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REVIEW ARTICLE

NUTRITION AND REPRODUCTION IN SHEEP

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ABSTRACT

High nutrition, but not overfeeding, has a positive effect on ewe reproductive capability in terms of the number of estrous cycles, length of the breeding season, greater ovulation rate, and improved lambing %. Copper deficiency hurts lambing percentage and lamb health. Manganese is required for the ovarian activity to be maintained. Protein is necessary for sheep for optimum sperm capacitation, conception rate, pregnancy, and reduced abortions. Protein insufficiency causes lower feed intake, poorer feed utilization, lower growth rate, lower milk output, and lower wool production. A possible reason for the decline in adult reproductive function is nutritionally impaired ovarian development. Functional impairment in any component of the hormone complex has a direct impact on reproduction. Factors such as photoperiod, nutrition, and social sexual cues, genetics, affect the reproductive capacity of both male and female sheep. In mammals, reproduction is energetically more demanding for the females than for the males.

KEYWORDS

Nutrition, Protein, Sheep, Reproduction

1. INTRODUCTION

The biochemical and physiological process by which an organism consumes food to sustain its existence is referred to as nutrition. Ingestion, absorption, assimilation, biosynthesis, catabolism, and elimination are all part of the process. Dietary nutrients stimulate the programming and expression of metabolic pathways that allow animals to reach their genetic reproductive potential. The biological process by which new individual organisms' "offspring" are formed from their "parent" or parents is known as reproduction. The enormous discrepancy between potential output and lambs produced indicates that sheep reproduction is an exceedingly inefficient operation. If all of the prospective eggs in a ewe's ovaries matured, she could produce around 40,000 lambs, but a ram generates 10,000 million sperm every day. A herd of sheep, on the other hand, only produces five to ten lambs throughout her lifetime. Much of this waste between potential and actual children is unavoidable. To fertilize an egg, just one sperm is required; yet, millions of sperm must be put in the ewe's vagina to achieve fertilization. Despite the significant amounts of waste found in all sheep breeds, the variation in lambing performances suggests that farmers may impact the reproductive performance of their sheep through management. Water, energy, protein, vitamins, and minerals are the five fundamental nutritional classes. A lack of any vitamin might impair performance or production.

2. WATER

All sheep require a steady supply of clean, fresh water. Water consumption varies according to climate and feed type. Sheep consume more water in the summer when they are fed dry feed and during the late gestation and lactation stages of production. During the winter or when eating succulent feeds or pasture, they consume less water. Expect sheep to satisfy their water needs by eating snow or drinking from ice-covered water sources.

3. ENERGY

The most prevalent dietary shortfall in ewes is a lack of energy. Forages are the main and, in some cases, the only, source of energy. When energy requirements are high (flushing, late gestation, breastfeeding), concentrate feeds such as barley, wheat, oats, and corn can be used to supplement energy. A lack of energy can impair the pace of conception, lambing, and milk production. It may also have a detrimental impact on wool output. Energy deprivation is associated with increased parasite susceptibility and is also the principal cause of pregnancy toxemia (ketosis) in late pregnancy. In developing animals, a lack of energy decreases the pace of increase. It can cause weight loss or even death in extreme circumstances. Excessive energy use might also hinder productivity. Over-conditioned (fat) ewes are reproductively less efficient and have more lambing difficulties. Excess energy intake is most likely to occur in ewes grazing highly productive pastures after weaning their lambs.

4. PROTEIN

The quantity of protein fed to sheep is more essential than the quality or type of the protein. Too much protein is costly and inefficient as an energy source. Diets should fulfill but not exceed the animal's nutritional needs. Legume hays (12-20% crude protein) satisfy the needs of adult ewes. Oily foods, such as soybean meals or cottonseed meals, are also great sources of supplemental protein. Non-protein nitrogen sources like urea can be used as a supplement if they are limited to one-third of the total protein supplement and supplemented with a readily accessible energy source like barley. Protein insufficiency causes lower feed intake, poorer feed utilization, lower growth rate, lower milk output, and lower wool production. These symptoms are evident only in severe deficiency cases and are often associated with an energy deficiency.

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5. Vitamins

Sheep require a diet rich in fat-soluble vitamins (A, D, and E). Sheep require B vitamins as well, but they are generated in substantial amounts in the rumen and do not need to be supplemented. All of the fat-soluble vitamins are abundant in high-quality legume hay and green pasture. Poor quality hay and winter range are likely to be deficient in vitamin A, but fat reserves are generally sufficient to see the ewes through the winter. Vitamin A deficiency in sheep can be remedied by feeding high-quality alfalfa hay. Injectable A&D treatments offer only short-term protection and may be expensive.

6. Minerals

The 15 essential minerals for sheep are Macro Minerals: Sodium, Chlorine, Calcium, Phosphorus, Magnesium, Potassium, Sulphur, and Trace Minerals: Iodine, Iron, Molybdenum, Copper, Cobalt, Manganese, Zinc, and Selenium. In general, salt (sodium, chlorine) and nutritional feedstuffs provide macro mineral needs (required in the largest quantities). Most pasture, legume hay, and range forages provide enough calcium but not enough phosphorus. Grains and protein sources provide adequate to good phosphorus supplies while being lower in calcium than forages. As a result, most diets provide enough calcium and phosphorus. Supplemental calcium sources include limestone and dicalcium phosphate. Phosphorus supplements include defluorinated rock phosphate and dicalcium phosphate. The calcium-to-phosphorus ratio in the diet should be at least 2:1. (not greater than 7:1). Lower than 2:1 ratios may increase the prevalence of urinary calculi, which are particularly common in wether lambs on heavy grain diets. Feeding a trace mineralized salt (TM salt) formulated for sheep usually provides appropriate amounts of trace elements. Be very careful when using TM salt formulated for other species. Sheep are especially sensitive to copper and levels of copper in salt formulations for swine are extremely toxic for sheep. Therefore, TM salt with no supplemental copper is recommended for sheep. Selenium (Se) concentration is another difference between TM salts formulated for sheep and other species. The approved level for Se in a sheep salt mix is 90 ppm. In areas of Se deficiency, it is important to use TM salt that contains 90 ppm Se. The goal is to provide 0.7 mg of Se/day. A sheep will consume about 1/2 oz of salt/day and 90 ppm salt will provide the 0.7 mg target.

Table 1: Effect of Mineral Deficiency on Reproductive Performance of Sheep and Goatss (Underwood And Suttle, 1999)

Deficiency in	Consequences on Reproductive Function	Comments
Calcium	Milk fever in ewes, Poor growth in lambs	
Phosphorus	Reduce lamb crop, Reduce milk production, especially during the first lactation	
Magnesium	Tetany in breeding ewes, mainly in the first month of lactation in twin-bearing ewes	
Copper	Delayed and depressed oestrus Abortion, dead fetuses	The effect associated with the presence of molybdenum
Iodine	Arrested fetal development Abortion, stillbirth The decline in libido in males Deterioration of semen quality Low milk yield Postnatal mortality Growth retardation in the offspring	Associated with thyroid dysfunction
Manganese	Depressed or delayed oestrus Poor conception rate	Rare occurrence Effect via reproductive hormone or direct action on the gonads
Selenium	Reduction of testicular growth relative to body weight High level of infertility in ewes High embryonic mortality Increased susceptibility of lambs to cold stress Rapid loss of weight in lambs	
Zinc	Block spermatogenesis in lambs	Complete recovery if supplement offer
Chromium	No effect known	Increased insulin sensitivity and glucose utilization, so could indirectly affect reproductive performance because of misuse of fuel
Vanadium	No direct effect known	Should not be a problem because sheep are the least susceptible farmed species to vanadium.

7. Flushing

Flushing is the practice of providing a high-energy diet to sheep for a brief period (10-14 days) before the breeding season. It entails feeding the ewes a meal that will help them gain weight as they reach the breeding season. Its goal is to boost lambing rates. A rise of 10-20% is conceivable. As a result, flushing is one of the most cost-effective management methods we can use. Flushing is accomplished by either providing the ewes with 0.5 pounds of grain per sheep per day or relocating the ewes to a lush pasture that has been set aside for flushing purposes. This increase in calorie intake should begin two weeks before the ram is turned in and should last for three to four weeks into the mating season. You can provide supplemental feed to ewes entering the breeding season in moderately poor body condition and improve their twinning rate significantly. It is believed that the additional nourishment increases the survival of eggs that would otherwise perish, allowing them to be ovulated. Ewes who are already in good bodily shape will not benefit from flushing, and you should avoid excessively training your ewes for the breeding season. Don't keep flushing your eyes for too long after breeding. Ewes that are over-conditioned will not respond to flushing, while ewes who are too overweight may not conceive at all. High nutrient levels during early pregnancy can harm embryos and reduce pregnancy and twinning rates. Although there was no significant difference in pituitary luteinizing hormone content or plasma luteinizing hormone concentrations at oestrus, 'flushed' ewes had a considerably greater ovulation rate (Haresign, 1981).

8. Nutrition and Fertility

To avoid loss of body condition or issues during lambing, proper feeding is essential. In females, poor nutrition may result in irregular cycles, decreased ovulation, fragile offspring, pregnancy toxemia, or diminished twinning. Poor nutrition in males may lower sperm quantity and quality. A multi-hormonal influence determines fertility, which includes not only sex and gonadotropic hormones, but also "metabolic" hormones (Abadjieva et al., 2011). A malfunction in any of the components of this hormone complex has a direct impact on reproduction. They also note that recent scientific research validates reproduction's tight reliance on energy sources and metabolic state, as well as their signaling pathways. They both have a big importance for good fertility. The amount of grain provided to ewes right before conception is also critical. Experiments have indicated that if a sheep is provided a substantial amount of nutrients at that moment, she is likely to lose more eggs than usual. This increases the number of twin births, resulting in a greater lambing percentage. Mineral and vitamin supplements must be given special consideration. Most researchers have reported that the absolute effects of Body Condition Score (BCS) and live weight have a greater impact on sheep reproduction efficiency than their variations, implying the importance of breed and interactions with nutritional and physiological conditions and their impact on reproduction efficiency (Gunn, 1983; Koycegiz et al., 2009).

9. Nutrition and Reproduction in The Ram

Nutrition is one of the most important aspects that might impact the ram's ability to produce spermatozoa. The testis is extremely susceptible to both negative and positive dietary impacts, and as a result, its size can change fast. The male reproductive function appears to be more vulnerable to dietary limits of energy and protein in young animals than in adults, and this may result in irreversible histological alterations at the level of the testis (Brown, 1994). Testicular size, and hence daily spermatozoa production, fluctuate in response to changes in body weight. In rams fed high nutritional content meals (twice maintenance), a 32% rise in bodyweight results in a 67% increase in testicular volume (Odham et al., 1978). Testicular activity in grazing rams, i.e. testicular volume and hormonal secretion, begins in spring–early summer when food availability and lightweight reach their highest values (Lindsay and Martin, 1994). In contrast, sexual activity and semen production in the ram reach their maxima in autumn (Cappai et al., 1981). Apart from testicular size, feeding can also modify the efficiency of semen production. It has been shown that variations in semen production are greater than variations in testicular mass. For instance, a 25% increase in testicular size corresponds to an 81% increase in semen production (Martin and Walkden-Brown, 1995). Underfeeding lowers the daily rate of sperm production and refeeding increases it. Importantly, undernutrition reduces the quality of the sperm generated, as evaluated by sperm count and motility, over some time longer than the 7-week timeframe of spermatogenesis (Robinson et al., 2006). Changing diet affects not just the total quantity of testicular tissue in rams, but also the efficiency with which that tissue produces gametes. Changes in sperm production are generally larger in proportion to changes in testicular size. It was discovered that an 86% increase in testicular size resulted in a 250% increase in spermatozoa production (Cameron et al., 1988).

10. Fetal Nutrition and Reproductive Potential

Fetal nutrients are derived largely from the mother, and fetal nutrition is thus closely related to maternal nutrition. However, it is important to appreciate that maternal nutrition is not the same as fetal nutrition. The reproductive performance of sheep conceived, born, and reared under different degrees of nutritional adversity provides evidence that inadequate or inappropriate fetal and/or early postnatal nutrition reduces adult reproductive performance (Gunn et al., 1995). When Scottish Blackface ewes were confined to food intakes comparable to 0.5 energy maintenance (M) rather than 1.0 M during the first trimester of pregnancy, the temporal pattern of oogonial development in the fetal ovary was altered (Borwick et al., 1997). Significantly, such an influence of maternal diet on a component of the fetal reproductive system has just recently been recognized. Because the effects appear to be independent of any suppression of the embryonic hypothalamopituitary axis, they may be gonad specific (Da et al., 2000). On the available evidence, they have no effect on age at puberty in the female, although they do cause a delay in puberty in the male. Nutritionally compromised ovarian development provides a plausible explanation for the reduction in adult reproductive performance observed for ewes conceived under harsh nutritional conditions (Gunn et al., 1995). Serious maternal malnutrition during the earlier parts of gestation can influence the development of reproductive functions and muscle fiber numbers and characteristics, but this is probably not very likely to occur under normal production conditions. Limitations in uterine development, as well as inherent weaknesses in the embryo, could contribute to embryo loss.

11. Nutrition and Ovulation Rate

Protein and energy both enhance the rate of ovulation. In the case of protein, this was followed by elevated plasma levels of FSH and androstenedione around the time of luteolysis, whereas LH levels remained unchanged. The nutrients needed to fuel ovulation as an event are insignificant, but the number of eggs produced during oestrus is strongly reliant on the nature of the female's long-term dietary regimens. The dietary state of the sheep just before ovulation also influences the ovulation rate. Ewe's physical condition, which indicates long-term food supply, and her present metabolism, which is a result of food availability and quality in the short term, are both significant. An improved diet does not prevent follicle attrition, but it does lessen the severity of it at critical stages, thereby enhancing the ovulation rate. Alterations in ovulation rate, in general, occur when the duration of the 'window' of time in which gonadotrophin-dependent follicles are viable is increased or when there is an increase in the rate of follicular through-put without any shift in the duration of the 'window' (Scaramuzzi, et al., 1993). In the case of ovulatory responses to nutrition, elements of both mechanisms could operate. In an attempt to identify blood-borne metabolites that mediate the stimulatory effect of a lupin-grain supplement on mean ovulation rate in ewes, suggested direct ovarian action through increased glucose availability (Dowing et al., 1995a). The accompanying sustained increase in plasma insulin also was observed when the ovulation rate was increased by either intravenous infusion of glucose or the branched-chain amino acids, leucine, isoleucine, and valine for 5 days in the late luteal phase of the estrous cycle. The daily provision of 100 g of rumen undegradable starch increased the mean ovulation rate (3.29 vs. 2.46) in carriers of the FecB gene but not in non-carriers (1.44 vs. 1.361, suggesting that an important feature of responses in ovulation rate to nutrient supply may be the ovulation potential of individual animals (Dowing et al., 1995b; Landau, et al., 1995).

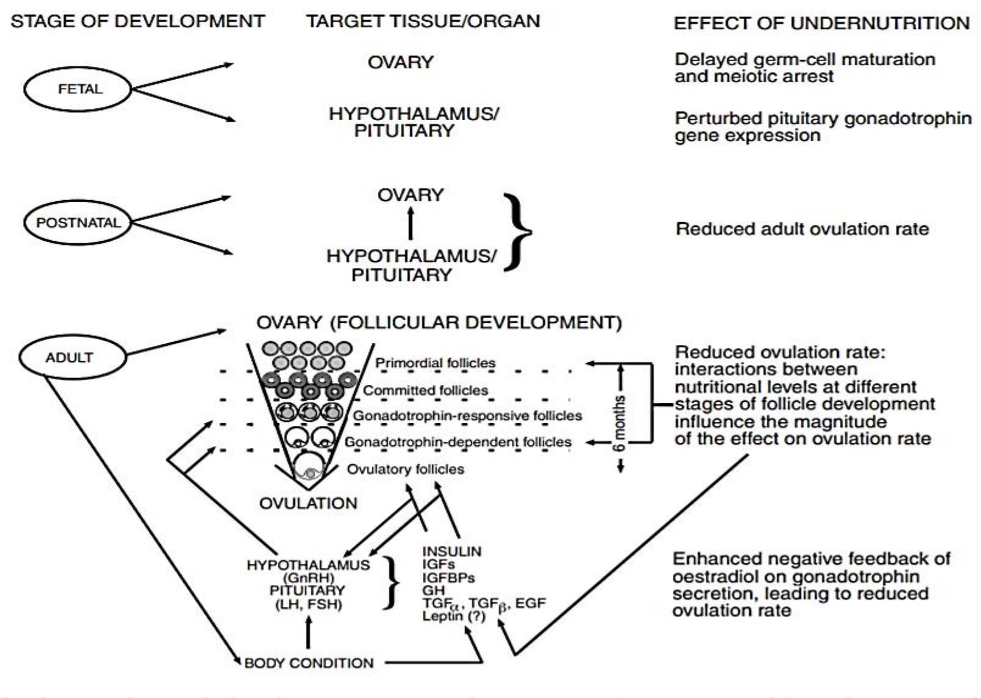

Figure 1: Stages of development during which undernutrition impairs the expression of genetic potential for ovulation rate and the suggested pathways and hormones that are involved at the hypothalamic, pituitary, and ovarian levels. IGF, insulin-like growth factor; IGFBP, insulin-like growth factor-binding protein; GH, growth hormone; TGF, transforming growth factor; EGF, epidermal growth factor; GnRH, gonadotrophin-releasing hormone; FSH, follicle-stimulating hormone; LH, luteinizing hormone

12. Nutrition and Embryo Survival

Both pre-and post-ovulatory feeding has an impact on embryo survival, the former through impacts on oocyte quality and the latter through influences on the composition of oviductal and uterine secretions that sustain the embryo throughout its early cell divisions. While better nutrition during the immediate pre-ovulatory phase normally improves the quality and survivability of embryos resulting from a naturally occurring oestrus, this is not the case when ewes are superovulated with exogenous gonadotrophins before embryo donation (McEvoy et al., 2001). Although the underlying processes are not fully understood, they appear to be connected to inferior oocyte quality caused by insufficient progesterone concentrations during oocyte maturation, owing to a highly substantial negative association between feeding level and systemic inflammation, progesterone concentrations in the ewe. This was the reasoning behind the initial recommendation of a maintenance level of feeding for super-ovulated embryo-donor ewes. Extremes in the level of feeding are detrimental to embryo survival, and so too are extremes in the supply of specific dietary nutrients such as vitamins, trace elements, and protein. Because of their involvement in metabolism, the effects of several vitamins and trace minerals are comprehensible. Retinoids are the primary metabolites of vitamin A and are involved in cell proliferation and differentiation, growth factor production, gene transcription, and steroidogenesis, all of which are vital in embryo survival. The processes behind the loss of embryo survival caused by high plane feeding in early pregnancy are currently under investigation. The stimulatory effects of high plane feeding on the metabolic clearance rate of progesterone, and the concomitant reduction in progesterone concentrations at the time (Days 11 and 12 post-mating in the ewe when the embryo is extremely sensitive to low concentrations, are undeniably significant (Parr, 1992; Prime and Symonds, 1993). However, the primary sites of action of progesterone differ between species, thus making it difficult to identify its role in promoting the numerous paracrine pathways that link endometrial function with embryo survival (Heap et al., 1992). Dietary-induced suppression of circulating progesterone during oocyte maturation in superovulated ewes primed with a single CIDR device (0.3 g progesterone) can impart a legacy of developmental retardation which leads to to decreased embryo survival (McEvoy, et al., 1995b). Again, the causal mechanisms are the subject of speculation, but may involve abnormal oestradiol: progesterone ratios which could disrupt oocyte maturation by way of incomplete or late closure of gap junctions within the follicle (McEvoy, et al., 1995b). Alternatively, the expression of maternal mRNAs required for maternally regulated development up to the mid-blastocyst stage may be impaired by low progesterone. Some of the developmental retardation and reduced embryo survival may be due to either inadequate stimulation of 'early' response genes such as c-myc, which is progesterone-dependent, or abnormal endometrial expression of erb-A, another 'early' response gene, which may modify the function of the progesterone receptor.

13. Influence of Protein Supplementation on Reproductive Traits

Protein is required for optimal sperm capacitation, conception rate, pregnancy, and lower abortions in animals (Armstrong et al., 1990). The protein deficiency might be responsible for the low conception, low lambing, and low twinning rates in ewes and depressed testicular growth and spermatogenesis of rams (Salman, 1996; Odham et al., 1978). The decline in reproductive performance is a result of protein shortage in the diet. Strategic supplementation is the most appropriate technique to boost productivity under such conditions and management practices. Providing nutrients to compensate for inadequacies or to satisfy production needs should be done during the summer when a protein deficit is predicted (Caton and Dhuyvetter, 1997). Using multi-nutrient blocks made from urea and agroindustrial by-products is one of the finest ways to supply nutrients to animals through supplementation (Hadjipanayiotu, 1993). The fertility of lambs and ewes was enhanced by using blocks (Salman, 1996). However, varying protein quality influences fertility and ovulation in different ways (Kaim et al., 1983). Including rumen undegradable protein in the diet improves not only body weight but also ovulation rate (Hamra et al., 1992). Higher ovulation rates and better fertility were achieved through lupin supplementation during mating season (Marshal et al., 1976). Therefore, enrichment of urea feed blocks with undegradable protein and vitamins has a beneficial effect on fertility. Breeding rams may also get the advantage of supplementation and may have better semen quality and higher sexual activity.

14. Factors Affecting The Reproductive Capacity

Several environmental and internal variables can influence both male and female reproductive potential. Because of the economic importance of sheep and the utility of sheep as an experimental animal, external variables impacting reproduction such as photoperiod, diet, and social sexual signals have been intensively researched in sheep (Blanche et al., 2002). Many of the reproductive system's reactions to inputs such as nutritional and socio-sexual cues are dependent on how well the genotype under consideration responds to photoperiod. Photoperiod is a very significant driver of reproductive activity in both males and females in temperate sheep breeds, but photoperiod has little effect on reproductive activity in more equatorial or semi-arid sheep breeds (Rosa and Bryant, 2003). In breeds of sheep that evolved in semi-arid climates, such as the Merino, nutrition has a significant effect on the reproductive capacity of both sexes (Sharma et al., 1999). In Merino sheep, increasing the plane of nutrition increases fertility by increasing sperm production in the male and ovulation rate in the female (GB Martin, 2010). Nutrition can modulate almost any stage of the reproductive cycle, affecting embryo survival, changing the genetic make-up of the offspring through fetal programming, and enhancing offspring survival by stimulating colostrum and milk production (GB Martin, 2010). In sheep, sexual-social signals play an important role in the regulation of the activity of the hypothalamic-pituitary-gonadal axis in both males and females. Reproductive processes are either triggered or modulated by the interaction of external factors with internal factors. Internal and external elements are classified into four interconnected 'dimensions': genetic, structural, communicational, and temporal (Blache, 2006). Differences across species, breeds, and people are explained by the genetic dimension. The structural dimension includes all organs involved in reproductive axis control, with the brain playing a specific integrative role. The communication dimension encompasses physiological systems that may create or perceive endocrine, neuronal, or nutrient-based signals. The temporal dimension depicts the reproductive axis's time-dependent regulation, such as changes in reaction to specific nutrients or responses of regulatory hormones related to earlier changes in body state.

15. Reproductive Cycle and Bioenergetics

Changes in energy balance, defined as the difference between the pools of disposable and wasted energy, can affect any of the three levels of the reproductive axis as well as regulatory feedback processes. All aspects of the reproduction cycle incur energy costs, from the expression of specific behaviors such as sexual or maternal behavior to the development of morphological elements such as gametes, fetuses, and milk. A complete reproductive cycle begins with the development of sexual activity in both sexes of a species and ends with the appearance of sexual activity in the next generation. The duration of several phases of the reproductive cycle varies across sexes. Production of sperm takes 49 days in rams, but the interval between ovulations is 17 days in ewes, and gestation lasts around 150 days in both sheep and goats. In mammals, reproduction is energetically more demanding for the females than for the males, because of the gestational development of the young and the production of milk over many months. The energy cost of reproduction also differs in its timing between the sexes, with the male investing most energy before fertilization, while females invest most of their energy following fertilization (Horton and Rowsemitt, 1992). Animals can meet the energy cost of reproduction, and produce offspring, only if their energy balance is either positive or slightly negative during the reproductive cycle.

16. Conclusion

Dietary nutrients affect the size, vigor, and viability of the newborn through their effects on embryonic and early fetal development. In the case of sheep, these effects also affect adult ovulation rates, which are boosted by both protein and energy. Lack of protein reduces the amount of feed consumed, the amount of feed used, growth rate, milk output, and wool production. The undegradable protein-enriched block improved the fertility of ewes. Reproduction is directly impacted by a functional flaw in any one of the hormone complex's components. In contrast, urea riched block decreased semen quality in rams but did not affect sexual behavior or the majority of blood characteristics.

References

Abadjieva, D., Shumkov, K., Kistanova, E., Kacheva, D., Georgier, V., 2011. Opportunities For the improvement of the reproductive performances in female animals. Biotechnology in Animal Husbandry, 27, Pp. 365-372.

Armstrong, J.D., Goodall, E.A., Gordon, F.J., Rice, D.A., MeCaugney, W.J., 1990. The effects of the level of concentrate offered and the inclusion of maize gluten of fish meal in the concentrate on reproductive performance and blood parameters of the dairy cow. Animal Prod., 50, Pp. 1-10.

Blache, D.Z.S., 2006. Dynamic and integrative aspects of the regulation of reproduction by metabolic status in male sheep. Reproduction Nutrition Development, 46, Pp. 379-390.

Blanche, D., Adam, C.L., Martin, G., 2002. The mature male sheep: A Model to study the effects of Nutrition on the Reproductive axis. Society For Reproduction & Fertility, Cambridge.

Borwick, S.C., Rhind, S.M., McMillan, S.R., Racey, P.A., 1997. Effect of undernutrition of ewes from the time of mating on fetal ovarian development in midge station. Reproduction Fertility and Development, 9, Pp. 711-715.

Brown, B.W., 1994. A Review of nutritional influences on reproduction in boars, bulls, and rams. Reproduction Nutrition Development, EDP Sciences, 34 (2), Pp. 89-114.

Cameron, A.N., Murphy, P.M., Oldham, C.M., 1988. Nutrition of rams and output of spermatozoa. Proc. Aust> Soc. Anim. Prod., 17, Pp. 117-126.

Cappai, P., Manunta, G., Branca, A., 1981. Seasonal variation in semen characteristics of Ram. Proc. 11th Congress SIPAOC Italy, Pp. 115-119.

Caton, J.S., Dhuyvetter, D.V., 1997. Influence of energy supplementation on grazing ruminants: Requirements and responses. J. Anim. Sci., 75, Pp. 533-542.

Da.Silva, P., Aikken, R.P., Rhind, S.M., Wallace, J.M., 2000. The effect of nutritionally mediated placental growth restriction on fetal pituitary gonadotropin gene expression and Gonadal morphology at day 104 of gestation. Journal of Reproduction & Fertility Abstract Series, Pp. 25-95.

Dowing, J.A., Joss, J., Connel, P., Scaramuzzi, R.J., 1995a. A Mixture of the branched-chain amino acids Leucine, isoleucine & valine increases the ovulation rate in ewes when infused during the luteal phase of the oestrus cycle an effect that may be mediated by insulin. Journal of Endocrinology, 145, Pp. 315-323.

Downing, J.A., Joss, J., Connel, P., Scaramuzzi, R.I., 1995b. Ovulation Rate and The Concentrations of Gonadotrophic and metabolic hormones in ewes feed lupin grain. Journal Reproduction Fertility, 103, Pp. 137-145.

GB Martin, B.D., 2010. Interactions between nutrition and reproduction in the management of the mature male ruminant. Animal, 4, Pp. 1214-1226.

Gunn, R.G., 1983. The influence of nutrition on the reproductive performance of Ewes. In Sheep Production, Haresign, W. (Ed). Butterworths, London, Pp. 99-110.

Gunn, R.G., Sim, D.A., Hunter, E.A., 1995. Effect of nutrition in utero and early life on the subsequent lifetime reproductive performance of Scottish Black face ewes in two management Systems. Animal Science, 60, Pp. 223-230.

Hadjipanayiotu. 1993. Urea Blocks II Performance of cattle & Sheep offered Urea Block in Syria. Livestock Research for Rural Development, 5 (3).

Hamra, A.H., Hassan, S., AI Jassim, R.M., 1992. Effect of Undegradable Protein on Ovulation Rate of Awassi Sheep. 12th Intr. Cong. Reprod. Artif. Insem., Pp. 23-27.

Haresign, W., 1981. The influence of nutrition on reproduction in the ewe affects ovulation rate, follicle development, and luteinizing hormone release. Animal Production, 31 (02), Pp. 197-202.

Heap, R.B., Taussig, M.J., Wang, M.W., Whyte, A., 1992. Antibodies Implantation and Embryo Survival. Reproduction Fertility Development, 4, Pp. 467-480.

Horton, and Rowsemitt. 1992. Natural selection and variation in reproductive Physiology.

Kaim, M., Folman, Y., Neumark, H., 1983. The effect of Protein intake and Lactation number on postpartum body weight loss & reproductive performance of dairy cows. Animal Prod., 37, Pp. 229.

Koycegiz, F., Emsen, E., Diaz, C., Kutluca, M., 2009. Effects of lambing season, lamb breed & ewe parity on production traits of fat-tailed sheep and their lambs. Journal Of Animal Vet Adv., 8, Pp. 195-198.

Landau, S., Bor., A., Leiborich, H., Zoref, Z., Nitsan, Z., Madar, Z., 1995. The Effect of ruminal starch Degradability in the diet of Booroola cross breed ewes on induced ovulation rate and prolificacy. Animal Reproduction Science, 38, Pp. 97-108.

Lindsay, D.R., Martin, G.B., 1994. Feeding and reproduction in sheep. Proc 11th Congress SIPAOC Italy, Pp. 251-263.

Marshal, T., Beetson, B.R., Lightfoot, R. J., 1976. A Study of Reproductive Wastage among commercial Sheep pasture in Southwestern Australia. Proc. Aust. Soc. Anim. Prod., 11, Pp. 229- 232.

Martin, G.B., Walkden-Brown, S.W., 1995. Nutritional influences on reproduction in mature male sheep and goats. J. Reprod. and Fert. Suppl., 49, 1595-1599.

McEvoy, T.G., Robinson, J.J., Aitken, R.P., Findlay, P.A., Palmer, R.M., Robertson, I.S., 1995b. Dietary-induced suppression of pre-ovulatory progesterone concentration in superovulated ewes impairs the subsequent in vivo & in vitro development of their Ova. Animal Reproduction Science, 39, Pp. 89-107.

McEvoy, T.G., Robinson, J.J., Ashworth, C.J., Rooke, J.A., Sinclair, K.D., 2001. Feed & Forage toxicants affecting embryo survival and fetal development. Theriogenology, 55, Pp. 113-129.

Odham, C.M., Adam, S.R., Gherardi, P.B., Lindsay, D.R., Mackintosh, J.B., 1978. The Influence of level of feed intake on sperm producing capacity of testicular tissue in the ram. Australian Journal of Agriculture Research, 29, Pp. 173-179.

Parr, R.A., 1992. Nutrition Progesterone interaction during early pregnancy in sheep. Reproduction Fertilization Development, 4, Pp. 297-300.

Prime, G.R., Symonds, H.W., 1993. Influence of plane of nutrition on portal blood flow and metabolic clearance rate of progesterone in ovariectomized gilts. Journal of Agricultural Science, Cambridge, 121, Pp. 389-397.

Robinson, J.J., Ashworth, C.J., Rooke, J.A., Mitchell, L.M., Mcevoy, T.G., 2006. Nutrition and fertility in Ruminant livestock. Animal Feed Sci. Technology, 126, Pp. 259-276.

Rosa, H., Bryant, M., 2003. Seasonality of reproduction in sheep. Small Ruminant Research, Pp. 155-171.

Salman, A.D., 1996. The role of multi-nutrient blocks for sheep reproduction in an integrated cereal-livestock farming system in Iraq. Second FAO Electronic Conference on Tropical Feeds Livestock Feed Resources within Integrated Farming System.

Scaramuzzi, R.J., Adams, N.R., Baird, D.T., Campbell, B.K., Dowing, J.A., Findlay, J.K., Tsonis, C.G., 1993. A Model for Follicle Selection & the determination of ovulation rate in the ewe. Reproduction Fertility Development, 5, Pp. 459-478.

Sharma, T.P., Blanche, D., Martin, G.B., 1999. Aromatase and 5a-reductase pathways and their interaction with nutrition in the control of pulsatile secretion of LH in male Sheep. Proceedings of the Australian Society for Reproductive Biology, Pp. 96.

Underwood, E.J., Suttle, N.F., 1999. The Mineral Nutrition of Livestock. CABI, Wallingford, 32 (02), Pp. 889-897.

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