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Prospects of
Goat Farming in Punjab

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Goat Farming- A Profitable Venture

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The goat species (*Capra hircus aegarius*) is an important component of farm animal genetic resources. Together with sheep, and partly because of their size, both are commonly called "small ruminants". Goats have been associated with mankind since the dawn of agriculture and the domestication of animals. Goats were domesticated as early as 7000-8000 BC, as evidenced by archaeological remains collected in Asia. Since then, it has been involved in development of many aspects of human culture like religion, tradition, folklore, nutrition, livelihood and economics. It is particularly important in tropics and subtropics, where it is used as a major source of meat, milk, fiber, skin and manure in many traditional societies. There is also a tendency to keep goats as a stock of wealth (poor man's bank) and sell them proportionally when the demand for funds raises or their number rises.

Goats provide products and services which are important for humans throughout the world. In the developed countries, goats are valued mainly for milk, fiber and meat; while in the developing countries, they are valued mainly for meat, followed by milk, fiber and skin. The socioeconomic importance of goats is greatest in developing nations, where they fulfill socioeconomic, cultural and recreational needs. Their small size is especially relevant and relates directly to economic, managerial and biological advantage over other species. The small size of the goat contributes to its popularity. Goats in addition to meeting daily food needs (milk and meat), are easily sold as a source of cash, provide insurance and are valued in religious ceremonies like gifts during marriages. This species acts as silver lining in Indian subcontinent especially for poor and landless marginal farmers. Poor and landless farmers often increase the size of their flocks to achieve greater food and economic security.

Present status

Goats constitute about 28 percent of total livestock population and 14 percent of total meat production of country (BAHS, 2020). In year 2019-20, 103.6 million goats and 56.5 million sheep yielded 1.2 and 0.8 million tones (MT) of meat with average 11.5 kg and 14 kg yield per animal, respectively (BAHS, 2020). Additionally, goats produced 5.85 MT of milk (3% of national production) with average 0.44 liter per goat per day in same year. India is one among the largest exporters of sheep and goat meat to the world. Major export destinations of India are United Arab Emirates, Saudi Arabia, Qatar, Kuwait and Oman. During 2015-16, India earned Rs. 446 crores through export of live goat/sheep and Rs. 871.08 crores through goat/sheep meat amounting 22,060.15 tones (excluding edible offal). The socio-economic contribution of small ruminants relates to large sizes of small ruminant populations; wide distribution across various agro-ecological zones and production systems; and diversity of breeds. Small ruminants are exchanged for crops in many pastoralist communities, and used for ceremonial purposes and for paying traditional doctors.

Societal contributions of goats

Livelihood concept is explained in terms of capabilities, assets (stores, resources, claims, and access), and activities that play interconnected roles in the wellbeing of households. The term coping is generally defined as an effort to prevent or diminish distress associated with threats, shocks, harm, or loss. In India, small land holders dependent mainly on crops are at greater risk of seasonal and climatic variations especially rainfall. Many parts face challenges of droughts and floods posing severe threats to livelihood of small landholders. The key part of resilience is the diversification of activities and use of different resources to increase household income as well as stability even when uncertainties prevail. The arid and semi-arid harsh conditions affect cattle more than goats and sheep. The ability of goats and sheep to graze, utilize poor quality forages, walk long distances, and withstand drought makes them better assets to sustain the livelihoods of pastoralists.

Goats are suited for diverse climatic conditions and play critical role in almost all the agro-climatic zones of India. Their contribution is more significant is eco-fragile, calamity prone and agriculturally less suited areas. About 70 per cent of the landless agricultural laborers, marginal and small farmers in the country are associated with goat husbandry. About 33 million households predominantly small land holders are engaged in rearing of goats (4.5 million in sheep farming) in India (19^{th} livestock census, 2012). In pastoral societies in India, goats are kept as a source of additional income and as an insurance against income shocks of crop failure. They are not only an important source of income and employment for them, but also a vital source of animal protein for the family. A number of micro studies concluded that the goats have great social and economic relevance in poverty reduction and social equity.

Women empowerment through goats

In many poor economies, women often don't own assets in the household or have control or power over assets and their use, and yet these women are over-burdened by the plight of looking for food for the household. Gender equality contributes to economic growth; however, it is not as clear that economic growth contributes to gender equality. The household role distribution and asset ownership determine the extent to which these assets can be converted into income generating activities. Goats play a critical role in the livelihoods of rural households, where they are often the property of poor women and children. A case study of Ethiopia shows that goats distributed to women farmers brought about substantial changes in their lives by enhancing food security and diversifying the livelihoods. Thus, through women empowerment positive social changes in the society can be rapidly taken up.

Compatibility of goats for small land holders

Goat production as against large ruminant and non-ruminant production plays greater role in reducing poverty, ensuring food security and overall household wellbeing particularly in rural regions of resource poor countries. Goats can quickly multiply, are resilient and easily convertible to cash to meet financial needs of the rural producers. The rural poor who cannot

afford to maintain a cow or a buffalo find goat as the best alternative source of supplementary income and milk. Goat rearing has distinct economic and managerial advantages over other livestock because of its less initial investment, low input requirement, higher prolificacy, shorter generation interval and ease in marketing. Goats are largely reared on extensive system using common resources, forest land and crop residues. Goats are well suited for mixed or integrated farming systems i.e. backbone for small landholders. Due to acceptability for wide variety of feed resources goats fits well with sylvipasture, agro-forestry etc. The adaptive capacities of goats to arid and semi-arid conditions make them one of the best assets for subsistence, food security, and livelihood for small holder farmers. They provide significant means through which landless, small land owners, pastoralists, and agro-pastoralists can escape the poverty trap as in times of emergency they can be used as moving bank. Goats contribute enormously towards promotion of livelihood security and as an insurance cover to cope with crop failures particularly for rural landless, small and marginal farmers.

Goats are more efficient in converting poor quality feed resources into quality meat compared to most of other farm animal species. In most of the Asian and rain-fed based economies, investment for other inputs is also less for goats than other farm animals. Due to smaller size goats are more suitable for transport, marketing and even domestic consumption thus have significant contribution in improvement of diet of economically weaker sections of the societies throughout the globe. Additional advantageous features of goats are higher feed use-efficiency from coarse roughages and high tolerance to tannins and diseases, as well as marketability within one season. Goat rearing can provide part time self-employment without affecting the main occupation for small and marginal farmers.

Conclusion

Small ruminants provide livelihood support to the poor underprivileged landless, and marginal farm households. The goat production systems are mainly subsistence-oriented but in view of the rising demand for meat, there is a great scope for their commercialization. Nonetheless, these animals have been grossly neglected in development programs and their potential for enhancing livestock growth remains untapped.

Since this is the only sector, which provides direct livelihood and income generating opportunities to landless and marginal farmers and the other vulnerable sections of the society, formulation of appropriate schemes for inclusive development of this sector is essential. The second component includes harnessing of the untapped potential in processing and value addition of chevon.

It can be thus concluded that goat farming in the state has a great potential to support the livelihood of small and marginal farmers.

An Insight on the Control and Managemental Strategies of Major Parasitic Infections of Goats

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Goat industry is mounting over the years as10.1% increase in the goat population is recorded with total 148.88 million goats in India as per 20th livestock census. Small ruminants hold an important niche for sustainable agriculture in developing countries and support a variety of socio-economic functions worldwide. The productivity of the goat industry is influenced by a variety of constraints allied with management and disease. The respiratory infections, skin diseases and gastrointestinal (GIT) diseases including diarrhoea are ranked as important health problems in goats throughout the world (Castro-Hermida et al., 2007). Thus, GIT parasites pose a serious threat to small ruminant production systems as it accounted for about 82.7% of the total losses in goats in India (Pawaiya et al., 2017). Parasites are broadly classified into endoparasites (helminthes, protozoa) and ectoparasites (ticks, mites, lice, fleas). Goat being the poor man's cow contributes significantly in economy of the landless marginally farmers as they rear them for their livelihood and is also a good source of food, fibre, skin and manure. In Indian scenario majority of the goat farmers raised their animals on the extensive grazing management that makes them more susceptible to GIT parasitic infections. These parasites are the major constraints in small and large goat production of the tropical and subtropical parts of the world due to morbidities, reduce weight gain and other production losses as the subclinical infections more common that are difficult to diagnose. The impact of parasites can vary in general due to ecological factors suitable for diversified hosts and parasite species; the epidemiology of GIT parasites in livestock varied depending on the local climatic condition, such as humidity, temperature, rainfall, and vegetation and management practices. These factors largely determine the incidence and severity of various parasitic diseases in a region. An overall prevalence of GIT parasite in sheep and goat of different agroclimatic zones of Punjab 83-84% was reported (Singh et al., 2017; Pawar et al., 2019).

Gastrointestinal nematodes (GIN) parasites: *Haemonchus contortus, Trichostrongylus circumcincta, Ostertagia trifurcata, Trichostrongylus axei, Strongyloides* species, *Cooperia, Paracooperia.* Among these nematodes, *H. contortus* is the most pathogenic predominant, haematophagous parasite (0.05 ml/ parasite/day) and estimated cost incurred on its treatment alone in India is $103 million per annum (Peter & Chandrawathani, 2005). The life cycle of GIN parasites is direct with free living developmental stages (eggs, larval stages L1-L3), parasitic forms (larval stage L3 to L5 and adults). The migration of the larvae in the host cause substantial damage to abomasum (*Haemonchus, Ostertagia* and *T. axei*) and Intestine (*Cooperia, Paracooperia, Trichuris spp*.) Oestertagiosis and trichostrongylosis have similar type of pathogenesis that cause inflammation and leakage of protein into the intestinal tract resulting protein losing gastro-enteropathy. Clinical signs of GIN parasites are anemia, bottle jaw, and

weakness, reluctance to move, exercise intolerance, and weight loss. The change in the colour of the faeces is one of the indicators in acute infections; tarry colour faeces in acute haemonchosis, black colour in trichostrongylosis, and bright greenish colour in oestertagiosis and mucoid greenish diarrhoea in oesophagostomosis (pimply gut infection). Young animals are most susceptible than adults. Severe blood and protein loss into the abomasum and intestine due to damage caused by the parasites often results in oedema, hypoproteinemia and bottle jaw condition. In field conditions mostly mixed infections of above GIN parasites are predominant, so it becomes difficult to rule out these infections routinely in morbid cases. However, if mortality occurs then postmortem examination confirms the genus specific parasites.

Treatment strategies for GIN parasites: GIN parasites are treated and control by broad spectrum anthelmintics: benzimidazole, tetrahydropyrimidines, cholinergic agonists and macrocyclic lactones. The frequent use of anthelmintic and lack of awareness among the farmers about the resistance in parasites to particular drug, anthelmintic resistance (AR) has become a major constraint in the control of the GIN parasites. AR development is a highly multifaceted process which is affected via the host, the parasite, type of anthelmintic and its utilization, animal management and climatic characteristics. Thus, enhancing the challenges for developing the controlling and preventing measures that could vary based on the animal production systems. Only 20% animals in herds are the shedder for 80% of the parasite, accordingly treatment should be given to the targeted animals only. The target selective treatment (TST) based on five check points; eye evaluation for anaemia, back for body condition scoring, tail for soiling with faeces, jaw for swelling and rough hair coat and use of FAMACHA tool. The dose, route and body weight should take into consideration before administration to overcome the problem of anthelmintic resistance. Fasting of animals for up to 24 hours may improve efficacy of dewormers, especially when using benzimidazoles and ivermectin.

The alternative approaches to slow down the development of AR are the development of resistant breeds by cross breeding programme, use of bio-control agents like plants (leguminous grasses), or bacteria (*Bacillus thuringiensis*), predacious fungi (*Duddingtonia flagrans*, *Arthobotrys* spp. & *Monacrosporium* spp), endoparasitic fungi (*Drechmeria coniospora* and *Harposporium anguillulae*) that kill the parasitic and free-living stages of the nematode parasites. Predacious fungi produce specialized adhesive knobs, networks, rings on the mycelium that traps the nematode, while endoparasitic fungi's spores penetrate the cuticle of the parasites and lead to death of worm lodged in the gut. Forage plants that contain high levels of condensed tannins include *Sericea lespedeza* (warmseason legume), birds foot trefoil (perennial legume) and chicory (leafy perennial). Condensed tannins have been shown to reduce gastrointestinal parasite loads in goats by reducing worm fertility, eliminating adult worms, and retarding the establishment of incoming larvae (Waller, 2006).

General control strategies: Proper cleanliness in and around the shed area, proper stocking density to avoid overcrowding, immediate removal of dung pat and disposal in a pit to heap so that eggs, larvae, cyst, or other stages of parasites are killed due to heat generated during

composting (Williams and Warren, 2004). Provide balance diet with vitamin and minerals as it aid in development of resistance to parasites, and results into functional immunity against the parasites (Hughes and Kelly, 2006).

Pasture management: It includes pasture rest, rotation and burning and ploughing of the pasture. The already grazed pasture by sheep and goats should be given rest for at least two months in tropical areas, upto 6 months in temperate areas in order to destroy the free living developmental stages and for the dilution of the contaminated pastures.

Grazing strategies: The grazing management includes animal density (5–7 goats/acre) in order to avoid the overstocking, zero grazing or clean or safe pastures especially for the young animals, alternative species wise grazing and age wise grazing. Under Indian condition the grazing time is more important criteria than pasture management due to non-availability of private land or large paddocks for grazing. It is advised to take the animals for grazing when there is sufficient sunlight, not too early in morning or in late evening or in the rainy day, as most of the infective larval stages available on the tip of the forages. Most of the endoparasitic infections predominate in rainy season so keep the animals on intensive system during this season. Graze the animals on the grass having height up to 10 cm from the ground, as the larvae or intermediate host prefers to be in the soil, on the dry grass.

Trematodes/Flukes: These are the snail borne parasites. The commonly flukes in the goats are different types of the paramphistomes (ruminal flukes) and *Fasciola* (liver fluke*). Fasciola hepatica* and *F. gigantica* (common liver fluke) requires *Lymnaea luteola* and *L. auricularia* snail. *Dicrocoelium dendriticum* is comparatively small liver fluke life cycle includes snails and ants as intermediate host**.** These burrow tunnels in the liver, causing scarring as the body tries to repair the damage. Because scar tissue is not functional, the liver loses part of its normal function, which includes filtering the blood of toxins and waste products. The accumulation of these toxins in the animal's blood can severely damage other organs, including the brain. Clinical signs of trematodal infection are poor appetite, lethargy, weight loss, jaundice, bottle jaw condition, acute cases die suddenly, profuse watery diarrhoea in amphitomosis. Antitrematodal drugs are rafoxanide (7.5 mg/kg orally), oxyclozanide (15 mg/kg orally) and nitroxynil (10 mg/kg, s/c).

Cestodes/Tapeworm: These are ribbon or tape like worms found in the GIT tract includes *Moniezia* spp., *Aviteillina* and *Stilesia* spp. do not show any clinical signs except in case of heavy infections cause intestinal obstruction that predisposing the animals to enterotoxemia and, potentially, intestinal rupture. Tapeworms have indirect life that includes oribatid mites as intermediate host. Presence of yellow or white segments of cooked rice grain is indicative of the tapeworm infections. The drug of choice for tapeworm is praziquantel @ 10 mg/kg, but fenbendazole (10 mg/kg), albendazole (10mg/kg), oxfenbendazole (10 mg/kg) and niclosamide (50 mg/kg) orally also found effective.

Protozoan Parasites: Major protozoan infections of goats are coccidiosis, cryptosporidiosis and toxoplasmosis. Coccidiosis is a predominant enteric parasitic infection, 13 species of *Eimeria*

worldwide, but from the Punjab state seven species of *Eimeria*; *E. ninakohlyakimovae, E. arloingi,E. caprovina, E.alijevi*, *E. christenseni, E. hirci* and *E. jolichevi* are reported (Kaur et al., 2019). Kids between 3- 4 months are the most susceptible due to no immunity to these parasites. Adult goats normally shed low numbers of oocysts and a source of infections to the young animals. Coccidiosis is clinically characterized based on bloody diarrhea not as common as in calves, straining, weight loss and dehydration and death. Subclinical infection can result in poor weight gain, poor hair coat, and an unthrifty appearance. The anticoccidials approved for use in goats are decoquinate (0.5- 1 mg/kg b.wt), monensin (20 g/ton of feed) and amprolium, @ 25-50 mg/kg/day for prevention (for 21 days) and for treatment (5 days). Two form of cryptosporidiosis in goats are as clinical neonatal diarrhoeic syndrome and asymptomatic form (Castro-Hermida *et al.* 2007). Clinical entity includes depression, anorexia, abdominal pain accompanied by abdominal discomfort and white to yellowish diarrhea with unpleasant odour.

Toxoplasmosis is abortion causing disease caused by apicomplexan unicellular parasite *Toxoplasma gondii*. Goats get infected with *T. gondii* when they ingest the oocyst while grazing or feed on roughages contaminated with cat feces. In most cases, the adult ewe or doe does not show any signs of infection before or after the abortion. If clinical signs are noticed, they usually include fever and neurological problems. Ewes that are infected before breeding usually will not abort. Those that are infected early in their pregnancy (30-60 days) will often resorb or mummify the fetus. In abortion cases examination of the placenta for demonstration of the organisms, necropsy revealed small areas of necrosis and calcification that appear grayish to yellow on cotyledons. It is also possible to test the placenta, and fetal fluids, brain, muscles, or lungs for the presence of the *T. gondii* organism. The presence of antibodies in 39.60% tested goats from the Punjab by ELISA test observed. The animals with history of abortion and farms having access to the cats were the main risk factor responsible of toxoplasmosis (Pandit et al., 2021). The control programme should focus on the prevention of feed water contamination with the cat faeces and proper carcass disposal of dead animals, aborted foetus and placenta in order to avoid access to the cats.

Haemoparasitic infections: The tick borne haemoprotozoan infectio of goat are anaplsmosis, babesios and theileriosis. Anaplasmosis caused by *Anaplasma ovis* , transmitted by ticks of genera *Boophilus*, *Rhipicephalus*, *Ixodes* and *Hyalomma*. Mechanical transmission may occur via biting dipterans flies, mosquitoes and by iatrogenic route of use of contaminated needles or dehorning or other surgical instruments. Babesiosis caused by *Babesia ovis* and *Babesia motasi*, transmitted by *Rhipicephalus bursa* and *Haemaphysalis* spp., respectively. However, malignant theileriosis is caused by *Theileria ovis*, *T. separata*, and *T. recondite* and *T. hirci* which are transmitted by *Hyalomma anatolicum anatolicum.* The clinical symptoms of all these haemoparasitic infection generally overlapping are fever, anemia, jaundice, loss of coordination, breathlessness, diarrhoea, prostration and death. The microscopic examination of blood smears stained with Romanowsky stain prior the treatment is mandatory, to decide the precise treatment of the exact cause of infection. The treatment regimen for anaplasmosis includes long-acting oxytetracycline at a dosage of 20 mg/kg, IM. Babesiosis can be treated with diminazene @ 3.5

mg/kg, IM and imidocarb @ 1.2 mg/kg subcuteneously. Buparvaquone is effective against theileriosis at a dose rate of 20 mg/kg body weight, intramuscularly.

Ectoparasites: Goats can suffer from a range of external parasites; ticks, mites, lice, fleas and flies. Ticks are the major ectoparasites of the livestock and in India *Boophilus microplus, Hyalomma anatolicum anatolicum, Haemaphysalis* spp affects the goats. Ticks cause direct (tick worry, tick toxicosis) and indirect (reduced growth, milk and meat production, damaged hides and skins, myiasis, vector borne transmission potential) losses to the animals. Acaricide application is the most widely used and effective method of tick control but it led to development of acaricide resistance. Ticks can live on the ground for up to 300 days without feeding. Treat the animals with acaricides in case of heavy tick infestation. Otherwise, remove the tick manually when present in little number. Quarantine measures of the new entry into the herd and treatment with acaricides should be followed. Lice (permanent ectoparasite) unlike ticks have a marked degree of host specificity, even sheep and goats having their own distinct species. *Linognatus, Damalinia* species are found in goats. Lousiness causes unthriftiness, matted, dull fleece with tufts of wool, reduced weight gain and production loss. Lice are also associated with development of cockle. Spraying or dipping with insecticides is effective, but it should always be carried out twice, the first time to kill the lice currently on the body, the second 14 days later to kill lice hatching from eggs present at first treatment.

A mite of genera *Psoroptes, Sarcoptes* and *Demodex* causes the mange in the goats. *Sarcoptes scabei* var *capri* is more pathogenic mite burrows deep into the skin, cause small red papules of the skin, severe itching and scratching, loss of hair, thick brown scabs and thickening and wrinkling of surrounding skin. Demodecosis or follicular or red mange caused by *Demodex* that invades hair follicles and sebaceous glands of all species of domestic animals, more severe in goats. It forms thick scabs overlaying the skin round the eyelids, nose, the brisket, lower neck, forearm and shoulder and the tips of the ear. Demodectic mange causes small nodules and pustules which may develop into large abscess. In severe cases there may be a general hair loss and thickening of the skin. *Psoroptes* is a non-borrowing mite live on the surface of the skin and most rarely found in goats than sheep (sheep scab).

Different categories of insecticide and acaricides are commercially available are Synthetic pyrethroids : deltamethrin (12.5%; 2-3 ml/L ticks, 4-6 ml/ L for mites and 1-1.5 ml/L for lice), cypermethrin (10%;1 ml/L on body, 5 ml/L), flumethrin (6% solution, 10% pour on; 1ml/2 liter in water, 1ml/10 kg b. wt as pour on preparation); Avermectins: doramectin and ivermectin (0.2 mg/kg b.wt s/c or 2.5 ml/10 kg b.wt orally); Formamidines: amitraz (12.5%; 2 ml/L of water for ticks, 4 ml/L for mite, lice). Precautionary measure for these drugs should be taken care off are use only when required as injudicious use lead to resistance, read the instruction given on label carefully, DO NOT treat goats just before slaughter, check the withdrawal time of acaricides. Seal with cement or mud all cracks in the floor and walls of shed housing.

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The Common Diseases of Goat in Punjab and their Prevention

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Livestock is the most prospective sector. It addresses the problems of landless, small-scale and marginal farmers by helping in the alleviation of poverty. Sheep and goat are very important species of the livestock sector. They are a promising source of nutrition and have an important role in uplifting the rural economy of developing countries. Small ruminants particularly in Punjab are mainly reared by small and marginal farmers which represent mostly the poorer sections of society. Due to intensification of small ruminant farming, there is increase in the number of disease outbreaks in the recent years and causes severe economic loss to the goat farmers. Several diseases cause acute infection hence there will be sudden onset of infection leading to huge mortality. Measures like use of vaccines before onset of disease, good management practices, etc., are essential to prevent the disease outbreaks. The present manuscript describes various diseases affecting small ruminants in Punjab and its preventive measures.

Pestes des petits ruminants (PPR)

PPR is highly contagious viral disease of domestic and wild small ruminants caused by *Moribilli- virus* belonging to family *Paramyxoviridae* and is clinically similar to rinderpest making differential diagnosis difficult. The country is now free from rinderpest, but unfortunately, PPR has become endemic in the country.

- Clinical signs exhibited include fever (105-107^{o}F), ocular and nasal discharges, white cheesy deposits on the tongue and gums, labored breathing and occasional cough,feces are loose and watery that soil the posterior region of the affected animals.
- Post mortem lesions include inflammatory and necrotic lesions in the oral cavity and throughout the GI tract; “zebra stripes” of large intestine.
- Samples required include unclotted blood, serum, swabs of nasal and rectum, mediastinal and mesenteric lymph node, spleen, lungs, tonsils.
- Confirmation of disease can be done by sandwich ELISA (which is rapid and sensitive, and differentiates between PPR and rinderpest), virus isolation and PCR
- There is no specific treatment, however, broad spectrum antibiotics to control secondary bacterial complications can be given along with supportive therapy
- A live attenuated cell culture vaccine for PPR provides immunity for more than five years and booster immunization is not required. The vaccine is safe in animals older than 3 months including pregnant animals.

Foot and mouth disease (FMD)

FMD is highly contagious disease enlisted in OIE list of notifiable diseases that infects cloven-hoofed animals *viz.* cattle, buffalo, sheep, goat, pig, camel and deer. The disease is caused by an aphthovirus (family Picornaviridae), which has seven major serotypes O, A, C, Asia 1 and Southern African Territories (SAT 1, SAT 2, SAT 3). Out of these serotypes (O, A, C, Asia 1) C strain has not been reported from India from last 20 years so this strain has removed from vaccine. Small ruminants play an important role in the epidemiology and transmission of Foot-and-Mouth Disease (FMD). The main reasons therefore are: FMD is difficult to diagnose as infected sheep not always show typical clinical symptoms or as the cardinal signs mimicked other diseases.

- Sheep and goats are considered maintenance hosts and show mild clinical signs viz. fever, oral lesions and lameness.
- Sample collection: Vesicular epithelium from the lesions, whole blood, serum sample and esophageal-pharyngeal fluid.
- Laboratory diagnostic techniques include sandwich-ELISA, NSP-ELISA (Differentiation of vaccinated and infected animals) and PCR. Can also perform virus isolation.
- The symptomatic treatment includes antibiotics to check secondary bacterial infection, anti-inflammatory and antipyretic drugs. In addition, antiseptic mouth and teat wash can be given with potassium permagnate solution (1: 1000) or 2-5% povidine iodine solution. Besides, boroglycerine paste can be applied on mouth ulcers. The feet should be dipped in phenyl or 2% copper sulphate. In addition, provide easily chewable diet to the animals like dalia and lush green fodder.
- During an outbreak, steps to control FMD may include vaccination, surveillance, quarantine measures, establishment of control zones, strict biosecurity, reporting of confirmed cases, and hygienic measures. In event of an outbreak, modified vaccination programs include 'Ring vaccination' to contain the outbreaks and 'Frontier vaccination' to produce a buffer area between the infected and free countries.

Goat Pox/Sheep pox

Goatpox and sheeppox are caused by a genus of Capripox virus of the family Poxviridae. The virus enters via the respiratory tract and transmission commonly is by aerosol and infection is usually associated with close contact with infected animals. After the virus get in to the body of sheep and Goat it has five developmental stages. This disease is more severe in young animals than adults;

- Fever (106^{o}F), ocular and mucopurulent nasal discharge and difficult breathing; vesicle and pustule formation over the entire body surface mainly in the region of sparsely wooled area involving nostril, lip, ventral surface of tail, medial region of thigh, inguinal and udder region.

- Postmortem examination: Nodular lesion on the lung and whitish necrotic areas in kidneys. Histopathologically, there is eosinophilic intracytoplasmic inclusion bodies characteristic feature of sheep pox.
- Samples required: Skin biopsies, lymph nodes, lung lesion and serum sample
- Diagnosis: History, Clinical signs, histopathological lesions and the confirmation of the disease by capripox diagnostic PCR.
- All diseased animals should be treated with broad-spectrum antibiotics to restrict secondary bacterial infections.
- Since this disease has no effective treatment, it is essential to vaccinate sheep and goat flocks regularly on an annual basis with a safe and efficient vaccine for the control of this serious and economically important disease in endemic regions.

Contagious pustular dermatitis (orf)

Contagious pustular dermatitis is caused by orf virus classified in the genus *Parapoxvirus* of the family *Poxviridae*. It is a non-systemic eruptive skin disease of sheep and goats transmissible to human beings.

- The virus generally causes proliferative and crusty lesions in the skin of the lips, around the nostrils and oral mucosa. Animals are also having difficulty in taking feed as a result of lesions on the mouth.
- Sample required**:** Scabs with underlying tissue scrapings.
- Treatment**:** Broad spectrum antibiotics, removal of scab and local antibiotics, soft feed to animals should be given.

Brucellosis

Caprine brucellosis is an infectious zoonotic disease having substantial economic impact on both livestock and human. The causative agent is *B. melitensis* that are small, non-motile, non-spore forming, gram-negative coccobacilli.

- Infection occurs primarily through ingestion of the organisms. Goats acquire infection by licking the aborted fetuses, placentas, newborn kids, vaginal discharges, or by consumption of feed contaminated with these infectious materials.
- Clinical manifestations include high abortion rates particularly during the fourth month of pregnancy and retained placentas, orchitis in bucks, arthritis and hygromas. In goats, mastitis and lameness may also be seen.
- Various diagnostic techniques have been used for the detection of brucellosis in small ruminants including CFT, RBPT, iELISA, PCR, bacteriological isolation etc.

Tuberculosis (TB):

Tuberculosis (TB) is an infectious, chronic, debilitating and granulomatous disease caused by acid-fast bacilli of the genus *Mycobacterium.*

- Lesions caused by *Mycobacterium bovis* in the lungs and lymph nodes of sheep and goats are similar to those seen in cattle, and the organism may sometimes disseminate to other organs.
- Sheep and goats are quite resistant to *M tuberculosis* infection. The intradermal skin test is commonly used for diagnosis.
- The comparative tuberculin skin test conducted in the cervical region using biologically balanced purified protein derivative tuberculins of *M bovis* and *M avium* can be used to differentiate sensitization to other mycobacteria. The responses should be observed at 72 hr for induration and swelling.

Paratuberculosis (Johne's disease/JD):

JD is caused by Mycobacterium aviumsubspecies paratuberculosis, a fastidious, acid-fast, gram-positive rod

- The organism is present in the environment and animals at young are affected either through ingestion of contaminated milk or direct contact. Infected goats may excrete the bacteria in the feces thereby contaminating the environment.
- The incubation period is usually months to years. Chronic wasting is a characteristic sign in goat and at times pasty feces or diarrhea (in advanced cases) can be witnessed. In advanced cases the animals may lose weight rapidly and will have a hide and bone condition.
- During PM examination intestine of the affected animals have a corrugated appearance
- History: progressive weight loss (despite a good appetite), bottle jaw, lethargy, diarrhea in some cases, decreased milk production, enlargement of regional lymph nodes, and death.
- Acid fast staining of fecal smear
- Advanced diagnostic tests: serum and milk ELISA, PCR.

Listeriosis

Listeriosis caused by *Listeria monocytogenes* is an infectious disease affecting wide range of animals including ruminants, monogastric animals and man. The disease occurs in three forms encephalitic, septicemic and abortions however, encephalitis is the most prevalent manifestation in sheep.

- In encephalitic form, nervous symptoms of circling, unilateral facial paralysis, unilateral blindness, dropping of ears and jaw. The infection results from trigeminal nerve infection consequent to abrasions of the buccal mucosa with feed or infection of tooth cavities.
- Cerebrospinal fluid reveals higher concentration of total proteins with increase in globulins.
- Histopathologically, micro-abcesses and perivascular cuffing in the brain are pathognomonic lesions of disease.
- Sample required: Brain stem (Medulla oblongata, Pons and cerebellum).
- Diagnosis can be made by characteristic clinical symptoms, histopathological findings isolation of organism, Immunohistochemistry and PCR.

- Drug of choice: Penicillin-G @ 44000 IU /kg body weight daily intramuscularly for 1-2 weeks.

Enterotoxemia (Overeating Disease)

Enterotoxemia, also known as overeating or pulpy kidney disease, is a condition caused by the absorption of a large amount of toxins produced by *Clostridium perfringens* types C and D in the intestines.These bacteria are found in the soil and as part of the normal microflora in the gastrointestinal tract of a healthy goats and sheep.

- Under certain conditions, these bacteria can rapidly reproduce in the animals, producing large quantities of toxins.
- C. perfringensType D primarily produce enterotoxamia and Type C sometimes causes sudden death in goats.
- Grain-fed kids (3–12 weeks old) on a high-concentrate diet are most susceptible, but adult goats may also be affected. Goats are commonly affected with a hemorrhagic form of enterotoxemia.
- The peracute condition is characterized by sudden death of younger and healthy kids. This is occasionally preceded by other signs such as loss of appetite, lack of rumen activity and rumination, bloat, depression and a drunken appearance; the animals may show neurological signs such as incoordination, inability to stand, and convulsions. There may be watery diarrhea and glucosuria.
- In goat's acute disease is mainly characterized by dysentery, abdominal discomfort and convulsions.
- In acute cases of goats, the necropsy findings include pulmonary edema, necrosis of intestinal walls and scattered hyperaemic areas of intestine. Intestinal contents may be green, blood-stained or mucoid, and fibrinous casts may be present in the lumen of the large intestine. Mesentric lymph nodes may be edematous. Fluid accumulation in the pericardial sac, extremely necrotic, soft kidneys ('pulpy kidneys'), focal encephalomalacia, and petechiae of serosa of the brain, diaphragm, gastrointestinal tract and heart are common findings.
- Diagnosis of enterotoxaemia depends on epidemiological features, type of diet, clinical and pathological features. Gram positive rods can be demonstrated in the smears of intestinal contents or in the lesions of intestine. The culture of bacteria from fecal samples in cooked meat media may be suggestive of the disease
- Vaccination of all animals in the herd against *Clostridium perfringens* types C and D is generally effective in preventing enterotoxemia.

Tetanus

Tetanus (Lockjaw) is an acute, highly fatal intoxication of all domestic animals and humans caused by neurotoxin(tetanospasmin) produced by the bacteria *Clostridium tetani*. Though all species of livestock are susceptible, sheep and goats are more susceptible than cattle and horses being the most susceptible.

- It is characterized by hyperasethesia, tetany and convulsions. The etiological agent, Clostridium tetani a strictly anaerobic, motile, slender, straight, spore forming (‘drumstick appearance’)’
- Spores are introduced into the tissue through wounds, specifically deep puncture wounds that provide the favorable anaerobic environment. Most outbreaks occur following mass contamination of animals during castration, vaccination, ear tagging, docking and other surgical procedures
- Diagnosis can be made based on clinical features such as muscular spasms, prolapse of third eyelid and based on history of trauma or surgery. The Gram-positive rods with terminal spores can be demonstrated in the smears prepared from necrotic tissue or wound

Disease control and prevention

Animals with infection or clinical signs should be separated from rest of the animals so that infectious pathogens do not transmit to naïve animals and it is also recommended to quarantine newly purchased animals before admitting them into the farm. These practices can curtail the spread of infectious agents. It is also advisable to screen for diseases before purchasing the animals to the farm.

Vaccination is the most successful and cost-effective way to control, eliminate or even eradicate an infection at the population level or to prevent clinical signs of disease. When epidemiological conditions make containment and control of an infection extremely difficult, then combination of strong biosecurity measures and mass vaccination can effectively stop the spread of the disease.

Vaccination Schedule

There is no single universally accepted vaccination schedule, but vaccine to be used depends on the prevalence of that disease in particular area or farm.

Sheep/ Goats

Disease	**Primary age**	**Revaccination**	**Remarks**
Peste Des Petits Ruminants (PPR)	3-months	Every year preferably in Dec-Jan	
Sheep pox	3-months	Annual preferably in Dec-Jan	Vaccinate after lambing season or during onset of breeding season
FMD	4-months	Twice a year preferably in Sep-Oct and Feb-March	
Enterotoxemia	4-months if dam vaccinated, and at 1-week if dam	Booster 2-3 weeks after primary vaccination and then biannually	

	unvaccinated		
HS	6-months	Biannual before monsoon	
BQ	6-months	Annually before monsoon	
Tetanus (Tetanus Toxoid)	3-4 months	Booster 6-8 weeks after primary vaccination and then annual	Usually done prior to surgery and wound treatment In pregnant animals, primary dose at 3rd month and booster dose at 4th month of gestation

* Some areas, vaccination against blue tongue and anthrax is also recommended