offers several advantages, including increased accuracy, reduced risk of contamination, and a non-invasive approach compared to traditional surgical methods. Here's a detailed explanation of endoscopic artificial insemination gun in goats.



AI gun using in endoscoping insemination

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

An endoscope is a long, flexible tube with a camera and light source at its tip. It allows veterinarians or reproductive specialists to visualize the cervix and the internal reproductive structures of the doe. The endoscope is introduced through the doe's vagina and gently advanced into the reproductive tract to provide a direct view of the cervix and uterus.

Equipment needed for insemination with frozen semen:

1) Thermometer
2) Sterile lubricant
3) AI light or headlight
4) Straw tweezers
5) Insemination gun (for straws)
6) Breeding stand or facilities to restrain the doe.
7) Thaw box
8) Paper towels
9) Straw cutter
10) Liquid nitrogen tank
11) Speculum

Procedure of Artificial Insemination

Artificial insemination (AI) in goats involves the introduction of high-quality semen into the female goat's (doe) reproductive tract for fertilization and conception. AI is commonly used in goat farming to improve genetic traits, improve reproductive efficiency, and aid in herd management. Here is a step-by-step guide to the artificial insemination procedure in goats:

1. **Semen Collection and Evaluation:** Fresh or thawed frozen semen is obtained from genetically dominant bucks (male goat). Assess sperm quality, motility, concentration and morphology to assure suitability for fertilization.
2. **Doe Selection:** Doe selection is an important aspect in goat breeding, as it straight influences the productivity and heritable improvement of the entire herd. Choosing the right breed will produce healthy offspring, improve milk and meat production, and ensure overall profitability. Here are some important factors to consider when choosing deer for goat keeping.

Symptoms of doe's in heat are:

a) Healthy and reproductive soundness
b) Age & maturity
c) Ancestor background should be good.
d) Body structure
e) Environmental adaptability
f) Genetics and breeding fertility history

3. **Heat Detection:** Estrus detection program is a major factor in determining whether an artificial insemination program is successful. Knowing when the female enters estrus allows the technician to better match the time of insemination with ovulation.
   a) A doe that is unusually aggressive, noisy, or active while estrus period.
   b) Females that stand to be mounted by buck (male goat).
   c) The appetite and milk production are decreased.
   d) Clear mucous discharge from the vulva.

It is imperative to set up a heat detection schedule amid the breeding season. Doe's thatare to

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

be inseminated ought to be watched twice day by day for 15-20 minutes. Early morning and late evening are great times to watch estrus. Watching does for warm discovery as it were amid chore time may result in estrus ewes being ignored since of their alter in behaviour as they expect nourishing. Precise records ought to be kept up, counting time of heat, length of heat, and length of time between heat periods. These records will offer assistance a maker precisely expect and identify heat in person doe's,and time insemination with ovulation.

Time of insemination: A goat is a seasonal breeder whose cycle is about every 21 days. The average estrus or estrus will last 24 to 36 hours, with ovulation occurring near the end of estrus. The standard AI recommendation is to spawn two (or three) times 12 hours apart.

If doe's normal heat period length is:	Breed her at this time after first observed signsof heat:
24 hr	As soon as the doe shows estrus
36 hr	Within 12 hr of estrus
48 hr	24 hr after estrus
72 hr	48 hr after estrus

** In all cases, if doe is still in heat 24 hrs after first breeding, breed her again.*

Thawing Semen: If sperm has been previously frozen for storage, it should be thawed at room temperature to ensure viability.

Cleaning the Reproductive Tract: Clean the vulva and surrounding area properly to minimize the risk of infection during the procedure.

Insertion of the Insemination od: A sterile insemination rod or catheter is used to introduce the semen into the doe's cervix or uterus. Care must be taken not to damage the reproductive tract.

Depositing Semen: The semen is carefully deposited into the reproductive tract using the insemination rod.

Post-Insemination Care: After insemination, it is essential to provide appropriate care and monitoring to increase the chances of successful fertilization.

4. Challenges and Considerations

Though artificial insemination is a valuable tool in goat breeding, it comes with challenges and considerations:
Timing: Accurate timing of insemination is crucial for success.
Skill and Training: Proper training and expertise are required to perform AI correctly.
Semen Quality: The success of AI heavily depends on the quality and viability of the collected semen.
Equipment and Hygiene: Adequate equipment and hygienic practices are essential toprevent infections and ensure successful outcomes.

By implementing proper artificial insemination techniques, goat breeders can significantly improve their herds and achieve specific breeding goals efficiently.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Advantages of Artificial Insemination in Animals

1) Artificial insemination can help reduce the amount of time and resources needed for breeding, as well as allow animals to produce more offspring per year. Increased utilization of proven sires for a greater number of offspring's.
2) By selectively breeding animals through artificial insemination, farmers and breeders can improve the genetic diversity and overall quality of their herd, creating healthier and stronger animals.
3) Artificial insemination helps prevent the spread of diseases that can occur during natural breeding, such as sexually transmitted infections or parasitic infections.
4) Helps in rigid selection of males and removal of inferior stock.
5) Severe and wounded bulls can also be used for insemination
6) livestock improvement occurs relatively quickly
7) Extended period of productive life of proven life of proven valuable sire.
8) AI breeding is possible even in remote areas where bulls cannot be captured
9) Regular checks of semen quality can improve the reproductive efficiency of cows.
10) With proper hygiene, cows have higher fertility rates than natural methods.
11) Owners of small herds save financial expenses on feed, labour, care and maintenance ofstallions.
12) Valuable animals with proven extended productive life.

Disadvantages on Artificial Insemination

1) Requirement expensive equipment.
2) Requires trained and experienced personnel.
3) It takes more time than the natural breeding method.
4) Proper cleaning and sterilization of equipment.
5) Personnel hygiene.
6) Risk of disease transmission

CONCLUSION

In conclusion, artificial insemination (AI) in goats is an effective and widely usedreproductive technique that has revolutionized modern goat breeding programs. By depositing high-quality semen into the reproductive tract of goats (females), AI offers many benefits, including improved genetics, disease control, andimproved reproductive efficiency.

Artificial insemination has opened the door to genetic improvement, allowing goat breeders to produce goats with desired traits, improving adaptability and increasing overall profitability. By leveraging AI in their breeding programs, goat producers can work towards sustainability, geneticdiversity and improved productivity in their herd. It allows breeders to access superior genetic resources from remote locations, helping to improve traits and increase performance in goat herds. To successfully deploy AI, technical expertise, the right equipment, and attention to factors such as estrus detection and sperm quality are required. Careful selection of females, good hygiene and post-insemination care are essential for optimal breeding results.

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CHAPTER 30

Valuable Role of Meat, Milk and Fiber Production of Goat Farming in Indian Economic

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ABSTRACT

Traditionally goat has served as source of livelihood and financial security to large section of society, mainly comprising of resource-poor people. The goat population in India is 27.80% (20th livestock census). Goat is called poor man cow. Tamil Nadu has largest population of goat 9.98% total population of goat in India. The small holders produce milk, meat, fiber, skin etc for the community with virtually no capital, resource and formal training. Goat milk, meat and ram production contribution of total is 3%, 13.53% and 16.99% of total Indian production (20th livestock census). Goat meat serves as a major source of meat in developing countries while it is less popular in western countries.

Keywords*: Meat, Fiber, milk.*

INTRODUCTION

Goats and Sheep constitute a very important species of livestock in India, mainly on account of their short generation intervals, higher rates of prolificacy, and the ease with which the goats and their products can be marketed. Because of their contribution to the growth of rural areas and people, they are regarded as being of great significance. Goats may be able to contribute to sustainable development in an eco-friendly environment all over the world if local initiatives are successful in promoting quality labels and cutting-edge cheese, meat, and fibre products. The living conditions in the nations where there is a market for goat products, however, will also have a substantial impact on the future of the goat and sheep business as an important economic activity. The term "chevon" describes goat flesh. 16% of the meat produced in our nation is produced in Chevon. West Bengal produces 0.242 million metric tonnes of chevon annually, making it the most in India. In terms of cattle and buffalo populations, India comes in first. India is the biggest exporter of sheep and goat meat as well as the biggest producer of buffalo meat. goat meat's second-largest producer. With 148.88 million goats, India is the second-largest goat producer in the world. Goat population leaders are Rajasthan (20.84 million), West Bengal (16.28 million), and Uttar Pradesh (14.48 million).With 8.60 million metric tonnes of meat produced in 2019–20, India is the fifth-largest producer of meat in the world. The output of meat will rise to 8.80 million metric tonnes in 2020–21 (BAHS, 2021). The nation's top three producers of meat are West Bengal

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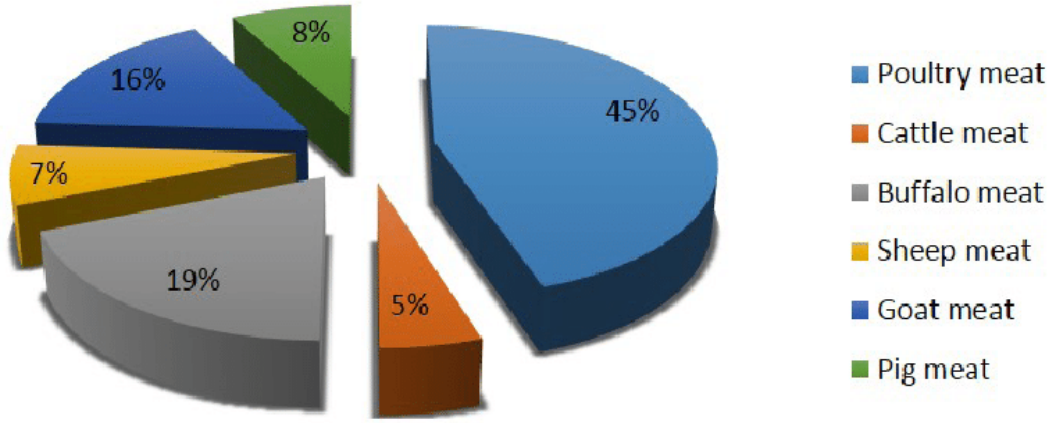
(6.48 litres), Andhra Pradesh (9.06 litres), and Uttar Pradesh (11.37 litres). In the upcoming years, there will likely be an increase in both domestic and international demand for goat milk and milk products. For the millions of small and marginal farmers in the nation, goat husbandry offers glimmerings of promise for the creation of employment, nutritional security, and wealth in the future.

Areas of Production

Rajasthan, Jammu & Kashmir, Uttar Pradesh, Gujarat, and the hilly regions of the North and Eastern Himalayas are the Indian regions with the maximum livestock population.

India Facts and Figures

The country is the world's largest exporter of Sheep and Goat meat. The country exported 9,592.31 MT of Sheep and Goat meats to the world for a value of Rs. 537.18 crores (66.92 USD million) during the years 2022–23. The meat production in the country as per 2015-16 data was 7 million tonnes, with a per capita availability of 4.94 kg. Total Goat Meat production in 2015-16 was 942.91 thousand tonnes. The meat type breakdown for the country is as below:



Standings of India in the World

Ranking	Sector
1st.	Total Livestock Population: Milk Production, Buffalo Population, Carabeef Production, Goat Milk Production, Total Bovine Population.
2nd	Cattle Population, Goat Population, Bristle Production, Aquaculture, Goat Meat Production.
3rd.	Egg Production, Sheep Population, Fisheries Production.
5th.	Poultry Production, Meat Production.
6th.	Poultry Meat Production.
8th.	Duck Production.
9th.	Camel Population, Wool Production.

Goat Population

Small Ruminant	Population as per 2012 census	No of farmers holders
Goat	135 million	33.01 million

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As per ICAR Data and Basic Animal Husbandry Statistics

DESCRIPTION	DETAIL
Average Yield per In- Goat Milk Animal in 2019-2000.	Average yield- 0.44 kg/day.
Average Yield per Season of Wool in 2019-2000.	Ram/Weather- 1.44 kg.
	Ewe - 1.10 kg.
	Lamb - 0.73 kg.
Number of Animals Slaughtered for Meat Production in 2019-2000.	103.60 million.
Leading States in India for Livestock Production.	Highest wool producing state-Rajasthan.
	Highest goat milk production-Rajasthan.
	Highest goat meat production-West Bengal.
	Highest goat population- Rajasthan.
Highest growth rate in wool production.	Jharkhand (5.73%).
Value Output from Livestock Rearing.	Wool and Hair-0.05 per cent.
Livestock Census 2019 was 20th Livestock Census.	Total goat population: 148.88 million.
Percentage Distribution of Total Livestock as per 20th Livestock Census.	Goat- 27.74 percentage.
Milk Contribution to Total Milk Production in India.	Goat -Percentage of Total Milk-2.95 per cent.
Meat Contribution to Total Meat Production in India.	Goat- Percentage of Total Meat-13.72 per cent.
Contribution to Total Wool Production in India.	Ewe-Percentage of Total Meat-70.61 per cent
	Ram/weather- Percentage of Total Meat-17.10 per cent.
	Lamb- Percentage of Total Meat-12.30 per cent.

Current Chevon Production Analysis

1) The entire amount of goat meat (Chevon) produced was 942.93 thousand tonnes, and of this amount, 86182.03 animals, or 64% of the population, were slaughtered. This amount has a domestic market value of approximately 37,717 crore (at 400/kg meat).
2) To obtain 377.55 thousand tonnes of meat, 75 thousand adult goats were killed (11087). To produce 107.97 thousand tonnes of mutton, 28 thousand young sheep were slaughtered.
3) There is a 2.08% CAGR.

Export Profile of Chevon in India

1) The share of Indian meat exports in the world market is less than 2%.
2) India is the world's largest exporter of Sheep and Goat meat. The country exported 21,950.71 MT of sheep and goat meat to the world for a value of Rs. 837.76 crore during the year 2015-16 (APEDA).

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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3) Sheep and goats together contribute 20% (13 and 7) of total meat production in the country. Out of these 20%, Goat (Chevon) contributes about 65%.
4) Major Export Destinations (2015–16): United Arab Emirates, Saudi Arabia, Qatar, Kuwait, and Oman
5) Major producing states are Rajasthan, Jammu and Kashmir, Uttar Pradesh, Gujarat, and the hilly regions of the North and Eastern Himalayas.
6) On the other hand, growth in ovine meat exports was 3.43 percent during 1980–90, which substantially declined and has become negative to the extent of 2.41 percent during 1990–99. The scope for exporting sheep, goat, and poultry meat is constrained by high domestic demand and prices.

Goat Milk Production

The world's largest producer of goat milk is India. About one-fourth of global production is produced by the nation alone. The second-largest market is in Europe. Goat milk typically costs Rs 50 per litre, but these days it may be found for more than Rs 1,500. Due to its many advantages, goat's milk has seen an increase in popularity as knowledge of lifestyle disorders has grown. Even individuals who are lactose intolerant are claimed to be able to consume it. The COVID-19 epidemic has increased demand for pasteurised goat milk.

Compared to standard cow milk, soy milk, or nut milks, goat milk has more protein per serving. And the protein in goat milk appears to be more digestible, meaning your body can use it more easily. Goat milk also contains significantly more protein than almond milk or rice milk. The correct answer is Saanen. Saanen is a dairy goat that originated in Switzerland in the Saanen Valley. It is famous for its high production and persistence of yield and is known as the Queen of Milk of the goat world. Goat milk contains medium-chain triglycerides (MCT), monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA), which might be beneficial for heart-related diseases.

Goat milk contains more protein per serving than regular cow, soy, or nut milks. Additionally, it appears that the protein in goat milk is easier for your body to absorb because it is more easily digestible. Additionally, goat milk has a higher protein content than rice or almond milk. The right response is Saanen. The Saanen goat is a dairy animal that was developed in the Saanen Valley of Switzerland. It is renowned for its high output and consistent yield and is referred to as the goat world's "Queen of Milk." Medium-chain triglycerides (MCT), monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA) are present in goat milk and may have a protective effect against heart-related illnesses.

1) The total milk production in the country is 155.5 million metric tonnes.
2) The total Goat milk production was 5377.59 thousand metric tonnes 3 percent
3) Growth of 6.27percent
4) The top five states in terms of the goat milk production estimate in India were: Rajasthan, Madhya Pradesh, Uttar Pradesh, MaharashtraandGujarat during 2014–2015.
5) The goats can be milked at any time of the day and are therefore named the moving refrigerators. Goat milk is prescribed for children, the elderly and sick people as it is easily digestible and has possible medicinal value.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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States	Milk Production (000 m MT)	Rank
Rajasthan	1822.82	1st
Uttar Pradesh	1287.84	2nd
Madhya Pradesh	556.75	3rd
Gujarat	267.30	4th
Maharashtra	247.43	5th

Source: Basic Animal Husbandry Statistics, 2014 (BAHS, 2014)

Goat for Fiber Production in India

Although sheep are frequently linked with the manufacture of wool, goats really generate some of the most luxuriant fibres. These fibres include cashmere from several goat breeds and mohair from Angora goats. Due to its softness, warmth, and durability, cashmere is a fibre in high demand. It comes from the goat's undercoat and is combed off. Goats of one solid coloration, such as white, brown, or grey, are favored than those with several colours. Per goat, averages of 4 to 6 ounces of under down are produced annually.Dehairing, a mechanical procedure, separates the coarse and fine hairs. Clothing made of knit is made using the long fibres. Weaved fabrics are made from shorter cashmere fibres. Cashmere is defined as fibres with a diameter smaller than 19 microns. 16 to 19 microns is the usual range.Wool from Angora or Kashmiri goats is produced in Jammu and Kashmir. An adult goat can produce up to 10 to 20 pounds of mohair, and angora goats are normally shorn twice a year. The Changthangi goat, which yields the best Cashmere, is the rarest breed of goat. The goats are also known as Pashmina goats or Changra goats. Additionally, the goats produce high-quality Cashmere wool just once a year. The largest wool-producing state in India is Rajasthan, which produces only 80 to 170 grammes of Ladakhi wool per year.More than 30% of India's total wool production comes from Rajasthan. Eight distinct breeds of sheep that are native to the state are well known for providing superior carpet wool. Mohair and cashmere are the two fibres that are produced most frequently. Mohair comes from angora goats. A type of fibre, not a breed, is cashmere. With the exception of Angora, practically any goat may produce cashmere fibre.

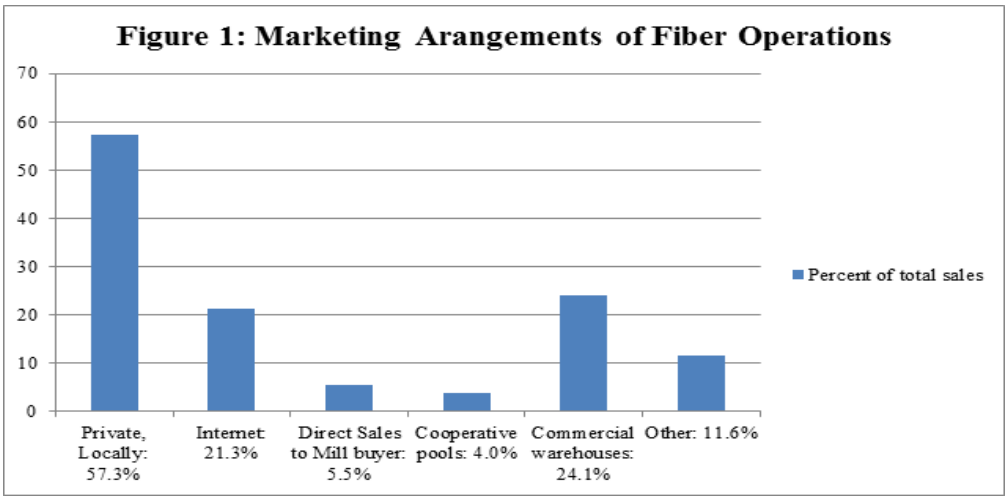

Figure 1 shows the different markets that goat fiber is sold in. Data is courtesy of the USD Veterinarian Service. Local markets account for 57.3% of total goat fiber sales.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

The production of fibre is not the main objective in many goat operations. It is typical for meat goat or dairy goat operations to also generate fibre in addition to their main products. Mohair and cashmere are the two fibres that are produced most frequently. Mohair comes from angora goats. A type of fibre, not a breed, is cashmere. With the exception of Angora, practically any goat may produce cashmere fibre.

CONCLUSION

From the above details, we can see that goat farming plays a significant role in improving the Indian economy. It generates employment in the rural areas of India. It helps to prevent malnutrition diseases caused by rural people in India. Goat is called the poor man's mobile bank because it gives the money at any time to the farmer, which means marketing facilities are available all over India. But some awareness of goat farming is necessary in the north-east state of India.

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Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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CHAPTER 31

Artificial Insemination of Goats

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ABSTRACT

Semen with live sperm is obtained from the male and injected into the female reproductive system with the aid of tools at the appropriate time. This process is known as artificial insemination. Enhancing goats' reproductive and productive abilities is a lovely strategy. It aids in keeping precise records of breeding. It facilitates better record-keeping and raises the rate of conception. This method has only been used on goat herds that primarily produce milk. To pick up genetic gain in their herds, producers of meat goats have expressed interest in mastering this method. Dairy goat breeders can use artificial insemination as a potent tool to accelerate the pace of genetic improvement in their herds. Despite the fact that AI is a strong tool, success with it depends on good methodology and close attention to detail. A person can become a competent AI technician with effective heat detection, record-keeping, and semen handling techniques.

Keywords*: Semen, artificial insemination.*

INTRODUCTION

During artificial insemination (AI), a buck's semen is obtained and then transferred to a doe's reproductive system. Either fresh or commercially available frozen semen can be used for insemination. The use of frozen semen to artificially inseminate embryos is covered in this article. This method has only been used in goat production on mostly dairy goat farms. To speed up genetic gain in their herds, producers of meat goats have expressed interest in mastering this method. Whatever the motivations for employing AI, it is crucial that the producer completely comprehends the doe's reproductive cycle as well as the proper handling and insemination techniques for semen.

Advantages of Artificial Insemination

1) The most effective method for dispersing superior genetic material throughout a population is artificial insemination. Super bucks' sperm can be harvested, frozen, and shipped anywhere in the world, where vast populations can use it to speed up progeny testing. Breeding offspring to evaluate their genetic potential is known as progeny testing.
2) Artificial insemination enables farmers to use desirable livestock that may be physically harmed and incapable of mating.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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3) Artificial insemination is excellent in reducing infections; it enables farmers to increase their herds without having to buy and keep bucks or lose them to predators, harm, or disease.
4) Artificial insemination is a crucial step in the breed's preservation.

Disadvantages of Artificial Insemination

1) Artificial insemination requires specialised equipment and facilities, and it takes a lot of time to check the heat, which is essential for a successful procedure.
2) The technician must be well-trained in the anatomy, function, and regulation of the doe reproductive tract to manipulate reproductive function and estrus synchronisation. A doe's heat phase typically lasts between 12 and 48 hours.
3) Artificial insemination improves the population's ability to spread harmful genes.

Reproductive Cycle of the Does

The doe's estrous cycle, which lasts an average of 21 days, is the space between two estrus or heat phases. Estrus, or heat, can persist anywhere between 12 and 48 hours. Does are open to being mounted by bucks during estrus. Knowing when a doe is in heat is crucial for artificial insemination. To find a doe in heat, producers are recommended to use teasers, typically a vasectomized buck.

Doe in heat symptoms include:

1) Swelling of the vagina
2) Seeking the buck
3) Standing for mating by the buck, teaser
4) Frequent urination
5) Flagging tail
6) Vocalization
7) The vagina with a mucus discharge that initially has a crystalline appearance but may take on a cheesy appear close to the period of ovulation.

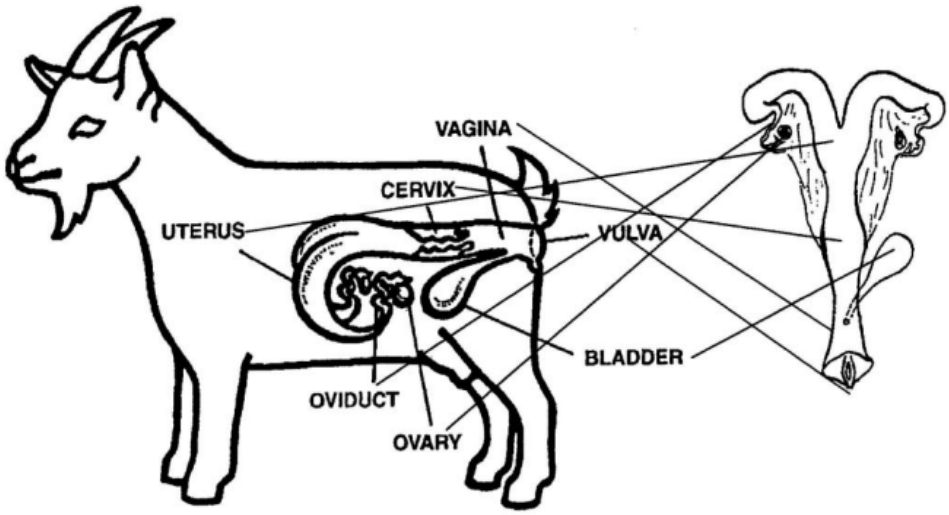

Fig. 1. Reproductive System of Does

Equipment needed to inseminate does with frozen semen

1) Liquid nitrogen tank
2) Speculum (25.0 x 175.0 mm for doelings or 25.0 x 200.0 mm for does)

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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3) AI light/ headlight
4) Straw tweezers
5) Sterile lubricant
6) Insemination gun
7) Breeding stand / facilities to restrain the doe
8) Thaw box
9) Paper towels
10) Straw cutter
11) Thermometer

Detail of Goat Semen

Uninteresting males breed with females, causing the region to lose valuable genetic material. The Eastern Regional Station of the ICAR-National Dairy Research Institute, Kalyani, West Bengal, has worked on the preservation of Bengal goat semen, standardization of artificial insemination techniques, and transfer to the field in order to prevent the dilution of valuable Germplasm by indiscriminate mating, preserve its purity, and propagate this unique Germplasm. For the preservation of goat sperm, a soybean-lecithin-based animal-source free semen extender was created. With a 47.26% conception rate, liquid semen has a storage life of roughly 72 hours when kept at a cold temperature. While in the field, frozen semen straws had a conception rate of about 46.52%. To spread the AI method in the field, training programmes on goat AI were held. Frozen semen straw manufacturing was trained in West Bengal's Hooghly area. Currently, he supplies roughly 5000 doses of Bengal goat semen each month and distributes it throughout the state's many districts. Additionally, he has been chosen as one of the 50 "SMARTFIFTY" new startup companies, supported by the Department of Science and Technology, Government of India, through IIM, Kolkata, and given financial support to spread AI in goats throughout West Bengal and neighbouring regions.

Techniques of artificial insemination ingoat

1) Recognise the doe in heat and confirm the appropriate AI time.
2) To allow for easier access to the doe's cervical Os, set the doe in the stand with its back legs raised, front legs supporting it, and head and neck pointing downward.
3) • If necessary, clean the doe's vulva to remove any debris, and then dry the region with a fresh paper towel.
4) Thaw the semen. Prior to thawing the semen, use a thermometer to check the water temperature (95.0 to 98.0°F) before withdrawing the straw from the tank.
5) Remove the straw from the tank for periods as brief as 5 seconds.
6) Cut the straw's proper end or the other side of the cotton plug.
7) Insert the straw into the A.I pistol, taking care to keep it out of direct sunlight and very hot environments.
8) Introduce the gun into the vagina in the direction of the cervical os, passing the gun through cervical rings until it reaches the uterine lumen.
9) Remove the A.I gun speculum and leave the doe for little minutes in the standing position before discharging her.

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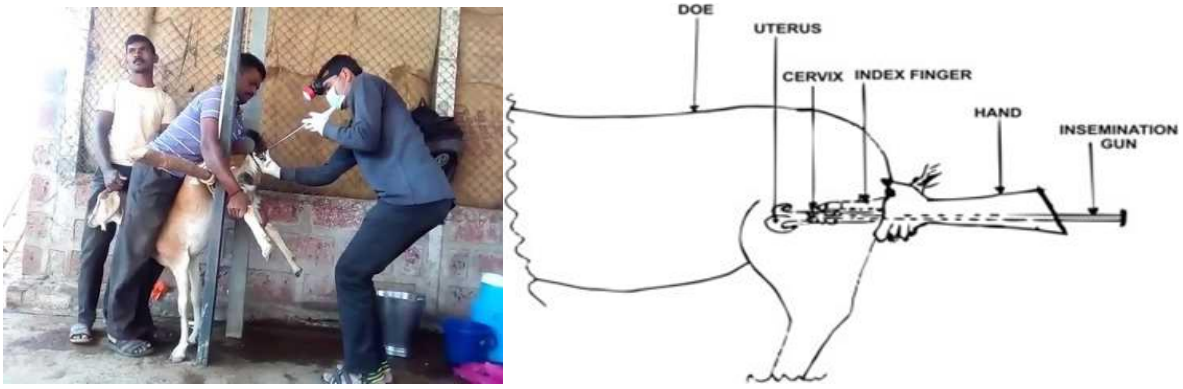

Fig. 2. Artificial Insemination in Does

CONCLUSION

Dairy goat breeders can use artificial insemination as a potent tool to accelerate the pace of genetic improvement in their herds. Despite the fact that AI is a strong tool, success with it depends on good methodology and close attention to detail. A person can become a competent AI technician with effective heat detection, record-keeping, and semen handling techniques. AI has the potential to be a first-generation assisted reproductive technology tool that can be applied to the breeding of research goats. Nevertheless, due to inadequate training of field veterinarians, AI workers, and government involvement, AI procedures are not as common in the case of goats. Several research institutions, universities, and non-governmental organisations now practise AI in India.In spite of the fact that the method is simple to use and cost-effective for goat breeders, it requires field-level education, awareness, and access to frozen buck semen.

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Indian Journal of Livestock and Veterinary Research
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CHAPTER 32

Indian Breeds of Goat

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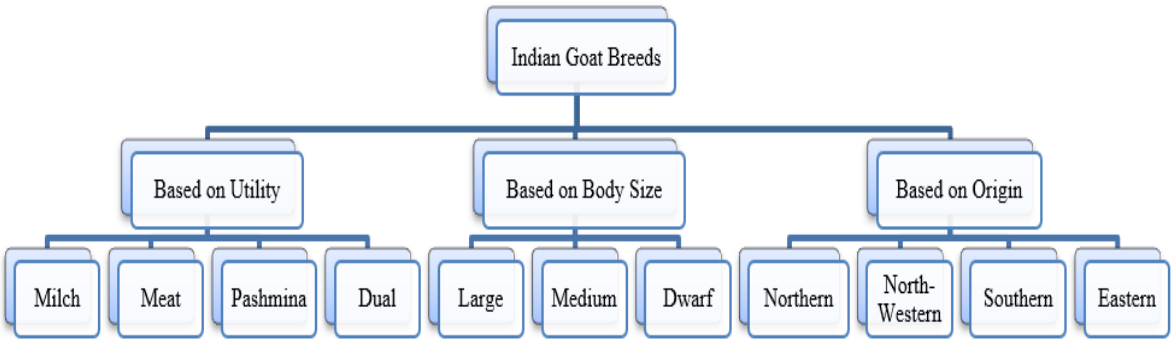
ABSTRACT



INTRODUCTION

The domestic goat (*Capra hircus*) is generally considered to have been first domesticated from the wild Bezoar goat (*Capra aegagrus*) somewhere in the Fertile Crescent of the Near East some 10,000–11,000 years ago. The rapid spread of domestic goats worldwide was probably the result of different activities, including commercial trade, thieving, warfare, or the migration of people with their livestock (Chakrabortty, 2022). The taxonomical classification of goats is as follow:

Phylum: Chordata
Class: Mammalia
Order: Artiodactyla
Family: Bovidae
Genus: Capra
Species: Hircus
Scientific Name: *Capra hircus*

There are many descript breeds of goats in the world, which belong to dairy, meat and fibre types or their various combinations. At present, India has 37 registered breeds of goats, which roughly constitute one-fifth of the total number of goat breeds available in the world.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Classification of Indian Goats

The Indian breeds of goats may be commonly classified on the basis of their utility, body size and geographical regions of the country to which they belong, as described below:

1. On the basis of their utility: On the basis of utility or major production characteristics, the goat breeds may be divided into three types, viz., dairy (or milk) and meat, meat, and fibre and meat types. Some breed is famous for dual purpose – milk & meat, or pashmina & meat.

(i) Dairy / Milk Purpose: This breed is used mainly for high yield milk production. Examples are Beetal, Barbari etc.

(ii) Meat / Skin Purpose: This breed is reared for quality meat production. Examples are Black Bengal, Berari, Nandidurga, Kodi-Adu etc.

(iii) Pashmina / fibre purpose: This breed is used mainly for pashmina production. Chegu, Changthangi, Bhakarwali etc.

2. On the basis of their body size: On the basis of body size or more precisely height at withers, goat breeds can be divided into three groups as follows:

(i) Large breeds: The height at withers of these breeds is over 65 cm. Examples are Jamunapari, Barbari, Beetal, Jhakrana, Gaddi and Malabari (Tellicherry)

(ii) Medium breeds: The height at withers of these breeds is 51 cm-65 cm. Examples are Zalawadi, Kutchi, Surti, Sangamneri, Osmanabadi, Mehsana, Ganjam, Changthangi and Chegu.

(iii) Dwarf breeds: The height at withers of these breeds is less than 51 cm. Example is Black Bengal.

3. On the basis of the geographical regions: Indian goat breeds are distributed throughout the country (Figure 1). The breeds of goats found in India may be classified according to the regions to which they belong. For this purpose, India may be divided into four regions as follows:

(i) North temperate region: This region comprises the states of Jammu and Kashmir, Himachal Pradesh, Uttaranchal and hilly tracts of Uttar Pradesh. The climate is temperate. This region represents only 2.8% of the total goat population of the country. The goat breeds of this region are small or medium type. They produce good quality fibres, which resemble wool. They are reared for fibre and meat. The breeds of this region are Gaddi, Chegu and Changthangi. Chegu and Changthangi breeds are popularly known as Cashmiri goats, as they belong to the state of Jammu and Kashmir. They are also known as Pashmina goats, as they produce the finest quality under-coat called cashmere or pashmina.

(ii) North-western arid and Semi-arid region: This region comprises the states of Rajasthan, Punjab, Haryana, plains of Uttar Pradesh, Gujarat and Madhya Pradesh. The climate is dry. This region represents about 43% of the total goat population of the country. The goat breeds found in this region are large in size and primarily used for meat and milk purpose. The breeds of this region are Jamunapari, Barbari, Beetal, Sirohi, Marwari, Jhakrana, Mehsana, Zalawadi, Kutchi and Surti.

(iii) Southern peninsular region: This region comprises the states of Maharashtra, Andhra Pradesh, Karnataka, Kerala and Tamil Nadu. In this region, the climate is semi-arid in the central peninsula and hot-humid along the coast. The breeds of this region are reared for dual production of meat and milk. The breeds of this region are Sangamneri, Osmanabadi and Malabari.

(iv) Eastern region: This region comprises the states of West Bengal, Bihar, Jharkhand, Orissa, Assam, Tripura and other north-eastern states. The climate is mostly hot and humid.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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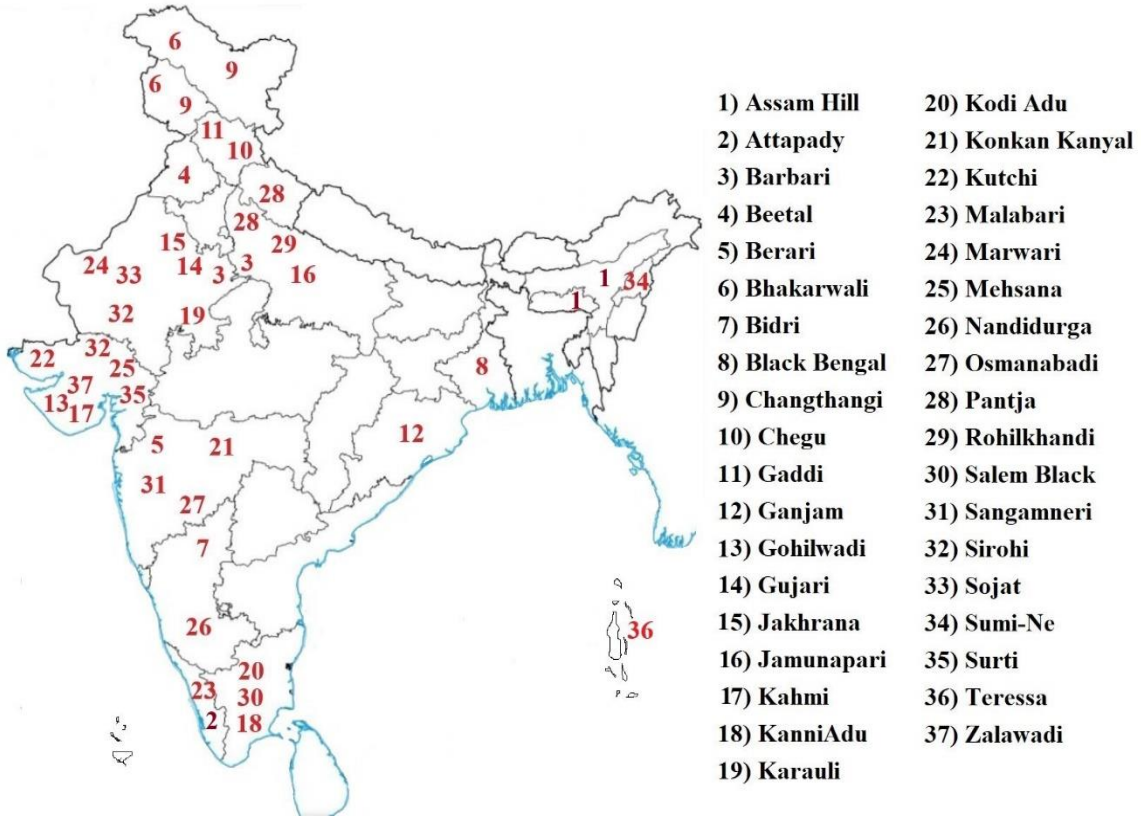
The highly prolific meat breeds are found in this region. The breeds of this region are Black Bengal and Ganjam.



F ig 1: Distribution of goat origin

Assam Hill Goat

Distribution: The home of this breed is in Dima, Hasao, Morigaon, Golaghat, Dhemaji, Dibrugarh, KarbiAnglong, Nagaon, Cachar districts of Assam.These goats also available in RiBhoi, West Jaintia Hills, East Jaintia Hills, West Khasi Hills, West Garo Hills, East Garo Hills, East Khasi Hills of Meghalaya.

Other Names& Registration No: Accession Number of this goat is INDIA_GOAT_0213_ ASSAMHILL _06031 and the local name is Asomi.

Adaptability to Environment: Assam hill goat is well adapted to the traditional open grazing zero input management system under varied range of topographic and climatic conditions of Assam.

Colour: Usually white with occasional black patches on backline and legs.

Horn Shape and Size: Cylindrical and tapering towards the end (corrugated) and pointed at the tip. Horns are mainly small in size, usually straight but in some animals slightly backward.

Visible Characteristics: These goats are short legged with small body size. Both buck and does are bearded. Ears are medium in size, horizontally placed with pointed tips.Tail is short and hairy. This breed is prolific in nature.

Body Weight: Average body weight of male and female are 19.81 and 18.61 kg respectively.

Productive Traits: Average litter size of Assam Hill goat is 1.56 where average age at first parturition and parturition interval of Assam Hill goats are registered13.34 months and 7.63 months respectively. Average Milk yield is 10.19 kg per lactation with 7.64% fat. The average dressing percentage of this goat is about 46%. This breed is mainly reared for meat.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Attapady Black

Origin / Breeding tract: Palakkad and Palghat districts of Kerala.
Other Names & Registration No: Accession Number of this goat is INDIA_GOAT_0900_ATTAPADYBLACK_0600.
Adaptability to environment: Attapady black goats are well adapted to the agro ecological conditions of the Attapady region and maintained mainly on grazing.
Description
Colour: These goats are mainly Black in colour.
Horn shape and size: Horns are curved, small and oriented backwards.
Visible characteristics: Extremities are black. Tail is bunchy type.
Body weight: Average body weight of male is 34.5 kg whereas that of female is 31.3 kg.
Performance: Average Litter Size of this goat is 1.28 per kidding. Average Age at first parturition and Parturition interval of Attapady Black goats are13.6 and 8.14 months respectively. Average milk yield is 17.33 kg per lactation where 4.11% fat is found in milk. The average dressing percentage of this goat is about 43%.

Barbari

Home tract: Barbari goats are found at Baratpur district of Rajasthan. Also found Etawha, Etah, Agra, Mathura and Aligharh districts of Uttar Pradesh.
Other Names & Registration No: Local names are Saibari, Titribari, Wadibari, Bari etc. Accession Number of this goat isINDIA_GOAT_2017_BARBARI_06002.
Description
Colour: White with tan spots, black spots in fewgoats is most common.
Horn shape and size: Horns are twisted, directed upward and outward. Horns are large in size.
Visible characteristics: Small sized animals, twisted horns. Ears - small and erect, tubular or almost tubular with slit.
Body weight: Small goats with compact body weighing36.7 kg in male and about20.3 kg in female.
Productive Performance: Average Litter Sizeis 1.43per kidding. Average Age at first parturition and parturition interval are20.82 and 11.4 months respectively.Milk yield is78.5 kg in a lactation period with 4.6% fat. Average dressing percentage is about 47.5% of this breed. Barbari is dual purposes, prolific breed.

Beetal

Distribution: Batala tehsil of Gurdaspur district of Punjab. Also found in Amritsar and Ferozpur districts of Punjab.
Other Names & Registration No: Local name is Amritsari. Accession Number of this goat isINDIA_GOAT_1600_BEETAL_06003.
Description
Colour: Black coat is common. Brown with white spots of different sizes is also available.
Horn Shape and Size: Small in size (about 12 cm), carried horizontally with slight twist, directed backward and upward horns are observed.
Visible Characteristics: Beetal goats are tall animals, having Roman nose and long ears (24.8 cm).
Body Weight: Average body weight in male is57.12 kg and in female is44.97 kg.
Performance: Average Litter Size is recorded1.66 per goat. Average Age at first parturition and parturition interval are24.45 and 10.94 months respectively. Beetal is mostly reared for

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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milk. Average yield per lactation is157.0 kg. In Beetal milk 5.03 % fat is present. Average dressing percentage of this breed is about49.68 %.

Berari

Origin / Breeding tract: Originated from Berar region of Central Province & Berar, which is recently known as Vidarbha region of Maharashtra state. Also found in Nagpur, Wardha, Amravati and Akola districts.

Other Names & Registration No: Locally known as Lakhi and Gaorani. INDIA_GOAT_1100_BERARI_06023 is registration no of Berari goat.

Adaptability to environment: The breed is performing well in Vidarbha region of Maharashtra where temperature is extremely high in the summer season.

Description

Colour: Coat colour varies light to dark tan.

Horn Shape and Size: Berari goat has flat, small, oriented upward and backward horns.

Visible characteristics: Black colored ring around neck in adult male. Black hair line along with the vertebral column extending up to tail in both sexes is observed.

Body weight: Average body weight of adult male is 36.0 kg and female is30.0 kg.

Performance: Mostly 1.6 litter size is observed in this breed. Age at first parturition is15.16 months and parturition interval is 7.9 months is recorded. Average milk production is77.7 kg/lactation. Average fat in milk is 5.72 percent. Average dressing percentage is about48.0 % is found.

Bhakarwali

Home tract: Corroborates with name of Tribal Bhakarwal community maintaining this goat population. These goats are found in Ramban, Kishtwar, Reasi, Rajouri, Poonch, Doda, Kathua, Udhampur and Jammu distrits of Jammua and Kashmir.

Other Names & Registration No: Locally known as Kagani.INDIA_GOAT_0700_ BHAKARWALI _06034 is the registration no of Bhakarwali goat.

Adaptability to environment: Well adapted to hills in the Jammu division of J&K state.

Footprint

Colour: Coat colour is mostly white; some have black face or hind quarters.

Horn shape and size: Curved and screw like directed upward and backward, about 15cm in size horns are observed.

Visible characteristics: Large sized goats having convex head. Body is covered with very long hairs. Udder is pendulous and medium in size.

Body weight: Average body weight inmale is30.15 kg and that of female is28.6 kg.

Performance: Average Litter Size 1.08 of this breed is observed. Age at first parturition is registered24.43 months whereas parturition interval is 12.36 months is observed. Milk yield is around140.65 kg/lactation. Average dressing percentage is about 53% of this breed is recorded. This breed produces fibre, which diameter is 64.57 µ. Average production of fleece is 0.75 kg/year/animal.

Bidri

Distribution: Named after its place of origin *i.e.* Bidar. Found in Gulbarga and Bidar area of Karnataka.

Local Names with Registration No: Accession Number of this goat isINDIA_GOAT_0800_ BIDRI _06032

Adaptability to environment: Well adapted to the agro ecological conditions of the region and maintained mainly on grazing.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Morphology
Colour: Mostly black in colour, some have white spots on ears, forehead, neck and knees.
Horn shape and size: Curved and directed backward, outward and downward.
Visible characteristics: Forehead is straight. Muzzle, eyelids and hooves are black. Ears are pendulous. Udder is hairy and small in size.
Average Body weight: Male 36.78 kg and Female 32.36 kg.
Performance: Average Litter Size1.71is observed in this breed.Average Age at first parturition is15.95 months. Parturition Interval is 9.04 months. These goats are reared for meat only. Milking not practiced. Twining is common but first kidding single.

Black Bengal

Origin/Breeding tract: This breed is distributed throughout West Bengal and adjoining parts of the neighbouring states, like Bihar, Jharkhand, Orissa, Assam and parts of Tripura. The pure Bengal Goat breed also prevails in Bangladesh.
Other Names & Registration No: Local names are Bengal or Desi. Accession Number of this goat isINDIA_GOAT_2100_BLACKBENGAL_06004.
Adaptability to environment: The breed is well adapted to the hot humid climatic conditions, wider range of vegetation, local management conditions, saline soil and water logging during rainy season.
Description
Colour: Predominantly black, brown, grey and white are also found.
Horn shape and size: Small in size (<15), directed upward and sometime backward.
Visible characteristics: Small-legged goat. Hair coat is short and lustrous. Nose line is slightly depressed.
Body weight: Goats are small sized; adult male body weight is about32.37 kg and that of female is 20.38 kg.
Performance: Average Litter Size is1.6 per kidding. Average Age at first parturition is17.43 months. Parturition Interval is 6.8 months. Milk yield per lactation is144 kg. Average dressing percentage is about55.8% of this breed. This is the most prolific breed of goat. Twins and even triplets are mostly common. The breed is famous for excellent chevon and morocco leather production.

Changthangi

Distribution: Changthangi goat is found in Lahaul valley, Ladakh and Kargil district of Jammu and Kashmir. Also found in Spiti of Uttarakhand.
Local Names & Registration No: Local names are Kashmiri, Pashmina. Accession Number of this goat isINDIA_GOAT_0700_CHANGTHANGI_06005.
Adaptability to environment: Adapted to cold desert area. In some places temperature goes down to -4^0C. This breed is known for quick movement.
Characteristics
Colour: Predominantly white but admixtures of brown, black also present,
Horn shape and size: Large and twisted like a corkscrew, turned outward, upward and inward to form a semi-circle.
Visible characteristics: Medium sized animals and sturdily built. Both ears are small, erected and stumpy.
Average Body weight: Adult males weight 21.8 kg and females weight about 21.4 kg.
Performance: Average Litter Size is about1.0 of this breed. Average Age at first parturition and parturition interval are27.4 and 13.5months respectably. Average Staple length is 4.95 cm and fibre diameter is 12.72 µ. Average production of pashmina is 70-500 gm/animal/year.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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This pashmina is used to prepare Kashmir Shawl or Rug. This goat is also used for transportation purpose.

Chegu

Origin / Breeding tract: Chegu is considered to be descendant of Markhor and Ibex existing in higher range of the Himalayas. Chegu is found in Lahul, Soiti, Kinnaur and Chamba districts of Himachal Pradesh.

Other Names & Registration No: Local names are Chayangra, Pashmina.Accession Number of this goat isINDIA_GOAT_0600_CHEGU_06006.

Adaptability to environment: Animals subsist on shrubs and leaves.

Morphology

Colour: Coat colour is compact white, black, grey, brown and mixture of these colours are common.

Horn shape and size: Horns are long, cork shaped, directed upward, backward and inward/outward. Horns are medium to large in size.

Visible characteristics: Reddish/tan/black coloration mostly around head & neck, and abdominal areas. Face and muzzle are tapering; possess long hair below with a second coat of pashmina.

Body weight: Adult males weight39.4 kg and females weight about25.7 kg.

Performance: Litter Size about1.13 is recorded per kidding. Average Age at first parturition and parturition interval are22.33 and 12.0months respectively. Milk yield per lactation is69.5 kg. Average Fleece weight is 0.12 kg/year. Average Staple length is 3.38 cm and fibre diameter is 14.36 µ. Average dressing percentage is about46 % of this breed.

Gaddi

Origin / Breeding tract: Name after the Gaddi tribe rearing these animals. These goats are found in Shimla, Kullu, Kangra, Chamba districts of Himachal Pradesh, also found in different region of Jammu and Kashmir.

Local Names with Registration No: Other names are Chamba, Gadderan, Gadhairun, Kangra valley, White Himalaya. Accession Number of this goat isINDIA_GOAT_0600_GADDI_06007.

Adaptability to environment: Adapted to migratory system. Firm footed animals, can transport up to 8.0 kg merchandise.

Description

Colour: White is dominant colour. Black coloured animals are also present.

Horn shape and size: Directed upward and backward and occasionally twisted. Both sexes, horns are long in size.

Visible characteristics: Skin is very tough, covered with coarse long hair measuring 17 to 25 cm. Ears are drooping and pointed (12 cm).

Body weight: Average body weight of male is 28.0 kg and female is 23.4 kg.

Performance: Litter Sizeabout 1.2 is reported. Average Age at first parturition is 55 months. Where, milk yield per lactation is 52.5 kg and fat in milk is 5.21 %. Average fleece weight is 0.3 kg/year and average fibre diameter is 74.5 µ. This breed is used mainly for pashmina production and good meat can be obtained.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Different types of Goat Breeds

Assam Hill (Assam & Meghalaya)

Barbari (Uttar Pradesh & Rajasthan)

Beetal (Punjab)

Berari (Maharashtra)

Black Bengal (West Bengal)

Changthangi (Jammu & Kashmir)

Chegu (Himachal Pradesh)

Jakhrana (Rajasthan)

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Different types of Goat Breeds

Jamunapari (Uttar Pradesh)

Mehsana (Gujarat)

Gujari (Rajasthan)

Osmanabadi (Maharashtra)

Salem Black (Tamil Nadu)

Sirohi (Rajasthan & Gujarat)

Sumi-Ne (Nagaland)

Sojat (Rajasthan)

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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Ganjam

Home: Gola tribe has developed this breed. Named after its palce of origin i.e. Ganjam district of Orissa. This breed is found in Nayagarh, Khurda, Gajapati, Rayagada and Ganjam districts of Odisha.

Other Names & Registration No: Local names are Dalua, Baigani, Gola Goat, and Lanka Goat.Accession Number of this goat isINDIA_GOAT_1500_GANJAM_06008.

Characteristics

Colour: Body colour varies, Black or Brown black is predominant but, white, brown and spotted animals are also available.

Horn Shape and Size: Horns in both sexes are twisted and curved. Long (up to 50cm in many cases), parallel and pointed backward and upward horns is found. Big size horns are a characteristic feature of Ganjam goats.

Visible Characteristics: Males usually have beards. Head convex, ears are long and drooping, wattles present in both sexes.

Body Weight: Tall goat breed where males are about35.05 kg in body weight and females are about28.87 kg.

Performance: Average Litter Size is 1.0 per kidding. Average Age at first parturition is19.19 months. Parturition Interval is 11.09 months. Milk yield per lactation is65.0 kg. Average fat observed in milk is 3.92 %. This breed is mainly prolific. Ganjam is mostly raised for meat purpose.

Gohilwadi

Origin / Breeding tract: Originated from Gohilwad, a part of Kathiawad region of Gujarat. This breed is found in Porbandar, Rajkot, Junagadh, Bhavnagar and Amreli districts of Gujrat.

Registration No: Accession Number is INDIA_GOAT_0400_GOHILWADI_06009.

Adaptability to environment: Adapted to hot semi-arid climate, and medium and deep black soil prevalent in South Saurashtra zone of Kathiawar Peninsulal.

Morphology

Colour: Mainly this breed is black in coat colour.

Horn shape and size: Horns are slightly twisted and turned upward, outward and backward. Horns are 15-25cm long.

Visible characteristics: Nose line is slightly convex. Ears are tubular and drooping. Body covered with coarse long hairs.

Body weight: This is also a large goat breed. Body weight of adult male averages52.04 kg and female averages41.67 kg.

Performance: Average Litter Size is 1.5 per kidding. Average age at first parturition and parturition interval are18.0 and 9.86 months respectively. Milk yield is240.0 kg in each lactation period. Average Fleece weight is 3.17 kg/year.

Gujari

Distribution: Gujari goat is large sized dual-purpose breed, distributed mainly in Jaipur and Sikar districts of Rajasthan.

Registration No: Accession Number of this goat isINDIA_GOAT_1700_GUJARI_06037.

Colour: The animals are brown and white mixed coat colour, while white coloured face, leg and abdomen is typical features of the breed.

Horn Shape: Ears are long, pendulous and folded, and horns are small, backward and twisted. Males have beard while, it is completely absent in adult females. Dewlap is present in majority of animals.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Body weight: Average adult weight is about 69.0 kg in males and 58.0 kg in females.
Performance: Average daily milk yield, lactation milk yield and lactation length are 1616.47±11.45 gm, 347.54±2.24 kg and 250.46±0.95 days, respectively. This is heaviest breed in India.

Jakhrana

Origin / Breeding tract: Derived name from village Jakhrana of Behror tehsil of Alwar district of Rajasthan.
Other Names & Registration No: Local name is Kali kotri. Accession Number of this goat is INDIA_GOAT_1700_JAKHRANA_06010.
Description
Colour: Predominantly black, black with white spots on ears and muzzle.
Horn shape and size: Curved upward and backward. Medium sized (15-25cm).
Visible characteristics: Straight face line. Forehead is narrow and slightly bulging. Udder size is large with conical teats.
Body weight: Large goat breed; males weight about 57.8 kg and females about 44.5 kg.
Performance: Average Litter Size is 1.54 per kidding. Average Age at first parturition and parturition interval are 18.5 and 9.5 months respectively. Good milk yielder. Average milk production is 152.87 kg / lactation and average fat in milk is 5.06 %. This breed is prolific breeder. Twins and even triplets are common.

Jamunapari

Origin / Breeding tract: Breed is named after natural habitat around river Yamuna. It's found in Etawah district of Uttar Pradesh.
Other Names & Registration No: Locally called as Etawah. Accession Number of this goat isINDIA_GOAT_2000_JAMUNAPARI_06011.
Characteristics
Colour: Body colour is white with patches of tan mostly on head and neck.
Horn Shape and Size: Small, sword shaped running backward and upward.
Visible Characteristics: Face is large and convex having tuft of hairs. Ears are long (about 30cm) flat and drooping.
Body Weight: Most majestic and biggest goat breed of India. Large sized tall body with average body weight in male 44.66 kg and in female 38.03 kg.
Performance: Average Litter Size is 1.5, usually doe kids once a year. Average age at first parturition is24.2 months and parturition interval is 7.5 months. Milk yield per lactation is201.96 kg. The breed is known to be best dairy goat of South East Asia and is tallest goat breed of the country. This breed is famous for dual purpose – milk and meat. Meat quantity is good with a bone and meat ratio of 1:3.9. This breed has been extensively used to upgrade indigenous breeds for milk and meat.

Kahmi

Origin / Breeding tract: Well known for more than 300 years among the breeder community and in the Saurashtra region. This breed is found in Devboomi Dwarka, Rajkot, Junagadh, Jamnagar of Gujarat and Pilibhit, Shahjahanpur, Budaun and Bareilly of Uttar Pradesh.
Local Names & Registration No: Locally called as Deshi. Accession Number of this goat isINDIA_GOAT_0400_KAHMI_06029.
Adaptability to environment: Excellent migratory capacity.
Footprint

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Colour: Coat color is unique - neck and face are reddish brown while rear abdominal part is black. Muzzle, eyelids and hooves are black in colour.
Horn shape and size: Curved upward and backward horns are available.
Visible characteristics: Medium size, unique coat color (Cranial Reddish brown and Caudal black coat, locally called Kahmi), ear type (long, tubular & coiled, locally called veludi), wattles in majority of goats and convex forehead.
Body weight: Body weight in male is56.4 kg and female is48.35 kg.
Performance: Average 1.38 litter size is observed in this breed.Average Age at first parturition is22.45 months and parturition interval is 9.57 months. Milk yield per lactation is326.87 kg with 3.39% average fat in milk. Average dressing percentage52.0 % is observed in this breed.

KanniAdu
Origin / Breeding tract: The names KanniAdu and VarikanAdu are derived from the presence of stripes on either side of the face. This breed is found in Sattur and Sivakashitaluks of Virudnagar district; Kovilpatti and Vilattikulamtaluks of Tuticorin district; Sankarankoviltaluk of Tirunelveli district of Tamilnadu
Other Names & Registration No: Lots of local names are available viz. VarikanAdu, KarapuAdu, Pullai Adu.Accession Number of this goat is INDIA_GOAT_1800_KANNIADU_06012.
Description
Colour: Generally Black with two white stripes on either sides of the face and white colour in the underbelly or inner side of the legs.
Horn shape and size: Directed backward and outward; backward outward and curved upward are predominantly present. Males are horned and females are pooled.
Visible characteristics: These goats have white strips on either side of face extending from base of horn to corner of muzzle. White lines on the edge of ears. Majority of the animals have white patch or line on either side of neck.
Average Body weight: Tall goat with a body weight of34.05 kg in male and 28.17 kg in female.
Performance: Average 1.9 litter size is observed per kidding. Average age at first parturition is13.9 months. Parturition interval is 6.9 months. Average dressing percentage is 45.0 %. This breed is very important for meat production.

Karauli
Home tract: Karauli goats are medium to large in size and dual purpose breed, distributed in SawaiMadhopur, Kota, Bundi, and Baran districts of Rajasthan.
Registration No: Accession Number of this goat isINDIA_GOAT_1700_KARAULI_06036.
Description
Colour: The coat colour pattern is black with brown strips on face, ears, abdomen, legs and near pin bones. Ears in Karauli goats are long, pendulous with folded and brown lines on border of ears. The animals have Roman nose.
Horn shape: The horns are medium sized cork screwing shapes which are pointed upwards are the most typical feature of Karauli goat. Karuali bucks have prominent hanging dewlap.
Body weight: Average adult weight is about 52.0 kg in males and 45.0 kg in females.
Performance: Average daily milk yield, lactation milk yield and lactation length are 1530.43±19.61 gm, 270.04±2.24 kg and 251.70±6.53 days, respectively.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
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KodiAdu

Origin/Breeding tract: The name KodiAdu means goat with long and lean body conformation and its synonym PoraiAdu has been derived from the body colour viz., splashes of black or reddish brown colour over the white coat. This breed is found in Thoothukudi, Tuticorin, Ramanathapuram of Tamilnadu.
Other Names & Registration No: Local people called as PoraiAdu.Accession Number of this goat isINDIA_GOAT_1800_KODIADU_06026.
Adaptability to environment: Adaptation to cover long distances during browsing
Characteristics
Colour: White with splashes of black or reddish brown colour.
Horn shape and size: Directed upward, backward and curved downward or upward and sharp at the tip. Size 15-25cm.
Visible characteristics: KodiAdu goats are tall, long, lean and leggy animals with compact body. Females have short, straight and sleek hairs on almost all parts of the body. Males have fairly long, straight and rough hairs on the neck and withers.
Body weight: Body weight is 33.43 kg in male and 30.94 kg in female.
Performance: Average Litter Size is 1.63 per kidding. Average age at first parturition is recorded 15.3 months where parturition interval is recorded 7.6 months. Average dressing percentage is 48.0 %. This breed is mainly used for meat and skin.

KonkanKanyal
Origin / Breeding tract: Name derived from the typical white bands on black face and black ear with white margin, locally called as Kanyal goats. Hilly tract of Konkan is coastal region, having high rain fall and hot and humid climate. Mainly found in Sindhudurg area of Maharashtra.
Other Names & Registration No: This breed is also known as Kanyal. Accession Number of this goat isINDIA_GOAT_1100_KONKANKANYAL_06022.
Adaptability to environment: This breed is well sustained in hilly tract of Konkan coastal region, having high rain fall and hot and humid climate.
Morphology
Colour: Black with white marking on collar, lower jaw and ventral surface.
Horn shape and size: Cylindrical, backward and medium in size(15-25cm).
Visible characteristics: Bilateral white strips from nostrils to ear. Legs- long, laterally black, medially white and white from knee to fetlock joint. Tail is dorsally black and ventrally white.
Body weight: Body weight of male and female is49.9 and 31.8 kg respectively.
Performance: Average age at first kidding and kidding interval are16.7 and 7.9months respectively. Milk yield per lactation is59.0 kg, where average fat present in milk is 3.01 %. Average dressing percentage is 53.0 %. This breed is mainly used for meat purpose.

Kutchi

Origin / Breeding tract: The breed derived its name from Kutch or Kachchh region of Gujarat state of India. This breed is found in Patan, Kutchchh, Mahesana and BanasKantha area of Gujarat.
Other Names & Registration No: Farmer's known as Kathiawari, Deshi. Accession Number of this goat isINDIA_GOAT_0400_KUTCHI_06013.
Description
Colour: Coat is predominantly black. White spots on neck, mouth and ear region.
Horn shape and size: Horns are small to long, corkscrew type and directed upwards.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Visible characteristics: Long and coarse hair, slightly Roman nose, and corkscrew type horns.
Body weight: Large breed with medium body weight (male: 46.96 kg and female: 39.91 kg).
Performance: Average Litter Size is 1.12 per kidding.Average age at first kidding is 24.14 months and kidding interval is 10.38 months. Milk yield per lactation is around 114.5 kg. Average dressing percentage is 58.4 %. This breed is used for dual purpose.

Malabari

Origin / Breeding tract: Name derived from Malabar region of Kerala. Mainly found in Calicut, Kannur, Cannanore, Wayanad and Malappuram area of Kerala. Malabari goat is a highly prolific goat.
Local Names with Registration No: Also known as Thalassery, Tellicherry, Cutch, West coast, Malabar. Accession Number of this goat isINDIA_GOAT_0900_MALABARI_06014.
Adaptability to environment: It is adapted to the hot and humid conditions of Kerala.
Characteristics
Colour: Majority complete white. Some are black or brown or admixtures.
Horn shape and size: Slightly twisted horns directed outward and upward. In some cases curved backward and downward touching the skin. Hornsare usually small in size.
Visible characteristics: Medium sized ears, directed outward and downward reaching up to the nose.
Body weight: Medium sized breed where males are usually of38.96 kg and females are31.12 kg.
Performance: Average age at first kidding is20.1 months and kidding interval is 9.4 months. Milk yield is around43.78 kg / lactation. Average fat in milk is 4.96 %. Malabari is mainly reared for meat; skin is also useful for tanning industry.

Marwari

Origin/Breeding tract: The breed derived its name from Marwar region of Rajasthan, which is natural habitat of the breed. This breed is found in Pali, Nagaur, Jodhpur, Jalore, Jaisalmeer, Bikaneer and Barmer districts of Rajasthan.
Other Names & Registration No: Local names are Barmeri, Black Desert goat of Rajasthan. Accession Number of this goat isINDIA_GOAT_1700_MARWARI_06015.
Adaptability to environment: The breed is well adapted to the inhospitable agro-climatic conditions of hot arid region.
Morphology
Colour: Whole body is Black.
Horn shape and size: Corkscrew type, directed upward and backward. Horns are varies from small to large in size.
Visible characteristics: Long shaggy hairy coat. Pendulous ears are present in this breed. Thick beard in both sexes are available.
Average Body weight: Medium sized breed where males are39.51 kg and females are31.86 kg.
Performance: Average age at first parturition and kidding interval are15.4 and 8.3months respectively. Milk yield is about85.8 kg / lactation, where fat present in milk is about4.1 %. Average dressing percentage is 56.3 %. It is good for meat. Lustrous hair can be used for different purposes.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Mehsana

Origin / Breeding tract: The breed derived its name from Mehsana district of Gujarat state of India. Rabari community is responsible for development of Mehsana breed. They maintain large herds of animals which include Kankrej cattle, sheep, goat and camel. Mainly found in Patan, SabarKanta, Mahesana, Gandhinagar, BanasKanth and Ahmadabad districts of Gujarat.
Registration No: Accession Number of this goat is INDIA_GOAT_0400_MEHSANA_06016.
Adaptability to environment: The breed is well adapted to the inhospitable agro-climatic conditions prevalent in the region.
Description
Colour: Black with white ear base, few reddish brown with white ear base.
Horn shape and size: Screw type. Twisted slightly, curved upward and backward and pointed at the tips. Horns are medium (15-25 cm) in size.
Visible characteristics: Ears have white spots ranging from a few spots to complete white with few black spots at the base. White spots are present on the upper part of upper muzzle and look like a ring in some of the animals. Hair coat is long and shaggy.
Body weight: Mehsana is larger than Marwari breed with an average body weight of 37.0 kg in male and32.0 kg in female.
Performance: Average Litter Size is 1.5 per kidding. Average age at first parturition is20.32 months. Kidding interval is about10.6 months. Milk yield is208.0 kg / lactation.Average milk-fat is 3.27 %.Average dressing percentage is 58.0 %. This breed is use for milk and meat purposes.

Nandidurga

Origin / Breeding tract: Named after its place of origin *i.e.* Chitradurga district of Karnataka and white colour. This breed is found in Devanagere, Tamkur and Chitradurga districts of Karnataka.
Other Names & Registration No: Local names are Nandi, Bilimeke.Accession Number of this goat isINDIA_GOAT_0800_ NANDIDURGA _06033.
Adaptability to environment: Nandidurga goats are adapted to hard rocky areas and graze efficiently on hillocks.
Characteristics:
Colour: Mainly White in colour. Some have Black/Brown spots on ears, forehead, neck and knees.
Horn shape and size: Horns are curved and directed backward, downward, inward and touching neck in few. Average horns sizes around males are 20.33cm and females are 15.79 cm.
Visible characteristics: Muzzle, eyelids and hooves are black. Ears are leafy and pendulous. Udder is hairy and pendulous. Teats are funnel shaped.
Body weight: Males are38.92 kg and females are30.11 kg in body weight.
Performance: Average age at first kidding is16.94 months where parturition interval is 7.07 months. Average dressing percentage is 50 %. This breed is mainly use in meat purpose.

Osmanabadi

Origin / Breeding tract: The breed derived its name after Osmanabad district of Maharashtra. This breed is found in Osmanabad, Solapur and Ahmadnagar districts of Maharashtra. The breed is known for early maturity, prolificacy and good dressing percentage.

Indian Journal of Livestock and Veterinary Research
Volume 3 Issue 1; 2023
ISSN 2582 9920; ISBN 978-81-963487-2-4

Registration No: Accession Number of this goat is INDIA_GOAT_1100_OSMANABADI_06017.

Phenotypic Character
Colour: Predominant colour is black. White colour is noticed only on ears and some spots on neck and forehead. Some animals are reddish in colour.
Horn shape and size: Horns are straight/ curved and small in size (about 13 cm) running backward, upward and downward.
Visible characteristics: Five types of animals are available: [1] entirely black with horns. [2] Entirely black with white ears and horns. [3] Entirely black and polled. [4] Entirely black, white ears and polled. [5] Brown and white patches from the face to lower side of the body.
Body weight: Average body weight in male is 33.66 kg and female is 32.52 kg.
Performance: Average Litter Size is 1.6 per kidding. The does can breed twice in a year and twinning is common. Average age at first parturition is 12.69 months. Parturition Interval is7.1 months. Milk yield per lactation is 40-75 kg. Milk fat is 8.34 %. Average dressing percentage is 50 %. This breed is mainly reared for meat.

Pantja

Origin / Breeding tract: Found around Pantnagar, mainly Nanital and Udhamsingh Nagar of Uttarakhand.
Other Names & Registration No: Locally known as Pantuja. Accession Number of this goat isINDIA_GOAT_2420_PANTJA_06024.
Adaptability to environment: Adapted to harsh climate conditions of Tarai region.
Description
Colour: Fawn to brown colour, which becomes lighter ventrally.
Horn shape and size: Small sized(<15cm). Triangular, twisted, slightly upwards and backwards, pointed tip.
Visible characteristics: White streak on either side of face. Head is slightly convex. Ears are pendulous.
Body weight: Average body weight in male is22.91 kg and female is18.81 kg.
Performance: Average Litter Size is 2 per kidding. Average age at first parturition and kidding interval are14.17 and 9.35months respectively. Milk yield per lactation is127 kg with milk fat is 3.87 %. Average dressing percentage is 56 %.It is reared for milk and meat, both purposes.

Rohilkhandi

Origin/Breeding tract: Originated in Rohilkhand region, mainly Pilibhit, Shahjahanpur, Budaun and Bareilly of Uttar Pradesh. Twinning is the most common and triplets are also frequently observed in this breed.
Another Names & Registration No: Farmers known as Chheri. Accession Number of this goat is INDIA_GOAT_2000_ ROHILKHANDI _06030.
Characteristics
Colour: Coat colour is mostly black. Few animals are brown, fawn or mixed.
Horn shape and size: Slightly curved and directed laterally and outwards.
Visible characteristics: Forehead is slightly convex. Tuft of hair (black or brown) is present in thigh region. Tail is bunchy. Ears shape is mostly pendulous.
Body weight: Male 29.92 kg and Female 25.33 kg.
Performance: Average kidding Size is 1.57 per kidding. Average age at first parturition is17.27 months. Parturition interval is 8.27 months. Milk yield per lactation is52.83 kg.

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Volume 3 Issue 1; 2023
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Average fat in milk is 4.24 %.Average dressing percentage is 46 %.It is reared for milk and meat, both purposes.

Salem Black

Origin / Breeding tract: The name Salem Black is derived based on the body colour (i.e., complete black body colour) and place of origin i.e., Salem district of Tamil Nadu. This breed is found in Krishnagiri, Erode, Dharmapuri and Salem districts of Tamil Nadu.
Other Names & Registration No: Other name is Karuppadu (In vernacular Tamil language).Accession Number of this goat isINDIA_GOAT_1800_SALEMBLACK_06027.
Adaptability to environment: Well adapted to the harsh climatic conditions (hot, semi-arid and tropical) of North-western parts of Tamil Nadu.
Morphology
Colour: Completely black with glossy hair coat.
Horn shape and size: No typical horn pattern however mostly directed upward and backward and sharp at the tip. Males: 20cm, Females: 13.7cm.
Visible characteristics: Salem Black goats are tall, long, lean and leggy animals with compact body. Head is medium in length. The eyes are small and bright and the eyelashes are black in colour. The ears are medium in length, leaf-like and semi-pendulous. Neck is thick, broad and well set to the thorax in males.
Body weight: Body weight of male is38.16 kg and female are 31.58 kg.
Performance: Average Kidding Size is 1.6 per kidding. Average age at first parturition is14.8 months. Parturition interval is7.1 months. Average dressing percentage is 50 %. It is reared for mainly meat and skin purposes.

Sangamneri

Origin / Breeding tract: The breed derived its name from its habitat *i.e.* Sangamner town of Ahmed nagar district of Maharashtra. Also found in Pune and Nashik districts.
Registration No: Accession Number of this goat is INDIA_GOAT_1100_SANGAMNERI_06018.
Description:
Colour: Generally white in colour. White mixed with Black and Brown both are also seen.
Horn shape and size: Horns are thin pointed, directed backward and upward. Average length is 12.71cm in females and 19.44cm in males.
Visible characteristics: Hair coat is extensively coarse and short.
Body weight: It is also a medium sized breed with average body weight for male is39.1 kg and female is32.62 kg.
Performance: Average kidding size is 1.4 per kidding. Average Age at first kidding and kidding interval are14.06 and 10.97months respectively. Milk yield per lactation is77.4 kg. Average dressing percentage is 46 %. Meat production of this breed is good.

Sirohi

Origin / Breeding tract: Name derived from Sirohi district of Rajasthan. Also found in Rajsamand, Udaipur, Chittorgarh, Bhilwara and Ajmeer districts.
Other Names & Registration No: This breed is also known as Majithi, Parbatsari and Devgarhi. Accession Number of this goat isINDIA_GOAT_1704_SIROHI_06019.
Adaptability to environment: Sirohi goat is a hardy animal adapted to harsh agro-climatic conditions of Rajasthan.
Characteristics
Colour: Coat colour is predominantly brown with light or dark brown patches.

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Horn shape and size: Horns are slightly twisted and curved, directed upward and backward. Horns are small in size (<15cm). Some polled animals are also present.
Visible characteristics: Flat and leaf like drooping ears.
Body weight: Average body weight of male is42.83 kg and female is35.27 kg.
Performance: Average kidding size is 1.0 per kidding.
Average Age at first kidding and kidding interval are26.14 and 10.06months respectively. Milk yield per lactation is81.5 kg. Average dressing percentage is 58.0 %. It is reared for milk and meat, both purposes.

Sojat

Home tract: It is large sized, dual-purpose goat, distributed in Pali, Jodhpur, Nagaur and Jaisalmer districts of Rajasthan.
Registration No: Accession Number of this goat isINDIA_GOAT_1700_SOJAT_06035.
Description
Colour: The coat colour of these animals is white with brown spots on head, neck, ear and legs, however,pure white animals are also available in the field. Wattles are present in majority of females while completely absent in males.
Horns: The horns are curved and downward oriented, twisted in females while males are completely polled.
Body weight: Average adult weight is about 60.0 kg in males and 53.0 kg in females.
Production parameter: Average daily milk yield, lactation milk yield and lactation length are 1060.12±12.59 gm, 266.64±0.63 kg and 232.92±1.17days, respectively. It is second heavy weight breed in India, mainly reared for meat purpose.

Sumi-Ne

Origin / Breeding tract: Indigenous. Sumi is a tribe in Nagaland and "Ne" means goat in Sumi dialect. Hence goats reared by Sumi people are known as 'Sumi-Ne'. Mainly found in Zunheboto area of Nagaland.
Other Names & Registration No: Also known as Apu-Asu-Ne, Nagaland Long Haired. Accession Number of this goat isINDIA_GOAT_1400_SUMINE_06028.
Adaptability to environment: Well adapted to the traditional open range zero input management system.
Characteristics
Colour: White with characteristic black markings on head, neck and legs.
Horn shape and size: Small sized and slightly curved backward.
Visible characteristics: Head is straight. Ears are horizontal. Horns are pointed. Beard is present. Presence of long hair in adult animals is the most important phenotypic character. The length of the fibre, however, is more in case of male as compared to that of females
Body weight: Goats are small sized; adult male body weight is about16.18 kg and female is about13.5 kg.
Performance: Average Litter Size is 1.12 per kidding. Average age at first parturition: 13.8 months. Parturition Interval is 7.6 months. Average fleece weight is 0.19 kg/year. Average staple length is 15.55 cm and fibre diameter is 225.56 µ. Average dressing percentage is 47.0 %. This breed is reared for mainly pashmina.

Surti

Origin/Breeding tract: The breed derived its name from Surat district of Gujarat state of India. Mainly found in Navsari, Narmada, Surat, Valsad, Bharuch and Vadodara districts of Gujarat.

Indian Journal of Livestock and Veterinary Research
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Other Names & Registration No: Other names are Khandeshi, Kungi, Nimari. Accession Number of this goat isINDIA_GOAT_0400_SURTI_06020.

Morphology
Colour: White, black, tan, coffee and grayish color. Mottled animals are also found.
Horn shape and size: Directed backward. Horns sizes are vary from Small to medium in size (3-23cm).
Visible characteristics: Pendulous and medium sized ears. Well-developed udder with large conical teats is observed.
Body weight: Average body weight is29.03 kg in male and31.06 kg in female.
Performance: Average Litter Size is 1.6 per kidding. Milk yield is317 kg / lactation.Surti goats are good milch animals. The milk production ranged from 1.5 - 4 lit/day. Surti goats are good breeders and twins are born to majority of does (50-60%), and triplets are rare (5%). They are mostly stall-fed animals and suitable for complete confinement.

Teressa

Origin/Breeding tract: The goat breed is present in the Nicobar group of islands since time immemorial. Nicobari tribes call this goat as Pookore which means Teressa goat due to their origin and distribution in Teressa islands.
Other Names & Registration No: Locally known as Pookore. Accession Number of this goat is INDIA_GOAT_3300_TERESSA_06025.
Description
Colour: Dark tan, brown, white and brown mixed, black and brown mixed, females mostly light brown and white mixed.
Horn shape and size: Flat at base and pointing towards tip. Starting from base and bending back along with/ behind the head or straight with slight curvature towards back/ side wards. Size small: 11.5cm in male and 10.5cm in females.
Visible characteristics: Peculiar white patch/line starting from inner canthus of both eyes or from eye brows and extending up to nostrils or mouth. Black hairs on dorsal midline up to the tail are observed.
Body weight: Average body weight is 39.85 kg in male and 31.94 kg in female.
Performance: Average Litter Size is 1.56 per kidding. Average age at first parturition is 12.3 months. Parturition Interval is 7.7 months. Milk yield is 56.0 kg / lactation. Average dressing percentage is 47 %. This breed is mainly reared for meat purpose.

Zalawadi

Origin/Breeding tract: The breed derived its name from the then Zalawad province of Kathiawad now known as Surendranagar district of Gujarat. Also found in Rajkot district of Gujrat.
Other Names & Registration No: Local name is Tara Bakari. Accession Number of this goat isINDIA_GOAT_0400_ZALAWADI_06021.
Adaptability to environment: The breed is well adapted to the harsh climatic conditions, wider range of vegetation, local management conditions of the region.
Characteristics
Colour: Body is covered with black, lustrous, shining hairs.
Horn shape and size: Horns are cork-screw type moving straight upwards, backwards and slightly outward with pointing tips.

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Visible characteristics: Long, wide leaf like and drooping ears. Well-developed udder with distinctly placed teat of long size of cylindrical shape projecting slightly outward and forward is observed.
Body weight: Male weight about 38.8 kg and female about 33.0 kg.
Performance: Average Litter Size is 1.6 per kidding.
Average age at first parturition and kidding interval are 22.17 and 11.27 months respectively. Milk yield is 294.0 kg/lactation. This breed is reared mainly for meat.

CONCLUSION

There is much less risk in goat farming especially in drought prone areas where large mortality occurs due to frequent droughts because of their higher prolificacy and capacity to recover flock size. There are much less housing requirements and management problems with goats. Woman and children essentially look after herding, feeding and health care of goats.

The involvement of woman increases as the farm size decreases, and the men are forced to seek off-farm employment. Most goats are maintained in small holder situation, integrated with crop farming; however, there are large flocks maintained under nomadic system. Goats contribute to the subsistence of small holders and landless rural poor. They also produce meat, milk, fibre, skins and manure and transport power, especially in high altitudes as in Himalayas.

Considering the economic importance of goat in national economy, the Government of India has set up Central Institute for Research of Goats at Makhdoom near Mathura, in U.P. At present, India has 37 well-documented and recognized breeds, however the majority of goats in our country are non-descript due to indiscriminate breeding and inter mixing of breeds. Goat farming is the backbone of economy of small and landless farmers in India. It will be best suitable option among the livestock farming for upliftment of the weaker section specially the landless and marginal farmers of economically backward region of India.

Goats are multi-purpose livestock, reared in different parts of the globe for their meat, milk and fibre and they play a significant role in the economy and nutrition of landless, small and marginal farmers in India. They also play socio cultural roles among many traditional societies. Goats are often termed as the ' ***poor man's cow***' and are an important source of savings for the agrarian community, especially in the developing countries.

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CHAPTER 33

Exotic Goat Breeds found in India

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ABSTRACT

The important exotic breeds of goat experienced in India for improvement of indigenous breeds through crossbreeding programme. Some exotic breeds of goats are being reared in India as such (in pure form, without crossbreeding) with very good performance since long. Crossbred goats (evolved by crossing local non-descript females with exotic male) are also reared in large numbers in our country. In India, exotic breeds of goats are classified in various ways as described below:

INTRODUCTION

Goats are one of the earliest discoveries of mankind in prehistoric times as ready and easy source of meat. Whether in cold arid up hills, or hot arid deserts, or hilly tracts of mountains of ravines constituted of leached soil, goats have survived and sustained the poor people. The present worldwide distribution of goats shows that the numbers of milch type or meat type goats are primarily located in the sub-tropical and tropical Asia and African countries. The goat belongs to the family *Bovidae* (hollow horned ruminants) and is the member of the genus Capra. Domesticated goats (*C. hircus*) are descendants of the pasang (*C. aegagrus*) represented in Europe by the Cretan and Cyclades races. The east was probably their original home; the earliest recorded being the Parsian race. There are about one-fifty descripting breeds of goats available around the globe; which belong to dairy, meat and fibre types or their various combinations. The important exotic breeds of goats experienced in India for improvement of indigenous breeds through crossbreeding programme. According to Indian weather some foreign breeds are reared; their characteristics are given below:

Alpine

Home Tract: This breed was originated in Alps Mountains of France. It's probably from crossing Swiss Alpine breeds with British goats.

Colour and Horn: Body coat colour is white to black with white spots. They may be horned or polled, when present are of the scimitar type.

Special Characteristics: It has erect ears and straight nose. The breed is more adapted to mountainous areas and in tropical environment. The breed is not suited in areas of high humidity.

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Body weight: Male and female body weight is 67-80 and 50-60 kg respectively.
Utility: The breed is valued first for its milk production. Average milk yield is 2-3 kg with 3-4% butterfat. This breed is mainly use for crossbreeding in tropical countries. There are usually 2 kids in a litter.

Angora

Distribution: Angora district in Asia Minor. They are commonly bred in the USA, Turkey and South Africa, the major producers of mohair.
Colour: Body coat colour is usually white; black (deep black to grey and silver), red (the colour fades significantly as the goat gets older), and brownish coat colours are also gaining popularity.
Visible characteristics: Soft silky hair covers the white body. The Angora is small in size with shorter legs. Horns are grey spirally twisted and inclined backward and outward. Tail is short and erect.
Body weight: Body weight of adult bucks and does varies from 80 to 100 and 30 to 50 kg respectively.
Productive traits: It produces a superior quality fibre called mohair. Annual yield of fibre is 4 -5 kg per goat. They usually sheared twice a year.

Boer

Origin / Breeding tract: South Africa
Colour: Usually white body with distinctive brown head. Few goats may be completely white or brown.
Visible characteristics: They have long pendulous ears.
Body weight: Adult buck body weight is 110-135 kg and female weight is 90-100 kg.
Performance: This breed mainly reared for meat purpose.

Nubian

Distribution: Originated in Nubia of North-eastern Africa. Also found in Ethiopia, Egypt and Sudan.
Colour: Black tan, dark brown with white spots.
Body weight: Adult buck body weight is 65-80 kg and doe is 50-60 kg.
Production: Average milk production is 0.8-1.3 litter per day. Highest record is 6.6 kg per day.

Saanen

Home tract: It is a native of Saanen valley of west and north-east Switzerland.
Other Names: It is known as "***milk queen of the goat world.***"
Colour: Colour is dull white to light cream or biscuit in colour. The breed is polled.
Special Characteristics: The face may be slightly dished and the ears point upward and forward. Both sexes are normally polled but sometimes horns do appear. The body has a good dairy conformation and the udder is well developed. There appears to be a tendency for them to be sensitive to strong sunlight and thus it needed to shade them and provide indoor management.
Body weight: Does weight 65 kg and the bucks 95 kg.
Utility: Average milk yield is 2-5 kg per day during a lactation period of 8-10 months. Milk fat is 3-5%. This breed is also used for crossbreeding purpose in different parts of India.

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Different types of Exotic Goat Breeds

Alpine

Angora

Boar

Nubian

Saanen

Toggenberg

Anglo-Nubian

Anglo-Nubian

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Toggenberg

Origin / Breeding tract:It is originated in the Toggenberg valley in north-east Switzerland. Toggenbergs are adaptable to a variety of climates, and have, therefore, been found in West Indies, Venezuela, South Africa, Tanzania and India.
Colour & Horn Character: Brown with white stripes on each side of face. Usually both male and female are hornless.
Visible characteristics: Skin I very soft and pliable. The male usually has longer hair than the female. These are large goats having long thin neck which are kept erect. The skin of the doe is very soft and pliable. The udder is well attached and carried high.
Body weight: The adult doe weights 65 kg or more and the bucks more than 80 kg.
Performance: Average milk production is 5.5 kg per day. The butterfat content of its milk is 3-4 percent.

Anglo Nubian

Origin/Breeding tract:Nubian along with Jamunapari together with native breeds of UK formed the cross bred Anglo-Nubian. The breed was derived from the Nubian type goat (Jamunapari with Zaraibi/Nubian) by crossing with English breeds in the UK in the late 19th century. The breed has proved to be the most suited to tropical climates and used widely for upgrading indigenous stock for meat and milk in West Indies, Malaysia, Philippines and India.
Other Names: Anglo-Nubian is known as the "***Jersey cow***" of the goat world.
Colour& Horn Character: It is a big body with a fine skin and glossy coat, pendulous ears and Roman nose.
Visible characteristics: Udder is large and pendulous with bigger teats. It is one of the most outstanding dual purposes (milk and meat) breed. The Anglo-Nubian is usually a big animal with fine skin, glossy coat, long pendulous ears and Roman nose and forehead.
Body weight: Bucks weight 65-80 kg and does from 50-60 kg.
Performance: Average milk yield is 3-4 kg per day. Peck yield may even go up to 6.5 kg or more. There are usually 2 kids in a litter.

CONCLUSION

Goat is economically an important and promising animal in the world especially developing countries in Asia and Africa. Goat farming is the backbone of economy of small and landless farmers in India. Due to continuous urbanization, the goat will be the livestock species of choice in the future as it occupies less space and less feed and fodder. More than 90% of the goat population is in developing countries where goat meat and meat products are considered as one of the most important sources of income. A good quality breed is selected by its high fertility, superior chevon quality, good milk producer, best quality skin, early sexual maturity, resistance against common diseases, low kidding interval and very good adaptability. Exotic breeds of goats experienced in India for improvement of indigenous breeds through crossbreeding programme.

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