REPRODUCTIVE PATTERN AND PERFORMANCE OF NANNY GOATS IN KERALA

By

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THESIS

Submitted in partial fulfilment of the
requirement for the degree

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DECLARATION

I hereby declare that this thesis entitled **"Reproductive Pattern and Performance of Nanny Goats in Kerala"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Mannuthy,

27 - 1 - 1992.

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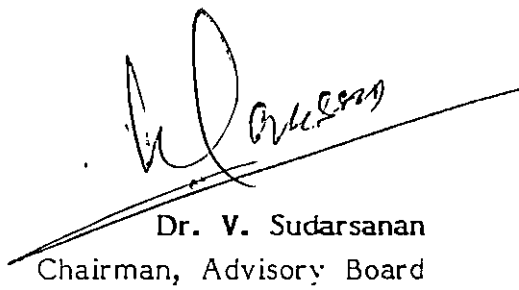
CERTIFICATE

Certified that this thesis, entitled **"Reproductive Pattern and Performance of Nanny Goats in Kerala"** is a record of research work done independently by **Dr. G. Krishna Kumar** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship, or associateship to him.



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INTRODUCTION

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G. KRISHNA KUMAR

CONTENTS

INTRODUCTION

INTRODUCTION

Goat is one of the earliest domesticated animals. Goat keeping in India is an avocation particularly of the rural population. How it is well knit into the socio-economic fabric of rural India is evident if a comparison of the trend of population of goats for the last 30 to 40 years is made to that of the human population. During the period, the human population has almost doubled, and so was the goat population. Goat is contributing to the national economy through the produces from it as milk, meat, skin, pashmina and manure. Probably low input, relatively higher income, high manoeuvrability and low risk of goat keeping are the reasons that prompted it to become more popular among the small and marginal farmers and among the landless labourers.

Goat keeping in Kerala and its socio-economic influences are also not different from the national trend. Here also during the last 40 years, the goat population has almost doubled. But unlike the rest of the country there is no sheep rearing in Kerala. Exclusion of the sheep from this geographical area is reasonably due to the climatic peculiarity of the region. Whereas the growth rate of goat population is well in consonance with the growth trend noticed in goats elsewhere in the country. Both sheep and goat, though identified as short

day polyoestrous species in subtropical regions, they were found to be polyoestrous in the tropical regions but with seasonal peaks. This change in the reproductive pattern is due to the seasonal and climatic variations that ensure fodder and pasture availability and survival of the young ones.

The state of Kerala comprising of a total geographical area of 3.88 million hectares, lies in north latitude between 8°-18° and 12°-48° peculiar by its location and boudaries, has a unique climate which is not only distinct from the rest of the country but also from the neighbouring states. Near total exclusion of sheep in the region also makes one believe that there is a climatic distinction not favouring its multiplication. The climate being unique to favour the multiplication of goat the pattern of reproduction which is well documented to be subject to climatic influences can be reasonably presumed distinct for the region. Elucidation of the pattern and the peaks will no doubt help to achieve a better economic exploitation of the prolificacy of the species. Prompted by the above the present study was taken up.

Cattle including sheep and goat are generally smaller in the tropical region compared to their size in subtropical regions. Scientists in their attempts to elucidate reasons for this size difference have designed experimental tropical climates and have studied the influence of the climate on placental development, foetal growth and birth weight. So also

there are many reports on the effects of the tropical heat on the growth rate of the foetus of the animals which were subjected to the exposure. The results of the above experiments suggest that the tropical heat and the consequent disturbances in the homoeostasis can cause embryonic loss, retarded placental growth and runting of foetus. Kerala with a mean maximum environmental temperature above 30°C throughout the year which is well above the comfort zone for Indian cattle of below 26-27°C reported by Appleman and Owen (1970), is to have the adverse effects on reproduction. This may be significant when the maximum environmental temperature rises above 35 to 40°C during certain periods of the year as March to May and September to November. It was under the above context that the environmental temperature effects on the sex of kids and the birth weight of kids were also taken up in the present study.

When the study was taken up with the above two major objectives, all incidental studies on parameters as durations of oestrus, of cycle and of gestation, conception percentages, incidence of multiple pregnancies, stages of parturition and secondary sex ratio were also included. This thesis embodies the findings of an investigation conducted on the above lines for a period of one year.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

2.1 Oestrous cycle

2.1.1 Pattern of cycle

Goats have been observed to be polyoestrous in their sexual behaviour (Perry, 1969). They are also reported to be seasonally polyoestrous, to have their young ones during the most favourable time of the year (Hafez, 1987). Their breeding season in the temperate climate according to Maule (1962) is from September to March when the day is short. The characteristic pattern of short day polyoestrous behaviour is not being maintained throughout the world. Gonzalez and Castillo (1971) observed that in French Alpine, Saanen, Toggenburg and Criollo crossbred goats maintained in a tropical zone of Venezuela, 82 per cent of all heats took place during summer, beginning in July. In the tropical climate where the length of day and night are almost equal, they breed throughout the year (Nimo, 1972 and Devendra and Burns, 1983).

Though goats are polyoestrous in the tropical area, seasonal peaks in oestrous behaviour are appreciable. Goel and Agrawal (1988) in their study on Jamnapari, Barbari and Jakhrana does stationed at Mathura, observed that in Jamnapari, oestrus incidence was much higher from May to July (Average 22.57%) and

September to October (Average 36.96%) in comparison to the rest of the year when it was the lowest. They have also observed a similar pattern in Barbari goats. In Jakhrana does, though a higher incidence was observed in May to June (Average 37.74%) and October to December (Average 37.97%) compared to the rest of the year, the number of animals that exhibited oestrus during the latter period did not fall very low as in Jamnapari and Barbari. The authors concluded that there is a trend of seasonality in oestrus incidence in all the three breeds of goats maintained in North India.

Rajkonwar and Borgohain (1978) and Bhadula (1980) reported that in the local goats of Assam, the highest incidence of oestrus was in the month of May. The former authors also noticed another peak during November and October.

Abdelaziz et al. (1982) observed that in Nubian goats, oestrus occurred mostly during January, June and September.

In Deshi goats of Bihar, the highest number of oestrus was noticed during the month of October and the lowest during March (Biswas, 1966 and Singh et al., 1978).

In Jamnapari does, incidence of oestrus was maximum during June (51.2%) and it was minimum during January to May (0%) (Wani et al., 1980). Month-wise distribution of oestrus during 1976-78 showed that there is difference between months but not between years.

2.1.2 Duration of cycle

The length of normal oestrus cycle is 21 days in goats although considerable variation due to breed differences, stage of the breeding season and environmental stress occur in the species. Abnormally short cycles observed early in the breeding season may be associated with prematurely regressing corpus luteum or anovulation (Ott, 1981; Corteel et al., 1982; Riera, 1982 and Hafez, 1987). Similarly long inter oestrous intervals are quite possible with aged animals (Camp et al., 1983). Suboestrous or extremely short oestrous interval are the prime factors for the occurrence of long inter oestrous interval (Van Rensburg, 1971).

Prasad and Bhattacharya (1979) reported that the inter oestrous interval of Barbari nannies was found to be 19.18 ± 0.38 days. But, Mittal (1981) after a similar study observed that they came into oestrus at an interval of 18.18 ± 0.31 days. The latter authors also reported that in Jamnapari goats, the length of oestrous cycle was 17.29 ± 0.73 days. But, according to Setiadi et al. (1988) Etawah (Jamnapari) goats have an average inter oestrous interval of 20.5 ± 3.6 days (range 7 to 28 days).

Mathai (1986) observed that Alpine-Malabari crossbreds came into oestrus at a mean interval of 21.174 days and it was very much similar to the interval of 21.4 days observed by

Ramachandriah et al. (1986) in native does. The inter oestrous interval in local Malvi goats was observed to be 24.2 ± 1.45 days (Quereshi et al., 1991) and that of Pashmina goats to be 20.39 ± 0.39 days (range 18-23 days) (Bhattacharya et al., 1981).

Phillips et al. (1943) documented that the oestrous interval of Toggenburg and Saanen goats were the same and ranged between 18 and 24 days. The oestrous cycle length of 23 days reported for French Alpine was also within the same range (Ricordeau and Bouillon, 1975).

Jarosz et al. (1972) reported that inter oestrous interval of Toggenburg does was 19.82 days and that of Toggenburg-West African dwarf crosses were 19.07 and 19.0 days. Between the crosses there was no significant variation in the interval. They have also observed that the above genotypes of does have a significantly shorter inter oestrous interval than that of West African dwarf goats (23.89 days). However, Otchere and Nimo (1975) reported a wider variation of 24.0 ± 9.9 days in the length of oestrous cycle of West African dwarf goats. The variability in the interval was observed to be minimum (19.05 ± 0.65 days) in Philippine goats (Sah and Rigor, 1985).

2.1.3 Duration of oestrus

Oestrus lasts 24 to 48 hours in the doe. Duration of oestrus is influenced by breed, age, season and presence of the

male. Oestrus is of shorter duration at the beginning and end of the breeding season, in the presence of male, and in the first breeding season of young females (Hafez, 1987). Sahni and Roy, (1967) reported that the duration of oestrus of Barbari goats was 24-36 hours with an average of 30 h, while Prasad and Bhattacharya (1979) and Mittal (1981) observed it to be 40 hours in the same breed. Mittal (1981) has also stated that the duration of oestrus of Jamnapari goats (36.42 ± 0.86 h) was found to be lesser than that of Barbari.

Mishra and Biswas (1966) observed that the length of oestrus of Deshi goats of Bihar was 37.6 ± 1.3 hours. Ramachandriah et al. (1986) also after a similar study in native goats, found that their observations well concurred with the earlier reports. Oestrus length of Pashmina goats was found to be 21-51 hours by Bhattacharya et al. (1981). From the above, it could be seen that there was no significant difference in the duration of oestrus of the non-descript and the descriptive breeds of Indian goats. Such a difference was also not significantly evident between the different breeds of Indian goats.

Oestrus length of Saanen and Toggenburg goats according to Carmenate (1977) varied from 16 to 48 hours, with around 65 per cent of them having a duration of 24-36 hours. Difference between the breeds was also reported to be non-significant. Egyptian Baladi goats under semi-arid conditions have an oestrus

length of 38-50 hours (Younis et al., 1988). Otchere and Nimo (1975) reported that the period of oestrus in West African dwarf goats was 17.0 ± 9.7 h while Akusu and Egbunike (1990) found it to be 31.1 ± 1.7 h. A wide variation of 12-48 hours in the length of oestrus has been reported in the Nubian goats (Abdelaziz et al., 1982.

Gonzalez and Madrid (1982), Simplicio et al. (1982) and Sah and Rigor (1985) studied the duration of oestrus of native goats of Venezuela, of North East Brazil and of Philippines, to conclude that the durations were 0-51, 12-192 and 3-51 hours respectively.

A critical look at the above reports will reveal that irrespective of geographical location and of the breeds, the goats the world over manifest behavioural oestrus for a period of 24-36 hours.

2.2 Gestation

2.2.1 Pregnancy rate by artificial insemination

Measurement of fertility is an important aspect that should get due consideration for the successful management of any breeding programme. Blokhuis was reported to have attained 48.51 per cent pregnancies with single insemination in goats (Perry, 1969). Sahni and Roy (1967) reported that 52.9 per cent

of the goats conceived artificial insemination at the first oestrus and the rest at the subsequent oestrus with an overall conception rate of 88.5 per cent.

In Malabari goats, Sudarsanan and Raja (1973) reported that the conception to first insemination was 55.2 per cent and to three inseminations was 75.8 per cent. Ricordeau and Bouillon (1975) reported that conception to artificial insemination in French Alpine goats was as low as 21.0 per cent early during the breeding season but, it rose to 60.5 per cent late during the season. Bhadula (1980) observed that in the local goats of Assam, the conception rate to single artificial insemination with extended semen was 54.0 per cent and overall was 72.0 per cent with four inseminations.

The conception rate in goats following artificial insemination was 55.76 per cent (Mathai et al., 1980). Mathai and Nair (1981) reported that the conception percentage to a single artificial insemination in goats was 42.78 per cent. Greesh Mohan et al. (1983) observed an overall fertility rate of 80.9 per cent when artificial insemination was performed on Pashmina goats.

2.2.2 Gestation period

Gestation period of goats, the duration between the date of successful insemination and the date of parturition varies from 144 to 149 days (Hafez, 1987). Gestation period of

Malabari goats was reported to be 146.2 days (Sudarsanan and Raja, 1973). Kuriakose (1981) reported the duration to be 146.66 ± 0.53 days in the same farm but comprising of Malabari, Alpine x Malabari and Saanen X Malabari. In Beetal goats and its crosses with Alpine and Saanen, Mehla and Mishra (1980) observed that the gestation lengths respectively were 148.9, 151.5 and 148.76 days. Beetal when bred with Black Bengal males, the gestation length was 142.4 days with singlet and 139.3 days with twins (Singh and Singh, 1983). Mishra et al. (1979) reported an average gestation period of 146.42 ± 0.24 days for Sirohi and Beetal x Sirohi. Larger among the Indian breeds of goats are reported to have longer gestation lengths. According to Khan et al. (1981), Jamnapari goats have a duration of 149.78 ± 0.41 days.

Garcia et al. (1976) observed that the duration of gestation in Nubian, Alpine, Toggenburg and Saanen goats averaged 149.3 days whereas Peaker (1978) reported an overall median gestation period of 150 days in British Saanen goats. Litter size is reported to have a significant inverse relationship with gestation length (Peaker, 1978; Singh and Singh, 1983 and Verma et al. (1990). But Prasad et al. (1971) and Badawy and El-Bashary (1972), on the contrary reported that the type of birth has no significant infuence. Female foetuses were seen carried for a shorter period than the male (Shelton, 1960; Verma et al., 1990). But Kuriakose (1981) and Amoah and Bryant (1983) did not find the sex of foetus to have an influence on gestation period.

2.2.3 Incidence of multiple pregnancies

Number of foetuses in a pregnancy is influenced by age, parity and environment, particularly the nutritional status of the doe. Roberts (1971) quoted Richter to say that in goats 63.3 per cent are twin births.

In the Malabari breed of goats reared in a Government farm, Nair and Raja (1973) observed that the incidence of singlet, twin, triplet and quadruplet births were 54.8, 39.8, 5.1 and 0.3 per cent respectively while Sudarsanan and Raja (1973) reported the incidence to be 47.06, 35.29 and 17.65 for singlets, twins and triplets respectively. In a flock comprising of Malabari, Alpine x Malabari and Saanen x Malabari, Kuriakose et al. (1983) observed that the incidence of multiple pregnancies was 51.2 per cent. In Malabari goats maintained in Tamil Nadu, Prakasam et al. (1987) observed 35.64 per cent twins and 0.99 per cent triplets with an overall incidence of 36.63 per cent multiple pregnancies.

In Beetal, Black Bengal and Jamnapari breeds of goats, the incidence of multiple pregnancies was 76.0, 77.6 and 38.09 per cent respectively (Amble et al., 1964; Moulick et al., 1966 and Khan et al., 1981). Gill and Dev (1972) found 52.07 and 57.68 per cent incidence of multiple pregnancies respectively among French Alpine and Anglo Nubian goats maintained in India.

2.3 Parturition

2.3.1 Stages of labour

The process of parturition has traditionally been divided into three stages and they do neither start nor end abruptly but pass gradually from one to the other. Duration of the stages varies widely particularly with a single oversized kid, with twins impacted in the birth canal or with an abnormal presentation (Hafez, 1987).

Information on the time taken for each stage of parturition in goat is scanty. Tiwari et al. (1969) reported that the second and third stages of parturition were 22.8 ± 3.0 and 150 ± 4.0 minutes respectively. Though they have classified parturition into 3 stages as given by Arthur et al. (1989) no mention is seen about the time taken for the first stage.

Kuriakose (1981) reported that there was no variation in the duration of first, second and third stages of parturition, between Malabari, Alpine x Malabari and Saanen x Malabari and the duration of the stages, varied from 45 to 355, 10 to 43 and 50 to 290 minutes.

2.3.2 Secondary sex ratio

Male and female ratio at birth among the caprine species was found to be favouring the former by most of the workers. Mittal (1976) found the ratio to be 55.2 : 44.8 in Barbari

goats. Bhadula (1980) reported a ratio of 55.7 : 44.3 in the local goats of Assam while, with local Malvi goats, Quereshi et al. (1991) obtained a ratio of 54.8 : 45.2.

Notte and Mansilla (1979) noticed that in a herd of 280 Anglo-Nubian x Puira Criollo goats, percentage of male kids was 52.5. The ratio reported by Tantawy and Ahamed (1960) in small Baladi goats was 56:44. In Red Sokoto goats, the percentage of male kids at birth was reported to be 51 (Haumesser, 1975). Gill and Dev (1972) reported a ratio of 60:40 in a study with a small population of French Alpine and Anglo-Nubian goats maintained under Indian conditions. On the contrary, Singh and Singh (1974) reported a male to female ratio of 44.81 : 55.19 in Jamnapari breed of goats. Amoah and Gelaye (1990) while comparing sex ratio of five breeds of goats, found that there was variation between breeds with one of the breeds having 58 per cent males and the rest having 50.20 to 61.20 per cent females.

2.4.1 Environmental temperature effect on kid sex ratio

Sex ratio at birth in all species of farm animals is close to 1:1. Exceptions of slight edge for males or females of a species are also not uncommon. Most deviations from a 1:1 ratio at birth are relatively small (Warwick and Legates, 1979). Though claims have been made that certain specific and intentional procedures influence sex ratio, references regarding

the environmental temperature effect on kid sex ratio are meagre (Roberts, 1971).

In Anglo Nubian x Puira Criollo goats the overall percentage of male kids born during a three-year period was 52.5 and the proportion of male kids born in summer, autumn, winter and spring were 47.3, 66.0, 52.4 and 48.9 per cent respectively (Notte and Mansilla, 1979). Prakash et al. (1986) in their study on Jamnapari and Barbari goats over a period of 3 years found that the sex ratio did not deviate significantly from 1:1 for both the breeds.

2.4.2 Environmental temperature effect on kid birth weight

Embryonic mortality increases in a number of species following exposure of the dam to elevated ambient temperatures, especially in tropical areas (Hafez, 1987). Prasad et al. (1979) have observed that when two groups of does in early pregnancy were maintained at a respective temperature and absolute humidity of 25.5 to 46.7°C, 18.5-31.5 mm and 19.6 to 23.1°C and 10.5-14.5 mm, the proportion of early embryonic loss was 37.5 and 42.11 per cent. Holmes et al. (1986) subjected feral does to elevated ambient temperature during the latter half of pregnancy and observed that the heat stressed does gave birth to lighter kids. But Prasteyo et al. (1984) after a similar study concluded that though heat stress had a deleterious effect on pregnant goats by raising their body

MATERIALS AND METHODS

MATERIALS AND METHODS

Goats of the All India Co-ordinated Research Project on Goats for Milk, Mannuthy formed the material for the study. It comprised of 154 sexually healthy does consisting of Malabari and their crosses with Saanen and Alpine. The animals were maintained in the project under uniform conditions of feeding and management through out the period of the study.

Breeding method followed during the study was artificial insemination of does detected in oestrus by vasectomised bucks. The practice in the farm was to keep does in units of 20 per room for easy identification. Heat detection in each room was performed twice daily at 0730 h and 1400 h using vasectomised bucks (Fig.1). In the morning and afternoon same buck was not used for the heat detection to avoid possible error.

3.1 Oestrous cycle

3.1.1 Oestrus detection

The animals in heat, detected by the buck were identified and subjected to detailed clinical examination and observation before breeding. Heat detection was done for a period of one year from 1.4.1990 to 31.3.1991.

1. Teaser billy goat detecting oestrus

Following behavioural and other signs were used to confirm the stage of oestrus in does that have been detected by the buck:

a. Frequent vocalization
b. Frequent twitching of tail
c. Interest in male
d. Vulval oedema and consistency and nature of discharge
e. Mounting behaviour
f. Cervical dilatation

Any one or more of the above signs when first noticed or on detection by buck was taken as the beginning of oestrus and cessation of the sign or signs or failure to be detected was taken as the end of oestrus. The period in between was considered as duration of oestrus. The time interval between two successive oestruses detected as above, was taken as the duration of oestrus cycle.

3.2 Gestation

3.2.1 Artificial insemination

Artificial vagina of 16 cm and of 4.5 cm diameter as in Fig.2 was used for semen collection.

For artificial insemination, the following equipments were used:

1. Vaginal speculum of 15 cm size
2. Micropipette of 0.5 ml capacity
3. Nylon Syringe
4. Rubber adapter to suit micropipette and syringe

All glass and metal equipments were cleaned and washed with permissible detergents and sterilized in hot air oven at 160°C for 30 minutes. Rubber and nylon equipments were cleaned and washed with permissible detergents but were sterilised by boiling for 30 minutes.

Semen for artificial insemination was collected every morning from sexually active bucks using artificial vagina. The sample, so collected, after evaluation for identification of the one with good characteristics was extended with freshly prepared Tris-buffered yolk and preserved under refrigeration for artificial insemination later on the day.

Tris extender used was of the following composition and was prepared once in 5 days and preserved at 4-5°C.

Tris (Hydroxy methyl) aminomethane - 1.52 g

Citric acid - 0.82 g

Fructose - 0.62 g

20

Distilled water - 50 ml

Egg yolk - 20 per cent

Benzyl Penicillin - 500 IU/ml

Dihydro Streptomycin - 500 ug/ml

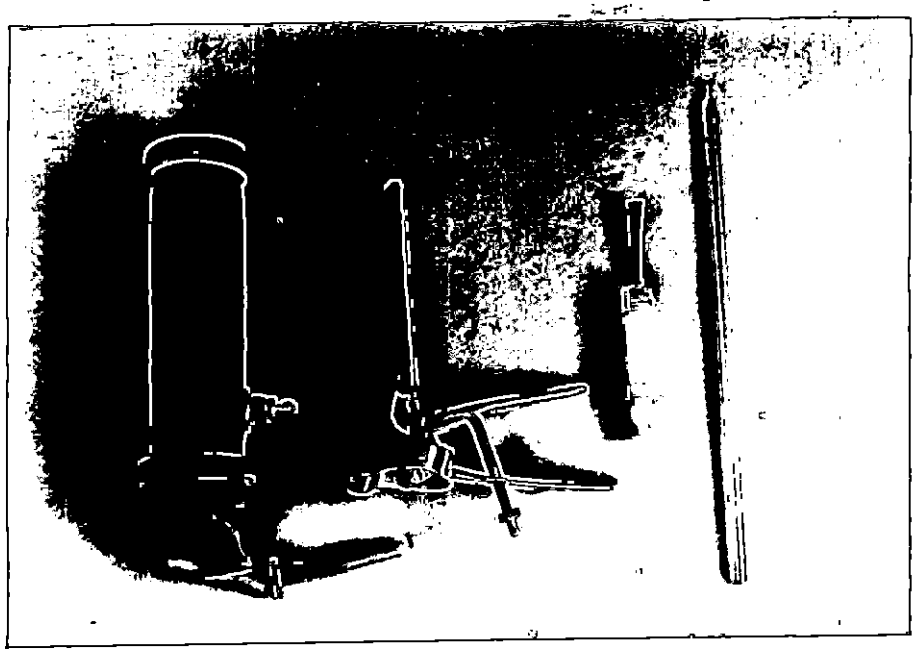
The extended semen with satisfactory motility was kept in glass vials wrapped with paper and stored in a thermos flask containing ice until it was used. 112 of the total of 154 animals were utilised for a comparative study of the conception percentage. Following the procedure of breeding every alternate animal by two inseminations in an oestrus, half of them were given single insemination during a heat as soon as they were detected and the other half were given two inseminations with the semen of the same buck, one at the time of first detection of heat and the other in the subsequent detection on the same afternoon. Animals once identified for single or double inseminations were subsequently bred in the respective manner. Of the does detected each time in oestrus, sexually healthy ones were selected for artificial insemination. Each one of them was restrained with the help of two attendants, one of whom secured the head while the other standing on the near side, held the animal by the hind cannon region with his right hand and gently lifted the hind region of the animal from the ground to a slightly higher level than that of the head. He also kept his right hand on the ventral abdomen of the animal to rest its weight. The animal's forelimbs were

still resting on the ground. The tail was held to one side by the attendant who was holding the foreparts (Fig.3). The perineal region was cleaned using a dry cotton pledget and a lubricated vaginal speculum was introduced. A micropipette with 0.25 ml of extended semen drawn into it, was passed through the speculum into the vagina and while passing the pipette, the external os of cervix was located. The pipette was introduced into the cervix and the semen was deposited. The speculum and the pipette were gently withdrawn, retaining the animal in the inclined position for 2 minutes.

In primi nannies where it was impracticable to introduce the speculum, vaginal insemination with 0.5 ml of extended semen was carried out by restraining the animal in the same manner as described above. Every time before insemination, motility of the semen was ensured to be above 60 per cent.

3.2.2 Conception and pregnancy

Anoestrus following insemination was considered as the first indication of pregnancy. It was confirmed at 2½-3 months by abdominal ballottement. Physical changes like mammary development and enlargement of abdomen during pregnancy though not dependable always, were of use in the diagnosis of pregnancy. At 135 days of gestation, the does were shifted to a loose box for a convenient and safe parturition and to facilitate monitoring of parturition to study the stages.



2. Artificial insemination equipments used in the study

3. Method of restraint of doe for artificial insemination

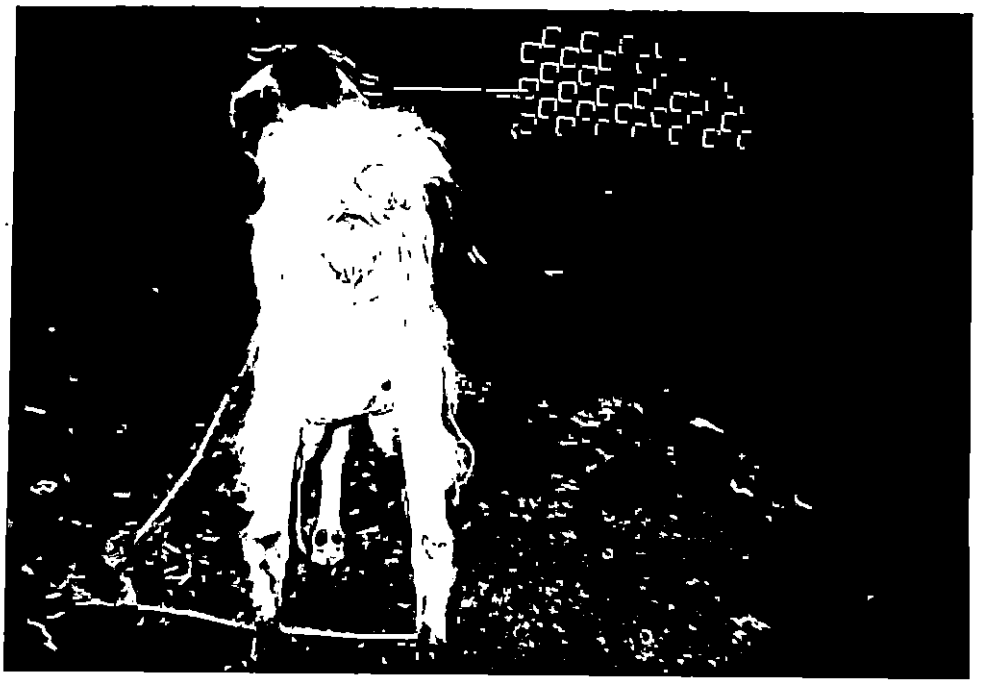
Gestation period in days was calculated from the date of successful insemination to the date of the normal parturition. Incidence of multiple pregnancy was assessed on the basis of type of birth.

3.3 Parturition

Imminence of parturition was identified from the following signs.

a. Relaxation of posterior border of sacrosciatic ligaments
b. Tumefaction of vulva
c. Engorgement of teat
d. Mucus discharge from genitalia

Commencement of first stage was not appreciable in all cases. Behaviour suggesting abdominal pain as restlessness, pawing, mucous discharge from genitalia, engorgement of teats (Fig. 4 and 5) and often lying down were noticed in a few cases. Hence rupture of foetal bag which invariably occurs inside the vagina and gush of foetal fluid was taken as end of the first stage and beginning of the second stage. Time taken until expulsion of foetus/foetuses was taken as the length of the second stage (Fig. 6 to 11). Period from the time of expulsion of the foetus/foetuses to expulsion of the foetal membranes comprised duration of the third stage of parturition. The durations in minutes were recorded using a stop watch.



4. Stages of cervical dilatation

5. Stages of cervical dilatation

6. Stages of expulsion of foetus

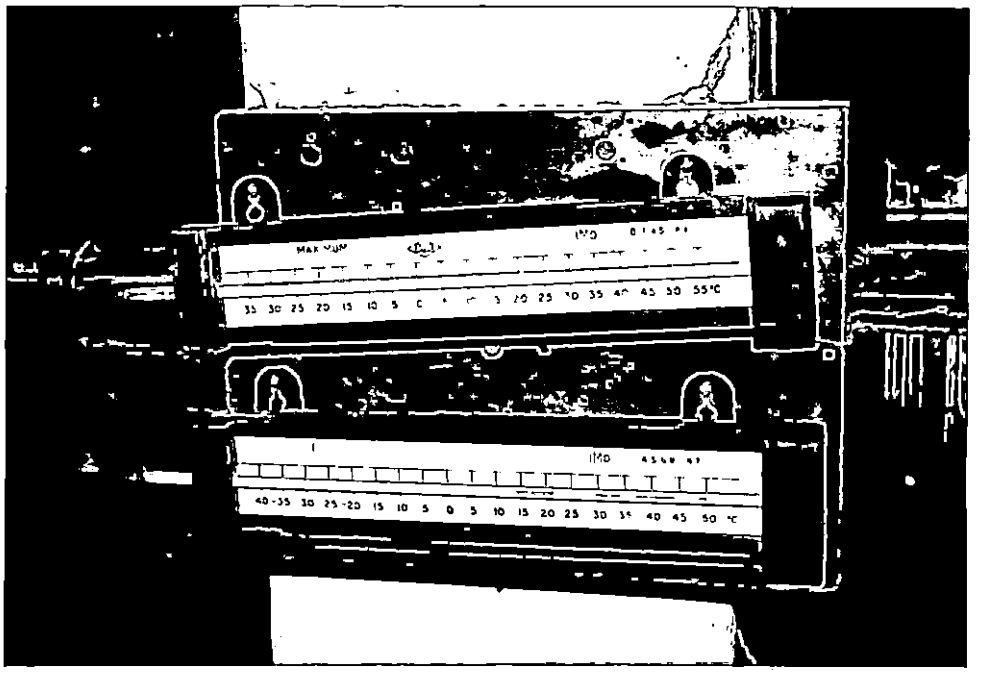
7. Stages of expulsion of foetus

8. Stages of expulsion of foetus

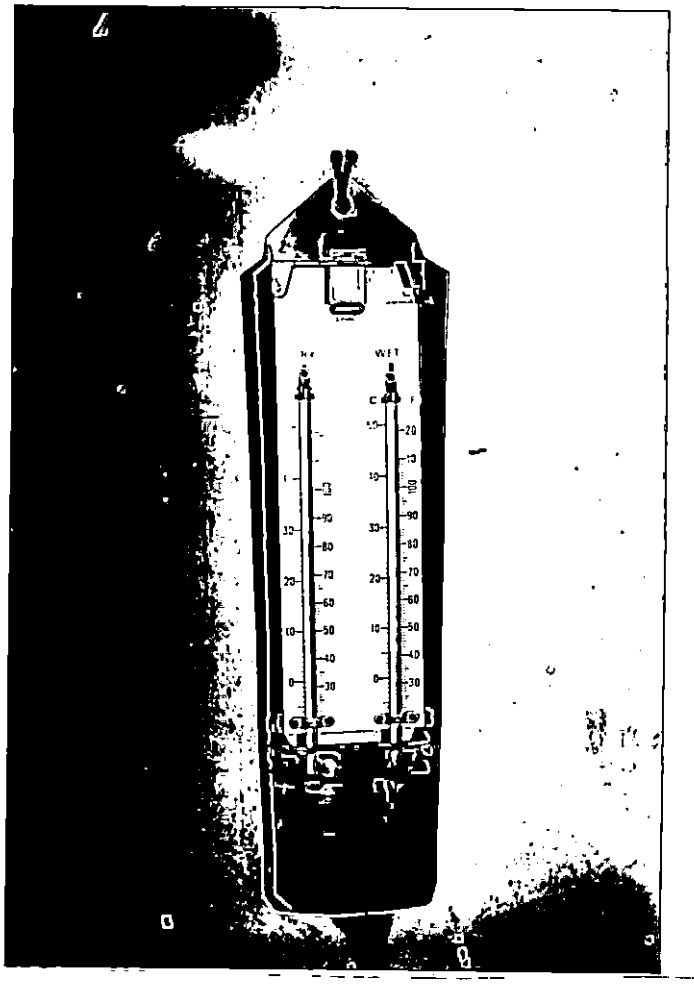
9. Stages of expulsion of foetus

10. Stages of expulsion of foetus

11. Stages of expulsion of foetus



12. Maximum-minimum thermometer installed inside the animal house



13. Dry and wet bulb thermometer installed inside the animal house

23

3.4 Environment temperature effect on kid birth weight and sex ratio

3.4.1 Environmental temperature record

Minimum and maximum temperature of each day during the period of the study were recorded at 0725 and at 1425 h from the thermometers of the range -40 to 50°C and -35 to 55°C installed in one of the sheds as seen in Fig.12. Dry and wet bulb thermometers as shown in Fig.13 were also kept side by side juxtaposed to know the humidity.

3.4.2 Kid birth weight and sex ratio

Kids soon after its birth were mopped with dry absorbent towel and weighed on a platform scale of 5 kg capacity and recorded the weights. Sex of the kids was also identified and maintained a record of it. The foetal membranes soon after its expulsion was collected and drained of the locked in fluids, then it was weighed in an analytical balance in instalments, and the total weight in g computed and recorded.

Later it was spread on a large clean tray (Fig.14) and counted the cotyledons and recorded the numbers. At random, dimensions of the cotyledons as length and breadth were measured with calipers and the measurements were recorded. Placental area was worked out from the total number of cotyledons and the

14. Spread out placenta for the biometry

mean area of cotyledon. Formulae used for calculation of area of circular cotyledon was πr^2, where π is a constant, 3.14 and r is the radius in cm and of elliptical ones was $\pi \frac{1}{2} l \times \frac{1}{2} b$ where l and b are the length and breadth in cm, to obtain the area in sq cm.

RESULTS

RESULTS

4.1 Oestrous cycle

4.1.1 Pattern of cycle

Total number of oestrus detected by teaser billy goat in the flock under study during a period of one year from April 1990 to March 1991 is shown monthwise (Fig.15).

Seventy four oestruses detected in July 1990 was the maximum during a month and sixteen recorded in January 1991 was the minimum during a month. Total number of oestrus showed a steady increase every month from January to July and steadily decreased from August to October. In November there was again an ascent which was not as much as that occurred in July. Thereafter it declined steadily to touch the minimum in January. Two peaks, the highest one in July and the other in November, in a year are evident from Fig.15

The same data when recast as a histogram (Fig.16) with quarterly total of detected oestrus, revealed a peak in sexual activity in the months of July, August and September and the lowest during the months of January, February and March. The periods of October, November and December and April, May and June showed moderate activity and between these periods there was no significant difference.

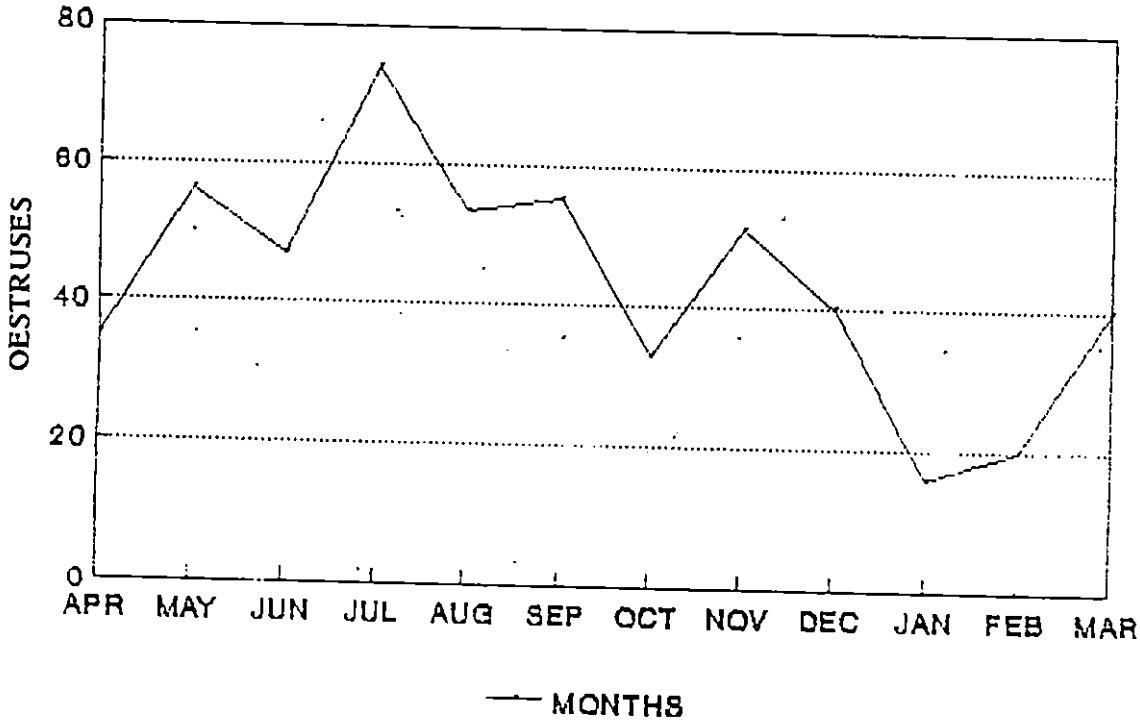


FIG.15 REPRODUCTIVE PATTERN ON THE BASIS OF MONTHLY TOTAL OF OESTRUSES

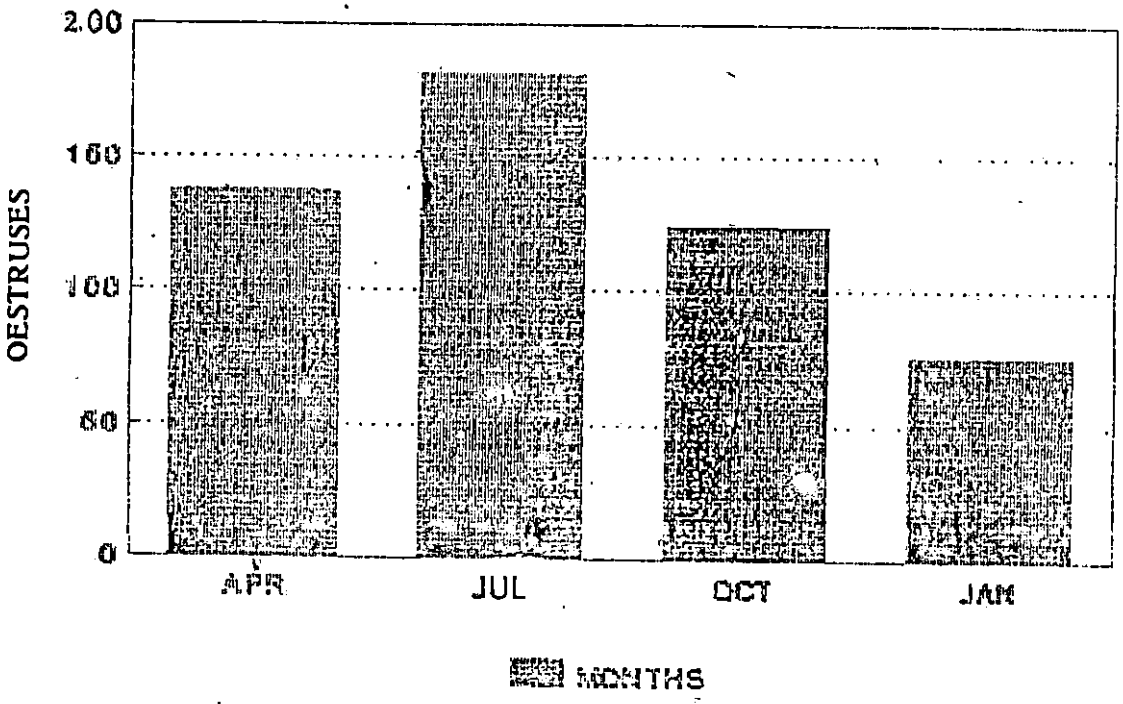


FIG.16 REPRODUCTIVE PATTERN ON THE BASIS OF QUARTERLY TOTAL OF OESTRUSES

Table 1. Month-wise distribution of oestrus during long and short days and total during each of the photoperiods and its per cent

Photoperiod	Month	Monthly total	Half yearly total	Per cent of half yearly total
Long day	April	35		
	May	56		
	June	47		
	July	74		
	August	53		
	September	55	320	61.54
Short day	October	33		
	November	51		
	December	40		
	January	16		
	February	20		
	March	40	200	38.46

Monthly total of detected oestrus are grouped according to daylight period and is given in Table 1 to show the photo-periodicity. The number of oestruses detected during the half year, April to September was greater than that of the half year October to March.

4.1.2 Duration of cycle

Inter oestrus interval of 18-23 days was taken as normal duration and the cycles of shorter and longer durations were classified as short and long respectively and is shown in Table 2. Short cycles noticed were 237 out of 520 observations. Ninety four oestrous cycles were of normal duration of 18-23 days. Long oestrus cycles of more than 23 days was constituted by 189 observations. From Table 2 it is evident that 18.08 per cent of the 520 oestrous cycles observed in a flock of 154 does, for a period of one year were of normal duration of 18-23 days.

Short cycles appeared to be a characteristic of the species as evidenced by 45.88 per cent of its incidence, of which 22.25 were of a duration of less than 6 days, 17.31 and 5.77 per cent were of 6-12 and 12-18 days, respectively. Long cycles variable from 23 to 140 days formed 36.34 per cent of the total observations. Of the oestrous cycles 18.84 per cent were of the duration of 23 to 35 days and the rest (17.5 per cent) were of longer duration than 35 days (Table 3).

Table 2. Classification of oestrous cycle, incidence under each class and its per cent

Oestrous cycle (in days)	Number of observation	Per cent
Short (<18)	237	45.58
Normal (18-23)	94	18.08
Long (≥23)	189	36.34

Table 3. Variability of inter oestrous interval, incidence and its per cent

Oestrous cycle length (in days)	Number of oestrous detected	Per cent
<6	117	22.50
6-12	90	17.31
12-18	30	5.77
18-23	94	18.08
23-29	60	11.54
29-35	38	7.30
⩾35	91	17.50
Total	520	100.00

4.1.3 Duration of oestrus

Detected oestruses were grouped according to its duration in hours as less than 12, 12-24, 24-36, 36-48, 48-60 and more than 60 and the number of observations under each group and their percentage are shown in Table 4.

Of the 520 oestruses observed 249 were detected in heat only once either in the morning or in the afternoon detection and it was considered as of less than 12 hours duration.. It formed 47.88 per cent of the total oestrus observations made in the present study. Animals which were detected in heat both in the morning and afternoon detections were taken as those having heat for 12-24 hours and they were 97 out of the 520 observations. Likewise animals which were detected in heat on three consecutive heat detections were considered as those having an oestrus duration of 24-36 hours, and 95 of the 520 observations, belonged to this group. Animals which were detected in oestrus on four consecutive oestrus detections were considered to be in heat for 36-48 hours and 44 of the observations were of this group. Similarly those animals which were detected in oestrus on five consecutive oestrus detections have been taken as in oestrus for 48-60 hours and they were 29 in number. Animals which were detected in oestrus for more than 5 consecutive oestrus detections were considered to be in oestrus for more than 60 hours and they were 6 in number and it formed only 1.15 per cent of the total number of oestruses detected.

Table 4. Variability of duration of oestrus, incidence and its per cent

Oestrus interval (in hours)	Number of observations	Per cent of incidence
<12	249	47.88
12-24	97	18.65
24-36	95	18.27
36-48	44	8.46
48-60	29	5.59
>60	6	1.15
Total	520	100.00

The proportion of the groups of less than 12, 12-24, 24-36, 36-48 and 48-60 were 47.88, 18.65, 18.27, 8.46 and 5.59 respectively. Animals with oestrus duration of 12-48 h formed 45.38 per cent of the total observations.

4.2 Gestation

4.2.1 Pregnancy rate by artificial insemination

Over a period that covered four oestrous cycles, 56 does required 120 artificial breedings by single insemination and the other 56 required 108 artificial breedings by two inseminations in a heat.

Of the former group 40 and of the latter 46 does were found to be pregnant. Conception in the flock which was bred by single insemination, following four breedings was found to be 71.42per cent whereas it was 82.14 per cent in those which were given two inseminations in a heat. Conception percentage of one breeding by single and double insemination were found to be 33.93 per cent and 42.85 per cent respectively (Table 5).

4.2.2 Gestation period

Gestation length of the 120 pregnancies recorded during the period from July 1990 to May 1991 was found to vary from 142 to 151 days with an average of 145.62 $\pm$ 0.23 days.

Table 5. Single and double artificial insemination during a heat to show its influence in pregnancy rate

No. of animals bred	No. of AI at each breeding	Success of one time breeding			Success of four times breeding		
		Total no. of breedings	No. of confirmed pregnancies	Percentage	Total no. of breedings	No. of confirmed pregnancies	Percentage
56	Single	56	19	33.93	120	40	71.42
56	Double	56	24	42.85	108	46	82.14

Table 6 shows classification of gestation length based on type of birth and sex of kids/kids. The overall gestation lengths in singleton, twin and triplet pregnancies were 146.05 ± 0.31, 144.86 ± 0.32 and 145.25 ± 1.03 days respectively.

In singleton pregnancies, where male kids were born, gestation length was 145.98 ± 0.36 days. It was 146.13 ± 0.52 days in the case of singleton female kids.

In twin pregnancies gestation length in the case of homogamous male, homogamous female and heterogamous kids were 144.0 ± 0.54, 145.33 ± 0.80 and 145.30 ± 0.45 days respectively.

4.2.3 Incidence of multiple pregnancies

Based on the type of birth 73 singleton and 47 multiple pregnancies were recorded during the period from July 1990 to May 1991. Of the 47 multiple births, 43 were twins and 4 were triplets. The percentages of singleton, and multiple pregnancies 60.83 and 39.17 respectively (Table 7).

4.3 Parturition

4.3.1 Stages of labour

Fifteen parturitions were monitored from its onset by the first signs of the first stage and the duration of each of the stages of parturition were noted.

Table 6. Relationship of type of pregnancy and sex of kids to gestation length

Type of birth	Number of observation	Gestation length (in days)
Singleton		
Male kid	38	145.98 ± 0.36
Female kid	35	146.13 ± 0.52
Overall	73	146.05 ± 0.31
Twin		
One male and one female kid	20	145.30 ± 0.45
Two male kids	14	144.00 ± 0.54
Two female kids	9	145.33 ± 0.80
Overall	43	144.86 ± 0.32
Triplet	4	145.25 ± 1.03
Overall	120	145.62 ± 0.23

Table 7. Incidence of multiple pregnancies and sex ratio of kids

Type of birth	No. of pregnancies	Per cent	Number of kids and its per cent				
			Total	Male	Per cent	Female	Per cent
Singleton	73	60.83	73	38	52.05	35	47.95
Multiple	47	39.17	98	53	54.08	45	45.92
	120	100.00	171	91	53.22	80	46.78

In six parturitions the first signs were not apparent and hence could be observed only from the time of commencement of the second stage and they were monitored to note the duration of the second and the third stages.

In another 61 parturitions only the third stage could be observed and time taken for expulsion of foetal membranes was noted.

The data obtained on duration of the stages of parturition is presented in Table 8. Average duration of first stage of parturition was observed to be 55.9 ± 14.5 and 60.6 ± 12.48 min respectively in single and twin births. Overall mean of fist stage of parturition was found to be 57.47 ± 10.29 min. Average of the 21 observations on the duration of the second stage was 14.52 ± 1.34 min. The mean duration for singlet and twin birth were 13.18 + 1.29 and 18.8 + 3.38 min respectively.

From the mean derived of 82 observations, the third stage of parturition took 128.87 ± 4.84 min while the mean time taken in single and twin births were 129.92 ± 6.74 and 126.93 ± 6.12 min respectively.

In 88.9 per cent of the parturition monitored, the kids were in anterior presentation while 11.1 per cent were in posterior presentation.

Table 8. Stages of labour, its duration in single and twin birth

Stage	Duration in minutes		
	Singlet	Twin	Overall
First	55.9 ± 14.5 (10)	60.6 ± 12.48 (5)	57.47 ± 10.29 (15)
Second	13.18 ± 1.29 (16)	18.8 ± 3.38 (5)	14.52 ± 1.34 (21)
Third	129.92 ± 6.74 (53)	126.93 ± 6.12 (29)	128.87 ± 4.84 (82)

Figures in parentheses indicate the number of observations

4.3.2 Secondary sex ratio

Secondary sex ratio was studied in the 113 births that occurred during a period from September 1990 to May 1991. Out of the 171 kids that were born 91 were males and 80 were female (Table 7). Male to female ratio of the kids born in the flock under study was 53.22 : 46.78.

4.4.1 Environmental temperature effect on kid sex ratio

Environmental temperature at the time of conception was taken as the criterion to know the effect of season on sex of kids and the does that freshened during the course of the present study were grouped accordingly (Table 9).

Animals conceived during the periods of March to May, when the mean environmental maximum temperature was 39.0°C (37.6-40.0°C), formed one group, June to August with a mean environmental maximum temperature of 33.4°C (32.8-33.9°C) formed the second group and September to November with a mean environmental maximum temperature of 36.3°C (34.9-38.4°C) formed the third group.

Thirty four does in the first group completed the gestation and produced 53 kids. They were born in 17 singleton and 17 multiple births and comprised of 29 females and 24 males.

Table 9. Quarterly mean environmental temperature at conception to show its effect on sex of kids

Month of conception	Mean environmental temperature (°C)		Births					Total number of kids	
			Total	Singleton		Multiple		Male	Female
	Maximum	Minimum		Male	Female	Male	Female		
March	40.0	20.6	6	1	1	3	5	4	6
April	39.4	22.1	12	2	4	7	6	9	10
May	37.6	22.6	16	6	3	5	10	11	13
Total	117.0	65.3	34	9	8	15	21	24	29
Mean	39.0	21.8							
June	33.6	21.5	12	3	4	7	4	10	8
July	32.8	20.9	21	6	9	9	3	15	12
August	33.9	20.7	9	4	2	3	3	7	5
Total	100.3	63.1	42	13	15	19	10	32	25
Mean	33.4	21.0							
September	34.9	21.0	13	7	3	5	1	12	4
October	38.4	20.5	9	4	2	2	5	6	7
November	35.6	19.0	15	5	7	3	3	8	10
Total	108.9	60.5	37	16	12	10	9	26	21
Mean	36.3	20.2							

Forty two does in the second group completed the gestation and produced out of 28 singleton and 14 multiple births a total of 57 kids. They comprised of 32 males and 25 females.

Thirty seven does in the third group, after a normal gestation produced out of 28 singleton and 9 multiple births, a total of 47 kids. They comprised of 26 male and 21 female kids.

4. 4.2 Environmental temperature effect on kid birth weight

Based on the environmental temperature chart prepared during the course of the study, the period during which 113 freshenings in goats were recorded, was classified into 3 trimesters. Mean maximum temperature in the month of conception was the basis for classification.

The period from March to May with a mean maximum temperature of 39°C (37.6-40.0°C) the highest during a year formed one trimester (I). Likewise the succeeding period from June to August with a mean maximum temperature of 33.4°C (32.8-33.9°C) the lowest among the three formed another trimester (II). The period from September to November with a mean maximum temperature of 36.3°C (34.9-38.4°C) intermediate to the above two formed yet another trimester (III).

Data gathered during trimester I, II and III on kid crop, sex of kids, birth weight and sex war mean birth weight are presented in Table 10.

Table 10. Quarterly mean environmental temperature at conception to show its effect on birth weight of kids

Month of conception	Monthly and quarterly mean environmental temperature (°C)		Births			Mean birth weight (kg)		
	Maximum	Minimum	Total	Male	Female	Male	Female	Overall
March	40.0	20.6	6	4	6	1.39	1.31	
April	39.4	22.1	12	9	10	1.65	1.53	
May	37.6	22.6	16	11	13	2.18	1.74	
Total	117.0	65.3	34	24	29	5.22	4.58	
Mean	39.0	21.8				1.74	1.53	1.64
June	33.6	21.5	12	10	8	1.88	1.77	
July	32.8	20.9	21	15	12	1.86	1.84	
August	33.9	20.7	9	7	5	2.26	1.90	
Total	100.3	63.1	42	32	25	6.00	5.51	
Mean	33.4	21.0				2.00	1.84	1.92
September	34.9	21.0	13	12	4	1.67	2.05	
October	38.4	20.5	9	6	7	1.83	1.68	
November	35.6	19.0	15	8	10	2.04	1.97	
Total	108.9	60.5	37	26	21	5.54	5.70	
Mean	36.3	20.2				1.85	1.90	1.88

Of the 113 freshenings, 34, 42 and 37 were respectively of animals conceived during the first, second and third trimesters. The kid crop in respect of each of the trimester was 53, 57 and 47 kids.

Fifty three kids born during the trimester I comprised of 24 males and 29 females and their average birth weights were 1.74 and 1.53 kg respectively. Overall mean birth weight was 1.64 kg. Thirty two males and 25 females comprised the kid crop of 57 born during the course of trimester II and their average birth weights were 2.00 and 1.84 kg respectively. Overall mean birth weight was 1.92 kg.

During the trimester III, 47 kids were born consisting of 26 males and 21 females with an average birth weight of 1.85 and 1.90 kg respectively. Overall mean birth weight was 1.88 kg.

From the Table 10 it could be seen that overall mean birth weight and sex war mean birth weight are significantly lower during the trimester I when the maximum environmental temperature is higher than that in the trimester II and III. Though there are variations in the birth weights between trimesters II and III it is not significant.

In 67 of the 113 freshenings, the placenta could be obtained fresh, intact and fit for biometry. Data on placental weight and area obtained from them are shown in Table 11

Table 11. Mean environmental temperature at conception to show its effect on placental weight and area

Month of conception	Mean env. temp.		Number of birth	Number of kids		Total birth weight of kids		Total placental weight	Correlation r	Total placental area	Correlation r
	Maximum	Minimum		Male	Female	Male	Female				
March	40.0	20.6	6	4	6	5.55	7.85	1552.27	0.76^{NS}	2233.66	0.59^{NS}
April	39.4	22.1	8	5	7	8.30	10.90	1963.35	0.84**	3143.31	0.86**
May	37.6	22.6	6	3	8	6.00	14.00	1979.93	0.91**	4108.01	0.98**
June	33.6	21.5	7	7	4	12.93	7.35	2095.33	0.95**	3326.75	0.77*
July	32.8	20.9	12	9	5	18.95	8.95	2901.80	0.71**	4584.30	0.68*
August	33.9	20.7	8	8	1	18.10	2.30	1880.24	0.72*	2547.18	0.64^{NS}
September	34.9	21.0	9	8	4	13.40	8.20	2346.76	0.84**	3490.09	0.70*
October	38.4	20.5	5	4	3	8.70	4.90	1420.11	0.68^{NS}	1867.30	0.94*
November	35.6	19.0	6	3	4	6.85	8.20	1660.96	0.97**	2670.24	0.66^{NS}

* P 0.05 ** P 0.01 NS = not significant

together with other details of the same group as shown in Table 10.

Trimester-wise details of the total number of births, male and female during the period of study were 20, 12, 21; 27, 24, 10 and 20, 15, 11 respectively. Mean birth weights of 1.74, 2.00 and 1.85 kg of males in the trimesters I, II and III did not significantly differ from the mean birth weight of 1.53, 1.84 and 1.90 kg of females. But the birth weight of both male and female during trimester I when compared with the corresponding birth weights of trimester II and III, there is a significant difference (Table 14 and 15).

On statistical analysis of month war total birth weight of kids and placental weight they were found to have significant correlation in all months, but it was not significant in the months of March and October.

On a similar analysis of birth weight and placental area, they were also found to be significantly correlated in all months but it was not significant in the months of March, August and November.

A simple linear regression equation was fitted to the data on overall birth weight and placental weight (Fig.17) and it was found that for every unit of 1 kg change in the birth weight there was a change of 86.645 g in the placental weight.

Table 12. Month-wise regression equation (Y = a + bx) on birth weights of kids and placental weight

Month	Number of observations N	a	b
March	6	108.07	112.42
April	8	127.05	73.98
May	6	165.39	90.44
June	7	118.81	98.11
July	12	83.18	79.72
August	8	91.77	63.11
September	9	79.87	100.49
October	5	104.38	92.60
November	6	84.19	89.60

Table 13. Month-wise regression equation (Y = a + bx) on birth weights of kids and placental area

Month	Number of observations N	a	b
March	6	223.143	111.293
April	8	118.892	171.263
May	6	61.008	342.67
June	7	226.794	135.03
July	12	166.880	108.113
August	8	53.631	116.637
September	9	106.115	156.484
October	5	66.140	226.598
November	6	262.109	85.084

Table 14. Birth weight of male kids - Analysis of variance

Source	df	SS	MSS	F value
Trimester	2	1.585	0.7925	3.459**
Error	48	10.996	0.2291	
Total	50	12.581		

** P = 0.01

Table 15. Birth weight of female kids - Analysis of variance

ANOVA	df	SS	MSS	F value
Trimester	2	1.247	0.6235	4.7451**
Error	32	5.126	0.1314	
Total	41	6.373		

** P = 0.01

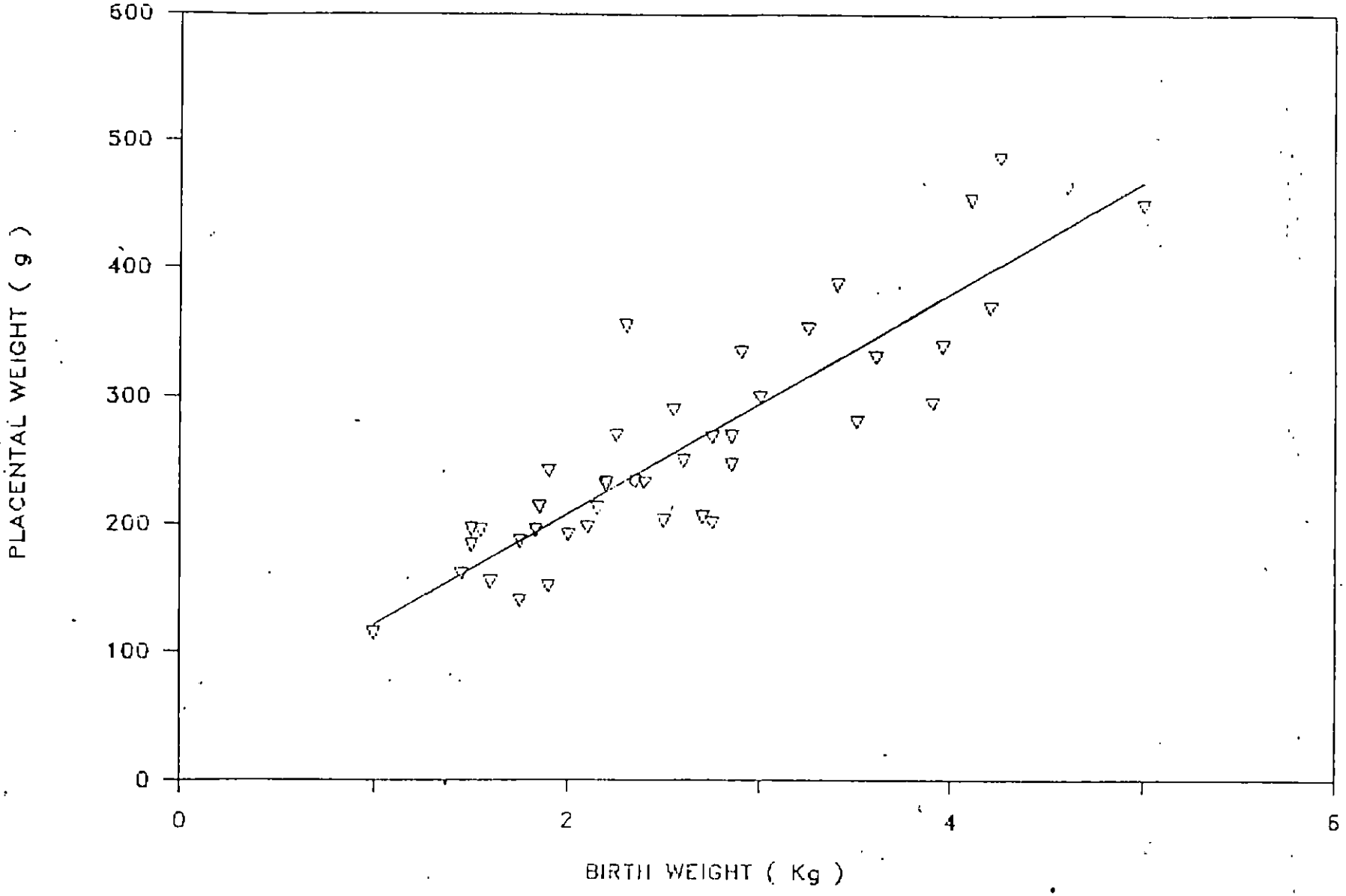


FIG.17 RELATIONSHIP BETWEEN PLACENTAL WEIGHT AND BIRTH WEIGHT

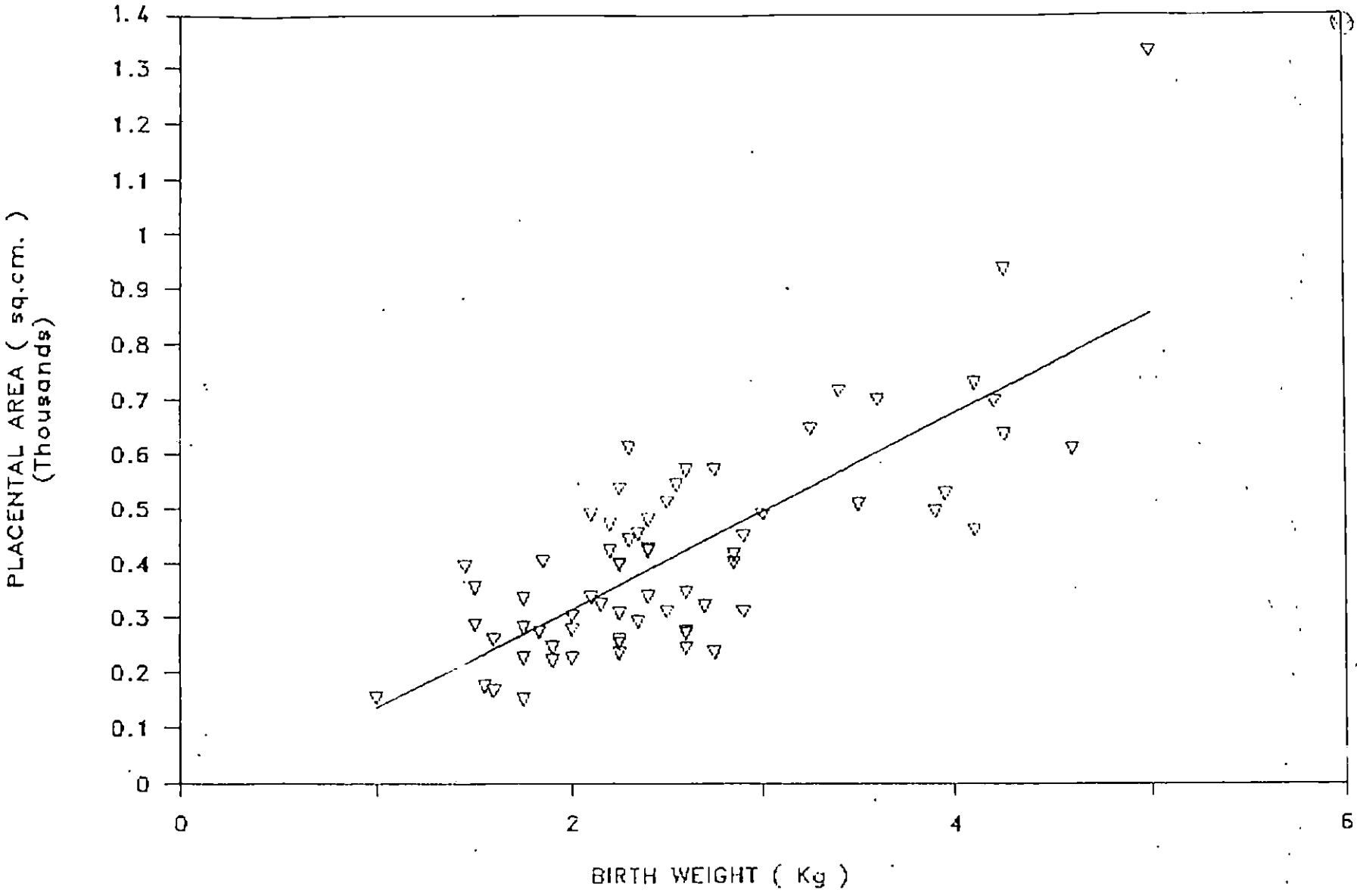


FIG.18 RELATIONSHIP BETWEEN PLACENTAL AREA AND BIRTH WEIGHT

The equation evolved was $Y = 34.676 + 86.645\ x$ where Y is the placental weight of g and x is the birth weight in kg. Similarly regression equations were fitted to the data on month-wise birth weights and presented in Table 12.

A simple linear regression equation was fitted to the data on overall birth weight and placental area also (Fig.18) and it was found that for every unit of 1 kg change in the birth weight there was a change in the placental area to the extent of 181.237 sq cm. The equation evolved was $Y = -46.383 + 181.237\ x$ where Y is the placental area in square centimetres and x is the birth weight in kg.

Similarly regression equations were fitted to the data on month-wise birth weights and placental area and presented in Table 13.

DISCUSSION

DISCUSSION

5.1 Oestrous cycle

5.1.1 Pattern of occurrence of oestrus

The data gathered in the present study involving the detection of oestrus in a flock of 154 goats using teaser billy goats for a period of one year, is evidence to the effect that goats in this region are polyoestrous as reported by Perry (1969) but, they showed peaks and valleys during certain periods of the year.

From the Fig.15 it appears that minimum number of animals came into oestrus during the month of January and the maximum was during the month of July. Thereafter, there was a downward trend for three months to be followed by a rise during November. This is in concurrence with the findings of Nimo (1972) and Devendra and Burns (1983), that goats in tropical climate breed throughout the year but during certain periods they come into oestrus in larger proportions. Peaks in breeding activity during certain periods of the year as has been seen in the present study was also reported from elsewhere in the country (Mishra and Biswas, 1966). But the period of minimum sexual activity in the present study was during the month of January, which is not in concurrence with reports from elsewhere. When this is viewed

in the context of the climatic peculiarities of this geographical region, i.e., southwest monsoon commencing from the beginning of June and widespread rains for the following four months, it can be seen that the environment is unsuitable for the survival of the young ones. January conceptions are to be born mostly during June and presumably that appears to be the reason why by adaptation, the animal is with reduced sexual activity during January. From February onwards there is an upward trend in the breeding activity, steadily increasing upto July with an insignificant drop in June. Perhaps conceptions that are taking place from February-March onwards are likely to be born only from middle of July onwards. By then heavy rains are over though the rainy season continues.

High environmental temperature and lack of feed may restrict sexual activity during some months of the year in the tropics, but shortly after the rainy season, sexual activity increases probably due to a change in feed availability (Hafez, 1987). Data on the occurrence of oestrus when recast on quarterly basis, dividing the year of study into four quarters nearly similar to the natural season, as could be seen in Fig.16, the peak breeding activity was noticed during July-August-September when the feed availability is good and the sexual activity was moderate during the periods of April-May-June and October-November-December. The sexual activity was the least during January-February-March i.e., near acute dearth for

natural availability of fodder. Similar observations have been seen reported from other countries in the tropical region (Nimo, 1972; Devendra and Burns, 1983). Increase in the natural availability of fodder that is occurring following commencement of rains from the beginning of June appears to be the reason for the significant increase in the breeding activity compared to the previous months. Following the respite in the incessant rain during August-September, there is a natural reduction in the fodder availability and the trend that is noticed in the reproductive activity is also downward. Again on commencement of rain during October, of the north-east monsoon, the natural fodder availability increases and that is becoming evident through the reproductive activity by an upward trend during November. Thereafter there is a steady decline to touch the minimum during January. A second peak in breeding activity though not at the same time as seen in the present study, has also been reported by Rajkonwar and Borgohain (1978).

From the Fig.15 and the details furnished above, it is evident that the goats in this geographical region have a reproductive pattern, distinct from what is seen elsewhere. Breeding season in temperate region, as per reports, is from late summer to early winter i.e., from late August to early February. In the Mediterranean breeds, they do not have a definite breeding season. Minor variations, even among breeds, according to geographic location, probably due to influences

caused by photoperiod and other factors have been observed (McDonald and Pineda, 1989).

On a regrouping of data on occurrence of oestrus as in Table 1 to find out the total in the half year from April to September when the day length is more, it could be seen that out of the 520 oestruses detected, 320 occurred during this time. This formed 61.54 per cent of the oestruses detected during year. Evidently, in contrast to the general belief that the breeding season of goat is the short days, only 38.46 per cent of the goats came into oestrus during October to March when the day is short. Seasonal peaks noticed in the polyoestrous behaviour of goats in this region is during the spring and summer i.e., the time when the day is long. This is in contrast to the seasonal peaks in temperate region reported by Maule (1962) while it concurs fully with the breed-wise oestrous incidence studies of Goel and Agrawal (1988). They have seen higher incidence of oestrus during May to July and the animals were reported to be cyclic round the year.

The findings in the present investigation is evidence to the effect that the breeding activity of the goats in this region is characteristic to this geographical region. The pattern that was noticed, is the polyoestrous behaviour throughout the year with the peak breeding activity during July, with another lesser peak during November and the least breeding activity during January. It was also noticed that 61.54 per cent

of the goats manifested oestrus during the half year when the day was long and also with a seasonal peak during this period against the general belief that they are short day breeders and wherever they are polyoestrus, the peak breeding activity is when the day is short. It is also seen that they are reducing birth of young during the time of heavy rains by suppression of breeding activity during the corresponding period of January and February.

5.1.2 Duration of cycle

Inter oestrous interval as short as 5 days and as long as 140 days have been observed during the course of the study. In the context of the reports by the various authors as the average inter oestrous interval of 21 days in goats (McDonald and Pineda, 1989; Hafez, 1987), 18-23 days was considered as the normal cycle length, those with a length lesser than 18 days were grouped as short cycles and those with a length greater than 23 days were grouped as long cycles. Of the 520 observations, 18.08 per cent were within the normal duration, 45.58 per cent were short and 36.34 per cent were long cycles. The flock comprised of nulliparous to pluriparous does of various ages from 1 year to 10 years and both lactating and non-lactating animals. The method adopted for detection of heat was the use of a teaser billy goat.

Incidence of short cycles is a characteristic that can be seen in animals first coming into oestrus like the nullipara,

the animals in post partum and those in anoestrus due to various extrinsic factors. The nulliparous animals and animals in anoestrus due to extrinsic factors when initiated into sexual activity will have short cycles. It is similar to animals which come into oestrus at the beginning of a breeding season manifesting abnormally short cycles (Ott, 1981; Corteel et al., 1982 and Riera, 1982). Short cycles may also be seen in animals in lactation or even in non-lactating goats due to short luteal phase. Presence of a billy goat is also a well accepted factor that will shorten the inter oestrous interval (McDonald and Pineda, 1989). Animals which are in post partum anoestrus will also have short cycles on resumption of sexual activity. Such abbreviated cycles have been observed by Riera (1982). Introduction of a buck to a flock of nanny goats in late anoestrus is reported to elicit premature resumption of oestrous cycle and the duration of the induced cycle was also found to be shorter (Hafez, 1987). Short cycles even during breeding season are induced by the teasing activity of the billy goats, due to induced luteolysis (McDonald and Pineda, 1989). As the practice in the present study has been the use of a billy goat for detection and the flock comprised of various types of animals as described above, the high incidence of short oestrous cycles in the flock appears fully justified.

Long inter oestrous intervals are quite possible with more aged animals (Camp et al., 1983). Long oestrous cycles are also possible when the duration of oestrus is extremely short

rendering the detection of oestrus difficult, when early embryonic death occurs and also when induced anoestrus due to lack of dietary factors especially when mass feeding has been the practice. Van Rensburg (1971) has reported that suboestrus or extremely short oestrous interval as the prime factors for the occurrence of long inter oestrous interval.

The distribution of inter oestrous variability is presented in Table 3. 22.5 per cent of the observations were with an inter oestrous interval of 5-6 days. This short cycle is presumably induced by the "male effect" as reported by Hafez (1987). This occurs due to the short luteal phase lasting only for 5 or 6 days (McDonald and Pineda, 1989). From the distribution it could also be seen that 17.31 per cent of the observations were between 6 and 12 days. This characteristic of manifesting heat at short intervals of around 9 days is relatively high in the animals initiated into the sexual activity the first time or following an anoestrous, and also during lactation as documented by McDonald and Pineda (1989).

The material for the study comprised of nonparous, parous and lactating animals. Incidence of reasonably high rate of short oestrus appears to be quite normal. Again on going through the distribution, the percentage of observations falling in the group, 12-18 days is the least i.e., 5.77 per cent, which obviously is not a period subject to the above said influences.

Presumably it may be only shortening of a normal oestrous cycle, expanding the minimum of variability which in the present study was arbitrarily fixed as 18 days.

A glance through the distribution of oestrous cycles of longer than the normal duration, it could be seen that the largest among the categories, i.e. 17.5 per cent are those manifested heats at intervals greater than 35 days. It appears probable that long duration of the inter oestrous interval may be due to suboestrus, extremly short oestrus which rendered the detection impracticable by the procedure followed or short anoestrus periods due to extrinsic factors as the causes for the prolongation of the inter oestrous interval.

Next higher proportion is 11.54 per cent of the oestruses which were manifested between 23 and 29 days, appears to be a prolongation of the oestrous cycle caused by the early embryonic mortality on commencement of the critical period of organogenesis, after the maternal recognition of pregnancy. Between 29 and 35 days, 7.3 per cent of the oestruses were detected. This speciously may be the failure to detect a heat in between due to failure to manifest/impracticably detectable short oestrous duration.

Duration of oestrus cycle was found to be 18-23 days well in agreement with the reports of Bhattacharya et al. (1981) and Mathai (1986).

5.1.3 Duration of oestrus

Duration of oestrus was found to vary from 12 to 72 hours. Minimum of the variability of duration of oestrus well concurs with the reports of Abdelaziz et al. (1982), Gonzalez and Madrid (1982) and Simplicio et al. (1982). Maximum duration of 3 days has been recorded by Pineda (1989). Breed, age, season and presence of male are the factors which can influence the duration of oestrus (Mishra and Biswas, 1966; Van Rensburg, 1971 and Pineda, 1989). The variability obtained in the present investigation is justified since the flock comprised of Malabari, Saanen and Alpine crosses of Malabari and also animals ranging from one to ten years of age and the practice of detection was using teaser billy goat.

Of the 520 observations made 93.26 per cent had a duration lesser than 48 hours and 84.8 per cent had an oestrus duration of less than 36 hours. This is well in consonance with the average duration of oestrus of 24-48 hours reported by Hafez (1987). Higher incidence of short duration oestrus, about 12 hours may be due to the method followed wherein the detections were made in the morning at around 0730 h and in the afternoon around 1400 h. The animals which were having oestrus for about 24 hours duration and would have come into oestrus after 1400 h, are likely to be detected in heat only once, i.e. in the morning detection and that would have in every probability been identified as an animal with an oestrous length of 12 hours

identified as pregnant The success rate obtained with single insemination was 33.93 per cent which was lesser than the result reported to have been obtained by Blokhuis (1957). Sahni and Roy (1967) reported that the success rate was 52.94 per cent. But from the reports it is not clear whether they followed single insemination in a heat or otherwise.

Success rate reported by Sudarsanan and Raja (1973) to first insemination is 55.2 per cent, that being natural breeding the success rate is likely to be higher. Ricordeau and Bouillon (1975) reported that the pregnancy rate can be as low as 21 per cent early during the breeding season and later it increases to 60.5 per cent. The result of the present study for a period of one year if compared with the overall success rate obtained by the above mentioned authors, may narrow down the difference. The success rate obtained in the present study is also lesser than that reported by Mathai et al. (1980). Mathai and Nair (1981) and Greesh Mohan et al. (1983).

The pregnancy rate of 42.85 per cent obtained with double insemination during one heat was significantly higher than the result obtained by single insemination and the former compares well with the results obtained by Mathai and Nair (1981).

Overall pregnancy rate by single insemination was 71.42 per cent which is very close to the results reported by

Sudarsanan and Raja (1973) and Bhadula (1980) whereas it was much lesser than the rates reported by Sahni and Roy (1967) and Greesh Mohan et al. (1983).

Pregnancy rate by double insemination during a heat was 82.14 per cent which was closer to the overall rates reported by Sahni and Roy (1967) and Greesh Mohan et al. (1983).

Under the facilities and practices in the place of the present study, two inseminations during a heat period appeared to be more desirable to obtain higher fertility.

5.2.2 Gestation period

Gestation period of the 120 pregnancies under observation was found to vary from 142 to 151 days. This is well in agreement with the variability reported by Sudarsanan and Raja (1973). Gestation period is subject to influence by breed, environmental conditions and age of dam (Hafez, 1987 and McDonald and Pineda, 1989). The variation in the gestation length from what has been reported by Hafez (1987) and McDonald and Pineda (1989) are reasonable since the flock composition of the present study, was not homogeneous.

Average gestation length was 145.62 $\pm$ 0.23 days and was observed to be lesser than the average reported by Sudarsanan and Raja (1973), Kuriakose (1981) and McDonald and Pineda (1989). For the male and female kids born as singletons, average

gestation lengths were 145.98 ± 0.36 and 146.13 ± 0.52 days respectively with the overall average of 146.05 ± 0.31 days indicating that the male kids were carried for lesser time than the mean gestation length and that of the female kids. This is not in agreement with the reports of Shelton (1960), Hafez (1987) and Verma et al. (1990) that the male kids are carried longer than the female kids.

In heterogamous twin pregnancies the duration of gestation was 145.30 ± 0.45 days, in homogamous male twin pregnancies it was 144.0 ± 0.54 days, in homogamous female twin pregnancies it was 145.33 ± 80 days and the overall for all types of twin pregnancies it was 144.86 ± 0.32 days. Average duration of gestation in all categories of twins were lesser than that of the singleton pregnancies. This is in consonance with the reports of McDonald and Pineda (1989). The average gestation length for the homogamous male twin pregnancies was lesser than that of the homogamous female twin pregnancies as has been seen above in the case of singleton pregnancies. This contradicts the reports of Kuriakose (1981) and Amoah and Bryant (1983) as the sex of the foetus has no influence on the gestation length.

The inverse relationship between gestation length and litter size reported by Peaker (1978), Singh and Singh (1983) and Verma et al. (1990) cannot be taken as a general rule as it appears from the observations in the present study. On a

comparison of the data in Table 6 between the singleton, twin and triplet pregnancies it will become evident that though the twins are carried for a lesser duration than the singletons and is in support of the above statement, between the triplet and the twin there is contradiction. In the four triplet births observed in the present study, an average gestation length of 145.25 ± 1.03 days was recorded which is longer than the average for the twins. Had there been an inverse relationship it should have been lesser than the mean for twins. So the findings of the present study fully endorse the views expressed by Prasad et al. (1971) and Badawy and El-Bashary (1972) as the type of birth has no influence on gestation length. Overall average gestation length obtained in the present study is lower than those reported by Garcia et al. (1976) for Nubian, Alpine, Saanen and Toggenburg goats and by Peaker (1978) in British Saanen goats. This variation may either be attributable to the influence of breed or to the environmental conditions.

Gestation period was found to vary from 142 to 151 days with an overall mean of 145.62 ± 0.23 days. Gestation length of twin pregnancies was found to be lesser than that of singleton. Female foetuses were noticed to be carried for longer time than male foetuses both in singleton and homogamous twin pregnancies.

5.2.3 Incidence of multiple pregnancies

Multiple pregnancies were found to be 39.17 per cent and singleton was 60.83 per cent. These figures are in contrast to

the incidence of multiple pregnancies of 63.3 per cent reported to have been observed by Richter (Roberts, 1971). It is also much lower than the incidence reported by Nair and Raja (1973); Sudarsanan and Raja (1973) and Kuriakose (1981). But it is higher than the incidence of twinning observed in a flock of Malabari goats maintained in Tamil Nadu by Prakasam et al. (1987). It appears from the reports of Amble et al. (1964); Moulick et al. (1966) and Khan et al. (1981) that there are breed differences in the incidence of multiple pregnancies between the Indian breeds of goats as Beetal, Black Bengal and Jamnapari, with Jamnapari having the least incidence of 38.09 and Black Bengal having the highest incidence of 77.6 per cent. Among the exotic breeds also, Gill and Dev (1972) observed difference in the incidence of multiple pregnancies. With 171 kids obtained out of the 120 births recorded in the present study, the kidding rate in the flock was found to be 142.

5.3 Parturition

5.3.1 Stages of labour

Of the 15 parturitions monitored to note the duration of the first stage of labour, 10 were singletons and 5 were twins. The mean duration of the first stage of labour in singlet and twins pregnancies were 55.9 ± 14.5 and 60.6 ± 12.48 minutes respectively and the overall mean duration was 57.47 ± 10.29 minutes. This is well within the range of 45-355 minutes reported by Kuriakose (1981).

Second stage of labour was observed in 21 parturitions of which 16 were singlets and 5 were twins. The mean duration of the second stage of labour in singleton and twin pregnancies were 13.18 ± 1.29 and 18.18 ± 3.38 minutes respectively and the overall mean duration was 14.52 ± 1.34 minutes. Tiwari et al. (1969) reported that the second stage of labour was 22.8 ± 3.0 minutes. Though the length of second stage of labour in the present observation is less than the time reported by Tiwari et al. (1969), it is within the variability of 10 to 43 minutes reported by Kuriakose (1981). The study by the latter author was conducted in the same flock and in the same environment.

Third stage of labour was studied in 82 parturitions and the mean time taken for 53 singlets and 29 twin births were 129.92 ± 6.74 and 126.93 ± 6.12 minutes respectively and the overall duration was 128.87 ± 4.84 minutes. The mean time recorded for the third stage of labour, in the present study is lesser than the length of time reported by Tiwari et al. (1969). But as in the case of the second stage, this is well within the range of 50 to 290 minutes reported by Kuriakose (1981). The minimum and maximum duration of time for the third stage of labour, in the present study were 67 and 195 minutes respectively.

Kuriakose (1981) could not find any variation in the duration of the first, second and third stages of labour between the three genotypes of goats involved in their study. The

observations of the present study fully concurred with the reports of Kuriakose (1981) but differed with the durations of the second and third stage of labour reported by Tiwari et al. (1969). It appears, since genotypic difference could not be seen, variation in the duration of the stages of labour may be due to the management effects on the general condition and health of the animal.

Anterior presentation of kids at the time of birth was found to be 88.9 per cent and the rest in posterior presentation. This is well in consonance with the observations made by Hafez (1987).

5.3.2 Secondary sex ratio

The secondary sex ratio of singleton births was found to be 52.05 per cent males whereas it was 54.08 per cent males in multiple births and the overall was 53.22 per cent. The results well agree with the sex ratio reported by Mittal (1976), Bhadula (1980) and Qureshi et al. (1991). They have all obtained 54.8 to 55.7 per cent males wherein they were not seen to have studied the sex ratio of singleton and multiple births separately. It is also not at variance with the sex ratio reported for the exotic breeds of goats, by Tantawy and Ahamed (1960), Haumesser (1975) and Notte and Mansilla (1979), where it varied from 51.0 to 56.0 per cent. The results of the present study do not agree with the sex ratio in Jamnapari goats

reported by Singh and Singh (1974) where they obtained only 44.81 per cent males. It also does not agree with the sex ratio of 60.0 per cent reported by Gill and Dev (1972) in a flock of French Alpine and Anglo-Nubian goats maintained under Indian conditions. Their result is also at variance with that of Notte and Mansilla (1979) on Anglo-Nubian and Puira Criollo goats. Secondary sex ratio of 106, of all kids born in this study, is well in consonance with the reports on sex ratio from in and outside the country, but for the one of Singh and Singh (1974).

5.4.1 Environmental temperature effect on kid sex ratio

Of the conceptions that have occurred during the quarter commencing from March, having the highest mean maximum environmental temperature, 34 that completed the gestation has dropped 53 kids of which 24 were males and the rest were females. This had a secondary sex ratio of 45.3 per cent. During the succeeding quarter from June to August when the mean maximum environmental temperature was the lowest, 42 of the conceptions resulted in birth of 57 kids. Thirty two of them were males and the rest were females, with a secondary sex ratio of 56.1 per cent. In the third quarter commencing from September when the mean maximum environmental temperature was intermediate to that of the above mentioned two quarters, 37 of the conceptions that resulted in birth dropped 47 kids comprising of 26 males and 21 females. The secondary sex ratio was found to be 55.3 per cent.

Statistical analysis of the data did not reveal any significant influence of the environmental temperature on the secondary sex ratio. The statement by Roberts (1971) as "though claims have been made that certain specific and intentional procedures influence sex ratio, references regarding the environmental temperature effect on sex ratio are meagre" stand further substantiated by the findings of the present study. Though there is a report by Notte and Mansilla (1979) recording variability in sex ratio of kids born in summer, autumn, winter and spring, the overall for a period of study of 3 years was 52.5 per cent. Results of the present study indicated that there is no significant variation in the secondary sex ratio of kids that were conceived between seasons having variable environmental temperature.

5.4.2 Environmental temperature effect on kid birth weight

Overall mean birth weight and sex war mean birth weight of the kids which were conceived during March to May (Trimester I) were significantly lower than the corresponding weights obtained for the kids conceived during June to August (Trimester II). Mean birth weight of male kids during the former period was 1.74 kg as against 2.0 kg of the latter period. Similarly the mean birth weight of female kids also was lesser and the weights were 1.53 and 1.84 kg. The overall mean birth weight of 1.92 kg for trimester II was significantly higher than 1.64 kg obtained during trimester I. Mean maximum environmental temperature during trimester I was

39°C and it was 33.4°C during trimester II, other conditions being identical the difference in birth weight is attributable to the variation in environmental temperature.

During the succeeding period from September to November (Trimester III) the mean birth weight of male, female and the overall were 1.85, 1.90 and 1.88 kg respectively. The overall mean birth weight was greater than the overall mean birth weights recorded during trimester I, but lesser than that recorded during trimester II, but with neither, the difference was significant.

Cartwright and Twaites (1976) from their experiments of subjecting non acclimatized cattle and sheep to hot room conditions have deduced that the placental development is inhibited due to high environmental temperature and the consequent inadequacy of foetal nutrition led to foetal stunting (Arthur et al., 1989). Huston (1967) and Hopkins et al. (1980) have also documented that lamb birth weight will be suppressed when dams are subjected to environmental heat stress in tropics. Hopkins et al. (1980) have also found that heat stress during the last month of pregnancy can significantly retard foetal growth. However Prasad et al. (1972) and Singh (1973) have reported that with Barbari and Jamnapari they could not appreciate any effect of month or season on the birth weight of kids. But the result of the present study reveals that the environmental temperature at the time of conception has a

significant influence on the birth weight of kids, fully concurring with the experimental evidence putforth by Cartwright and Twaites (1976) and also with the observations of Huston (1967) and Hopkins et al. (1980) on the tropical heat stress effect on lamb birth weight.

Further to substantiate the above, a study of the placental weight and area in relation to the birth weight of kid was concurrently taken up. The data presented in Table 11 and linear regression curve in Fig.17 show that a definite correlation exists between the placental weight and the birth weight and also between the placental area and the birth weight (Fig.18). Between the mean birth weight of male and female kids during a trimester there is no significant difference whereas when it is compared between the trimesters, there is a significant increase in the birth weight of both males and females conceived during trimester II, to that of trimester I. There having been a relationship established between the placental weight and the placental area the difference in birth weight between trimesters is attributable to the difference in placental weight and placental area.

From the details given above, it appears plausible that there is a suppression of early placental development due to the high environmental temperature as has been found by Cartwright and Twaites (1976) in their experiments in 'hot room' condition.

Holmes et al. (1986) observed that the pregnant does in the latter half of gestation when subjected to elevated ambient temperature gave birth to lighter kids. Similar observations were reported by Prasteyo et al. (1984) when the body temperature of pregnant goats was raised to a stage of heat stress. In the present study the reduction in birth weight is not attributable to the reasons stated by Holmes et al. (1986) and Prasteyo et al. (1984) since the ambient temperature during the latter half of the gestation was lesser than the time at which conceptions occurred. This further strengthens the surmise that the reduction in birth weight was due to the suppression of early placental development.

According to Prasad et al. (1979) and Hafez (1987), the elevated ambient temperature effect may cause embryonic mortality and the former, by controlled experiments has estimated the embryonic loss to be as high as 42.11 per cent. Though there are sufficient indirectly connected reasons to believe that due to high environmental temperature effect, there is arrest of placental growth and thereby retardation of growth of foetus, resulting in low birth weight, there is scope for further detailed studies. A study during early pregnancy when placental growth and attachment are taking place may help to assess the extent of inhibition of the growth/embryonic mortality due to environmental thermal stress.

SUMMARY

SUMMARY

1. On an analysis of the 520 oestruses detected during a period of one year in 154 goats using a vasectomised buck, it was found that the goats in Kerala have a reproductive pattern distinct from what is seen elsewhere. Of the 520 oestruses, 320 (61.54 per cent) occurred during the period from April to September, when the day was long. Remaining 38.46 per cent came into oestrus during the period of short days which is generally believed to be the breeding season of goats. They were found to be polyoestrous with two peaks in their breeding activity, a greater peak in July and a lesser one in November. Breeding activity was found to be the lowest in January when the day is short. Low breeding activity during January and February appears to be to reduce birth at the time of heavy rains during June and July, the period being not conducive for the survival of the young ones.

2. Duration of the oestrous cycle of goat was found to be 18-23 days. A disproportionate incidence of short cycles of 45.58 per cent was noticed. The high incidence appears fully justified on consideration of flock composition and the method of detection of use of a vasectomised billy goat.

3. Duration of oestrus in goats was found to vary from 12-72 hours and in 84.80 per cent of them oestrus ceased by 36 h and in 93.26 per cent of them by 48 h.

4. Single artificial insemination as soon after the detection of a goat in heat was found to give a success rate of 33.93 per cent as against a 42.85 per cent success rate when the first insemination was followed up and given another insemination after 7 h. Overall pregnancy rate to single and double insemination were found to be 71.42 and 82.14 per cent respectively suggesting that two inseminations during a heat is more desirable to obtain higher fertility among goats.

5. Gestation period was found to vary from 142 to 151 days with an overall mean of 145.62 ± 0.23 days. Gestation length of twin pregnancies was found to be lesser than singleton. Female foetuses were noticed to be carried for longer time than male foetuses both in singleton and in homogamous twin pregnancies.

6. Multiple pregnancies in the flock were found to be 39.17 per cent. Of the 120 births observed, 171 kids were obtained recording a kidding rate of 142.

7. The first stage of labour in singleton and twin pregnancies were found to be 55.9 ± 14.5 and 60.6 ± 12.48 min respectively with an overall mean duration of 57.47 ± 10.29 min. The second stage of labour in singleton pregnancy was for a duration of 13.18 ± 1.29 min and in twin pregnancy it was 18.8 ± 3.38 min. The overall mean of duration of second stage of labour was 14.52 ± 1.34 min.

The third stage of labour was for a duration of 129.92 ± 6.74 min in singleton and it was 126.93 ± 6.12 min in twin pregnancies. The overall mean duration was found to be 128.87 ± 4.84 min.

8. Presentation of kids at the time of birth was found to be with 88.9 per cent in anterior and the rest in posterior presentation.

9. Secondary sex ratio in singleton births was found to be 52.05 per cent, in multiple births it was found to be 54.08 per cent and in all the kids born it was 53.22 per cent.

10. On a comparison of the secondary sex ratio of kids, grouped according to the environmental temperature at the time of conception into three quarters commencing from March, did not reveal any significant difference between the groups.

11. Mean birth weight of kids which were conceived during March to May when the environmental temperature was the highest, was found to be significantly lower than the corresponding weight of the kids conceived during June to August, when the environmental temperature was the lowest. The birth weight obtained of the conceptions during the period from September to November when the mean environmental temperature was intermediate, was higher than the birth weight obtained of March to May conceptions. But it

insignificantly varied with the weight obtained during the period of higher temperature and the period of lower temperature. This has clearly suggested that the environmental temperature at the time of conception is having an inverse relationship with the mean birth weight of kids. A correlation between the birth weight and the placental weight as well as placental area could be established suggesting that the high environmental temperature is exerting its influence at the time of placental growth and development to cause a reduction in birth weight of kids.

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REPRODUCTIVE PATTERN AND PERFORMANCE OF NANNY GOATS IN KERALA

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ABSTRACT

A study to elucidate the reproductive pattern and performance of nanny goats under the agroclimatic conditions of Kerala conducted on a flock of 154 nanny goats of mixed genotype, Malabari, Saanen x Malabari and Alpine x Malabari, maintained under the All India Co-ordinated Research Project on goats for milk, Kerala Agricultural University, has revealed the following results and conclusions.

The method adopted was detection of oestrus twice a day using a vasectomised buck and by clinical examination. On detection, all animals of good reproductive health were bred artificially with freshly collected semen extended in Tris buffered yolk extender and preserved at low temperature. A group of animals were given a second insemination after seven hours of the first insemination for a comparison of the success rate to single and double inseminations during a heat. Following breeding, the duration of gestation, durations of stages of parturition, presentation of kids, incidence of multiple birth and secondary sex ratio were also recorded.

Daily record of maximum and minimum temperature for a period of one year of the study was maintained. The period was divided into four quarters almost in agreement with the four natural seasons and the conceptions during each of the quarters

were related with their secondary sex ratio and birth weight records to know the influence of the environmental temperature on them. Placental area and weight records were also maintained and by applying linear regression equation they have been correlated with the birth weight to establish that the birth weight difference was due to the influence of environmental temperature on placental growth and development.

Goats were found to be polyoestrous and 61.54 per cent came into oestrus during the period from April to September when the day is long. Of the two peak breeding activities noticed the greater one occurred in July and the other during November. Breeding activity was found to be low during the months of January and February. The duration of oestrous cycle was found to be 18-23 days but the cycle length varied from 6 to 140 days. 45.8 per cent of the animals had an oestrus duration of less than 18 days. Duration of oestrus varied from 12-48 h. Cessation of oestrus was noticed in 84.8 per cent of animals by 36 h and in 93.26 per cent of animals by 48 h.

Conception percentage to first time single and double inseminations during a heat were 33.93 and 42.85 respectively. Overall conception percentages for the above were 71.42 and 82.14 respectively.

Average gestation length was 145.62 $\pm$ 0.23 days while with singleton, twin and triplet, the durations were 146.05 $\pm$ 144.86 $\pm$ 0.32 and 145.25 $\pm$ 1.03 days. In twin pregnancies and

in pregnancies with male foetus/foetuses in both singleton and homogamous twin, was found to have lesser duration of gestation. Mean durations of the first, second and third stages of labour were 57.47 ± 10.29, 14.52 ± 1.34 and 128.87 ± 4.84 min respectively. Presentation of kids at the time of birth was 88.9 per cent in anterior and the rest in posterior presentation. Secondary sex ratios of singleton and multiple pregnancies were 52.05 and 54.08 per cent with an overall of 53.22 per cent.

No significant variation could be observed in the secondary sex ratio of kids those were conceived between seasons having variable environmental temperature. Mean birth weight of kids born during the three trimesters with mean environmental maximum temperature 39.0, 33.4 and 36.3°C were respectively 1.64, 1.92 and 1.88 kg. Between the trimesters having 39.0°C and 33.4°C there was a significant increase in birth weight. A definite correlation was found to exist between the placental weight and birth weight and the placental area and birth weight.

The following conclusions were derived:

1. There is a reproductive pattern difference as could be seen from the above as 61.54 per cent of the oestruses occurred during the period of long days, contrary to the belief that breeding season of goats is the short days. Peak breeding activity was also noticed during the month of July. An instinctive attempt to reduce the number of births during

the months of heavy rain which is not conducive for the survival of the young could be appreciated from the low breeding activity seen during January and February.

2. The duration of oestrous cycle, oestrus, gestation and the first, second and third stages of parturition were found to be in consonance with the already available informations.

3. Two inseminations during a heat was found to improve the conception percentage over single insemination.

4. Incidence of multiple pregnancy was found to be lower in the flock.

5. Secondary sex ratio of the kids born was 53.22per cent and it confirms well with the reports already available. Presentation of foetus was anterior in 88.9 per cent and the rest of posterior presentation.

6. Conception between periods of variable environmental temperature did not seem to influence the sex ratio, to significantly alter the secondary sex ratio.

7. Environmental temperature at the time of conception was found to significantly influence the birth weight of kids. From the correlation that could be established between placental weight and birth weight and between placental area and birth weight it could be inferred that the environmental temperature effect on birth weight is through its influence on placental development and growth.