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Developing Feeding System and Tecnology Innovation for Intensive and Export-Oriented Goat Production

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Abstract. There is large potential for exporting meat goats and so gaining more economic benefit from raising this animal. There are several constraints faced by the goat producers or traders in fulfilling the potential demand of the market. Developing a more intensive goat production system is urgently needed in order to increase the capacity of the stock supply while at the same time the goat population is developing to make the system sustainable in the long term.

In intensive goat production system feed play a central component in achieving the maximum economic efficiency of the production, since under such production system the feed could contributed up to 70% of the total production cost. To reach a high efficiency in feed utilization for goat production system there are at least two feeding system that could be considered. Feeding system and feed management is aldo critical to be developed intensively to be more well adaptive. Feed budget or feeding standard are some alternative feeding approach for intensive goat production system and feeding strategy and feed technology are important in optimizing the level of productivity of goats during each phase of its life cycle and production.

Keywords : *Goat Production, Feeding System, Intensive, Cost Benefit, Feed Budget*

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Introductions

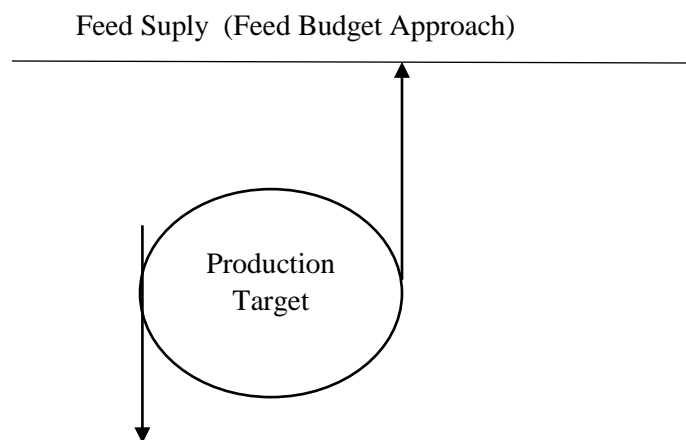
Exporting the agriculture commodities is currently strongly promoted by the Indonesian government to gain more value added . Goats is one of among other food animals that has been considered to be a potential export commodity [2]. Although exporting live goat and sheep in particular to Malaysia has been in progress recently, this economic activity has been proceeding sporadically. The adequacy of continuous supply of animal stocks with specific qualities required by the importer country is an crucial element in this supply chain [19]. The dominance of the smallholder type system of goat production in Indonesia with small operation scale, large variation in animal quality and highly-scatterd geographical distribution make the supply of live goats difficult to consolidate. Other constrain is the available breed type of goat which is dominated by Kacang goat and its crossbeds having relatively low body weight and

growth rate. Boerka goat, a new goat breed with better growing and body weight capacity provide a prospect alternative type of meat goat for export purpose.

It is important to realize that a competitive and improved goat production system should be developed in order to maintain a continuous supply of live goats with good quality. The production system should be able to keep the national goat population and quality to be dynamically sustainable in the long term. To achieve this purposes the type of production and management should be adapted accordingly. Among other management aspects in goat production system the feed and feeding system play a crucial role, since it is the largest contributor to the total production cost and biologically the most determinator of production level. This paper describe alternative feeding systems that might be implemented in intensive goat production system. Recent technological innovation that potentially adopted in various physiological state goat production cycle is discussed.

Feeding System Approach for Intensie Goat Production

In intensive goat production system feed play a central component in achieving the maximum economic efficiency of the production, since under such production system the feed could contributed up to 70% of the total production cost. To reach a high efficiency in feed utilization for goat production system there are at least two feeding system that could be considered (Figure 1). The feed budget approach put the potential of feed available as the limiting factor for reaching the optimum level of production parameters. Thus, under this feeding system the target is how to maximize the potential and efficiency of utilization of available feeds. The target of production (animal genetic potential) is therefore compromised.





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Genetic Potential (Feeding Standard Approach)

Figure 1. Feeding system based on the feed supply (*feed budget*) and on the animal genetic potential (*feeding standard*)

In the feed budget approach the basis of feed is developed and managed based on the maximum potential of available feed that could be obtained from a production system. The feed types could be forages, roughage or agroindustrial by-product and plant residues. The feed budget should be linked to the its seasonal availability. In this case, a feed calendar would be important to develop so that the continuity of the feed is guaranteed by anticipating when there might be surplus or shortage of the feed during a certain period of time. Increasing the nutritional potential of available feed could be achieved through the implementation of appropriate or specific feed technology. The nutritional and availability capacity of the feed could be improve by: (1) utilization of new feed ingredient, (2) correcting the improper technological use, and (3) improving the efficiency of available feed utilization. The pattern of the fluctuation of the feed should be predicted tactically for less fluctuated or strategically for more fluctuated feed (Bell, 2009). The feed budget system would be more applicable in a less intensive production system where feed will mostly consist of locally available feed ingredients such as agro-industrial by products and/or plant residues. Many of such feed ingredients are able to support a moderate to high levels of production when used efficiently in different agro-ecosystem (Table 1). Feed technology such as total-mixed ration and ensiling could be adopted to improve the efficiency of feed utilization in the palm oil-goat production system where fibrous feed such as palm oil frond and palm pressed fibre and concentrate feed such as palm kernel cake and palm oil mill effluent are abundantly available. In the horticulture-goat production system there is potential of horticulture by products as the source feed. In addition, feed availability and utilization may be increased through the introduction of appropriate grass and leguminous species. *Calliandra callothyrsus* is a potential leguminous tree to be developed in the high land of agricultural. As the tannin content in this leguminous tree is relatively high that might reduce its palatability for goat other leguminous trees such as *Indigifera zollingeriana* could be introduced to complement the calliandra callothyrsus as protein supplement. Ensiling technology would be appropriate to conserved the horticulture by products or residues for used as goat feeds which production and availability are usually seasonal. In the food crop-goat production system most feed are of the fibrous



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type with low intake and digestibility. The improve the nutritional value of such feed ingredient ammoniation and bio-conversion process could be alternative for consideration. Since the protein content of the fibrous feed is typically low, the strategic supplementation should improve the nutritional quality of these feed.

Table 1. Implementation of the feed budget approach in several agro-ecosystem for goat production

Production system	Feed type	Feed technology
Palm oil-goat system	Fibrous and concentrate feed and forages	<ul style="list-style-type: none"> • Total mixed ration • Ensiling • Strategic supplementation
Horticulture-goat system	Fibrous feed and forages	<ul style="list-style-type: none"> • Ensiling • Strategic supplementation
Food crop-goat system	Fibrous feed forages	<ul style="list-style-type: none"> • Ammoniation • Bio-conversion • Strategic supplementation
Grazing system	Forages	<ul style="list-style-type: none"> • Rotational grazing • Introducing grass species • Introducing legume species • Internal parasite control

Where there is vast grazing area goats could be raised under intensive grazing system by applying the rotational grazing and introducing grass species with higher productivity. Grass species such *Brachiaria ruziziensis* is a good alternative to develop in the open grazing area where *Stenotaphrum secundatum* is a shade tolerant grass species so that it will fit for the plantation area. Leguminous species such as *Indigofera zollingeriana*, *Leucaena leucocephala* could be introduced in border land and used as green concentrate supplement. *I. zollingeriana* will be suited in the area with more acidic soils while the *L.leucocephala* is less suited in the acidic soil and so should be developed in the area of non acidic soils.



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. Alternative to the feed budget approach is the feeding standard system. In this feeding approach feed is assumed not to be a limiting factor, but the animal genetic capacity is the limiting factor. Feeding standard system allocate feed ingredient to meet the standard requirement of the animal. There three main component of the feeding standard system i.e. the animal (genetic potential), the feed and the agroecosystem . The feeding standard system would be more fit to the high input system and accurate information about the nutritional characteristics and animal requirements on the various nutrients under certain physiological state are essential. Ideally, any feeding system should be responsive and predictive in nature so the mechanistic and deterministic modelling approach is important, although under practical situation the less dynamic model are more relevant. Some figures on metabolizable energy and protein (digestible and crude) requirement of goat at several physiological state recently published is presented in Table 2.

Table 2. Energy and protein recommendation for goat in feeding standard system

Physiological state	Metabolisable energy	Digestible Protein	Crude Protein
Growing	104-108 Kcal/BW ^{0.75} ^{ab}	0.446 g /kg Gain ^b	-
	116 Kcal/BW ^{0.75} ^c	-	-
Gestation			
Whole Lactation	1166 Kcal/kg milk ^d	1.45 g /g milk ^e	-
Early lactation (1-4 wk)	2700Kcal/kg feed ^f	-	190g /kg feed ^f
Mid lactation (5-8 wk)	2600Kcal/kg feed ^f	-	180g /kg feed ^f

^aMandal et al. (2005); ^bSalah et al. (2014); ^cLuo et al. (2004); ^dNsahlai et al.(2004a); ^eNsahlai et al.(2004b); ^fGorgulo et al. (2003)

Performnaces Target in intensive production system

Intensive and export-oriented goat production system required that a certain target of technical parameters of goats should be clearly defined for any stage of physiological states. Since breeding enterprise is the most crucial segment of the animal supply chains in providing good quality of animal stock sustainably, the technical parameters of breeding does is essential to achieved (Table 3). The amount of animal stock produced will depend on the reproduction and production index of the breeding goats, and these parameters are strongly influenced by the feeding system. In order to achieved the maximum genetic

potential of the goat it is required that the nutrition of the animals is provided properly and feeding strategy should be allocated for each physiological state in order to obtained maximum efficiency of feed utilization.

Tabel 3. Typical performances of Boerka (Boer x Kacang) goats in intensive production system

Parameters	Boerka ^a	Kacang and its Crosses ^{a,b}	Ideal target
Does			
Litter size, head	1,56	1.5	2
Kidding interval, day	268	260	240
Reproduction index, kid/doe/year	1,65	1.30	Maximum
Production index, kg/doe/year	1,88	1.50	Maximum
Kid			
Daily gain (2 month post weaning), g	150	60	-
Pre-weaning mortality, %	< 7	<7	<5%
Body Weight at 30 day-weaning, kg	10-14	5-8	-
Body Weight at 5 month, kg	20-25	15-17	Maximum
Body Weight at 12 month, kg	40-55	20-25	Maximum

^aDoloksaribu et al. (2005); ^aElieser (2012); ^aElieser et al. (2017) ^bGinting and Mahmilia (2008);

Principal Nutrition for Pregnant dan Lactating Goats

Nutrition in pregnant goats is used for growth and maintenance of fetal tissues (fetus, placenta) and maternal tissues (uterus and mammary gland). The nutrition adequacy for the fetal tissue depend on the maternal nutrition and the efficiency of nutrient transfer accros the placental tissue by difussion mechanism. Glucose is the main nutrient required for the metabolism mammary and uterus tissues. The mammary gland tissue then converts the glucose into lactose while the uterine tissue used the glucose as the energy source. Other potential energy sources for pregnant goats are acetate, fatty acids and keton



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bodies. However, these substrates are not used by the fetal tissues since they could not be transported across the placenta. It is therefore that the fetal tissues totally depend on the maternal glucose. Amino acids are transported actively across the placenta and the fetal amino acid level is consistently higher than the maternal amino acids. The glucose and lactate oxidation provide only 50-60% of the total calori needed by the fetal tissues and the remining energy (30-40%) is provided by the oxidation of amino acids. Although the level of nutrient requirement during the early pregnancy is relatively low, the availability of these critical nutrients in the early pregnant goats will influenced their reproductive parameter [7]. Thus some nutrients that are critical during the early pregnancy are glucosa, amino acids and vitamins which are directly used as substrate for metabolism or indirectly modify the hormonal function that further influence the the maturity of the ovum, embryo development, fetal growth, and the viability and vigor of the born kids.

During the late pregnancy, (six week prior to partus) approximately 66% of the body weight at birth of kids and 95% of the secretory mammary gland tissue are built . Accordingly, the level of nutrient requirement during this period increase sharply. It is recommended that the requirements for energy metabolism, crude protein, Calcium (Ca) and phosphor (P) in the late pregnancy are approximately 1,5-1,8 times the requirement for maintenance. The sufficiency and the balances of nutrients are very important for the development of fetus for maximum birth weight and for development of the mammary gland for high milk production during the lactation period. Sub-optimal nutrition during the late pregnancy put the goat in the situation of highly negative risk for fetal development, birth weight, perinatal growth, and the capability of the does for body condition recovery.

There are several amino acid that are spesifically important in the late pregnancy. Cystein for example, play important role in the maternal immunity system and seem to be the first limiting amino acid for fetal development. Other amino acid, glysine is also highly occur in the fetal tissue [7]. Hypoglycemia is a common metabolic disorder that happened in the pregnancy due to low Ca intake or due to low Ca absorption related to the hormonal function. The parathyroid hormone influence the process of convection of vitamin D (25-hydroxy cholecalciferol) into 1,25-dihydroxycholecalciferol that stimulate the absorption of Ca in small intestine by enhancing the production of Ca-binding protein in the small intestine.



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The nutrient requirements is increasing during the lactation period which are at peak level during the 3rd and 8th weeks of lactation period. Attempt to meet the nutrient requirement during lactation is challenged by the tendency of decreasing feed intake particularly during the early lactation. Nutrients are required to maintain the high level of fat and protein content in the milk in the early lactation.

Strategic feeding during late pregnancy and lactation

Managing the maternal energy and protein status of goats could be performed using body condition score (BCS) as an indicator. BCS is particularly responsive to energy and protein adequacy and numerically determined by judging the fatness. The evaluation of the BCS is simple but requires a trained panel of individuals to get accurate estimation. By maintaining BCS of 3.5 at mating, the nutrition at maintenance level will be sufficient for early gestation (30-90 d), even though a 0.5 unit BCS reduction might be expected as the gestation progresses. When the BCS at mating is too low (2.0) a higher level of nutrition would be required in order to prevent the placenta from retardation [12].

Providing nutrients only during the most critical period of breeding goats i.e. from late gestation to early lactation rather than the whole period of gestation and lactation will improve the efficiency of feed utilization and the economic of the feeding. In this case, feeding is focused on supplementing basal feed with feed supplements to increase the supply of the most critical nutrients such as glucose, amino acids, certain micro-mineral and vitamins. When feeding standard is practiced feed supplement could be selected more easily, but in the feeding budget system less choice is available, but some feed alternative could be developed (Table 4).

Table 4. Strategic supplementation for goat in feed budget system

Feed type	Lactation 30 d	Gestation 90-120 d	Post-weaning 30 d
Green concentrates ^a	0,5-1% BW	0,5%-1 BW	<i>Ad libitum</i>
Synchronous P- E ^b	<i>Ad libitum</i>	<i>Ad libitum</i>	<i>Ad libitum</i>
Non-conventional feeds ^c	0,5-1% BW	0,5%-1 BW	<i>Ad libitum</i>



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^aLeguminous tree- leaf (*Indigofera*, *Leucaena*, *Calliandra*, *Gliricidia*); ^bSynchrony of protein and energy source for rumen microbial; ^cagroindustry-by products

Strategic feeding for breeding goats

Flushing refers to a feeding practice of increasing the supply of nutrition level, mainly protein and energy to doe to increase the ovulation rate and the proportion of multiple births. Improving the nutrition level during pre-ovulation will positively influence the quality and viability of the embryo. Flushing is commonly practiced approximately 2 weeks prior to breeding and is widely used in sheep. The success of flushing in goats depend on the maternal nutritional state as indicated by its BCS. It is reported that when the doe is in reasonable BCS (2.5 to 3.5) there is no response of flushing of energy and protein on kidding or conception rate (Merkel and Gipson, 2015). It is however important to note that flushing will also give no response when the doe is superovulated with exogenous gonadotrophin hormone. In this situation, increasing the energy state of the doe (2 x maintenance level) could result in lowering the viability of embryo. This phenomenon may be relate to the decreased oocyt quality due to the sub-optimum progesterone level during the oocyt maturing process [16]. Robinson et al. (2002) has indicated that there is a negative relationship between the nutrition level and the systemic progesterone concentration.

Strategic feeding for pre-weaned kids

The performances of pre-weaned kids is mostly determined by the ability of does to synthesize milk and milking the kids. However, pre-weaned kids are commonly starting to consume solid feed as earaly as two weeks after birth. Provided solid feed to kids earlier will promote the development of the gastro-intestinal system faster and may minimize the problem of checked growth in early weaning. Early solid feed provision (creep feeding) will potentially provide extra growth for the kid and facilitating weaning. It is suggested that the creep feed contained at least 16% protein and should be medicated with a coccidiostat.

Strategic feeding for buck

The nutrient requirements for mature male (above 2 year old) should be sufficiently provided from good quality forages with standard feed intake level. Young male buck (< 2 years) required higher level of nutrition and may need some feed concentrate to stimulate growth and to reach standard body weight. Feeding system should provide the young buck to get a BCS of 3 to 4 and feeding concentrate feed at



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0.10 to 0,25% body weight will be able to maintain this BCS to prevent the male goat from urinary calculi. The BCS of the mature male need to be monitored every 2 to 3 month befor use for mating.

Complete feed for intensive goat production

Feeding technology such as complete feed in various physical forms (pellet, block; mixed) provide alternative feeding practice in intensive goat production system. Complete feed has been shown to be better compared to convensional feeding where thas basal and feed concentrate are fed separately [23]. Minimum feed ingredients selection and so more homogenous intake and more stable of rumen fermentation could be expected in complete feed system. Complete feed is becoming more accepted in intensive goat production system. This feed technology could improve the efficiency of feed utilization particularly of the non-conventional feeds through increased feed intake and feed digestibility (Table 5).

Table 5. Benefits of complete feed to support intensive feeding system for goat production

Feed and nutrition merits	Effect on feed utilization	Impact on the feed utilization
Feed intake	Increasd feed intake ^{a,b}	More flexible in feed utilization; improved feed efficiency
Rumen fermentation	Stable pH, substrate synchrony,microbial protein ^c	Less feed loss; improved feed efficiency
Digestibility	Increased digestibility ^d	Less feed loss;improve digestion efficinecy
Feedstuff management/handling	Feed preservation; Feed logistics	More flexible feed management

^aSharma et al. (2006); ^bBabu et al. (2013); ^cMudgal et al. (2012), ^dSaijpul et al. (2016)

Complete feed in the pellet form will improve the benefit of practicing complete feed and more effective in preventing the potential occurrence of metabolic disorder due to increase intake of certain substrat (Østergaard dan Grohn, 2000). Basal feed that is functioning as fibre source for goats could be forages such as grass (*Brachiaria ruziziensis*) or legumes (*L.zollingeriana*) (Ginting et al. 2018) and other plant residues such as palm oil fronds (Ginting et al. 2017). This study indicated that complete feed was



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accepted by Boerka goats with good feed intake (1100 g DM per day) with mean body weight of 25 kg or equivalent to 56,5 g/ kg BB. Mean gain was achieved at 115 g/d. High level of feed intake has also been reported by Pi et al. (2005).

Conclusion

There is large potential for exporting meat goats and so gaining more economic benefit from raising this animal. There are several constraints faced by the goat producers or traders in fulfilling the potential demand of the market. Developing a more intensive goat production system is urgently needed in order to increase the capacity of the stock supply while at the same time the goat population is developing to make the system sustainable in the long term. Feeding system and feed management is also critical to be developed intensively to be more well adaptive. Feed budget or feeding standard are some alternative feeding approach for intensive goat production system and feeding strategy and feed technology are important in optimizing the level of productivity of goats during each phase of its life cycle and production.

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