CHAPTER 2

Literature review

2.1 Goat production in Laos

All most goats in Laos were produced by smallholders, which they were classified into four systems (Phimpachanhvongsod, 2001) according to management practices such as free range systems, semi-rotational grazing system, semi-free range system and permanent grazing system. All these goats are focused in producing meat, they are kept in the free range systems, where they graze freely all year round in small groups in the forest, fallow land, flatland, roadsides and on communal land (Xaypha, 2005). The conventional feeding system in goats in Laos is based mainly on the use of natural grasses. In the dry season forage is in short supply as natural pasture becomes dried and improved grasses cannot grow. Insufficient of feed is a problem for goat production, and goat management practices have been changing, and vary from site to site depending mostly on land availability, labour and community regulations (Phengsavanh, 2003), the goat production are lack of plan breeding, inbreeding is allowed to happen, concentrates are seldom used, missing with the vaccination protection (Xaypha, 2005). The most of goats breed commonly used in Laos is native mixed breed which can be included in the Southeast Asian Mountain goat groups (Wilson, 2007), goats in Laos, usually farmers keep a certain number of goats that depends on the availability of labour and land. The number varied from 2 to 40 goats per household (Kounnavongsa, 2008), and the first kidding was approximately 12-18 months (Stur *et al.*, 2002). Goats in Laos, goats are a good source of income compared to other livestock species. The figures of sheep and goats have increased respectively in the recent year in 2005 to 2012 by 190,000 to 444,000 head (NSC, 2013) as reported in the Table 2.1. The increasing of goats and sheep is due to higher consumption for goats meat in the local market (NAFRI, 2005) and also higher demand for export, which goats are produced for meat about 500 tones in each year (FAO, 2005).

Table 2.1 Numbers of livestock (Thousand head) from 2005 – 2012

Animal/year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Buffalos	1,097	1,108	1,123	1,155	1,178	1,183	1,197	1,188
Cattles	1,272	1,321	1,353	1,499	1,426	1,474	1,538	1,692
Goats, Sheep	190	210	268	289	339	366	433	444
Pigs	1,827	2,033	2,186	2,548	2,947	2,753	2,650	2,794
Chickens	19,802	20,803	20,453	21,983	22,521	24,079	26,852	28,779

Source: NSC (2013)

2.2 Nutritional management of goat production

Commonly, feedstuffs that consumed by goats are mostly of plant origin, forages contain varying quantities of water, and the DM fraction is composed of organic and inorganic components, organic matter included nutrient such as carbohydrates, proteins, fats and vitamins, whereas both organic and inorganic provide nutrient for body maintenance, growth, reproduction, pregnancy and lactation (Mahgoub *et al.,* 2012).

In recent year concentrate ingredients has been commonly used in goats feeding systems to supply both protein and energy to the animal, which feeds are increasingly important in goat feeding systems (Ferdous *et al.*, 2011; Sultana *et al.*, 2012; Berhanu *et al.*, 2013). Although concentrates, such as grain, are fed extensively to ruminant livestock, because of the digestive capacity of goats to utilization, using concentrate supplemented with forages represent the most important, valuable feed resource for goat production (Devendra and Burns, 1983). In meat goat, growth rate is very important because income of farmers come from the meat production (Kounnavongsa, 2008). So feeding with good quality of the diet can improved growth rate of goat (Kabir *et al.*, 2002), feeding plays a crucial role. The goat needs to get sufficient energy for their growth. Therefore, roughage together with concentrate feed need to meet all requirements of the goats (Ferdous *et al.,* 2011).

2.3 Nutrient requirements for goats

Meat and milk production are physiological processes that require large quantities of readily available nutrients and nutrient concentrations in the diet of goats are effected by feed intake (Mahgoub *et al.,* 2012), the nutrient requirements of goats are determined by age, sex, breed, production system, body size, climate and physiological stage. Feeding strategies should be able to meet energy, protein, mineral, and vitamin needs depending on the condition of the goats (Rashid, 2008). The daily feed intake of goats ranges from 3 - 4% of body weight as expressed in pounds (dry matter/head/day), the daily feed intake is influenced by body weight, palatability, and physiological stage of the goats (growth, pregnancy, and lactation), and the percentage of dry matter may range from 12 – 35% in forages and 86 - 92% in hays and concentrates, The nutrient requirement of goats was also mentioned as follow:

2.3.1 Protein requirements

The level of protein in the diet affects voluntary intake of food (Campling *et al.,* 1962; Blaxter and Wilson, 1963). Protein is digested and broken down into amino acids and are eventually absorbed in the small intestine (Rashid, 2008). Amino acid from protein in the diet are required for body maintenance, growth, gestation and lactation. Protein from feed is partially degraded in the rumen, with NH_3 being available for utilization by rumen microorganisms and synthesis of microbial protein (Mahgoub *et al.,* 2012). Those amino acids are building blocks for body proteins (muscles), the rumen plays a major role in breaking down consumed protein into bacterial protein through bacterial fermentation. Feeds like forages, hays, pellets (alfalfa), barley, peas (screenings, whole, split), corn, oats, distilled grains and meals (soybean, canola, cottonseed meals) are common sources of protein for goat ration. The protein requirements are higher during growth (kids), milk synthesis (lactation), and mohair growth (Rashid, 2008). The protein requirement of goats weight 20 kg live weight and for goat gaining about 150-200 g/day, which is typical of most goat in the humid tropics (Oyenuga and Akinsoyinu, 1976). In contrast a deficient of protein intake may cause suppressed oestrus, low conception rates, fetal resorption, premature parturition and weak offspring, whereas an excessive protein intake may cause a low conception rate (Bearden and Fuquay, 1992; NRC, 2007).

2.3.2 Energy

Energy is the nutrient component required in greater quantities in the diet of meat goats (Mahgoub *et al.,* 2012). The energy requirement depend on factors such as physiological state (maintenance, growth, gestation and lactation), level of production, activity and ambient temperature. The average requirements for growth derived from regression analysis were 4.6 kcal ME/kg of average daily gain of growing goats of 4-8 months of age (Lu and Potchoiba, 1990) and beor goat 15-30 kg needed to supply the required energy concentrations of 2.73 - 3.28 Mcal ME/kg by taking into consideration to goat body weights (NRC, 2007) as in the table 2.2.

2.3.3 Fats

Fats, also known as lipids are composed of triglycerides, which are esters of glycerol and tree fatty acids. The fat content of the goat diet is generally < 2%. The inclusion of fat in range supplements is not common, although consumption of small quantity of fat can improve energy intake and goat performance. However the excess fat in the diet may reduce diet fiber digestibility (Mahgoub *et al.,* 2012). Fats can also be a source of energy for goats, the goats do consume some amount of fats. The excess energy produced by carbohydrates is stored in the form of fat especially around internal organs. The stored fat in the body is used during high energy needs, especially the lactation period, supplying fats may not be a cost-effective idea for goat production (Rashid, 2008).

Table 2.2 Nutrient requirement of meat indigenous breed and Boer goats of various production stages

Stage	ME (Mcal/kg)	CP (%)	MP (%)	DIP (%)
Starter (<15kg BW; 200g ADG/day)				
Indigenous breeds,				
Doeling and Male castrates	3.25	22.4	15.3	8.1
Intact Males	3.21	20.5	14.1	8.0
Growth (15-30kg BW; 250 ADG/day)				
Boer Doeling and Male castrates	3.28	26.5	18.2	8.2
Intact Males	3.25	24.7	17.0	8.2
Indigenous breeds				
Doelings and Male castrates	2.73	18.0	12.4	6.9
Intact Males	3.18	19.4	13.4	8.0
Boer				
Doelings and Male castrates	3.24	25.1	17.2	8.1
Intact Males	3.21	23.1	15.9	8.0
Finisher (>30kg BW; 300g ADG/day)				
Indigenous breeds				
Doelings and Male castrates	2.40	15.4	10.6	6.0
Intact Males	2.60	15.4	10.6	6.5
Boer				
Doelings and Male castrates	2.61	19.6	13.4	6.5
Intact Males	2.87	19.9	13.7	7.2
Mature does				
Maintenance	1.91	7.1	4.8	4.8
Breeding	1.91	7.1	4.8	4.8

Body weight (BW), Average daily gain (ADG), Metabolizable energy (ME), Crude protein (CP), Metabolizable protein (MP) and Degradable intake protein (DIP).

Source: NRC (2007)

2.4 Paper mulberry leaves

Paper mulberry (*Broussonetia papyrifera*) is a member of the Moraceaae family (Wu, 2012). It is a small tree or shrub which grows naturally in Asian and Pacific countries such as Thailand, China, Myanmar, Laos, Japan, Korea, India and the southern USA (Dweck, 2002). Paper mulberry is a fast growing tree. The tree grows up about 15 m in high, and it can be adapted in the tropical climate (Silivong *et al.*, 2012). Moreover paper mulberry is a plant which can quickly colonize distributed areas (Morgan and Overholtz, 2004). Paper mulberry can be used as food for both human and animal consumption (Dweck, 2002). Paper mulberry is a large shrub or small tree with a mounded appearance (Alhassan, 2011). Its leaf scars are in alternate pattern, although on occasion they are opposite as well. The tree is dioeciously and therefore male and female plants must be grown if seed is required, the leaves range from 8-25 cm in length with the fruits of the plant are generally 1.5 - 2.0 cm in diameter and reddish purple in colour, appearing in summer (Dweck, 2002).

2.4.1 Utilization of paper mulberry

It has been known for almost 1,500 years as a plant whose bark can be used to make paper of various grades up to the highest quality. It is used in the production of flowers, umbrellas, fans, lanterns as well as lamps, dolls and toys, cloth and others (Dweck, 2002). The bark of paper mulberry is used in the handicraft industry to make paper and envelopes (Inthapanya and Preston, 2009). Paper mulberry has several other used including medicinal and as food (Dweck, 2002). The leaves are fed to livestock (Owusu-Sekyere, 2006). Paper mulberry compares favorably with other species used as leaf supplements in ruminant nutrition in respect of the chemical composition and its acceptability by sheep as observed (Alhassan, 2011). The leaves are also fed to rabbit and pigs (Inthapanya and Preston, 2009). Also in Indonesia, the steamed young leaves are eaten as a leaf vegetable (Whistler and Elevitch, 2006). In Ghana, the stem is used as firewood and for making charcoal. The bark is used in strips as binding ropes for mud houses and sometimes weaved into mesh used in erosion prevention (Alhassan, 2011). In Laos, farmers used leaves to fed the animal when they lack of feed in dry season suck as goats, pigs and cattle by supplemented with the native forage as a basal diet.

2.4.2 Nutritional composition of paper mulberry leaves

The nutritional composition of paper mulberry leaves (Table 2.3) has been conducted in Thailand by Cheva-Isarakul *et al.* (2007), in Ghana by Alhassan (2011), and Laos by Inthapanya and Preston (2009); Silivong *et al.* (2012).

Table 2.3 Chemical composition of paper mulberry leaves in (%) dry matter

DM	CP	EE	Ash	CF	NFE	NDF	ADF	Reference
21.3	24.1	5.9	13.3	11.8	44.9	-	-	Cheva-Isarakul *et al.* (2007)
-	20.5	10	13.2	-	-	43.00	34.00	Alhassan (2011)
28.4	16.0	-	-	-	-	-	-	Inthapanya and Preston (2009)
29.1	26.7	-	11.9	-	-	-	-	Silivong *et al.* (2012)

These found that the chemical composition of paper mulberry leaves of dry matter and crude protein was 21.3-29.1 % (DM) and 16.0-26.7 % (CP).

2.5 Concentrate supplementation

Concentrate feed is an option to considering in goat production, the amount of concentrate given to goats for supplementing with the basal diet must determined not only technical, but also from an economical point of view (Gall, 1981). The supply of concentrates is increased in crude protein, energy intake for the animal and growth performance (NRC, 1981). Concentrate supplementation 150, 200, 250 and 300 g improved average daily gain of Black Bengal goats (27.6, 35.1, 43.2, 43.8 g/head/day) and increased milk yield (206.8, 233.4, 359.3 and 374.7 ml/day respectively), it is suggested that supplement 250 g of concentrate daily to female goats benefit for goat production (Sultana *et al.,* 2012). The supplementation of concentrate mixture with 15.60% crude protein at 30% of total required dry matter increased growth rate in 75 days (3.93 kg), it is suggested for optimizing growth performance of Black Bengal goats (Ferdous *et al.,* 2011). Berhanu *et al.* (2013) reported that concentrate supplementation 0, 200 and 400 g increased feed intake (380.5, 412.2 and 508.7 g/head/day of DM), increased average daily gain (2.7, 33.5 and 54.7 g/head/day), increased pregnancy rate (66.6, 77.7 and 85.7 %) and kidding rate (50, 85.7 and 91.6 % respectively). Kraiem *et al.* (1997) reported that using concentrate 15 % crude protein supplementation at the level 20, 40 and 60 % with hays as basal diet increased DMI of rams 1,363; 1,551; 1,751 and 1,784 g DM/day. Getinet and Yoseph (2014) reported that ADG in the T2 (Crude protein of concentrate mix, CMCP 100%) and T3 (Crude protein khat leftover KCP 33%) + (Crude protein of concentrate mix, CMCP 67%) were higher than the control group T1 (natural grass hays alone), T4 (Crude protein khat leftover, KCP 67% + Crude protein of concentrate mix, CMCP 33%) and T5 (Crude protein khat leftover, KCP 100%) (61.3 and 55.7 vs - 5.6, 42.2 and 28.4 g/day). There are some researchers commented that goats feeding of concentrate during the dry period should be considered the forage quality, milk yield and physical conditions of the goats (Gall, 1981). The effect of concentrate on growth performance of animal is depend on production level, type of basal ration, concentrate intake levels and feeding method (Devendra and Burns, 1983).

2.6 Reproductive efficiency in goats

Reproductive efficiency in female goats is determined by many different process, which include early initiation of reproductive life, length of breeding season, cyclic activity, ovulation rate, fertilization rate as well as postpartum anoestrus period. All this reproductive traits was depend on numerous components: genotype, environment and husbandry factor. Increasing reproduction is the most important way of improving meat production (Mahgoub *et al.,* 2012).

2.6.1 Onset of puberty goats

In the animal puberty is an important reproductive trait. In goats, puberty was determined the age at first estrous activity and therefore initiates the start of the reproductive career of the animal (Mahgoub *et al.,* 2012). In female goats, it is commonly defined as being the age at which estrus is first detected and is followed by the establishment of a functional corpus luteum (CL) and a characteristic cyclic ovarian activity. Moreover non-pregnant animal had reported that sexual maturity is different from puberty and occurs later (Drymundson, 1983). In young female sheep and goats, sexual maturity was indicated acquisition of full reproductive potential (maturation of the hypothalamic-pituitary axis, estrous expression, embryo survival) that is reached at a later age than puberty. The occurrence of puberty in goats is similar to ewe lams and fits within the model that classifies luteinizing hormone (LH) surge in young female sheep

(Foster and Ryan, 1981). At puberty, the response of the hypothalamic pituitary axis to inhibition by estradiol (E_2) is considerably reduced. Basal secretions of LH therefore increase as a result of the acceleration in the rate of LH discharges, thus resulting in one or more of the follicles developing towards the pre-ovulatory LH surge. The mean body weight at puberty of Boer goats (female goats) has been set at 30.6 kg for animal on high energy diet and 27.5 kg on a lower energy diet (Greyling, 1988). Anyway Boer goats in South Africa can reach puberty at 18.0 kg body weight (Attwood, 2007). Goats delayed attainment of puberty can be explained by their low growth rate under unfavourable management conditions in the tropic (Mahgoub *et al.*, 2012).

2.6.2 Seasonality of reproduction

The majority of goat breeds show seasonality in reproduction activities (Chemineau *et al.*, 1992). For goats bred under temperate latitudes (above 40^{o}N), the female experience a period of an estrus from the beginning of spring to late summer, with no behavioural or ovarian activity (Mahgoub *et al.*, 2012). In the northern hemisphere, the breeding season starts in the summer and autumn month and ends in winter. In contrasts, animal in the topical do not appear to be seasonal breeders (Devendra and Burn, 1983). The effect of season on reproduction in sheep and goats are mediated by similar mechanisms, the change in the duration of the night time for melatonin pattern alters the hypothalamic responsiveness to E_2, and this leads to changes in the frequency switches of the reproductive system and the high frequency switches it on (Mahgoub *et al.*, 2012). During the sexual season, the hypothalamus demonstrates little response to E_2 and the LH pulse frequency is high, whereas, during anoestrus, the hypothalamus is very responsive to E_2 and the LH pulse frequency is low. At the onset of the breeding season, the secretion of gonadotropins, particularly the frequency of LH pulses, increase to more than three pulses every 6 h in mid-September (Chemineau *et al.*, 1988). This seasonal changes in pulse frequency are mediated by melatonin-induced difference in responsiveness to gonadal feedback (Chemineau *et al.*, 1988). This gradual enhancement of gonadotropic activity stimulates ovarian folliculogenesis and therefore the gradual onset of cyclic ovarian activity (Mahgoub *et al.*, 2012).

2.6.3 The ovarian cycle and related endocrine event

Estrous activity of female goats is greater in the tropics than in temperate climates. The average length of estrous cycle in the female goats is 21 days, but can vary from 18 - 22 days depending on the breed differences, stage of breeding season and environmental stress (Jainudeen *et al.*, 2000). The abnormally short cycles that are observed in the female goats early in the breeding season may be associated with premature regression of the CL. The estrous lasts for 24 - 48 h in the female goats and the duration of estrus can be influenced by breed, age, season and presence of the male goats as in the Table 2.5 (Jainudeen *et al.*, 2000). And moreover the female goats can ovulate producing one or more oocytes to approximately 30 - 36 h after the beginning of estrus (Gonzalez-Stagnaro *et al.*, 1984). Following ovulation, the follicle transforms into the CL (the luteinization process), which is active in secreting progesterone (P_4) during the luteal phase, which lats 16 days. If the female goats not conceive, the CL regresses and new follicular phase starts. Several hormonal changes are associated with the main event of the estrous cycle. The maximum plasma P_4 concentration is attained around day 10 (day 0 is ovulation time) and remain high until day 15 (Simoes *et al.*, 2006). Starting on days 16 - 17 of the estrous cycle, the prostaglandin $F_2\alpha$ ($PGF_2\alpha$) released from the non-pregnant uterus, most likely influenced by ovarian oxytocin will induce luteolysis (Homeida, 1986). The rapid decline of plasma P_4 concentrations is associated with an acceleration of the frequency of LH pulses and increase in their amplitude (Mori and Kano, 1984). This is the major event triggering the start of the ovulatory follicular phase during which there is stimulation of the growth of follicle with the mean diameter >1 mm (Akusu *et al.*, 1986). The growing follicles increased their steriodogenic activity and hence start secreting E_2 at high concentrations >10 pg/ml (Rubianes and Menchaca, 2003). The sustained increased in E_2 concentration which in turn induce a positive feedback action on the pituitary gland, culminating in the pre-ovulatory LH surge. This surge usually lasts between 8 and 10 h; its maximum is reached 3 h after the peak of E_2 and 10 - 15 h after the onset of estrus (Chemineau and Delgadillo, 1994). In parallel to the endocrine changes, estrous cycle is also characterized by major change in follicular turnover (Mahgoub *et al.*, 2012). Usually according to different authors the number of follicle in female goats waves ranges between 2 – 5 mm in diameter of waves per cycle of normal length (19 - 22 days) (Mahgoub *et al.*, 2012). There is good evidence showing that the pattern of fluctuation of serum follicle stimulating hormone (FSH) concentration is tightly associated with the emergence of most follicular waves in sheep (Evans *et al.*, 2000). An increase in FSH concentrations commonly precedes the emergences of the wave and this is followed by decrease, which is negatively correlated with the estrous cycle of the goats are inconclusive (Mahgoub *et al.*, 2012). However, the positive effects of an exogenous FSH treatment on follicular recruitment are well established in goats (Rubianes and Menchaca, 2003).

Table 2.4 Duration characteristics events of estrous cycle in female goats.

Characteristic events	**Average time**
Duration of estrous cycle	18 – 21 days
Duration of estrus	24 – 48 h
Time of ovulation	24 – 36 h after estrus

Source: Jainudeen *et al.* (2000)

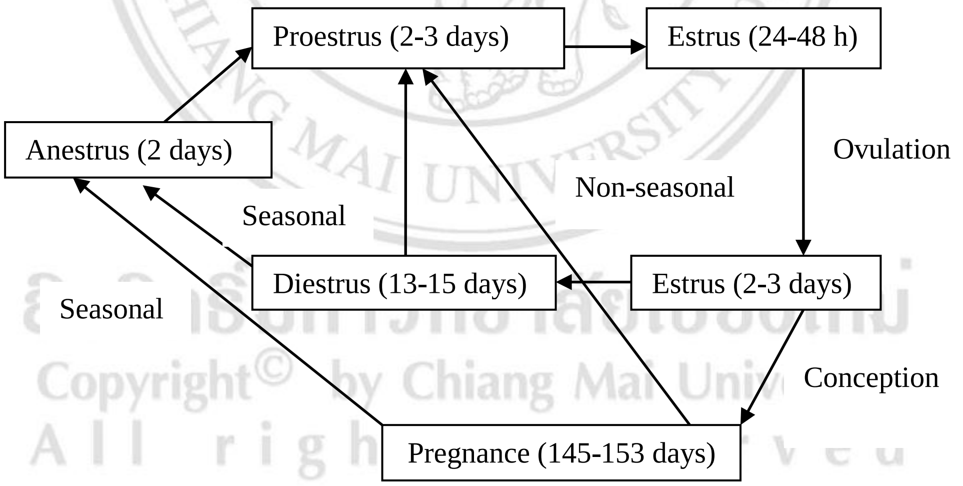

Figure 2.1 The estrous and reproductive cycles of the female goats

Source: Rahman *et al.* (2008).

2.7 Nutritional influences on reproductive function

Nutritional condition has a strong influence on the activity of the hypothalamo–pituitary–gonadal axis in mammals (Miller *et al.,* 1998; Ohkura *et al.,* 2004; Zabuli *et al.,* 2009). Nutrition is considered to be an important factor affecting reproductive function in small ruminants influencing the onset of ovarian activity in goats (Walkden-Brown *et al.,*1994; Zarazaga *et al.,* 2005). Extra ovarian factors, such as nutritionally mediated changes in metabolic hormones, also directly affect follicular development and oocyte quality (Webb *et al.*, 2004). The mechanisms of nutritional effects on follicular growth and development (folliculogenesis) are probably not effects of quantitative nutrient supply per se; it is much more likely that they are specific nutrient signaling effects that link reproduction with favorable environmental conditions for reproduction (Scaramuzzi *et al.*, 2006). There are many reports suggesting the correlation between plant of nutrition and reproductive activity in goat (Walkden-Brown *et al.*, 1994; Zarazaga *et al.*, 2005).

2.8 Estrous synchronization in goats

Estrous synchronization has been successfully used for reproductive management in goats (Sonmeza *et al.*, 2009). In the past of estrous synchronization has focused to allow for optimal timing of milk production in dairy goats. However, the expanded popularity of meat goat production leads to increase interest in reliable methods to synchronize estrus in goats (Whitley and Jackson, 2004). With this technology, producers are able to more efficiently use complementary techniques for reproductive management, including artificial insemination (AI) and embryo transfer, so that genetic material is more easily obtained or transferred domestically and internationally (Whitley and Jackson, 2004). The ultimate aims of any estrous synchronization method are to reduce the time used for estrous detection and to provide an optimum litter size with a high survival to weaning (Kusina *et al.*, 2000). In efforts to extend the lifespan of the CL for estrous synchronization, various forms of progestogens synthetic P_4 and different methods of administration have been used in cycling goat to synchronize estrus (Amoah and Gelaye, 1990; Whitley and Jackson, 2004). Controlled internal drug release (CIDR) devices were developed in early 1980s and serve as an alternative method of administering exogenous P_4 for estrous synchronization in goat (Motlomelo *et al.*, 2002).

2.9 Effect of nutrient on ovarian follicular development

Among the environmental factors influencing reproduction in ruminant, the level of nutrition is one of the most important. It is widely accepted that nutrition exerts major effects on reproductive responses in males and females. Nutritional status influences virtually all aspects of female reproductive performance starting at the beginning of fetal life to their oocytes and embryo quality. The mechanisms of nutritional affect on folliculogenesis (Scaramuzzi *et al.,* 2006) in female goats. Nutritional effects on reproduction are complex and nutrition modulates reproductive activity at multiple levels through the circulating metabolic hormones such as insulin, insulin-like growth factor I (IGF-I), growth hormone (GH) and leptin (Armstrong *et al.*, 2003). These hormones have important roles in the control of follicular development and are likely to be mediators of the effects of dietary intake on ovulation rate (Webb *et al.,* 1999; Muñoz-Gutiérrez *et al.,* 2002), by acting to regulate the action of key reproductive hormones such as gonadotrophins, steroids and inhibin in follicles. Gonadotrophins are certainly the main driving force for antral follicular development, but they also interact with a range of local growth factor systems. Extra-ovarian factors such as nutritionally mediated changes in metabolic hormones also directly affect follicular development and oocyte quality (Webb *et al.,* 2004). It appears that nutritionally induced changes in circulating concentrations of metabolic hormones and the intra-ovarian insulin-glucose system are important for follicular development. Glucose infused for 3 or 5 days stimulated folliculogenesis by increasing the numbers of large follicles but without any effect on the number of small and medium sized follicles (Muñoz-Gutiérrez *et al.,* 2002; Downing *et al.,* 1995). For example lupin (high energy and high protein) feeding increased the number of large follicles although to a lesser extent than glucose-infusion (Scaramuzzi *et al.,* 2006). The main influence of lupin feeding was on medium-sized follicles the numbers of which were approximately doubled by lupin feeding (Muñoz-Gutiérrez *et al.,* 2002; Kendall *et al.,* 2003). Moreover the infusion of leptin at a systemic dose of 1 μg increased the number of large follicles > 3.5 mm but, did not effect the number of medium sized 1–3.5 mm follicles (Kendall *et al.,* 2004). The data suggest that the effect of lupin grain supplementation on folliculogenesis is not solely mediated by the glucose-insulin and leptin systems.

2.10 Effect of nutrition on ovulation rate

Ovulation rate is a consequence of the influence of genetic, nutritional, hormonal, age-related and seasonal factors, nutrition is one of the most important in animal, ovulation rate is related to nutrition (Drawning and Scaramuzzi, 1991). Nutrition has a profound effect on the number of oocytes ovulated in each estrous cycle. This in turn is determined by the number of selected follicles available for ovulation and it is at the stage of follicle selection that nutrition is thought to exert one of its most important influences on ovulation rate. In sheep, follicular populations are very sensitive to nutritional input and folliculogenesis and ovulation rate can be readily increased by nutritional manipulation (Somchit, 2011). There are in a agreement of some researchers reported that increased dietary protein has in conjunction with increasing ovulation rates, increased the circulating levels of FSH during the latter half of the estrous cycle (Davis *et al.*, 1981; Knight *et al.*, 1981). Protein intakes of around 200 g/day produced a maximum increase in ovulation rate (Smith *et al.*, 1981). Moreover protein and energy to ovulation rate has been stimulated by the findings of an increased rate following supplementation with lupin grain (Knight *et al.*, 1975). Effects of both protein and energy on ovulation rate and that there was an increase in pituitary weight and gonadotrophin content but not in the concentrations of FSH and LH in the gland (Memon *et al.*, 1969; Howland *et al.*, 1966). The sensitivity of ewes to gonadotrophin releasing hormone (GnRH) can be altered by nutrition, but with the animals on sub maintenance diets having the greater FSH release following GnRH administration (Cumming *et al.*, 1975). A similar increased response in LH release to GnRH in prolonged undernourished ewes whose prestimulation LH levels were lower than the better-fed ewes. Short-term increases in nutrition did not alter pituitary LH content or plasma LH concentrations although ovulation rate was increased (Haresign, 1981). While obtaining changes in ovulation rate with feeding with lupin, found no changes in the basal LH levels nor in the frequency of LH pulses during the immediate pre-oestrous period (Radford *et al.*, 1980). And it was reported that ovulation is the most significant event of estrus (Perry, 1971). The point of ovulation can be seen in the resulting CL on the ovary days after ovulation. Ovulation is controlled by gonadotrophins, as FSH is predominant during the phase of follicular growth and LH is generally regarded as ovulation inducer and also responsible for the formation of CL.

Ovulation in the female goats is spontaneous and most goat breeds ovulates between 24 – 36 h after onset of estrus (Jainudeen *et al.*, 2000). And average ovulation rate in the female goats is 1-3 oocytes, but can vary from 1-5 depending upon the breeds and management condition (Pineda, 2003).