EFFECTS OF FEEDING LEVEL AND REARING METHOD ON SEXUAL DEVELOPMENT IN YANKASA SHEEP

BY

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C E R T I F I C A T I O N

This thesis, "Effects of feeding level and rearing method on sexual development in Yankasa Sheep" by Nwachi Gerald Akpa meets the guidelines stipulated for the award of the degree of Master of Science (M.Sc.) of Ahmadu Bello University, and is certified for its contribution to knowledge and literary presentation.

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D E D I C A T I O N

This thesis is dedicated to my late father, Lawrence Akpa, my mother, Roseline Akpa, my brothers, Vincent, Aloysius, Ibeabuchi, Chinazo, and my sisters, Appolonia, Chika and Kenechukwu, for their encouragements and support. I pray to Almighty God to bestow on them his mercy, his forgiveness and make paradise their eternal home - Amen.

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A B S T R A C T

The study examined the effects of feeding level and rearing method on sexual development in Yankasa sheep. Seventy-two animals with mean age and body weight of 145.3 +17.7 days and 10.1+2.6 kg respectively were used for the 4 months investigation. Animals were randomised in a 3x3 factorial design with feeding rate at 3 levels (low, medium and high) and rearing method at 3 levels (males alone, females alone and both males and females). Sixty-six animals survived to the end of the experiment, made up of 34 females 32 males. Traits investigated included, age, body weight and scrotal circumference at puberty, and changes in scrotal circumference in ram lambs; progesterone concentrations in ewe lambs, sexual activity and growth performance in both sexes.

Feeding level and rearing method had highly significant ($P<0.001$ and $P<0.01$, respectively) effects on average daily gain (ADG) on experiment. The overall ADG (+ s.e.m.) was 77.8+3.0 g/day. Animals on the low, medium and high levels gained 66.8+5.49, 77.8+5.6 and 89.0+5.6 g/day respectively. As feeding level increases, there is a corresponding increase in live weight gain. Generally, males gained faster in weight than females.

Males were sexually more active (26 out of 32) than females (3 out of 34). Mixed rearing produced animals that were sexually more active (13 out of 15) than males alone (13 out of 17). Sex and rearing method had highly significant ($P<0.001$ and $P<0.01$, respectively) effects on sexual activity.

Progesterone concentrations in the Yankasa ewe lambs within 264 days of age was 0.57+0.04 ng/ml. Feeding level had a very highly significant ($P<0.001$) effect on progesterone concentrations, with the concentrations for low, medium and high levels of feeding as 0.43+0.05, 0.73+0.05 and 0.56+0.04 ng/ml, respectively. Although rearing method had no significant ($P>0.05$) effect on progesterone concentrations, mixed rearing showed relatively higher (0.61+0.04 ng/ml) concentrations than females alone (0.53+0.04 ng/ml). Generally, progesterone concentrations decreased with increase in the sampling date; implying probably that season of the year might have influenced progesterone concentrations in Yankasa sheep.

For pubertal determination, the results showed that age, body weight and scrotal circumference at puberty in the ram lambs were 232.5+12.7 days, 18.3+0.4 kg and 22.7+3.1 cm respectively. The implication is that these animals are

capable of breeding from this age. In the ewe lambs, serum progestrone profiles gave no clear indication of pubertal age. Feeding level and rearing method had no significant ($P>0.05$) effect on age and scrotal circumference at puberty in the ram lambs. However, feeding level showed a very highly significant ($P<0.001$) effect on body weight at puberty.

C H A P T E R 1

L I T E R A T U R E R E V I E W

1.1. General Introduction:

Sheep and goats are widely distributed in Africa. The 171 million sheep and 144.7 million goats found in Africa, represent 28.9 and 20.2% respectively of the total population of ruminant livestock in the tropics and subtropics (Nuru, 1985). Sheep play an important role in the socio-economic life of the people of Nigeria. They also make a significant contribution to the national economy. Nigeria has an estimated 8.5 million sheep and 24.5 million goats, a ratio of 1:3. In the West African Subregion, Nigeria has the highest number of goats (52%) but second to the Sahelian countries only in the production of sheep (Nuru, 1985).

Sheep and goats contribute largely to domestically produced meat consumption. They also serve as suppliers of skins for the leather industry in Nigeria. It has been estimated that goats contribute 16% and sheep 5% of the total domestically produced meat in Nigeria. This has been estimated at 813,000 tonnes per annum (FAO, 1983).

Sheep give rise to three major products; meat, wool and milk. In many parts of the world, particularly the tropical regions, meat is the major product from sheep. In animals reared mainly for meat production, the two most important factors that need improvement are reproductive performance and growth rate. Litter size in Nigerian sheep is low,

1.25for Yankasa sheep (Ferguson, 1964; Adu et al., 1979). Therefore, emphasis on improvement in the indigenous sheep should be placed on their reproductive performance.

For genetic improvement of sheep, a survey of the breeds available and their different potentials is a raw material for the sheep breeder. These become even more important when high yielding breeds that are adapted to the local environment are to be developed. Adu and Ngere (1979) have described the indigenous sheep of Nigeria and the distinct breeds are the Balami, Uda, Yankasa and West African Dwarf sheep. These breeds were defined with information on reproduction, growth rate, age at first lambing and lambing percentage. Amongst them, Yankasa appears to be the most important breed, constituting about 60% of the total sheep population. They are predominantly found in the semi-arid and sub-humid zones of the country.

In sheep breeding programmes, optimal rate of genetic improvement might be got, using high selection pressure and reduction in generation interval. The first is enhanced by a high reproductive rate, achieved for example through accelerated lambing schemes, while the second might be got by the use of selected animals for breeding at an early age. Studies on reproductive characteristics in Yankasa sheep show that pubertal age in males is 39 weeks (Osinowo et al., 1985a) and 34 weeks in ewes (Kuteyi, 1979; Oyedipe et al., 1986). Nutrition can greatly influence the reproductive

performance of sheep.

The aim of intensive sheep production is to increase the number of lamb crops per year through the application of advances in reproductive physiology, breeding and nutrition. Therefore, successful breed improvement will only evolve through better understanding of the animals and their production environment.

In sheep there are considerable differences between and within breeds in the rate of postnatal sexual development (see review by Dyrmundsson, 1973a&b). This makes it essential for studies to be carried out for each breed under conditions in which it will be used.

The present study aims at determining the effects of feeding level and rearing method on sexual development in Yankasa sheep.

1.2. Phases of Sexual Development:

Sexual development can be defined as a gradual quantitative phenomenon comprising a series of events culminating in onset of reproductive ability in line with general body growth (Mukasa-Mugerwa, 1989). Puberty can therefore, be said to occur when the gonads begin to secrete sufficient steroids to accelerate the growth of the genital organs and the development of secondary sexual characteristics. Sexual development can be subdivided into four phases:

PRENATAL PHASE - involves the development and differentiation of the gonad and patterns of growth of the reproductive system up to birth.

POSTNATAL-PREPUBERTAL PHASE - is the period between birth and attainment of puberty. Here, the developmental changes in the reproductive system are in the form of; (a) anatomical, morphological and physiological; (b) endocrinological; and (c) behavioural changes. The animal needs to grow well in order to exhibit its optimum potentials.

PUBERTAL PHASE - is when the animal attains physiological maturity. Changes in body form and reproductive functions of the animal are important at this stage.

POST-PUBERTAL PHASE - is the period after the animal has reached physiological maturity. Activities commonly associated with reproductive process follow a well defined, rythmic and recurrent pattern - this is connected with the oestrous cycle. In the males, this process is contineous.

In ruminants, sexual development is highly dependent on the rate of growth of the animal which in turn depends largely on the level of energy intake. Reduced energy intake impairs body growth as well as the growth of the endocrine glands and reproductive organ (Rattray, 1977). Besides, sexual development and onset of the first oestrus are under complex neuro-endocrine control. This involves the anterior pituitary and hypothalamic area of the brain, which regulates the synthesis and release of gonadotropic and gonadal

hormones (Nalbandov, 1964; Donovan and Ten Bosch, 1965; Parkes, 1966).

1.3. SEXUAL DEVELOPMENT IN EWES:

A. The Reproductive System: Reproduction in the female is a complex process that involves the entire animal body. In the ewe, the reproductive system is not very different in general structure from those of the cow, although it is much reduced in size. The reproductive tract itself includes the two ovaries, two oviducts, the uterus, cervix, vagina, and the vulva.

a. Ovary: This is a paired organ and the site of oogenesis or development of the female gametes or ova. The size and appearance of the ovaries vary according to the stage of reproduction and the number of ova shed at any one time. Ovarian follicles can develop in both ovaries and will rupture at oestrus to give ovulation (Owen, 1981; Frandson, 1981). The weight of one mature ovary is 3-4 g and the number of matured graafian follicle is 1-4 (Terrill, 1962). The ovary is composed of the medulla and the cortex. It is surrounded by the germinal epithelium and in general increases four to seven times in weight from birth to the onset of puberty (Hafez, 1974). It is also endocrine in function.

b. Oviduct: This is a paired organ which conveys ova from the ovaries to the uterus. Each tube is suspended in a

peritoneal fold derived from the lateral layer of the broad ligament. The oviduct can be subdivided into the infundibulum with its fimbriae, the ampulla and the isthmus. The oviductal end adjacent to the ovary is expanded to form a funnel-like structure, the infundibulum, whose size varies with the species and age of the animal. The surface area is from 6cm² to 10cm² in sheep. The length and degree of coiling of the tubes vary in the farm animals. However, in the mature ewe, the length is 15-19 cm (Terrill, 1962; Hafez, 1974).

c. Uterus: The uterus of domestic mammals consists of two horns which unite to form the common body. In the cow, ewe and mare, the uterus is of the bipartite type. In these species, a septum separates the two horns and the uterine body is prominent. In sheep and cattle, the uterine horns are curved like the horn of the ram (Terrill, 1982). Implantation of the fertilized egg and development of the embryo occur here (Winters, 1963). In mature ewes, the lengths of the horns and body are 10-12 cm and 1-2 cm respectively, and the surface-lining of the endometrium has 88-96 caruncles (Hafez, 1974).

d. Cervix: The cervix is a sphincter-like structure which projects caudally into the vagina. It is characterised by a thick wall and constricted lumen. The cervical canal is characterised by various prominences. In ruminants these are in the form of spirally interlocking ridges known as the

annular rings. They are especially prominent in the cow (usually four rings) and the ewes where they fit into each other to close the cervix securely (Hafez, 1974). The cervical length in the mature ewe is 4-10 cm, with an outside diameter of 2-4 cm (Terrill, 1962). The function of the organ is to close the uterine lumen against intruders. It remains closed at all times except during parturition. At oestrus, it serves as a passage-way for sperm (Terrill, 1962).

e. Vagina: The vagina is the lowest part of the internal reproductive tract and serves as the female organ of copulation. At parturition it is the dilatable passage way for the foetus. The lining of the vagina shows several longitudinal folds (Terrill, 1962). It extends horizontally from the cervix to the vulva, is separated from the uterus by the cervix and partially separated from the vulva by the hymen. The hymen is a fold that narrows the entrance to the vagina. The vagina, like the uterus, is highly elastic capable of great dilatation which is necessary in giving birth. The vagina has no gland (Winters, 1963) and it has a length of 10-14 cm in ewes (Hafez, 1974).

f. Vulva: The vulva, also known as the urogenital sinus, is the terminal organ of both the urinary and genital system. It is a continuation of the vagina and the urethra leads to its floor. The diameter of the vulva is considerably longer than that of the vagina. The walls of the vulva are well

supplied with glands which are especially active during sexual excitment. The clitoris lies partially embedded in the posterior floor of the vulva. It is the homologue of the penis and excepting the urethra consists of the same parts (Winters, 1963). The vestibule has a length of 2.5-3 cm in the adult ewe.

B. Ovulation and Oestrus: The whole cycle of gametogenesis in the mammalian female ends in ovulation - that is, the liberation of the oocyte from the ovary. Oogenesis unlike spermatogenesis in the male, is a noncontinuous process and the total number of germ cells is fixed at birth (Mauleon, 1969).

The ovary of the ewe contains a large reserve pool of between 12,000 and 86,000 primordial follicles (with less than 2 layers of granulosa cells; diameter < 0.06 mm) and between 100 and 400 larger follicles at various stages of development (Cahill et al., 1979). The time taken by follicles to grow from the primordial stage to the immediate preovulatory stage (diameter, 8 mm) is estimated to be 6 months (Cahill and Mauleon, 1980). But the stimulus for primordial follicles to enter the growth phase is uncertain and may not require gonadotropic support (Cahill, 1981). However, once within the growing pool, follicles become increasingly dependent on gonadotropins and continue to grow until either they become atretic or are ovulated.

The process of oogenesis runs from oogonia

multiplication through maturation of the oocyte to ovulation (Mauleon, 1969). Crossbred ewe lambs have higher proportion of developing oocytes in their ovary than purebred lambs but the total number at birth is higher in purebreds (Land, 1970). Bradford (1972) indicated that ovulation rate is the primary factor to consider in breeds of sheep characterised by low litter size. Ovulation rates of pubertal ewe lambs vary with breeds (Southam et al., 1970, 1971). Ewe lambs have smaller ovaries and lower ovulation rates than yearlings and adult ewes (Mckenzie and Terrill, 1937) and "silent ovulation" occurs more frequently in ewe lambs than in yearlings and adults (Hafez, 1952). Akusu et al. (1986) reported that ovulation occurred in goats operated on 20-48 hours from the onset of sexual receptivity. They also observed a mean ovulation rate of 1.57 ova per doe and the right and left ovaries had similar follicular activity in relation to sizes of follicles and ovulations. Normal ovulation rate determined from abattoir studies for Yankasa sheep is 1.36 (Pathiraja and Oyedipe, 1985).

The intensity of oestrus in the ewe lambs is relatively low when compared with that of adults (Hafez, 1951). It might be inferred that deficiency in steroid secretion by the developing pubertal ovary is responsible for the low intensity or even intermitent absence of behavioural oestrus in ewe lambs. This is associated with the activities of the central nervous system and the pituitary gland (Cupps et al.,

1969).

Oyedipe et al (1986), reported the presence of short oestrous cycles without overt signs of oestrus prior to puberty. They also confirmed the occurrence of normal oestrous cycles following puberty in Yankasa ewes. Age at first oestrus for 3 breeds of sheep; West African Dwarf Sheep (Orji, 1976), Yankasa (Ojo et al., 1981) and exotic Border Leicester (Hunter, 1957), have been reported to be 267.30 (172-378), 241.5 and 247 (170-277) days respectively.

C. Hormonal Effects: Reproduction in the ewe is controlled by a number of hormonal systems coordinated in a complex way to give the desired result (Hafez, 1974). For instance ovarian follicle development is known to be a hormonally dependent process, although the initial trigger for primordial follicle growth and the developmental stages at which gonadotropic hormones act remain unclear (Halpin et al., 1986). These authors also suggested that an intra-ovarian auto-regulatory mechanism might exist to control the number of large follicles that were found. Prolactin has been implicated on one hand with the growth process in sheep (Ohlson et al., 1981) and on the other, by its involvement in ovarian functions (see review by McNeilly, 1984).

It is now known that hormones of the anterior pituitary gland, the ovaries and uterus control the oestrous cycle (Cupps, et al., 1969). The growth of follicles elicited by

the FSH leads to rapid increase in oestrogen secretion which is responcible for oestrus manifestation (Robinson, 1959). Short (1973) had shown that progesterone inhibits FSH secretion and thus prevents follicle development.

Studies in which adrenal function and ovulation rate were examined have been conducted in sheep. In one experiment, administration of ACTH for 3 days prior to oestrus increased ovulation rate in addition to delaying the onset of oestrus and lengthening the oestrous cycle (Doney et al., 1976). For the neuroendocrine regulation of the transition into adulthood in the female sheep, low tonic LH secretion, presumably in the form of slow pulses is necessary for development or maintenance of ovarian function before puberty (Foster and Olster, 1985). Absence of LH during the last part of sexual maturation might delay the ability of the ovary to respond to high frequency LH pulses during the pubertal gonadotropic rise (Foster et al., 1986).

The incidence of fertilized ova in immature animals following artificial insemination is low even with hormone treatment (Land et al., 1970). However, hormone treatment induces ovulation and oestrus as well as synchronizing breeding activities in ewe lambs prior to or during the natural pubertal period (Burfening and Horn, 1970). In an indigenous breed (Yankasa), the importance of hormone treatment has been demonstrated for twice-yearly lambing (Osinowo, 1982).

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D. Pattern of Sexual Development in Ewes: At the beginning of embryonal development, cells termed "Primordial germ cells" are identified. These cells migrate in stages to the genital ridges (Mauleon, 1969). In mammals generally, these germinal cells migrate across the dorsal mesentery as far as the primitive gonad.

Sexual differentiation of organs following conception begins about day 39-40 in the gonads. But thickening of germinal epithelium and growing of mullerian ducts occur within days 45 and 40-48 respectively;and increases in uterine diameter and regression of wolffian ducts in about day 63 (Mauleon, 1969). In sheep, it has been reported that sexual differentiation of organs commences about the 35th day following conception. However, full organ development is not reached until puberty (Terrill, 1969).

E. Puberty: Puberty is the time when reproduction first becomes possible while sexual maturity is the time at which the animal attains full reproductive capacity (Asdell, 1946). The former can be further defined as well, as the age at first oestrus as recorded by observations (Joubert, 1963). In the indigenous ewes, this ranges between the ages of five to ten months (Orji and Steinbach, 1980b; Ojo et al., 1981; Oyedipe et al., 1986). This range is in line with data on improved breeds of sheep (Dyrmundsson, 1973a).

a. Age and Body Weight at Puberty: The onset of puberty is related to body weight which depends on the level of

nutrition, age, type of birth and the season of the year the lambs were born. In sheep, there is neither a fixed age for puberty nor a definite time of the year for the first oestrus (Hammond and Marshall, 1952). The mature body weights of tropical breeds of sheep and goats have been given to range from 25 to 60 kg (Osinowo and Abubakar, 1988). Body weight at first oestrus is 40 to 60% of mature weight (Terrill, 1962).

Genetic factors may be of considerable importance in determining the age at which puberty is attained within a single species (Cole and Cassady, 1947). But individual variability in association with environmental factors may obscure the genetic effects (Cupps et al., 1969). However, there is also some genetic variability in the age at puberty among individuals of the same breed (Hafez, 1953; Dyrmundsson, 1972). In the ewe, apparent differences exist as regards breed and strain, in the age and body weight at first oestrus (Southam et al., 1971). And the reproductive performance of crossbred ewes tend to be better than those of the purebred ewes (Lang and Hight, 1967).

An earlier onset of first oestrus in ewe lambs is fostered by faster body growth during rearing. Ewe lambs reared under unfavourable conditions grow slowly. Consequently, such ewes may not reach the physiological and endocrinological development necessary for normal sexual function in their first year of life (Hafez, 1953, Dyrmundsson 1972).

b. Puberty and Oestrous Cycle: Female lambs attain breeding age between 5 to 8 months of age and behavioural oestrus lasts for 1 to 2 days in sheep (Osinowo and Adu, 1985). Full oestrous behaviour is manifested at the peak of oestrogen secretion in the cycling animal.

Lambs of either sexes have various forms of playful behaviours at puberty. But the actual sexual display is more pronounced in the males than in the females. Also, oestrous intensity is less marked in the ewe lambs than in yearlings and adults. In the female lambs too, attempts are not made by them to approach rams but they accept service at sexual advance by the ram (Hafez, 1952).

Early birth and faster growth rates enhance the duration of breeding activity in ewe lambs (Hafez, 1952) and increases the total number of heat during the breeding season. Attainment of puberty by ewe lambs during the first breeding season result in greater variation in sexual activity and the number of oestrous cycles depends on the breed, environment and sexual development of the lambs. The duration of oestrus is normally shorter in ewe lambs than in yearlings and adults (Hafez, 1952; Mounib et al., 1956).

F. Factors Affecting Sexual Development in Ewe Lambs:

a. Genetics (Breeds): Genetic factor is very important in sexual development of any species, although individual variability in association with environmental factors may obscure the genetic effect (Cupps et al., 1969). The mean

age at puberty is 213 days, with a range of 187 to 250 days (Asdell, 1946). However, there are genetic variations in the age at puberty among individuals of the same breed (Hafez, 1952; Dyrmundsson, 1972). Roux's (1936) report on puberty in merino, of South Africa, and Blackhead Persian ewes, showed that they reached puberty at 5 to 6 months of age, against 19 months in Border Leicester X merino crossbreds. The purebred merino ewes were even later maturing than the crossbreds. Breeds studied in Nigeria have also shown genetic variations in attainment of puberty, ranging from 5 to 10 months (Orji and Steinbach, 1980b; Ojo et al., 1981, Oyedipe et al., 1986; Osinowo and Abubakar, 1988).

Genetic selection causes a reasonable degree of variation in ovulation rate within a breed due to additive gene effects (Hanrahan, 1980). Hareeign (1985) reported that breed and level of nutrition are the main factors influencing ovulation rate in the ewe during the premating and mating periods.

Measures of growth particularly body weight at the yearling stage, appear mostly to be positively correlated genetically with the number of lambs born per ewe mated and per ewe lambing (+0.46±0.18) (Atkins, 1986). The age or parity of the ewe does not appear to have a clearcut effect on the magnitude of the genetic correlation (Chang and Rao, 1972; Forest and Richard, 1974). However, lower estimates of genetic correlations have been reported between lifetime

litter size and post and preweaning body weights (0.37 and 0.17, respectively) than when hogget body weight was used, 0.59 (Atkins, 1986).

b. Nutrition: The quality and quantity of feed are important because either low quantity or poor quality, or both will impair growth and development of the animal. Quantity is the level of feeding or the amount of feed given to the animal at any time. The quality is important because if the diet is low in protein, the ability of the animal to synthesize body protein will be limited.

Maustgaard (1969) showed that plane of nutrition imposed at different stages in life and during the reproductive cycle in females influences reproductive performance. Since growth and maturation of the reproductive system are not independent of normal body growth, any alteration of nutrition in the young animal retards puberty (Sadleir, 1969). The effect of nutrition on the sexual development of ewe lambs was investigated by Allen and Lamming (1961). These authors reported that a high plane of nutrition fosters greater daily gain to puberty, with age at puberty significantly lower than on a moderate plane. Mounib et al. (1956) made an interesting observation, that puberty was reached earlier in single ewe lambs than in twins. This also can be related to rate of growth determined interalia by the plane of nutrition. Thus, owing to the close association between general body growth and sexual development, high level of

nutrition will result in more ewe lambs attaining puberty at the first breeding season. This will also increase conception at a lower age and heavier body weight, than in ewe lambs growing at slower rates (Williams, 1954; Southam et al., 1971).

In adult ewes, increase in ovulation rate has been achieved through nutritional flushing (Coop, 1966) and this is of lesser effect in the yearlings. The level of nutrition imposed during pregnancy will produce substantial differences between treatment groups in respect of ewe liveweights and body condition at parturition and on the birth weights of their lambs (Peart, 1967; Osinowo and Adu, 1985). Casida (1959), reported that total body growth over a long period of time appears to be more important than the smaller amount of growth that might occur during a relatively short flushing period. But for the adult ewes, emphasis on high plane of nutrition should not be towards maternal body weight gain because it tends to decrease lamb birth weight with increasing protein level in the diet (Robinson et al., 1971).

c. Ram Effect: When several rams are present, a high proportion of ewes are mated with, more than one ram. The onset of breeding activity in ewes may be influenced by the introduction of the ram (Schinckel, 1954). Lees and Weatherhead (1970), reported that preference by Clun Forest ewes for rams of their own breed may be partly visual or through the sense of smell or presence of pheromones.

Pheromones are substances which are implicated in various aspects of sexual attraction in animals (Morgan et al., 1972).

Sudden introduction of rams to ewe lambs in transition from non-breeding to breeding activity resulted in a high degree of synchronisation of first mating, but did not affect the mean date of onset of oestrous activity (Dyrmundsson and Lee, 1972). In the Australian merino, ewes running all the year round with vasectomised rams experienced a non-breeding season during the summer months (Kelley and Shaw, 1943). Teasing the ewes 3 weeks prior to mating resulted in early lambing and a higher lambing percentage. This might be due to stimulation by the rams which resulted in a rapid increase in the pulsatile release of LH, irrespective of prolactin concentration before teasing. This will make most ewes to ovulate within the period of teasing (Poindron et al., 1980). However, there is no available information on "ram effect" on the attainment of puberty in ewe lambs.

d. Photoperiodism: Many species of animals have a defined breeding season and usually the breeding is in such a way that the pregnancy terminates just before food becomes abundant. The abundance of food will enable the mother to have enough food for milk production which is important for the young's survival (Turek and Campbell, 1979).

Most temperate zone birds require long days for the induction of reproductive activity (Gaston and Menaka, 1967),

while other species (eg. sheep, deer) utilize short days to signal the onset and maintenance of gonadal function (Dodge and Salisbury, 1970). Sheep in higher latitudes tend to have a shorter and more marked breeding season than those from the tropics. It is believed that this variation might be due, partly, to natural selection (Yeates, 1949).

There is relationship between date of birth and the onset of first oestrus in ewe lambs (Hammond, 1944). Studies carried out by Tiwari and Sahni (1977) showed significant differences between breed groups of lambs exhibiting first oestrus, by 12 months of age for autumn-born lambs and by 18 and 24 months for spring-born lambs. In this study, the number of ewes lambing by 24 months, as a percentage of ewes mated ranged from 24.3 for Rambouillet to 79.3 for Malpura. The proportion of autumn-born lambs exhibiting oestrus by 12 months of age varied between breeds, from 12 to 72% while no spring-born lambs exhibited oestrus by 12 months of age. However, photoperiod had no significant effect on age or weight at puberty nor on LH level in the high energy fed animals at 18-21 weeks of age (Fitzgerald, 1981). But low levels of energy would significantly lower the LH and thyroxine level. The consequence is retardation in age and body weight at puberty.

Ewe lambs born early in the season tend to attain puberty earlier in the season than lambs born late (Dyrmundsson, 1972). However, in the tropics, puberty occurs

in ewes irrespective of the daylight environment. This is due to the little variation in day-length (Hafez, 1952). Thus, seasonal effect on the sexual development of ewes is more pronounced in the temperate breeds of sheep than tropical ones.

e. Temperature: Environmental temperature has direct and indirect effects on the functions and physical well-being of the animal. Too high a temperature affects the functions of the thyroid gland thus affecting fertility. Fitzgerald (1981) reported that increasing environmental temperature above 21°C will reduce serum thyroxine at sexual maturity as well as the onset of oestradiol secretion. Also, decreasing progesterone concentrations of the peripheral blood in the ewe is associated with high environmental temperatures. This might have contributed to the poor lambing performance observed in Merino ewes in the inland areas of Australia (Powell, 1976). It might as well be associated with increased early embryonic losses in sheep (Ashworth et al., 1984).

The influence of temperature increases in importance in subtropical and tropical regions. Temperature influences the time of the onset of oestrus in anoestrual ewes (Dutt, 1960; Lees, 1966). Ryle (1961) observed that high ambient temperatures exercised a profound effect on the reproductive behaviour of ewes. It slightly reduces the number of ovulations and the development of the potential embryo (Brown

et al., 1977). Birth weight of lambs from ewes in a hot environment will be significantly lower than those in a mild environment. Also, small lambs resulting from maternal heat stress of 25 to 53 days duration will be proportional dwarfs, and will occur independent of the ewe's level of nutrition (Brown et al., 1977).

It appears there is lack of information on direct influence of temperature on attainment of puberty in ewe lambs.

6. Age at First Conception and Life-time Performance:

The over-all life-time performance of ewes depends on the time of the onset of cyclicity. Ewes below the yearling stage may not be as efficient as older ewes as a result of certain factors which militate against their carrying the foetus to term. The time of breeding depends on a combination of factors which include body weight and body size at the time the animal attains puberty.

Growth and development of ewe lambs are checked when bred early in life. But ewes retarded to 16 months can make up between 16 and 28 months of age about 60% of the early retardation in carcass weight. Palsson (1962) reported success in breeding ewe lambs provided they were fed to gain approximately 10 kg bodyweight from weaning at 4 months to lambing at 12 months of age. Under good management, rebreeding within 40 to 60 days post partum in the breeding season in temperate areas (Hunter, 1968), or throughout the

year in the tropics (Osinowo and Ekpe, 1985) is possible. This will increase lifetime performance.

It is now clear that early breeding has no detrimental effects under good management and adequate nutrition. From reports, early breeding enhances subsequent fertility and the over-all life-time productivity (Bowstead, 1930; Spencer et al., 1942). Ewes bred as ewe lambs tend to be reliable breeders, make better mothers and have fewer lambing troubles at the yearling stage (Apps, 1953; Boaz, 1960).

H. Reproductive Efficiency: A fertile animal is one that produces viable offspring regularly. A number of reports have been made on the reproductive performance of the indigenous Nigerian breeds. Age at first parturition is between 14 and 18 months (Orji et al., 1976; Molokwu and Igono, 1978; Adu et al., 1985). The average parturition interval is 250 days and post-partum interval to first oestrus in Yankasa sheep is 34.3 days (Osinowo and Ekpe, 1985). Post-partum intervals to conception (rebreeding interval) is 42.5 days in Yankasa sheep (Osinowo and Ekpe, 1985) and 48.8 days in West African Dwarf sheep (Chiboka, 1986). Preweaning growth rates upto 14 weeks of age averaged 109 g/day for Desert Sudanese sheep (Suleiman et al., 1985). These reports confirm the potential for two parturitions in a year for those breeds studied. The lower relative growth rate, feed efficiency and carcass characteristics of the

indigenous breeds compared to the temperate ones, is probably as a result of poorer husbandry and lack of genetic selection (Osinowo and Abubakar, 1988).

High body weight has a beneficial effect on the reproductive performance of ewes. Higher numbers lambing and numbers born are obtained with ewe lambs that are of greater weight and higher age at mating. And efficiency can be improved by using crossbred ewe lambs rather than purebred lambs (Spencer et al., 1942; Fox et al., 1964; Dyrmundsson, 1973a).

Some of the problems of breeding losses in the ewe lambs include dystocia (generous feeding of dam during the late pregnancy could result in large singles being born), low birth weights and poor viability of lambs (Dyrmundsson, 1973a). However, losses could be minimised through the quality and quantity of feed and time of feeding during gestation and the overall health status of the dam at this time. Guerra et al. (1971) have reported that small body size will impose a low ceiling on reproductive performance when plane of nutriton is high.

I. Fertility and Selection for Improved Reproductive Efficiency

The number of lambs reared per ewe mated has a marked effect on the biological and economic efficiency of sheep production systems. This is largely determined by the number

of live lambs born. Variation in litter size is influenced by both genetic and environmental factors and interaction between them (Haresign, 1985). Ovulation and prenatal survival rates contribute much more to variation and size than does fertilization rate in cattle, sheep and pigs (Hanrahan, 1982). Measures of growth, particularly body weight at the yearling stage, appear mostly to be positively correlated genetically with lambs born per ewe mated and per ewe lambing, +0.66±0.18 (Alkins, 1986). It implies that the number of lambs born per ewe mated is a combination of the ability to reproduce (fertility) and litter size (prolificacy). Age or parity of the ewe does not appear to have a clear cut effect on the magnitude of the genetic correlation (Chang and Rae, 1972; Forest and Bichard, 1974). Even when this exists, the relatively large standard error of the estimates would mask any true effect. However, lower estimates of genetic correlations of 0.37 and 0.17 have been reported between lifetime litter size and post- and preweaning body weights respectively. But for hogget body weight there is high genetic correlation of 0.59 (Alkins, 1986).

Selection is a process in which certain individuals in a population are preferred to others for breeding purposes. It is a differential reproduction in which some members of the population are allowed to reproduce more than others. Animals could be selected, for instance on the basis of their

early and general reproductive efficiencies. Fertility is of low heritability and genetic improvement based on direct selection will be relatively low. But indirect selection based on the characters of the animal will be adequate.

For progeny testing, if survival is ensured, ewe lambs could be used in breeding programmes to shorten the interval between generations. This will speed-up genetic improvement. For instance, if rams are progeny tested for traits like prolificacy and mothering ability, the reduced generation interval and the consequent accelerated genetic improvement will provide a first-hand information on the test rams at a considerably earlier age (Chang and Rae, 1972).

Table 1. Performance characteristics of some indigenous breeds of ewes

Trait	Breed	Value	Reference
Birth weight (kg)	WADS	2.03 (1.0-2.75)	Orji, 1976.
		1.7(1.0-2.2)	Osinowo and Abubakar, 1988.
		1.5 2.18	Hill, 1960
	Yankasa	3.55	Ferguson, 1964
		2.9(2.5-3.1)	Osinowo and Abubakar, 1988.
	Uda	3.2(3.1-3.2)	"
	Balami	3.3(3.1-3.6)	Osinowo and Abubakar, 1988.
Weight at 3 mths. (kg)	WADS	9.3(8.4-9.9)	
	Yankasa	10.2(9.6-10.9)	Osinowo and Abubakar, 1988.
	Uda	16.9	
	Balami	20.1	
Weight at 12 mths. (kg)	WADS	18.9(18.9-19.7)	
	Yankasa	27.9	Osinowo and Abubakar, 1988.
	Uda	29.9	
	Balami	33.5	
Weight at maturity (kg)	WADS	32.0	Orji, 1976
	Yankasa	63.68	Ferguson, 1964.
Age at 1st Oestrus (days)	WADS	267.20(172-378)	Orji and Steinbach,1980b.
		238(198-267)	Osinowo and Abubakar, 1988.
	Yankasa	241.50	Ojo et al, 1981
		240(238-242)	Osinowo and Abubakar, 1988.
	Uda	306.00	Ojo et al, 1981
		298(290-306)	Osinowo and Abubakar, 1988.
Liveweight at 1st Oestrus	WADS	11.5	Osinowo and Abubakar, 1988.
	Yankasa	18.4	
Length of Oestrus (days)	WADS	18.5(9-27)	Orji and Steinbach, 1979.
	Yankasa	16.60	Igono et al, 1982.

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Trait	Breed	Value	Reference
Duration of Oestrus (hrs)	WADS	47.06(12-132)	Orji and Steinbach, 1979.
	Yankasa	24-33.6	Igono et al, 1982.
Duration of pregnancy (days)	WADS	147.4(142-153)	Orji and Steinbach,1980b.
		157(140-169)	Hill, 1960
		152(147-157)	Osinowo and
	Yankasa	151	Abubakar, 1988.
Age at 1st parturition (days)	WADS	424.9(310-692)	Orji et al, 1976
		513(425-638)	Osinowo and Abubakar, 1988.
Litter size	WADS	1.24(1.01-1.50)	Osinowo and Abubakar, 1988
		1.4(1-3)	Orji et al, 1976
	Yankasa	1.31(1.23-146)	
	Uda	1.29(1.27-1.31)	Osinowo and
	Balami	1.22	Abubakar, 1988
Weaning rate, %	WADS	88(65-89)	
	Yankasa	79	Osinowo and Abubakar, 1988.
Lambing interval (days)	WADS	268(224-326	
	Yankasa	236(196-276)	
	Uda	270	Osinowo and
	Balami	279	Abubakar, 1988.
Multiple birth, %	WADS	20	Hill, 1960
		55	Dettmers and Loosli, 1974
	Yankasa	25.5	Ferguson, 1964.

1.4. SEXUAL DEVELOPMENT IN RAMS:

A. The Male Reproductive System: The male reproductive or genital organs of the sheep is essentially of the same basic components with that of other domestic animals which are the external and internal genitalia. The external genitalia comprises of paired testes, epididymis enclosed in a scrotum and the penis. THe internal genitalia is madeup of the vas deferens and the accessory sex glands.

a. The Gonads: These are the two testes which are responsible for the production of male germ cells and male sex steroid hormones. They vary in shape, size and location from species to species, but the essential structure is the same (Frandson, 1981).

b. Epididymis: An enlongated tube closely apposed to the testis. The tube is very tortuous and is made up of the head, body and tail. The epididymis serves as a place for spermatozoa to mature prior to the time they are expelled by ejaculation (Frandson, 1981).

c. Scrotum: This is a cutaneous (skin) sac that conforms in size, shape and location to the testes it contains. The scrotal skin is thin, pliable and relatively hairless (Frandson, 1981). The scrotum gives the condition with which spermatogenesis could occur. The temperature is usually 2º to 8º C below the abdominal temperature.

d. Ductus Deferens: This is the straight muscular tube which at the time of ejaculation propels spermatozoa from the epididymis into the urethra (Frandson, 1981).

e. Accessory Sex Glands: These are the vesicular gland, prostrate gland, ampulla and bulbo-urethral gland. They provide fluid vehicle for nourishment and transportation of spermatozoa through the tract (Ham, 1965).

f. Penis: The male organ of copulation. It is made up of three parts: root (the part attached to the pelvic bone); body (the main portion of the penis); and glans penis (the modified free end). In bulls, rams and boars, the shape of the penis is sigmoid (Frandson, 1981).

g. Secondary Sexual Characteristics: Male secondary sexual characteristics depend on the presence of adequate amount of testosterone in the body. Characteristics commonly associated with masculinity are massive head and shoulders in bulls, development of crest in stallions, horns in some breeds of rams and tusks in boars (Frandson, 1981). Also, in all species, there is little or no development of the mammary gland (Frandson, 1981).

h. Castration: Castration is the removal of the testes of

the male, although technically it can apply to spaying or removal of the ovaries of the female as well (Frandson, 1981). Castration of males at prepubertal stage results in failure to develop secondary sexual characteristics, accumulation of body fat, appearance of general neutral sexual condition, and the absence of libido (Emmens, 1969).

Castration could be bilateral or unilateral. Bilateral castration might depress growth rate but unilateral castration has little or no effect on body growth rate because of compensatory growth in the other testis (Dutt et al., 1968; Renfro and Dutt, 1970). When castrates are injected with exogenous testosterone, they exhibited the complete male courtship pattern, excepting to intromission and ejaculation (Banks, 1964). Wiggins and Terrill (1953) found that penile development in ram lambs was arrested by castration and by the administration of the synthetic oestrogen, dienestrol. Injections of testosterone tended to advance penile development in entire ram lambs, but only slightly.

B. PRENATAL DEVELOPMENT: During embryonic development in mammals, the gonads of the embryo differentiate into testes after the migration of the primordial germ cells into the gonadal ridge (Ashdown and Hancock, 1975; Nalbandov, 1976). The primordial germ cells migrate from the yolk sac endoderm to the developing testes during the 5th week of gestation.

They are then incorporated into the sex cords. Finally, they differentiate into cells that later give rise to the gametes (Abdel-Raouf, 1960; Ham, 1965).

The differentiation of the primordial mammalian gonad into a testis or ovary is influenced by both genetic and other factors. Their differentiation is determined at the time of fertilization and it requires the "genetic sex". On the other hand, the "gonadal sex" influences and regulates the differentiation of the "body sex" (Somatic sex) (Wasternberg, 1980). Also, the secretion of androgens influences the differentiation of the male sex organs. When these hormones are absent, the mullerian ducts and the urogenital sinus develop into female sex organs. The regression of the mullerian ducts seems to be induced by the testes (Josso et al., 1977).

The differentiation of the sex organs in sheep commences at about the 35th day of conception (Terrill, 1974). In this, the primordial germ cells first become the gonocytes of the ram testes and eventually turn into spermatogonia from which spermatozoa are derived through the process of spermatogenesis (Ham, 1965).

C POSTNATAL DEVELOPMENT

a. The Testes: In rams and bulls, the testes enter the scrotum half way through foetal life (Ashdown and Hancock,

1975). This means that the testes are already descended at birth (Terrill, 1974). After birth, the components of the reproductive tract undergo differentiation and grow in size in relation to overall body weight (Abdel-Raouf, 1960). But there is no simultaneous attainment of functional competence by all components of the reproductive system.

In goats, the growth of the testes from birth to 90 days is independent of birth-weight and takes place at a definite and uniform rate (Yao and Eaton, 1954). After 90 days of age, its growth is well correlated with birth weight until 120 days of age. Thereafter, the correlation ceases to exist (Yao and Eaton, 1954). The growth of the seminiferous tubules is closely related to the weight of the testis rather than to the age of the animal (Yao and Eaton, 1954). Spermatozoa appeared in the seminiferous tubules at the age of 92 days in male goats and the entire process of spermatogenesis takes approximately 22 days (Yao and Eaton, 1954). In the indigenous Yankasa rams, the seminiferous tubules at 1.2 weeks as is normal were small in diameter (32.3u), had no lumen and contained a single layer of sertoli cells. There was a 4-fold increase in tubular diameter between 1.2 and 13.9 weeks of age with formation of lumen and onset of spermatogenesis (Osinowo et al., 1985a).

b. Formation of Spermatozoa: Spermatozoa are formed in the testes through a process known as spermatogenesis. After

formation, they undergo further maturation in the epididymis where they are stored until ejaculation takes place (Johnson et al., 1970). The process involves cell division and differentiation. During this time, the number of chromosomes is halved and both nuclear and cytoplasmic contents of the cell are reorganised (Bishop and Walton, 1960).

c. Hormonal Requirements for Spermatogenesis: The gonadotropins are concerned either directly or indirectly with the maintenance of the seminiferous epithelium and production of spermatozoa. Testosterone has been shown to partially maintain spermatogenesis, provided the germinal epithelium is intact (White, 1974). It appears that the formation of Type A spermatogonia requires testosterone but development through the pachytene primary stage can occur without hormones. The division of pachytene spermatocyte to form a secondary spermatocyte again requires testosterone but the final stage of the metamorphosis of spermatid to sperm requires FSH (White, 1974).

D. PUBERTY

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a. Definitions: Puberty has been defined as the age or time at which the genital organs become functional and reproduction may occur (Roberts, 1971). In the male it has been defined as the age at which the ejaculate first contains a minimum of 50 million spermatozoa with at least 10%

motility (Barber and Almquist, 1975; Oyedipe et al., 1981). It has also been defined as the age at which sperm cells first appeared in ejaculate (Marire, 1986). However, it will be more appropriate to define puberty as the age and body weight when males are capable of copulating and producing sperm.

b. Appearance of Spermatozoa in Ejaculates: Spermatozoa are present in seminiferous tubules and cauda epididymis at 14 weeks in rams and 32 weeks in cattle. The ram ejaculate contains spermatozoa at 10 weeks of age (Abdel-Raouf, 1966). However, in the indigenous Yankasa rams, spermatozoa were first found in the ductus deferens and ampullae of 2 out of 3 rams at 26.9 weeks and in all rams by 38.8 weeks (Osinowo et al., 1985b). Therefore, the age at puberty in the Yankasa breed is about 38.8 weeks.

c. Endocrinology of Puberty: Pituitary gonadotropins govern the physiology of puberty. The bioeffects of LH and FSH appear to be limited to the stimulation of various physiologic processes within the gonads (Niswender et al., 1974). LH stimulates testosterone secretion from the interstitial cells of the testis. Testosterone promotes the development and functioning of the accessory sex glands and the secondary sex characteristics (Ashdown and Hancock, 1975; Frandson, 1981). The sex hormones also regulate spermatogenesis and sexual behaviour (White, 1974 and

Nalbandov, 1976).

E. FACTORS AFFECTING SEXUAL DEVELOPMENT IN RAMS

a. Genetics (Breeds): Age at sexual maturity in sheep varies from breed to breed (Terrill, 1974). The rate of testicular development was found to be higher for faster-growing breeds like Hampshire and lower for slow-growing breeds like Merino (Chang and Rae, 1970). In the indigenous breeds there are breed differences in the attainment of puberty (Orji,1976; Osinowo et al., 1985b) and ranges between 4 and 12 months of age.

b. Age: In bulls, age and testicular development have a curvilinear relationship (Coulter and Foote, 1976; Osinowo et al., 1981). In rams, as the age increases, there is a general increase in testicular weight and mean cross-sectional area of the seminiferous tubules (Watson et al., 1956). But after puberty, in bulls, further testicular development is very slow (Almquist et al., 1976). Holstein dairy bulls were found to reach their maximum scrotal circumference in 5 to 6 years (Hahn et al., 1969), after which the size was relatively stable. Also, the testicular consistency was high in young bulls, decreasing as the animal grew, and remaining relatively constant in mature bulls (Coulter et al., 1975).

In the Red Sokoto bucks, spermatogenesis commenced by 90

days in one out of three bucks which had the highest body weight (8.6 kg) and testicular weight (31.3 g) within its age group. But by 120 days however spermatozoa were found in the caput, corpus and cauda epididymides of all bucks (Marire, 1986). It has been reported that ram ejaculate contains spermatozoa at 18 weeks of age (Abdel-Raouf, 1966). In the indigenous Yankasa rams, spermatozoa were first found in the ductus deferens and ampullae of 2 out of 3 rams at 26.9 weeks and in all rams 38.8 weeks (Osinowo et al., 1985).

c. Nutrition: Under-nutrition delays growth and puberty in rams, boars, stallions and bulls by many months (Foote and Trimberger, 1968; Leathem, 1975). With normal nutritional level, puberty occurs when body weight reaches 60% of the adult body weight in sheep and 45% in cattle (Thibault and Levasseur, 1974). Overfeeding accelerates growth, body weight at the time of puberty is higher than normal, and the animal reaches maturity at a younger age. On the other hand, underfeeding delays puberty and body weight does not reach that of normal-fed animals (Thibault and Levasseur, 1974). Lambs reared on a high plane of nutrition reach puberty earlier than those on low plane (Ward, 1980).

In rams, testicular size which is highly correlated with spermatogenic activity, responds to nutrition, and sperm production can be increased by "flushing" with high protein supplement for about 8 weeks before mating starts (Pryor,

1980). Vitamin A deficiency was found to retard testes development in cat and ram (Leathem, 1975) and if combined with protein deficiency, leads to testicular malformation and aspermia (Baronos et al., 1969).

The number of motile spermatozoa in the ejaculate of underfed animals was found to be 50% lower than normal, if the underfeeding was prepubertal (Flipse and Almquist, 1961). Low protein intake would produce more adverse effects on immature animals than on mature ones (Leathem, 1975).

d. Body weight: Body weight has been found to be related to testicular traits in animals (Coulter and Foote, 1979; Osinowo, 1979; Osinowo et al., 1981). It has been found that testicular weight is more closely related to body weight than age. An increase in body weight from 23-27 kg in rams leads to a great increase in the cross-sectional area of the seminiferous tubules (Watson et al., 1956). Terrill (1974) reported that sexual development in ram lambs is more closely related to body weight than age. A curvilinear relationship was obtained between scrotal circumference and body weight in rams (Watson et al., 1956).

e. Hormonal Effects: The sex differentiation of the male sex organs is under the influence of the secretion of androgen. If these testicular hormones are absent, the mullerian ducts and the urogenital sinus develop into female

sex organs. But if they are present, the wolffian ducts and the urogenital sinus develop into male sex organs (Josso et al., 1977).

The proliferation of gonocytes is stimulated by the pituitary gonadotropin. The gonadotropic releasing hormone from the hypothalamus stimulates the anterior pituitary to release luteinizing hormone (LH) and follicle stimulating hormone (FSH) (White, 1974). LH stimulates leydig cells to produce testosterone which in turn stimulates the germinal cells and maintains spermatogenesis (Gemzell and Roose, 1966). Androgen also helps in the development and maintenance of the accessory sex glands, stimulation of sexual behaviour and spermatogenesis (White, 1974).

f. Disease: Epididymitis has been reported as one of the diseases affecting testicular development. The resultant effect might be testicular degeneration, which is the most frequent cause of infertility in rams and bulls (Smith et al., 1970).

Orchitis is another disease which may lead to degeneration of the testes. It is usually due to hematogenous metastasis of infection, and less frequently through the spread of infection from the genito-urinary passages (Jubb and Kennedy, 1970).

In rams, epididymitis produced by Actonobacillus seminus delays testicular development and results in a decrease in

semen quality and quantity (Smith et al., 1970). Also, testicular hypoplasia affects testicular development but may not be observed until after puberty (Jubb and Kennedy, 1970). Some testicular disorders such as cryptorchidism and testicular hypoplasia have been reported to be of genetic origin (Bishop, 1972). Depending on duration and severity of infection, the function of the testes will be adversely affected by many of the infectious agents that may interfere with the general well-being of the animal.

g. Light and Temperature: Daylight and temperature may influence the sexual performance of rams under natural or controlled experimental conditions. There were seasonal variations in both the production and quality of ram semen, as well as in the desire to mate (Dymundsson, 1973b). It has been found that a decline in ram fertility was associated with high atmospheric temperature (Lodge and Salisbury, 1970; Moule, 1970; Van Demark and Free, 1970). Studies by Osinowo et al. (1982) reported higher quality for ram ejaculates collected during the wet season than those collected during the dry season. However, the observed seasonal differences do not appear severe enough as to prevent all year round breeding.

F. SEXUAL BEHAVIOUR IN RAM LAMBS

At an early age, ram lambs may attempt mounting other lambs or even, ewes. This behaviour is termed "play activity" (Scott, 1945). In ram lambs, there is both hetero- and homosexual activity sometime before the attainment of puberty (Dyrmundsson, 1973b). For Clun Forest rams, physiological puberty was attained at approximately 45% of adult body weight, while completed matings were achieved first at approximatley 40-50% of adult body weight (Dyrmundsson, 1973b). This implies that physiological puberty normally precedes complete mating ability; thus, the two are not synonymous in the ram lambs.

Homosexual activity is common among the rams and this might interfere with the establishment of normal heterosexual mating behaviour, especially for rams reared in large groups of males (Banks, 1964; Hulet, 1966; Pretorius, 1967). Such rams will exhibit varying degrees of libido ranging from lack of heterosexual interest to intense mounting activity leading to successful matings taking place (Dyrmundsson and Lees, 1972).

On sexual behaviour dominance, mature rams are normally dominant over young rams (Hulet et al., 1962).

G. ESTIMATION OF TESTICULAR SIZE

Testicular weight provides an accurate estimate of the sperm reserve of the testes (Coulter and Foote, 1979). Since

it is not possible to measure testes weight directly in live animals, indirect methods have been used. These methods include measuring the testes length and diameter, the paired testes width and scrotal circumference (Hahn et al., 1969; Almquist et al., 1976; Orji and Steinbach, 1980b; Daudu, 1984).

Linear measurements are made with callipers while the scrotal circumference is measured with flexible plasticized cloth or metal tape around the greatest diameter of the testes and scrotum (Hahn et al., 1969; Coulter and Foote, 1979; Orji and Steinbach, 1980b).

Scrotal circumference is highly correlated with testicular development (Lino, 1972), easy to measure, highly repeatable, highly correlated with testicular weight in rams and may be used for prediction of testicular weight and epididymal spermatozoa reserves (Hahn et al., 1969; Lino, 1972). It has been reported that causes of variation in testicular measurement in bulls are age, breed, bull stud (Coulter et al., 1975), and year and season of measurement (Coulter and Foote, 1976).

Table 2. SOME PERFORMANCE CHARACTERISTICS OF INDIGENOUS BREEDS OF RAMS

Trait	Breed	Value	Reference
Age at puberty	NDS	105 days	Aire, 1973
	NDS	20-24 weeks	Orji, 1976
	Yankasa	38.8 weeks	Osinowo et al, 1985b.
Body wt. at puberty	NDS	10-13 kg	Orji, 1976.
Mature testis weight	NDS	156.42 g	Orji and Steinbach,1980b
	Yankasa	193.33 g	Daudu, 1981.
Ejaculate vol.	WAD	0.73 ml	Chiboka, 1980
	Yankasa (AV)	0.50 ml	Osinowo et al, 1982
	Yankasa (EE)	0.95 (0.20-3.20) ml	Daudu et al 1983
	Yankasa (EE)	1.25(0.50-5.0) ml	Iheukumere, 1979.
Semen pH	WAD	7.2	Chiboka, 1980
	Yankasa	7.1	Osinowo et al, 1982.
Testicular sperm reserve	Yankasa	12.38(2.39-14.79) X10^9	Daudu, 1981
Estimated daily sperm production rate	Yankasa	2.4 x 10^9	Daudu, 1981
Spermatocyto-genesis	Yankasa	14 weeks	Osinowo, 1990
Spermiogenesis	Yankasa	39 weeks	"
Spermatozoa in testis	Yankasa	39 weeks	Osinowo, 1990

...../contd. from previous page

Trait	Breed	Value	Reference
Preputial-separation	Yankasa	39 weeks	"
Live wt. at 1.7 yrs	Yankasa	32.8 kg	"
SC at 1.4-yrs.	Yankasa	26.8 cm	Osinowo, 1990
Ejaculate vol. at 1.4 yrs	Yankasa	0.72 ml	Osinowo et al, 1988.
Total sperm/ ejaculate at 1.4 yrs.	Yankasa	2.469 X10^9	

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CHAPTER 2

MATERIALS AND METHODS

A. EXPERIMENTAL SITE: The investigation on the effects of feeding level and rearing method on sexual development in Yankasa sheep was carried out at the Small Ruminant Research Programme Experimental Unit, National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Shika, Zaria, from December 1989 to March 1990. Shika is situated in the Northern Guinea Savanna Zone, Latitude 11º 12'N and Longitude 7º 33'E. The altitude of the area is 610 m with mean annual rainfall of 1092 mm, falling between April and October. Mean temperature ranges from 27.4 ºC in August at the peak of the rainy season to 35.2 ºC in April (Smith and Gunn, 1981; Osinowo and Ekpe, 1985).

B. EXPERIMENTAL DESIGN: The experiment was carried out in a 3x3 factorial design which gave rise to 9 treatments. Each treatment was replicated 4 times with treatments 4, 5 and 6 repeated.

Seventy-two lambs made up of 36 ewe lambs and 36 ram lambs were used for the study. Animals were got from the Sheep Breeding Project of the Small Ruminant Research Programme and were transferred to the Experimental Unit of the Programme. Majority of the animals were born between June and July 1989. There were few outliers which were

either born before June or in August. The mean (± S.E.M.) age and weight of animals at the beginning of the experiment was 145.3±17.70 days and 10.1±0.50 kg, respectively. Selection of animals for the experiment was based principally on weight and to a certain extent, age of the animals.

In the experiment, animals were grouped into 3: females alone, mixture of males and females, and males alone in a randomised 3x3 factorial design. Each group was assigned to 3 different feeding levels with 4 animals in each level. The feeding levels were low (40g/kgW$^{.75}$), medium (50g/kgW$^{.75}$) and high (60g/kgW$^{.75}$), for concentrate feed, but hay (Gamba grass) was given at 2% body weight to all treatments. The low level was based on 3% body weight which was the feeding standard used for concentrates at the Experimental Unit. This was then increased by 10 and 20 grams to get the medium and high levels of feeding, respectively. Concentrate feed was given in the morning hours (between 8.00 and 9.00 hours) and hay in the afternoon (between 12.00 and 13.00 hours) daily.Water was supplied ad libitum.

Table 3: Experimental Design

Feeding level	Rearing Method	No. of animals
1	1	6
2	1	6
3	1	6
1	2	6
2	2	6
3	2	6
1	3	6
2	3	6
3	3	6
1	3	6
2	3	6
3	3	6

Feeding level: 1 = low (40g/kgW$^{.75}$); 2 = medium (50g/kgW$^{.75}$); 3 = high (60g/kgW$^{.75}$).

Rearing: 1 = males alone; 2 = females alone; 3 = mixture. method

D. NUTRITION: The concentrate feed was formulated to give 16% C.P. This consisted of 43.89% cotton seed cake, 54.86% maize, 0.5% Bone meal, 0.5% common salt and 0.25% vitamin/mineral premix. It was fed at the rate of 40, 50 and 60g/kgW$^{.75}$ for low, medium and high levels, respectively. This was adjusted every 10 days to account for changes in body weight. Hay which was made of Gamba grass, Andropogon gayanus, was fed at the rate of 2% of the body weight to all groups and adjusted every 10 days as above. Proximate and gross energy analysis were carried out for both concentrate and hay (Gamba grass, Table 2).

Table 4: Proximate and gross energy analysis of experimental feed

Components	%CP	%EE	%CF	%Ash	DM	GE(kcal/gDM
Concen-trate:	18.0	6.96	13.33	3.44	94.35	4.45
Hay	7.13	2.29	31.72	7.72	96.06	4.24

E. HEALTH MANAGEMENT: Animals were dewormed and sprayed with acaricide after 5 days on the experiment. They were sprayed again with acaricide when they were 3 months old on the study. Cases of diarrhoea were treated with either Ivax or Terramycin LA, depending on the causes of diarrhoea. This

was under the full supervision of the Health Management Unit of the Small Ruminant Research Programme.

F. EXPERIMENTAL PROCEDURES

a. Body Measurement: Body measurements taken included body weight and scrotal circumference . Measurements were made every 10 days from the start of the experiment through the 4 months duration. Scrotal circumference was taken at the widest diameter using a flexible tape. Weight gain on experiment was obtained by substracting initial weight from the final weight. To deduce the average daily gain (ADG), weight gain was divided by the number of days on experiment.

b. Sexual Activity Observations: Daily observations were made on all animals for either homosexual or heterosexual activities. For the males, further observation were made of nudging, sniffing and flehmen reaction . These observations were followed up for at least 5 occasions to confirm evidence of sexual activity in such individuals. During the observation the scoring was 1 for any animal that was sexually active and 2 for any that was not sexually active.

c. Preputial Swab Examination: Swabs wetted in normal seline were taken from the prepuce of all ram lambs and smears made on glass slides with cover slips and viewed under

a phase-contrast (phase 776482) microscope with magnification of X40 (Swift Instrument International, S.A. No. 776950) to check for presence of sperm cells. This was done on weekly basis (Mondays). Rams with smears containing sperm cells were excluded from subsequent examinations. Such animals were then weighed, scrotal circumference taken and their ages recorded.

d. Blood Sample Collection and Storage: Blood samples were collected every Tuesday and Friday by jugular vein puncture with 10 ml syringes with needles. Six ml of blood was drawn on each occasion into evacuated glass tubes with caps. Samples were then transferred at the end of collection to the refrigerator and left over-night to coagulate, serum was then collected and stored at -20 °C until analysed for progesterone. Blood sampling commenced on the 18th day of the experiment and was done between 7.30 and 10.00 hours on each day for collection.

e. Radio-immunoassay (RIA): The serum samples were analysed for progesterone with the aid of the new FAO/IAEA progesterone RIA Kit. The serum samples were allowed to thaw at room temperature.

The essential part of the new progesterone RIA kit is the test tubes which are coated with the antibody. The radio-immunoassay method depends on the competition between progesterone in the serum sample and the ^{125}I-Labelled

progesterone-specific antibody immobilized on the internal wall of the lower part of the test tubes. The proportion of the ^{125}I-Labelled progesterone bound to the antibody is inversely related to the concentration of the progesterone present in the serum .

Procedure

1. The standard curve, quality control and sample tubes were labbelled. Normal plastic tubes were used for total counts, and 2 coated tubes per standard curve point and quality control were used also.

2. 100 μl of the standards, quality controls and samples were pipetted into the bottom of the correspondingly lebelled tubes. The serum stands were used.

3. 1 ml of ^{125}I-progesterone was added to each tube within 5 minutes of adding the serum or standards and vortexed. These were then incubated for 4 hours at room temperature or left overnight.

4. The tubes were decanted (except the first two control tubes) vigorously and allowed to drain. The tubes were then stricken sharply on adsorbent paper to shake off residual droplets.

5. The radioactivity of the tubes were counted for 1 minute in a gamma counter (NE 1612 Turbo, Nuclear Enterprises

Ltd., Sighthill, Edinburg, EH 11 4BY Scotland). All the calculations were done automatically by the gamma counter together with the standard curve. Also, determination of the progesterone concentration of unknown samples were automatically done by the counter.

f. Statistical Analysis: least squares analysis (Wilkinson, 1988) of variance was done for all parameters considered except sexual activity which utilized chi-square test. Least squares analysis was carried out in view of unequal sample sizes/treatment or unbalanced nature of the design. Initial weight of the animals had great influence on growth rate during the experiment and was therefore treated as covariate in the analysis.

CHAPTER 3

RESULTS AND DISCUSSION

3.1. RESULTS:

A. GROWTH RATE: The growth rates of the Yankasa sheep in this study showed that the overall average daily gain was 77.8±3.00 g/day (Table 5). The age and body weight at the end of the experiment averaged 264.1±13.6 days and 19.2±1.9 kg, respectively.

Least squares analysis of variance for ADG (Table 6) indicated that feeding level and rearing method significantly influenced average daily gain ($P<0.001$ and $P<0.01$ respectively). Figures 1 and 2 indicated that as feeding level increases, there is a corresponding increase in live weight gain. While Figures 3 & 4, showed that males gained faster (87.6 g/day) than females (65.5 g/day). The mixed groups gained 75.2 g/day. Also, animals on the high feeding level gained highest (89.0 g/day), followed by those on the medium level (77.8 g/day). Animals on the low level gained least (66.8 g/day).

Table 5: Least squares means for average daily gain (g/d) on experiment in Yankasa lambs

Factor	Level	Means±SEM(g/d)
Feeding level	low	66.8±5.49[a]
	medium	77.8±5.57[b]
	high	89.0±5.62[c]
Rearing method	males	87.4±7.90[d]
	females	65.5±3.55[e]
	mixture	75.2±4.78[d]
Overall mean		77.8±3.00

[abcde]Subclasses with the same superscript are statistically the same; otherwise they are different from each other.

Table 6: Summary of analysis of variance for the effects of feeding level and rearing method on average daily gain in Yankasa sheep

Source	DF	MS
Initial weight*	1	11836.149***
Feeding level	2	4109.801***
Rearing method	2	2419.152**
Error	60	459.315

** = P<0.01; *** = P<0.001

*Initial weight was used as a covariate.

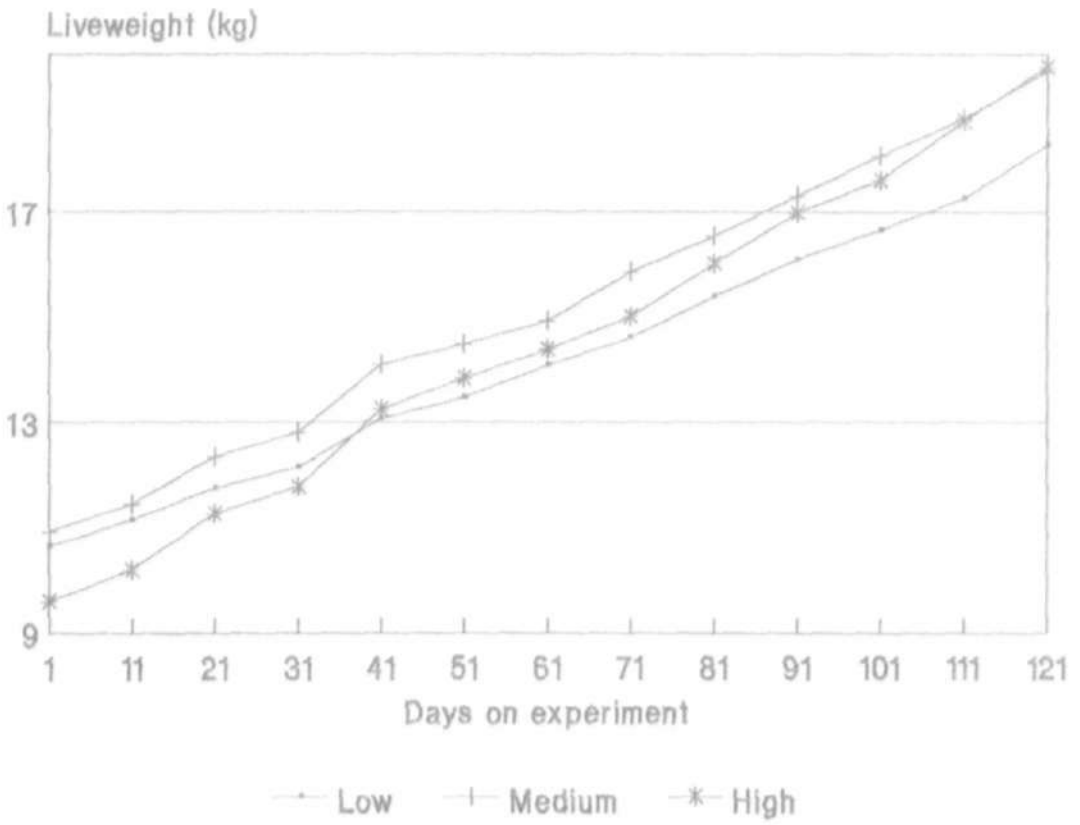


Figure 1. Effect of feeding level on liveweight gain

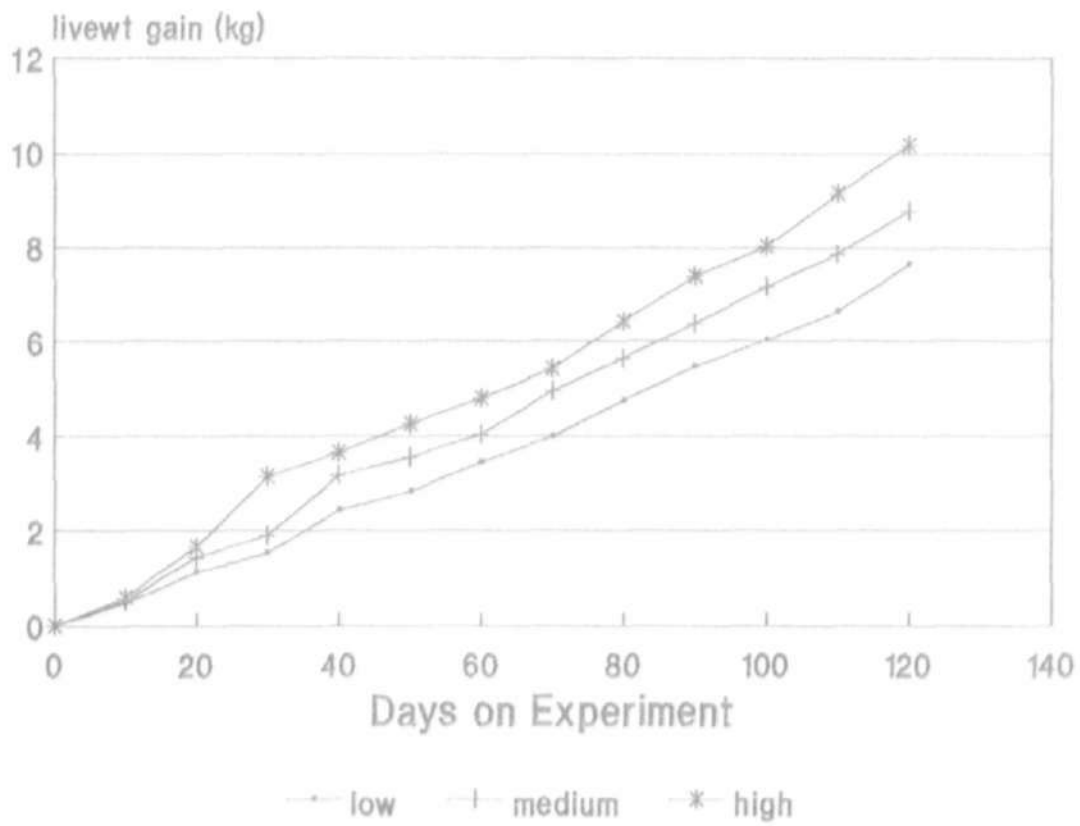


Fig 2 Effect of feeding level on changes in liveweight in Yankasa lambs

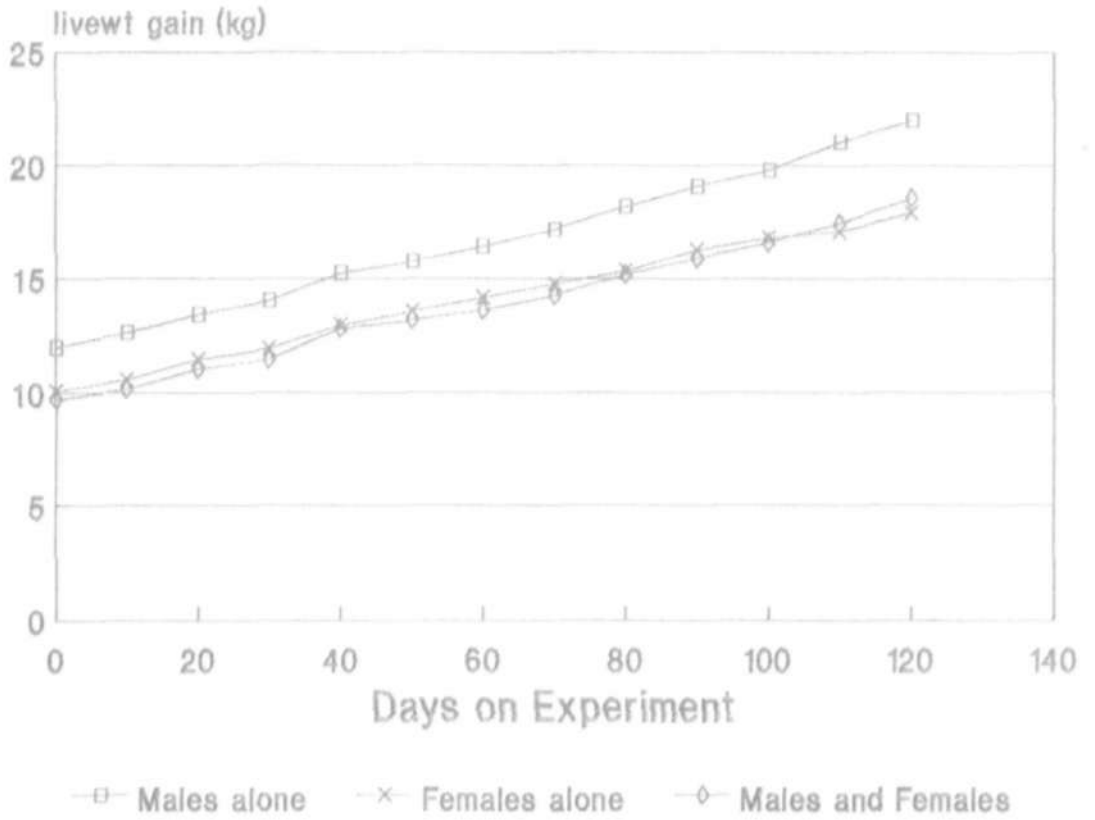


Fig 3 Effect of rearing method on liveweight gain in Yankasa lambs

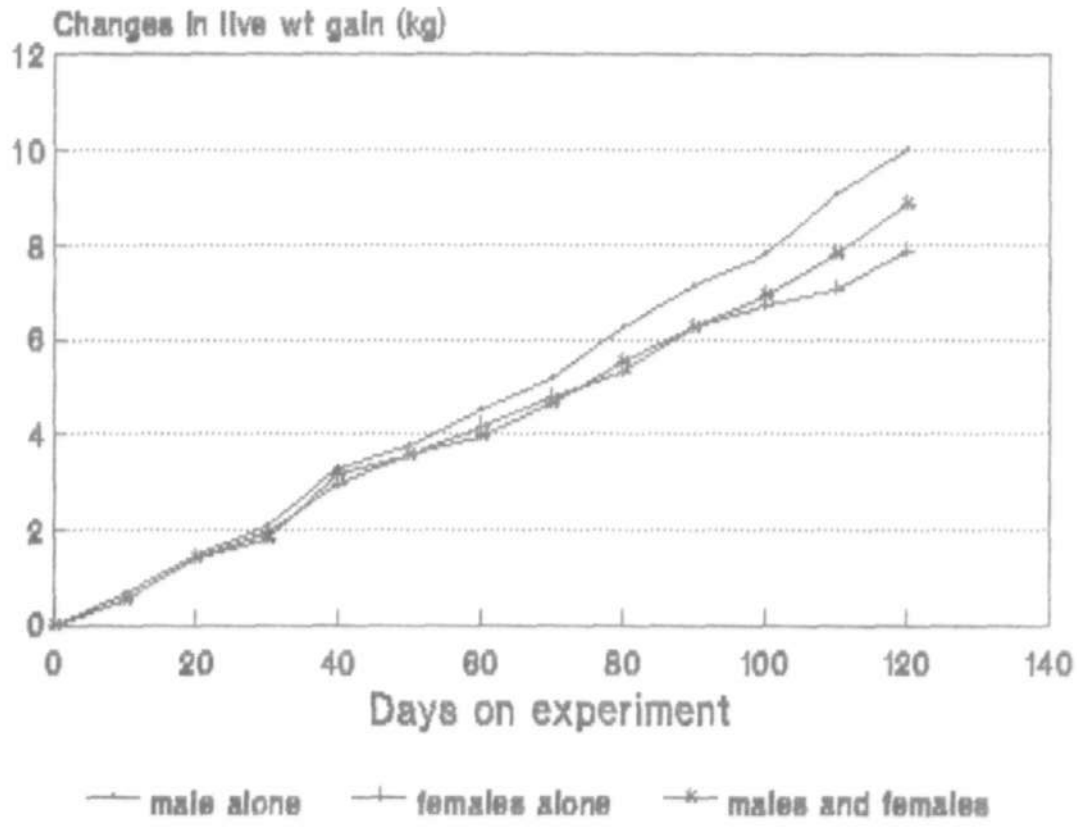


Fig 4 Effect of rearing on changes in liveweight gain in Yankasa lambs

B. SEXUAL ACTIVITY: The results on the effects of sex, feeding level and rearing method on sexual activity are summarised in Table 7. Sex of the animal greatly influenced sexual activity in Yankasa lambs (X^2 = 35.1; d.f = 1; P<0.001) while feeding level had no significant effect (X^2 = 0.032; d.f. = 2; P>0.05). Rearing method significantly influenced sexual activity in Yankasa lambs (X^2 = 11.70; d.f. = 2; P<0.01). Twenty-nine out of sixty-six animals used for the analysis were sexually active and out of this number only 3 were females. The males were sexually more active (26 out of 32) than females (3 out of 34). Males in the mixed group were slightly sexually more active (13 out of 15) than males in the sole group (13 out of 17).

C. PROGESTERONE CONCENTRATIONS IN EWE LAMBS: Least squares analysis of variance (Table 9) showed that feeding level had a very highly significant (P<0.001) effect on progesterone concentrations, with the concentrations for low, medium and high levels as 0.43±0.05, 0.73±0.05 and 0.56±0.04 ng/ml, respectively (Table 8). Although rearing method had no significant (P>0.05) effect on progesterone concentrations, mixed rearing showed comparatively higher (0.61±0.04 ng/ml) concentrations than females alone (0.56±0.04 ng/ml). Progesterone concentrations in the Yankasa ewe lambs was 0.57±0.04 ng/ml. Generally, progesterone concentrations, irrespective of feeding level and rearing method, decreased

with increase in the sampling date (Figure 5). This implies probably that season of the year might have influenced progesterone concentrations in Yankasa sheep.

Table 7: The effects of sex, feeding level and rearing method on sexual activity in Yankasa lambs.

Factor	Level	Active	Inactive	Total	
Sex	males	26	6	32	[X^2=35.1, df=1,
	females	3	31	34	P<0.001]
Total		29	37	66	
Feed.Lev.	low	9	12	21	
	medium	10	12	22	[X^2=0.03, df=2,
	high	10	13	23	P>0.05]
Total		29	37	66	
Rear.Meth.	males	13	4	17	
	females	3	13	16	[X^2=11.70, df=2,
	mixture	13	20	33	P<0.01]
Total		29	37	66	

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Table 8: Least squares means of progesterone concentrations in Yankasa ewe lambs

Factor	Means± s.e.m. (ng/ml)
Feeding level:	
low	0.43±0.05[a]
medium	0.73±0.05[b]
high	0.56±0.04[b]
Rearing method:	
females alone	0.53±0.04[c]
mix. of males&females	0.61±0.04[c]
Overall mean	0.57±0.04

[a,b,c]Treatments with different superscripts are statistically different, otherwise they are the same.

Table 9: Summary of analysis of variance for effects of feeding level and rearing method on progesterone concentrations in Yankasa ewe lambs

Source	DF	MS
Feeding level	2	7.27***
Rearing method	1	1.82[NS]
Error	224	0.62

***= P<0.001; NS= P> 0.05

D. CHANGES IN SCROTAL CIRCUMFERENCE IN RAM LAMBS: Table 10 shows the least squares means for changes in scrotal circumference in Yankasa ram lambs. The mean change in scrotal circumferenc was 11.8±0.04 cm. Least squares analysis

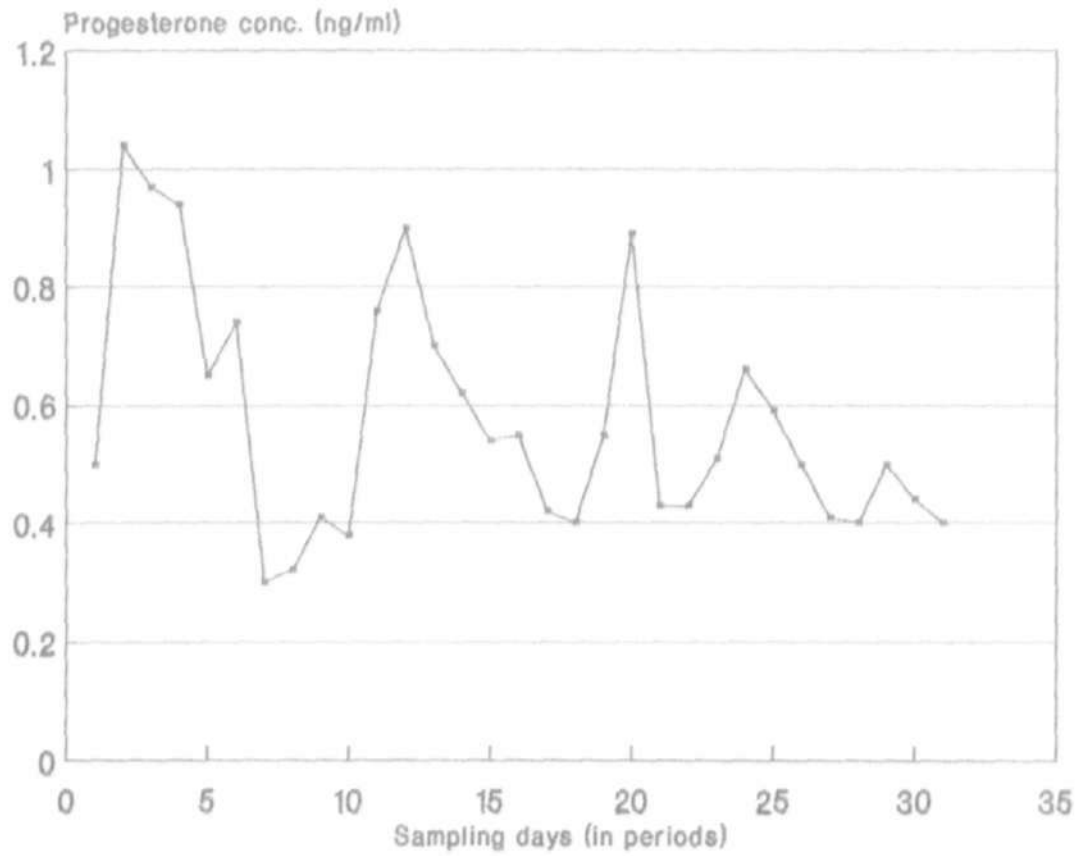


Fig.5. Progesterone concentrations in Yankasa ewe lambs

of variance (Table 11) showed no significant (P>0.05) effect of feeding level and rearing method on changes in scrotal circumference. However, Figures 6 and 7 indicated that there is a corresponding increase in scrotal circumference with increase in feeding level. Also, a higher change was observed (Figure 9) for mixed rearing than for males alone.

Table 10: Least squares means for changes in scrotal circumference in Yankasa ram lambs

Factor	Means± s.e.m. (cm)
Feeding lev.: low	9.9±1.11[a]
medium	12.9±1.03[a]
high	12.4±1.19[a]
Rear. meth.: males alone	11.0±0.99[a]
mix. of mal.& fem.	12.5±0.85[a]
Overall mean	11.8±0.04

[a]Treatments with the same superscript are not statistically different.

Table 11: Summary of analysis of variance for the effects of feeding level and rearing method on changes in scrotal circumference

Source	DF	MS
Feeding level	2	26.35[NS]
Rearing method	1	18.34[NS]
Error	29	13.10

NS = P>0.05

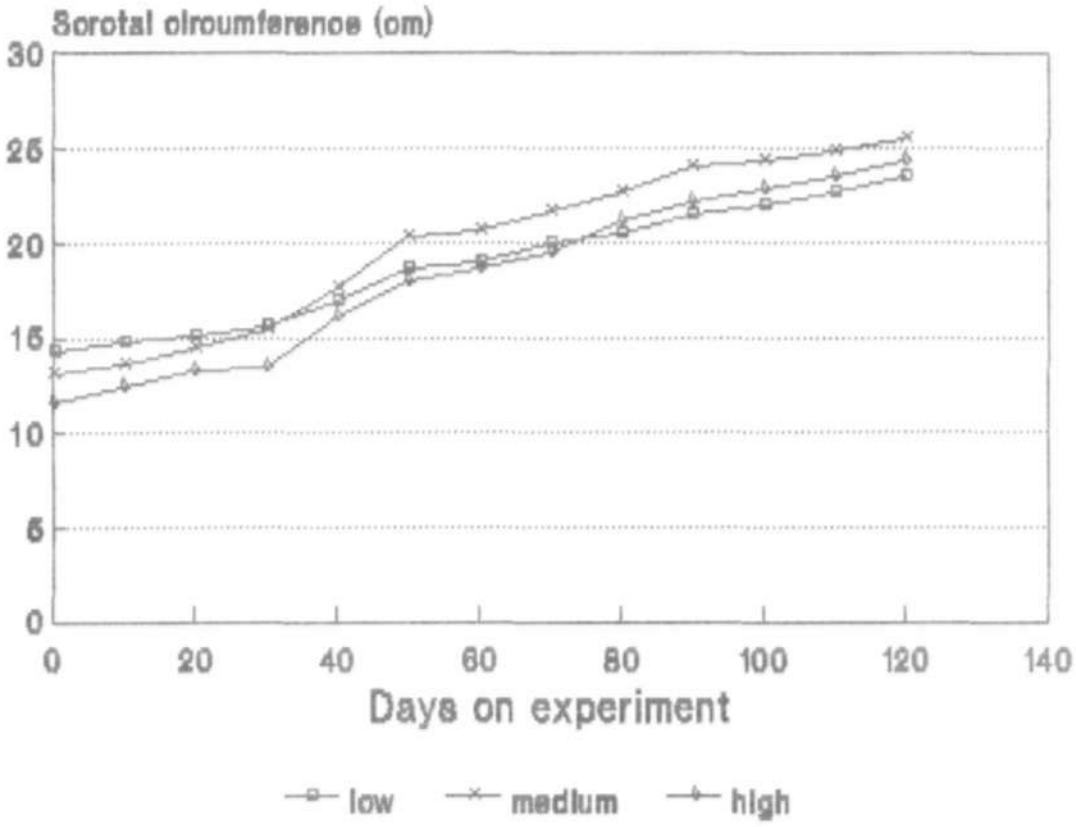


Fig.6. Effect of feeding level on scrotal circumference in Yankasa lambs

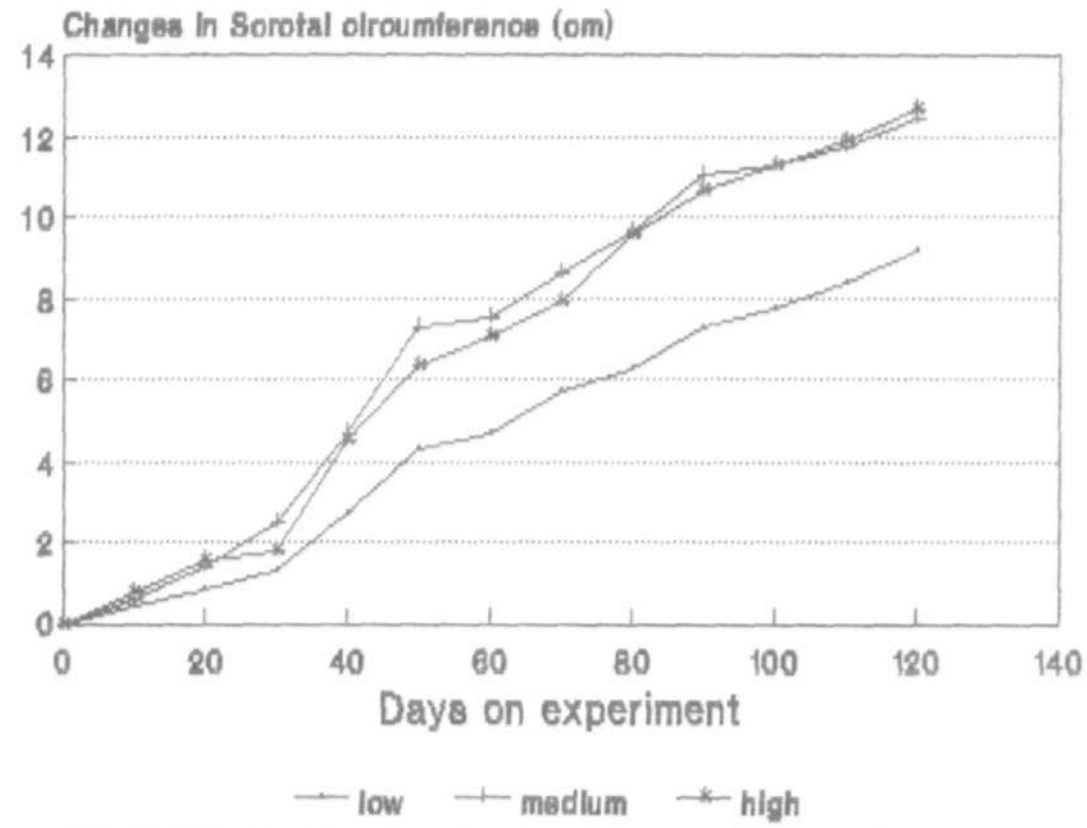


Fig.7. Effect of feeding level on changes in scrotal circumference in Yankasa ram lambs

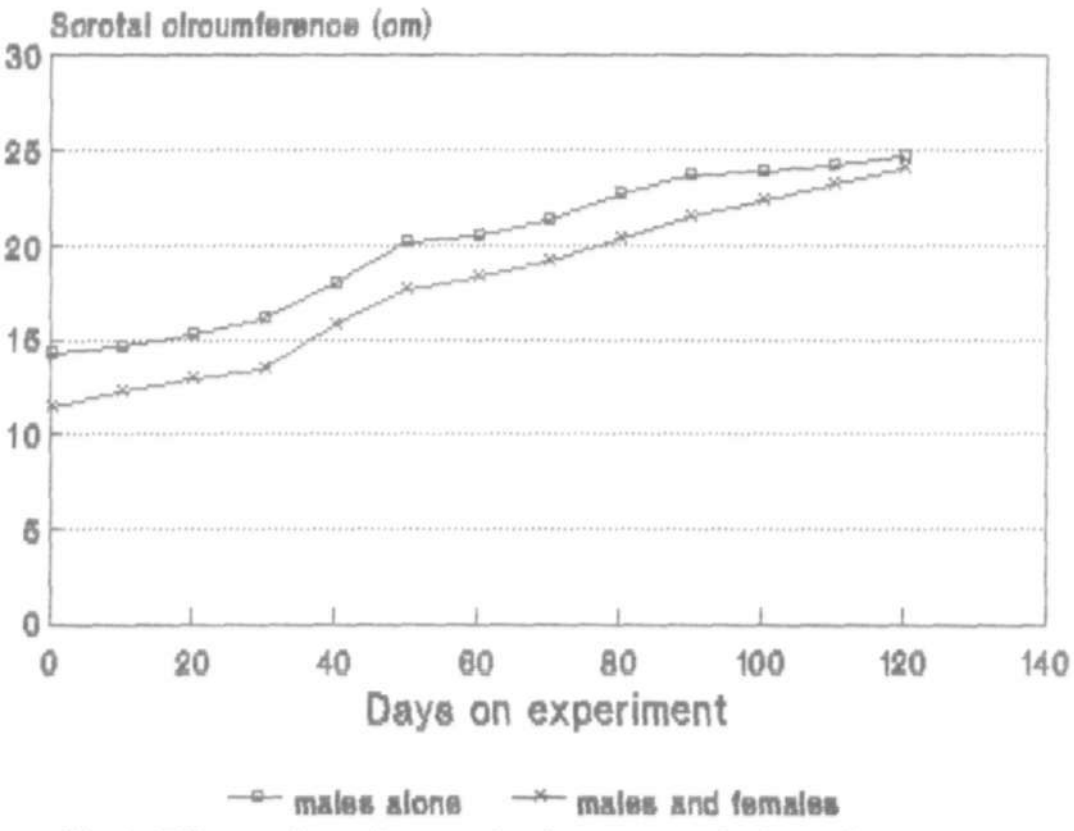


Fig.8. Effect of rearing method on scrotal circumference in Yankasa ram lambs

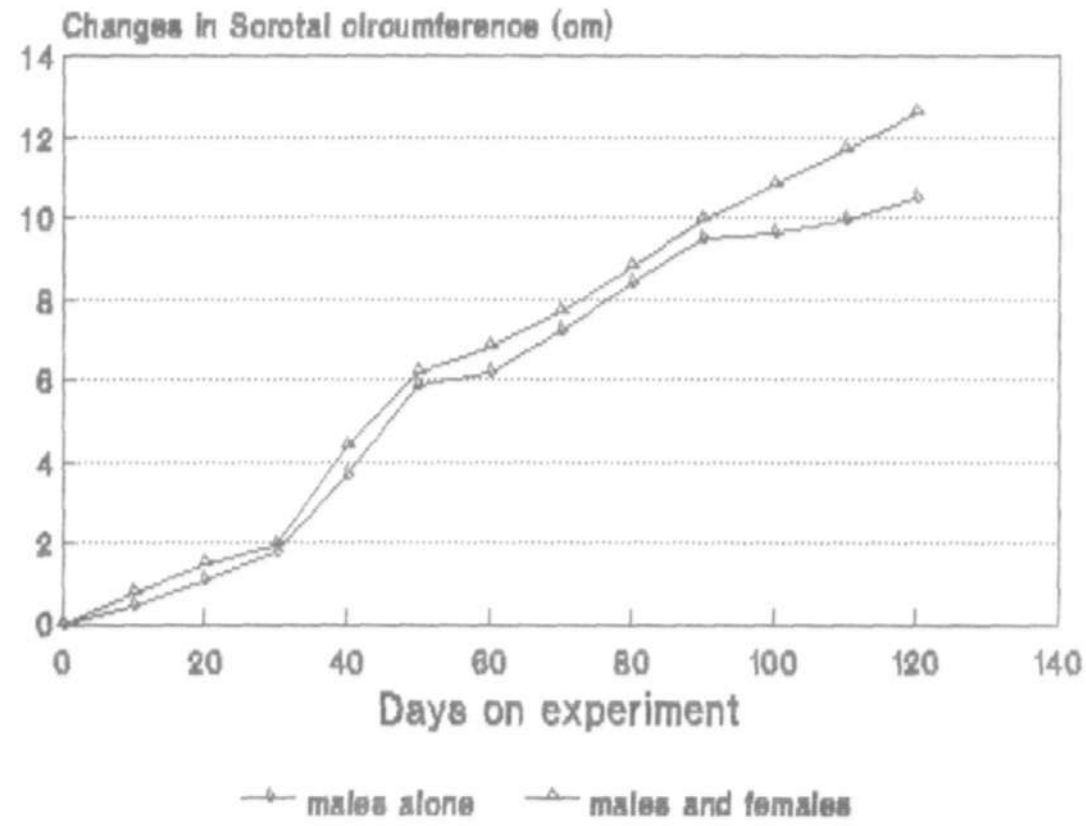


Fig.9. Effect of rearing method on changes in scrotal circumference in Yankasa ram lambs

E. PUBERTY IN RAM LAMBS:

For males, puberty was defined as the age, body weight and scrotal circumference when at least one sperm cell was present in preputial swabs.

i. Scrotal Circumference at Puberty (SCPUB): Least squares analysis of variance indicated no significant effects of feeding level and rearing method on SCPUB (Table13, P>0.05). The average scrotal circumference at puberty was 22.7±3.10 cm (Table 12). However, the minimum and maximum scrotal circumference at puberty was 14.9 and 29.5 cm, respectively (Table 18).

Table 12: Least squares means of scrotal corcumference at puberty in Yankasa ram lambs

Factor		Means±s.e.m.(cm)
Feeding level:	low	22.6±3.28[a]
	medium	23.1±3.38[a]
	high	22.1±3.80[a]
Rear. meth.:	males alone	22.2±3.50[a]
	males & females	23.3±3.03[a]
Overall mean		22.7±3.10

[a]Treatments with the same superscript are statistically the same.

Table 13: Summary of analysis of variance for effects of feeding level and rearing method on scrotal circumference at puberty in Yankasa rams

Source	DF	MS
Feeding level	2	1.41^{ns}
Rearing method	1	7.98^{ns}
Error	25	10.32

NS = P>0.05

ii. Age at Puberty: least squares analysis of variance indicated no significant (Table 15, P>0.05) effect of feeding level and rearing method on age at puberty. The mean age at puberty (Table 14) was 232.5±12.66 days (7.7 months). Age at puberty ranged from 206 to 301 days (Table 18).

Table 14: Least squares means of age at puberty in Yankasa ram lambs

Factor	Means±s.e.m. (days)
Feed. lev.: low	239.0±24.67^{a}
medium	227.8±21.67^{a}
high	230.7±22.36^{a}
Rear. meth.: males alone	235.0±18.70^{a}
mix. males & females	229.9±18.04^{a}
Overall mean	232.5±13.66

^{a}Treatments with the same superscript are statistically the same.

Table 15: Summary of analysis of variance for effects of feeding level and rearing method on age at puberty in Yankasa ram lambs

Source	DF	MS
Feeding level	2	300.83^{NS}
Rearing method	1	178.93^{NS}
Error	25	560.55

NS = P>0.05.

iii. Body Weight at Puberty (WTPUB): There was a very highly significant effect of feeding level on body weight at puberty (Table 17; P<0.001), while rearing method had no significant effect (P>0.05). The average body weight at puberty was 18.3±0.44 kg (Table 16). For low, medium and high levels of feeding, WTPUB were 17.2±1.65 kg, 18.6±0.85 and 19.0±1.39 kg respectively. Males reared solely weighed 18.7±0.99 kg while animals in mixed rearing weighed 17.8±1.04 kg at puberty. This study indicated that as level of feeding increases, there is a corresponding increase in body weight at puberty (Figure 10).

Table 16: Least squares means of body weight at puberty in Yankasa ram lambs

Factor	Means±s.e.m. (kg)
Feed. lev.: low	17.2±1.65[a]
medium	18.6±0.85[b]
high	19.0±1.39[b]
Rear. meth.: males alone	18.7±0.99[c]
mix. males & females	17.8±1.06[c]
Overall mean	18.3±0.44

[a,b,c]Subclasses with the same superscripts are statistically the same, otherwise they are different.

Table 17: Summary of analysis of variance for the effects of feeding level and rearing method on body weight at puberty in Yankasa ram lambs

Source	DF	MS
Initial weight*	1	319.413***
Feeding level	2	28.529***
Rearing method	1	8.128
Error	24	3.242

*Initial weight was used as a covariate.

Only the 29 rams that attained puberty were used in the analysis. *** = P<0.001.

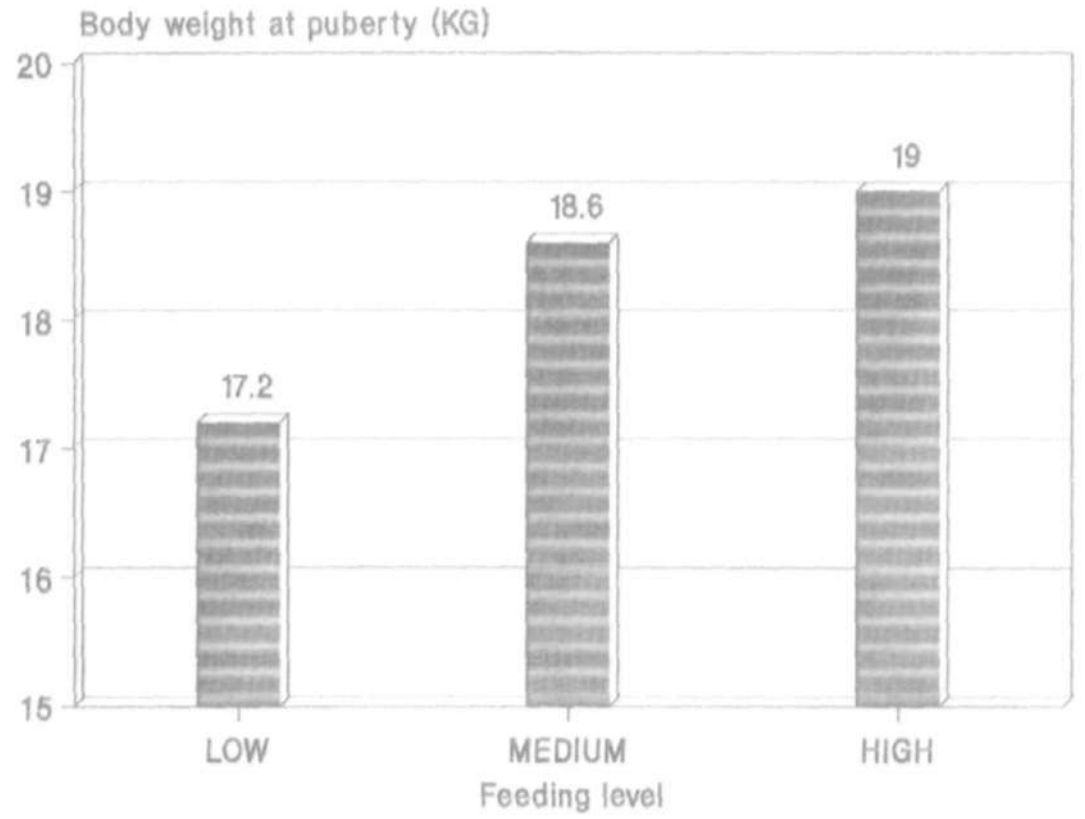


Fig.10. Effect of feeding level on body weight at puberty in Yankasa rams

Table 18: Performance characteristics in Yankasa lambs

Parameters	Means±s.e.m.
Average daily gain	77.8±3.0 g/d
Weight gain in 120 days	9.5±0.35 kg
Changes in scrot. circum. (120 d)	11.8±0.04 cm
Progesterone conc. in ewe lambs	0.57±0.05 ng/ml
Scrot. circum. at puberty	22.7±3.10 cm
Age at puberty (rams)	232.5±13.66 days
Body weight at puberty (rams)	18.3±0.44 kg
% matured body weight at puberty	40.7

F. PUBERTY IN EWE LAMBS

It was not possible to determine the age and body weight at puberty in the ewe lambs using the progesterone profiles. This was as a result of no clear pattern in the progesterone profiles. Therefore, puberty could not be determined in the ewe lambs in this study.

3.2. D I S C U S S I O N

The rate of growth of the rams and ewes observed in this study was in conformity with the results of earlier studies on the Ghana Forest Sheep (Ngere, 1973) and the Nigerian Dwarf Sheep (Orji and Steinbach, 1981). The rams were found to grow faster and have heavier body weights than the ewes. Average daily gain on experiment increased with level of feeding. Average daily gain for rams in this experiment was higher (87.6 g/d) than what was previously reported for males of the same breed, 66.8 g/day (Osinowo et al, 1985b), probably because the lambs in the present experiment were younger. It is known that the rate of gain decreases with age. The average daily gain of 77.8 g/day for the Yankasa sheep is considered low. The higher gains made by males alone (87.6 g/d) than females alone (65.5 g/d) is expected, due to the anabolic effect of testosterone.

That males were sexually more active than females was in agreement with previous reports (Scott, 1945, Fraser, 1968). The non-significance of feeding level on sexual activity in Yankasa sheep supports the observations of Wierzbowsky (1978), who reported that restricted nutrition had no effect on sexual behaviour in bulls. This observation contrasts with the general view that a higher level of feeding is necessary for sexual efficiency. On the other hand, the present result shows that each of the three levels of feeding

used was enough for sexual activity. And that more feed or higher level of feeding does not necessarily mean increase in sexual activity. Generally, males to be used for breeding are not overfed so as not to become fat since fat males are known to have low sexual activity. The highly significant effect of rearing method ($P<0.01$) on sexual activity indicates that mixed rearing will be more appropriate for achieving the desired sex drive, and hence the best use of the sires. It has been reported that homosexual activity is common among the rams and this might interfere with the establishment of normal heterosexual mating behaviour, especially for rams reared in large groups of males (Banks, 1964; Hulet, 1966; Pretorius, 1967). The present result eliminates the preference of male to male or no preference at all by young rams that were reared without the females when introduced into a mixed flock (Price et al., 1989) . Also, the incidences of greater sexual activity in the mixed groups support the report that the frequency and duration of ram courtship behaviour was greater when the ewes were allowed to mix freely with the males (Zenchak et al., 1988).

Increasing level of feeding significantly ($P<0.001$) increased progesterone concentrations in Yankasa ewe lambs. This finding agrees with the literature report (Cumming et al., 1971; Gombe and Hansel, 1973; Peron and Fernandez, 1988) that increasing plane of nutrition or energy or protein intake increases progesterone concentrations in ewes.

However, in some other studies it was reported that undernutrition increases progesterone concentrations while overfeeding decreases it (Jordan and Swanson, 1979; Parr and Cumming, 1982; Williams and Cumming, 1982; Parr et al., 1987; Rhind et al., 1989). The general trend of declining progesterone concentrations as the sampling date increased suggests that season of the year had influence on progesterone concentrations in Yankasa ewe lambs. In the present study, blood sampling started in December which is the peak of harmattan (cold) period and terminated in march which falls within the heat period in Nigeria. The effects of different climatic conditions on plasma progesterone concentrations seem to be conflicting and are difficult to explain. The physiological state of the animal as well as the severity of the stress seem to affect progesterone concentrations. Rosemberg et al. (1982) reported that plasma progesterone levels were higher in the winter than in the summer. Peripheral progesterone concentrations in sheep in the northern hemisphere wer reported to be significantly higher in cycling ewes in November, when the temperature would be expected to be lower than in July (Lamond et al., 1972). and in December than in March (Rhind et al., 1978). Such a relationship has also been found in cold seasons compared to hot seasons in dairy cows (Rosemberg et al., 1982) and Murrah buffalo cows (Rao and Pandey, 1982). However, environmental temperature was not actually measured

in this study. Therefore, analysis of data on progesterone concentrations was based on the effects of feeding level and rearing method on progesterone concentrations. The mean progesterone concentrations of 0.57 ng/ml observed in this study was normal for non-pregnant ewes. A study comparing serum progesterone concentrations in pregnant and non-pregnant Awassi ewes showed that progesterone concentrations for pregnant ewes was 2.65 ng/ml and 0.34 ng/ml for non-pregnant ewes (Hunaiti et al., 1989). These authors also found that the concentrations increases with the age of the animals and that progesterone concentrations in 60 months old ewes was higher (2.65 ng/ml) than that of 24 months old ewes (1.66 ng/ml).

There was no significant effect of feeding level and rearing method on changes in scrotal circumference in the Yankasa rams. However, graphical observations showed a corresponding increase in scrotal circumference with increasing feeding level. Thus, supporting previous reports (Alkass and Bryant, 1982; Rekwot et al., 1988) that animals on high plane of nutrition had higher values than those on lower planes. This result shows that each of the feeding level, low, medium and high, used in this experiment was high enough to support optimal sexual development. Although not significant, changes in scrotal circumference was higher in mixed rearing than sole rearing. This finding probably suggests a higher testicular growth rate of the rams in the

mixed rearing compared to males alone due to the sexual stimulus provided by the presence of ewes. It has been reported that larger testes produce more sperm (Foote et al., 1977) and that scrotal circumference is highly correlated with testicular development and testicular weight (Lino, 1972; Osinowo et al., 1985).

Feeding level showed a highly significant effect on body weight at puberty. However, the non-significant effect of feeding level on age at puberty supports the reports of Johnson et al. (1988) on age at puberty for Morada Nova ewe lambs in Northeast Brazil fed varying dietary energy levels. Earlier reports (Hafez, 1952; Allen and Lamming, 1961, Dyrmundsson, 1972; Orji and Steinbach, 1980b) suggest that lambs with rapid growth rates before puberty usually attained puberty at a younger age but at a higher body weight than the slower growing lambs. The lower age at puberty observed in the mixed groups supports the general view that animals reared in mixed sexes of males and females attain puberty at an earlier age (Brooks and Cole, 1970; Zimmerman et al., 1974; Mavrogenis and Robinson, 1976; Nelson et al., 1982). In this study puberty was attained at 40.7 (25.8-54.9) % of matured body weight . With normal nutritional level, puberty occurs when body weight reaches 40-60 % of the adult body weight in sheep (Terrill, 1962; Thibault and Levasseur, 1974). Dyrmundsson (1973b) reported body weight at puberty to be approximately 45 (40-50) % of adult body weight . The

observation in the present study is comparable to literature reports. Furthermore, it confirms the evidence of breed differences in body weight at puberty and that genetic variations exist in the Yankasa breed.

The reason for the lower weight at puberty for the animals in the mixed groups is not known. Probably, growth hormone and the gonadotropins (LH and FSH) are likely to play a part because of their respective roles in the determination of growth pattern and reproductive efficiency.

The age at puberty in this study was lower than that reported for rams of the same breed, 232 days (33 weeks) compared to 39 weeks (Osinowo et al., 1985b). This reduction could be as a result of the interplay between level of feeding and rearing method in this study. However, the discrepancy in the trend for the age at puberty under the medium and high feeding levels could be partly due to different genotypes of the rams responding differently to the levels and partly due to the differences in the number of rams involved in both cases. However, the results of this study support the view (Hafez, 1952) that puberty sets in only when animals concerned have attained the degree of physiological development (usually expressed as liveweight) which at that stage is typical of their breed. In Yankasa sheep, this falls at about 18 kg body weight.

Puberty was not determined in the ewe lambs used in this study. This was due to the non-consistent pattern of the

progesterone profiles which is difficult to explain. The inability of the present study to determine puberty in the ewe lambs should not be seen to have resulted from the animals failing to attain puberty at the end of the experiment. The use of progesterone assays to determine puberty demands for qualitative rather than quantitative result (Inns et al., 1989). To do this effectively a number of factors that interfere with blood progesterone concentrations has to be held constant; or another means of checking puberty has to be devised to complement the progesterone assays. In this study, vasectomised rams were not used to complement the progesterone assays because of the design of the experiment. If this was done it would have introduced the ram effect in all the groups which was to be avoided in 3 out of the 6 groups where females were found. Maybe, in subsequent studies of this kind, the effects of feeding level and rearing method on attainment of puberty should be studied separately. Or if they are to be considered together, an alternative means of checking puberty should be used in addition to progesterone assays.

3.3. C O N C L U S I O N

This study on the effects of feeding level and rearing method on sexual development in Yankasa sheep showed that:

1. Yankasa sheep within 264 days (8.8 months) of age could weigh on the average 19.2 kg and gain 77.8 g/day. Feeding level and rearing method had significant effects on growth rate .

2. Males were sexually more active than females. Feeding level had no significant effect on sexual activity but rearing method had significant effect on sexual activity.

3. Feeding level increased serum progesterone concentrations significantly, while mixed rearing on the other hand increased serum progesterone concentrations non-significantly. The mean progesterone concentration was 0.57 ng/ml and is within the range for non-pregnant cycling ewes.

4. There was no significant effect of feeding level and rearing method on changes in scrotal circumference, although mixed rearing fostered greater changes in scrotal circumference than sole rearing. The average change in scrotal circumference was 11.8 cm.

5. Feeding level and rearing method had no significant effect on scrotal circumference and age at puberty. However, feeding level showed a very highly significant effect on body weight at puberty. The age, body weight and scrotal circumference at puberty in the rams was, 232 days, 18 kg and 22 cm, respectively. Thus, puberty in Yankasa rams is reached at 40.7±2.00 % of adult body weight and rangee from 25.8-54.9 %.

6. There was no clear pattern in the progesterone profiles of the ewe lambs used in this study. Therefore, puberty was not determined in the ewe lambs. The study suggests that subsequent investigations involving the effects of feeding level and rearing method on attainment of puberty , be studied separately. However, incase they are to be studied together, an alternative means of checking puberty, such as laparoscopy could be used in addition to progesterone assays.

7. On the economics of production, Medium (50 g/kgW$^{.75}$) level of feeding appears to give the best feeding regime for optimum performance for both productive and reproductive characteristics in Yankasa sheep.

R E F E R E N C E S

Abdel-Raouf, M. 1960. The postnatal development of the reproductive organs in bulls with specific reference to puberty. Acta Endocr. Suppl. 49(34): 1-109.

Adu, I.F., Brinckman, W.L. and Kuteyi, I.S. 1979. Reproductive performance of indigenous sheep and their crosses. Nig. J. Anim. Prod. 6: 38-40.

Adu, I.F. and Ngere, 1979. The Indeginous Sheep of Nigeria. World Review of Animal Production Vol. XV (3): 51-62.

Adu, I.F; Taiwo, B.B.A. and Buvanendran, V. 1985. Reproductive and lamb growth performance of Balami and Desert Sudanese Sheep in the Sahelo-Sudan Savanna Zone of Nigeria. J. Anim. Prod. Res. 5: 67-76.

Aire, T.A. 1973. Development of sexual maturity in the Dwarf West African ram lamb. Nig. Vet. J. 2(1): 3-7.

Akusu, M.O.; A.I.A. Osuagwuh; J.U. Akpokodje and G.N. Egbunike 1986. Ovarian activities of the West African Dwarf goat (Caprahircus) during oestrus. J. Reprod. Fert. 78: 459-462.

Alkass, J.O. and Bryant, M.J. 1982. Some effects of level of feeding and body condition score upon sperm production and gonadotrophin concentrations in the ram. J. Anim. Prod. 34: 265-277.

Allen, D.M. and Lamming, G.E. 1961. Some effects of nutrition on the growth and sexual development of the ewe lambs. J. Agric. Sci. 57: 87-95.

Alkins, K.D. 1986. A genetic analysis of the components of life time productivity in Scottish Blackface sheep. Quoted by Brien (1986) in Animal Breeding Abstract 54: 975-997.

Almquist, J.O.; Branas, L.J. and Barber, K.A. 1976. Postnatal changes in semen production of charolous bulls ejaculated at high frequency and the relationship between testicular measurements and sperm output. Journal of Animal Science 42(3): 670-676.

Apps, A.W.J. 1953. The matings of Hoggets. New Zealand Journal of Agric. 87: 112.

Asdell, S.A. 1946. Patterns of Mammalian Reproduction. Ithaca N.Y. Comstock Publ. Co., Inc. London.

Ashdown, R.R. and Hancock, J.L. 1975. Functional anatomy of male reproduction. In: Reproduction in Farm Animals, 3rd ed. Philadelphia, Lee and Febiger. pp. 3-23.

Ashwort, c.J.; Sales, D.I. and Wilmut, I. 1984. Patterns of progesterone secretion and embryonic survival during repeated pregnancies in Damline ewes. Proc. 10th Int. Congr. Anim. Rep. A.1. Urbana 2: 74-76.

Banks, E.M. 1964. Some aspects of sexual behaviour in domestic sheep (Ovis aries). Behaviour 23: 249 [ABA 33: 1348].

Barber, K.A. and Almquist, J.O. 1975. Growth and feed efficiency and their relationship to pubertal traits of charolais bulls. Journal of Animal Science 40: 288-301.

Baronos, S.; Mann, T.; Rawson, E.A. and Skinner, J.D. 1969. The effect of nutrition and androgens on the composition of bovine plasma and seminal plasma at puberty. British J. Nutri. 23: 191-201.

Bishop, M.W.H. 1972. Genetically determined abnormalities of the reproductive system. J. Rep. Fert., Suppl. 15: 51-78.

Bishop, M.W. and Walton, A. 1960. Spermatogenesis and the structure of mammalian spermatozoa. In: Marshall's Physiology of Reproduction. Vol.1 Part 1, Parkes, A.S. (educational services),London, Longmans. Pp. 3-9.

Boaz, t.G. 1960. Research in Agriculture on the Leeds University Farm. Journal of the Yokshire Agric. Soc. 111: 25-36.

Bowstead, J.E. 1930. The effect of breeding immature ewes. Scientific Agric. 10(7): 429-459.

Bradford, G.E. 1972..Genetic control of litter size in sheep. J. Reprod. Fert. Suppl. 15: 23-41.

Brooks, P.H. and Cole, D.J.A. 1970. The effect of the presence of a boar on the attainment of puberty in gilts. J. Reprod. Fert., 23: 435-440.

Brown, D.E.; Harrison, P.C.; Hinds, F.C.; Lewis, J.A. and Wallace, M.N. 1977. Heat stress effects on fetal development during late gestation in the ewe. J. Anim. Sci. 44(3): 442-446.

Burfening, P.J. and Horn, J.L. Van. 1970. Induction of fertile oestrus in prepubertal ewes during the anoestrus season. J. reprod. Fert. 23: 147-150 [ABA 39: 2003].

Cahill, L.P. 1981. Folliculogenesis in sheep as influenced by breed, season and oestrous cycle. J. Rep. Fert. Suppl. 30: 135-142.

Cahill, L.P.; Mariana, J.C. and Mauleon, P. 1979. Total follicular population in the ewes of high and low ovulation rates. J. Reprod. Fert. 55: 27-30.

Cahill, L.P. and Mauleon, P. 1980. Influence of season, cycle and breed on follicular growth rate in sheep. Journal of Reproductinn and Fertility, Suppl. 30: 135-142.

Casida, L.E. 1959. Effect of feeding level on some reproductive phenomena in cattle, sheep and swine. ABA 28: 472.

Chang, T.S. and Rae, A.L. 1970. The genetic basis of growth, reproduction and maternal environment in Romney ewes. Genetic variation in hoggert characters and fertility of the ewes. Australian Journal of Agricultural Research 21: 115-129.

Change, T.S. and Rae, A.L. 1972. The genetic basis of growth, reproduction and maternal environment in Romney ewe. II. Genetic covariation between hogget characters, fertility and maternal environment of ewe. Austr. J. Agric. Res. 23: 149-165.

Chiboka, O. 1986. Accelerated lambing through zero weaning in West African Dwarf ewes in the humid tropics of Nigeria. Turrialba 36: 375-379.

Cole, H.H. and Casady, R.B. 1947. Studies on indices and causes of prolificacy in rats. Endocrinology 41(2): 119-126 (ABA 36:209)

Coope, I.E. 1966. Effects of flushing on reproductive performance of ewes. J. Agric. Sci. 67: 305-323

Coulter,G.H. and Foote, R.H. 1976. Effects of season and year of measurement on testicular growth and consistency of Holstin bulls. Journal of Animal Science 42:434-437

Coulter, G.H. and Foote, R.H. 1979. Bovine testicular measurements as indicators of reproductive performance and their relationship to productive traits in cattle: A Review. Theriogenology 11(4): 571-574.

Coulter, G.H., Larson, L.L. and Foote, R.H. 1975. Effect of age on testicular groeth and consistency of Holstein and Angus bulls. Journal of Animal Science 4(5): 1383-1389.

Cumming, I.A.; B.J. Mole; M.A. DeB. Blockey; C.G. Winfield and J.R. Goding. 1971. Increase in plasma progesterone caused by under nutrition during early pregnancy in the ewe. J. Reprod. Fert. 24: 146.

Cupps, P.T., Anderson, L.L. and Colr, H.H. 1969. The oestrous cycle. In: Reproduction in Domestic Animals. H.H. Cole and P.T. Cupps (eds.). London, UK., Academic Press. 2nd ed. pp. 217-250.

Daudu, C.S. 1981. Semen characteristics (Gonadal and Extra gonadal) and estimation of daily sperm production of Yankasa rams. M.Sc. Thesis, University of Nigeria, Nsukka.

Daudu, C.S. 1984. Yankasa ram: Body weight, withers height, scrotal and penic size, and sperm reserves. International Goat and Sheep Research 2(2): 126-128.

Daudu, C.S., G. Igboeli and B.I. Orji. 1983. Ejaculate and seminal plasma characteristics of the Yankasa ram. Trop. Vet. 1:29-32.

Dettmers, A. and J.K. Loosli. 1974. Live performance and carcass traits in West African sheep. Proc. 1st Annual Conf. Nig. Soc. Anim. Prod.

Doney, J.M., Gunn, R.G., Smith, W.F. and Carr, W.R. 1976. Effects of premating enveromental stress, ACTH, cortisone acetate or metyrapone on oestrus and ovulation in sheep. J. Agric. Sci. 87:127-132.

Donovan, B.T. and ten Bosch, J.J. 1965. Physiology of puberty. London, U.K. Edward Arnold.

Dutt, R.H. 1960. Temperature and light as factors in reproduction among farm animals. Journal of Dairy Science 43:123-144.

Dutt, R.H., Dame, R.R. and Renfro, R.E. 1968. Effects of unilateral castration on body weight and accessory gland development in ram lambs. Progress Report, Kentucky Agric.Exptal. Station No176: 37-38 ABA 37:3671).

Dyrmundsson, O.R. 1972. Studies on the attainment of puberty and reproductive performance in Clun Forest ewe and ram lambs. Ph.D. thesis, University of Wales, U.K.

Dyrmundsson, O.R. 1973a. Puberty and early reproductive performance in sheep. I. Ewe lambs. Anim. Breed. Abstr. 41: 273-289.

Dyrmundsson, O.R. 1973b. Puberty and early reproductive performance in sheep. II. Ram lambs. Anim. Breed. Abstr. 41: 419-430.

Dyrmundsson, O.R. and Lees, J.I. 1972a. A note on mating ability in Clun Forest ram lambs. Anim. Prod. 14:259-262 (ABA 40:3264).

Emmens, C.W. 1969.Physiology of gonadal hormones and related synthetic compounds. In: Reproduction in Dumestic Animals. H.H. Cole and P.T. Cupps (eds.) London, U.K., Academic Press, 2nd. ed. pp.85-112.

F.A.O. 1983. 1983 Production Year Book, Rome, Italy.

Ferguson, W. 1964. The development of sheep and goat production in the Northern region of Nigeria. FAO Reg. Mtg. Anim. Prod. Hlth., Addis Ababa.

Filzgeralds, A. 1981. The influence of artificial photoperiod, diet and temperature upon endocrine aspect of sexual maturity in the ewe lambs: changes in prolactin, LH and T4. Dissertation Abstracts International B41(12): 4403.

Flipse, R.J. and Almquist, J.O. 1961. Effects of total digestible nutrient intake from birth to 4 years of age on growth and reproductive development and performance of Dairy bulls. Journal of Dairy Science 44:905-914.

Foote, R.H.; G.F. Seidel, Jr.; J. Hahn; W.E. Berndston and G.N. Coulter. 1977. Seminal quality, spermatozoal and testicular changes in growing Holstein bulls. J. Dairy Sci. 60: 85.

Foote, R.H. and Trimberger, G.W. 1968. Artificial insemination. In: Reproduction in Farm Animals. Philadelphia, Lea and Febiger. pp. 135-137.

Forest, P.A. and Bichard, M. 1974. Analysis of production records from a lowland sheep flock. 3. Phenotypic and genetic parameter for reproduction performance. Anim. Prod. 19: 33-45.

Foster, D.L.and Olster, D.H. 1985. Effect of restricted nutrition on puberty in the lambs: Pattern of tonic luteinizing hormone (LH) secretion and competency of the LH surge system. Endocr. 116:375-381.

Foster, D.L., K.D. Ryan, R.C. Goodman, S.I. Legan, F.J. Karsch and S.M. Yellon. 1986. Delayed puberty in lambs chronically treated with oestradiol. J. Reprod. Fert. 78: 111-117.

Fox, C.W., Eller, R., McArthur, J.A.M. and Shelton, M. 1964. Reproductive performance from purebred and crossbred ewe lambs. Anim. Breed. Abstr. 32:3570.

Frandson, R.D. 1981. Anatomy and Physiology of Farm Animals. 3rd. ed. Lea and Febiger, Bailliere Tindall, London.

Fraser, A.E. 1968. Reproductive behaviour in ungulates. London, U.K. Academic Press. Pp. 202 [ABA 37: 1107].

Gaston, S and Menaker, M. 1967. Photoperiodic control of Hamster testis. Science 167:925-928.

Gemzell, C. and Roose, P. 1966. The Physiology and Chemistry of FSH. The Pituitary Gland. London. Butterworth 1:492-517.

Gombe, S. and W. Hansel. 1973. Plasma LH and progesterone levels in heifers on restricted energy intakes. J. Anim. Sci. 37: 728-733.

Guerra, J.C., Thwaites, C.J. and Edey, T.N. 1972.The effects of components of bodyweight on reproductive efficiency in the Merino ewe. J. Agric. Sci. Camb. 78: 245-249.

Hafez, E.S.E. 1951. Mating behaviour in sheep. Anim. Breed. Abstr. 19:1262.

Hafez, E.S.E. 1952. Studies on the breeding season and reproduction of the ewe. J. Agric. Sci. 42: 189-265.

Hafez, E.S.E. 1953. Puberty in female farm animals. Anim. Breed. Abstr. 22:14.

Hafez, E.S.E. 1974. Biotechnical procidures for control of the oestrous cycles of domestic animals. In: Procedings Munich 7th Int. Congr. Anim. Reprod. Art. Insem. pp. 75-96.

Hahn, J., Foote, R.H. and Cranch, E.T. 1969. Tomometer measuring testicular consistency of bulls to predict semen quality. Journal of Animal Science 29:483-486.

Halpin, D.M.G., Charlton, H.M. and Faddy, M.J. 1986. Effects of gonadotriphin deficiency on follicular development in hypogonadal (hpg.) mice. Journal of Reprod. Fert. 78: 119-125.

Ham, A.W. 1965. The male reproductive system. In:Histology. Philadelphia and Montred, J.B. Dippinoott company. pp.946-973.

Hammond, J. (Jr.) 1944. On the breeding season in the sheep. Anim. Breed. Abstr. 12:202.

Hammond, J. (Jr.) and Marshall, F.H.A. 1952. The life cycle. In:Marshall's Physiology of Reproduction. Vol. II. A.S. Parkes (ed.). London, N.Y. Toronto. pp. 793-846.

Hanrahan, J.P. 1982. Selection for increased ovulation rate, litter size and embryo survival. Proceedings of the 2nd Wld. Congr. on Genetics Applied to Livestock Prod. 5: 294-309.

Haresign, W. 1985. The physiological basis for variation in ovulation rate and litter size in sheep. Livestock Prod. Sci. 13:3-20.

Hill, D.H. 1960. West African Dwarf sheep. Third Ann. Conf. Sci. Assoc. Nig. , Ibadan.

Hulet, C.V. 1966. Behavioural, social and physiological factors affecting mating time and breeding efficiency in sheep. Journal of Animal Science 25:5-20.

Hulet, C.V., Ercanbrack, S.K., Price, D.A., Blackwell, R.L. and Wilson, L.D. 1962. Mating behaviour of the ram in the one sire pen.Journal of Animal Science 21:857-864.

Hunaiti, A.A.; Muwalla, M.M.; Abuirjeie, M.A. and Tawfeeq, F. 1989. Determination of plasma progesterone in Awassi ewes using radioimmunoassay. Anim. Breed. Abstr. 57: 7294.

Hunter, G.L. 1957. The maternal influence on size in sheep. Journal of Agric. Science 48:36-60.

Hunter, G.L. 1968. Increasing the frequency of pregnancy in sheep. 1. Some factors affecting rebreeding during postpartum period. Animal Breed. Abstr. 36:347-378.

Igono, M.O., E.C.I. Molokwu and Y.O. Aliu. 1982. Effects of season on oestrous cycle of Yankasa sheep. Theriogenalogy 18:261-266.

Iheukumere, F.E. 1979. Semen characteristics of Nigerian Yankasa rams. M.Sc. Thesis, University of Nigeria, Nsukka.

Inns, J.H.; G. Cecchini and M. Mattoni. 1989. The effects of anticoagulant, storage time and temperature, and sodium azide on blood progesterone concentrations. ILCA Bulletin 33: 9-13.

Johnson, W.L.; N.N. Barros; E.R. De Oliveira; A.A. Simplicio and G.S. Riera. 1988. Dietary energy levels and age and body weight at puberty in Morada Nova ewe lambs, in Northeast Brazil. Small Ruminant Research, 1: 67-72.

Jordan, E.R. and Swanson, L.V. 1979. Serum progesterone and LH in dairy cattle fed varying levels of crude protein. J. Anim. Sci. 48: 1154-1158.

Johnson, A.D., Gome, W.R. and Van Demark, N.L. 1970. The Testis. Vol. 1. New York, Academic Press. pp. 1-20.

Josso, N., Picard, J.Y. and Tran, D. 1977. The antimullerian hormones. Recent Progress Hormone Research 33:117-163.

Joubert, D.M. 1963. Puberty in female farm animals. Anim. Breed. Abstr. 31:295-306.

Jubb, K.V.F. and Kennedy, P.C. 1970. Pathology of Domestic Animals. 2nd. Edition. New York and London, Academic Press, Vol. 1:444-481.

Kelley, R.B. and Shaw, H.E.B. 1943. Bull. Coun. Sci. Industr. Res. No. 166.

Kuteyi, I.S. 1979. Preliminary studies on oestrus phenomena in indigenous sheep. NAPRI Seminars Vol. 1: 67-73.

Lamond, D.R.; Gaddy, R.G. and Kennedy, S.W. 1972. Influence of season and nutrition on luteal plasma progesterone in Rambouillet ewes. J. Anim. Sci. 34: 626-629.

Land, R.B. 1970. Number of oocytes present at birth in the overies of Pure and Finish Landrace Cross Blackface and Welsh sheep. Anim. Breed. Abstr. 38:3829.

Land,R.B., Thimonier, J. and Pelletier, J. 1970. The possibility of inducing the secretiong of LH. in the lamb by injection of oestrogen as a function of age. Competes Rendus Hebdomadaires des seances des Academic des Science (Science Naturallel) 271:1549-1551.

Lang, D.R. and Hight, G.K. 1967. Age at puberty, lenght of breeding season and ovulation rate in Romney Marsh and Border Leicester X Romney Marsh hoggets. Anim. Breed. Abstr. 36:474.

Leathem, H.J. 1975. Nutritional influence on testicular composition and function in mammals. Handbool of Physiology 7(v): 753-765.

Lees, J.L. 1966. Variation in the time of onset of the breeding activity in the ewes. Anim. Breed. Abstr. 35:3723.

Lees, J.L. and Weatherhead, M. 1970. A note on mating preference of Clun Forest ewes. Animal Production 12:173-176.

Lino, B.F. 1972. Relationship of scrotal circumference, testis weight and the number of spermatozoa in different parts of the urinogenitaltract. Austr.J. Bio. Sci. 25: 359-366.

Lodge, J. and Salisbury, G. 1970. Seasonal variation and male reproductive efficiency. In: The Testis. Vol. 3. A.D. Johnson, W.R. Games and N.L. Van Demark (editors). Academic Press, New York. pp. 139-167.

Mckenzie, F.F. and Terrile, C.E. 1937. Oestrus, ovulation and related phenomena in the ewe. Research Bulletin. Missourl Agric. Expt. Station No. 264:88.

McNeilly, A.S. 1984. Prolactin and ovarian function. Neuroendocrine Perspective 3:278-613.

Marire, B.N. 1986. Postnatal Development of the Reproductive Tract of Red Sokoto Bucks. M.Sc. Thesis. A.B.U., Zaria.

Mauleon, P. 1969. Oogenesis and folliculogenesis. In: Reproduction in Domestic Animals. H.H. Cole and P.I. Cupps (eds.). London, U.K., Academic Press. 2nd. ed. pp. 187-215.

Mavrogenis, A.P. and Robinson, O.W. 1976. Factors affecting puberty in swine. J. Anim. Sci., 42: 1251-1255.

Molokwu, E.C.I. and Igono, M.O. 1978. Reproductive performance and pattern in the Brown goat of Nigerian savanna zone. Proc. 4th. Wid. Conf. Anim. Prod. Argentina.

Morgan, P.D., Arnold, G.W. and Lindsay, D.R. 1972. A note on the mating behaviour of ewe with various senses impaired. J. Reprod. Fert. 30: 151-152.

Moule, G.R. 1970. Australian reseaech into reproduction in the ram. Anim. Breed. Abstr. 38: 185-206.

Mounib, M.S., Ahmed, I.A. and Hamada, M.K.O. 1956. A study of the sexual behaviour of the female Rohmany sheep. Alexandra Journal of Agric. Res. 4(2): 85-108 (A.B.A. 25:1936).

Moustgaard, J. 1969. Nutritive influence upon reproduction. In:Reproduction in Domestic Animals. H.H. Cole and P.T. Cupps (eds.). London, U.K. Academic Press. 2nd. pp. 489-516.

Mukasa-Mugerwa, E. 1989. A review of reproductive performance of female Bos indicus (Zebu) cattle. ILCA Monograph No. 6.

Nalbandov, A.V. 1964. REproductive Physiology. London, U.K. W.H.Freeman and Co. 2nd. ed. pp. 316.

Nalbandov, A.V. 1976. Origin of the germ cells. In:ReproductivePhysiology of Mammals and Birds. 3rd. ed. San Francisco Freeman and CO. pp. 15-19.

Nelssen, J.L.; D.L. Davis; J.V. Craig and R.H. Hins. 1982. Reproductive development in young boars exposed to sexually mature, non-pregnant sows and gilts. Theriol. 17(5): 545-550.

Ngere, L.O. 1973. Size and growth rate of the West African Dwarf Sheep and a new breed, the Nungua black-head of Ghana. Ghana Journal of Agric. Science, 6: 113-117.

Niswender, G.D., Nett, T.M. and Akbar, A.M. 1974. The hormones of reproduction. In: Reproduction in Farm Animals. E.S. Hafez (ed.). 3rd. ed. pp. 57-80.

Ohlson, D.L., Specer, L.G. and Davis, S.L. 1981. Use of active immunisation against prolactin to study the influence of prolactin on growth and reproduction in the ram. J.Anim. Sci. 52:1350-1359.

Ojo, S.A., Kuteyi, I.S. and Adu, I.F. 1981. Studies of oestrus phenomena in Yankasa and Uda breeds of sheep and the Yankasa crosses. Nig. J. Anim. Prod. 8: 26(abstr.).

Orji, B.I. 1976. Studies on the Biology of Reproduction of the Nigerian Dwarf sheep. Ph.D. Thesis,University of Ibadan.

Orji, B.I. and Steinbach, J. 1979. Oestrous cycle characteristics of the Nigerian Dwarf sheep. I. Duration of oestrous and lenght of oestrous cycle. East Afric. Agric. and For. J. 44:298-305.

Orji, B.I. and Steinbach, J. 1980a.Gestation period and weight changes during pregnancy in the West African Dwarf sheep. bull. Anim. Hlth. Prod. Afriica. 28:356-365.

Orji, B.I. and J. Steinbach, 1980b. Pubertal development in the Nigerian Dwarf Sheep. 1. Age and body weight at puberty in ewe lambs. Nig. J. Anim. Prod., 7(1): 63-70.

Orji, B.I. and Steinbach, J. 1981. Post-weaning growth and development of Nigerian Dwarf Sheep. Tropical Animal Health Production, 13: 101-106.

Orji, B.I., Steinbach, J., Olaloku, E.A. and Adeleye, I.O.A. 1976. Reproductive performance of the Nigerian Dwarf sheep. Nig. J. Anim. Prod. 3(2):124-130.

Osinowo, O.A. 1979. Testicular Growth and Semen Quality of West African bulls. Ph.D. Thesis, A.B.U., Zaria.

Osinowo, O.A. 1982. Oestrus synchronization, artificial insemination and early rebreeding in Yankasa sheep. Nig. J. Anim. Prod. 9:107-111.

Osinowo, O.A. 1990. Reproduction in Yankasa sheep: A decade of research at NAPRI (1979-1989.). A conference paper presented at the 15th Annual Conference of the Nigerian Society for Animal Production (NSAP), Ogun State University, Ago Iwoye.

Osinowo, O.A., and Abubakar, B.Y. 1988. Appropriate breeding strategies for small ruminant production in West and Central Africa. In: Proc. Wkshop. on the Improvement of Small Ruminants in West and Central Africa. O.A.U./I.B.A.R., Nairobi, Kenya.

Osinowo, O.A. and Adu, I.F. 1985. Guide on intensive sheep production. Animal Production series No. 2. NAPRI/ABU, Shika, Zaria.

Osinowo, O.A., Bale, J.O. and Eduvie, L.O. 1982. Semen quality of Yankasa rams. Trop. Anim. Hlth. Prod. 14:189.

Osinowo, O.A., Buvanendran,V. and Adu, I.F. 1985a. Feasibility of twice yearly lambing in Yankasa sheep. Paper presented at the 10th Ann. Conf. Nig. Soc. Anim. Prod., University of Ife, Ile-Ife.

Osinowo, O.A.; Marire, B.N. and Ekpe, G.A. 1985b. Yankasa rams: Postnatal growth and reproductive tract development. Int. Goat and Sheep Research (In Press).

Osinowo, O.A. and Ekpe, G.A. 1985. Postpartum intervals to oestrus and conception in Yankasa sheep. J. Agric. Sci. Camb. 104:253-255.

Osinowo, O.A., Molokwu, E.C.I. and Osiri, D.I.K. 1981. Growth and testicular development in Bunaji bulls. J. Anim. Prod. Res. 1(1):55-67.

Owen, J.B. 1981. Sheep Production. ELBS ed. ISBN07020 08982.

Oyedipe, E.O., Kumi-Kiaka, J. and osiri, D.I.K. 1981. Determination of onset of puberty in Zebu bulls under tropical conditions of Northern Nigeria. Theriogenology 16(4): 419-431.

Oyedipe, E.O., Pathiraja, N. Edqvist, L.E. and Buvanendran, V. 1986. Onset of puberty and oestrous cycle phenomena in Yankasa ewes as monitored by plasma progesterone concentrations. Anim. Reprod. Sci. 12: 195-199.

Palsson, H. 1962. Methods of increasing meat production per sheep in Leeland. Anim. Breed. Abstr. 31:1199.

Parkes, A.S. 1966. Activation of the gonad. In: Marshall's Physiology of Reproduction. Vol. III. A.S. Parkes (ed.). London, U.K. Longmans, Green and Co. Ltd. 3rd. ed. pp. 1-25.

Parr, R.A. and Cumming, I.A. 1982. Effects of maternal nutrition and plasma progesterone concentrations on survival and growth of the sheep embryo in early gestation. J. Agric. Sci. Camb., 98: 39-46.

Parr, R.A.; I.F. Davis; R.J. Fairclough and M.A. Miles 1987. Overfeeding during early pregnancy reduced perpheral progesterone concentrations and pregnancy rate in sheep. J. Reprod. Fert., 80: 317-320.

Pathiraja, N. and Oyedipe, E.O. 1985. Normal ovulation rates of indigenous Nigerian sheep and goats as determined from abbatoir studies (unpublished data).

Peart, J.N. 1967. The effect of different levels of nutrition during late pregnancy on the subsequent milk production of Black Face ewes and on the growth of their lambs. J. Agric. Sci. Comb. 68:365-371.

Peron, N. and Fernandez, O. 1988. Effect of level of nutrition (low or moderate) on blood progesterone values in 3/4 Holstein-Friesian-1/4 Zebu heifers. Anim. Breed. Abstr. 56: 7422.

Poindron, P., Cognie, Y., Gayerie, F., Orgeur, P., Oldham, C.M. and Ravault, J.P. 1980. Changes in gonadotropins and prolactin level in isolated (seasonally or lactationally) anovular ewes associated with ovulation caused by the introduction of rams. Physiology and Behaviour 25(2): 227-236 [ABA 49(4): 2024].

Powell, C. 1976. Breeding pattern in the Australian sheep industry. Australian Sheep Industry Survey, 1970-1973. Bureau of Agric. Econs., Canberra. pp. 76-82.

Pretorius, P.S. 1967. Libido en dekbehendigheid by ramme, grootgemaak en gehou in isolasie van ooie (Libido and mating dexterity in rams reared and kept in isolation from ewes). Procedings of the South African Society of Animal Production 6: 208-212 (ABA 37:3773).

Price, E.O.; Katz, L.S.; Swallach, S.J.R. and Zenchak, J.S. 1989. The relationship of male-male mounting to the sexual performance of young rams. Applied Animal Behaviour Science, 21(4): 347-355.

Pryor, W.J. 1980. Feeding sheep for high reproductive performance. In: Current Therapy in Theriogenology. Marrow, D.A. (ed.). Philadelphia, London and Toronto, Sanndere Company. pp. 882-888.

Tiwari, S.B. and Sahm, K.L. 1977. Occurrence of Puberty and sexual maturity in exotic, native and crossbred sheep under semi-arid conditions. Indian J. Anim. Sci. 45(6):351-356.

Turek, F.W. and Campbell, C.S. 1979. Photoperiodic regulation of neuroendocrine-Gonadal activity. Bio. Rep. 20:32-50.

Van Denmark, N.L. and Free, M.J. 1970. Temperature effects. In: The Testis. Vol. III. A.D. Johnson, W.R. Gomes and N.L. Van Denmark (eds). London, Academic Press. pp. 233-312 (ABA 40:1203)

Ward, W.R. 1980. Development of the female reproductive trait, oogenesis and puberty. In: Current therapy in theriogenology. D.A. Marrow (ed). Philadephia, London and Toronto, Saunders Co. pp. 888-891.

Wasternberg, H. 1980. Studies on the early development and sexual differntiation of the mammalian gonad. Arch. Biol. Med. Exp. 13:315-320.

Watson, R.H., Sapsford, C.S. and McCance. 1956. The development of the testis, epididymis and penis in the young merino rams. Australian J. Agric. Research 7:574-590.

White, I.G. 1974. Mammalian semen. In: Reproduction in Farm Animals. E.S.E. Hafez (ed). 3rd ed. pp.109-123.

Wierzbowskey, S. 1978. The sexual behaviour of experimental underfed bulls. Appl. Anim. Ethol., 4: 55-60.

Wiggins, E.L. and Terrill, C.E. 1953. Variation in penis development in ram lambs. J. Anim. Sci. 12:524-535.

Wilkinson, K. 1988. Systat. The System for Statistics. Evanston II: Systat Inc.

Williams, S.M. 1954. Fertility in Clum forest sheep. J. Agric. Sci. UK 45:2020-2028.

Williams, A.H. and Cumming, I.A. 1982. Inverse relationship between concentrations of progesterone and nutrition in ewes. J. Agric. Sci. Camb., 98: 517-522.

Winters, L.M. 1963. The reproductive organ. Animal Breeding. 5th ed. John Wiley and Sons, Inc. N.Y. London.

Yao, T.S. and Eaton, O.N. 1954. Postnatal growth and histological development of reproductive organs in male goats. American J. Anatomy 95:401-431.

Yeates, N.T.M. 1949. The breeding season of the sheep with particular reference to its modification by artificial means using light. Anim. Breed. Abstr. 17:941.

Zenchak, J.J.; Katz, L.S.; Price, E.O. and Wallach, S.J.R. 1988. Sexual behaviour of rams as influenced by the degree of restraining oestrous ewes and by the additional presence of anestrous ewes. J. Anim. Sci., 66(11): 2851-2855.

Zimmerman, D.R.; Corlson, R. and Lantz, B. 1974. The influence of exposure to the boar and movement on pubertal development in the gilts. J. Anim. Sci., 39: 230, Abstr.