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Doe productivity of Kacang and Peranakan Etawah goats and factors affecting them in Indonesia

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PREFACE

In Indonesia nearly 99% of small ruminants like goats and sheep are found in the hands of smallholders. This fact indicates an important role for smallholders. The contribution of goats within the total farming income for small ruminant keepers is substantial. Small ruminant production plays an important role as an income generating activity, particularly for smallholders, whilst being a source of animal protein to support the national programme.

The major breeds of goats in Indonesia are the Kacang (Lokal) goat and Peranakan Etawah. Kacang is a local breed of goat found in Indonesia. It is called locally „Kambing Kacang“ or Kambing Lokal“ or Kambing Jawa“. The population of Kambing Kacang is widely distributed over the whole archipelago and adapted to a wide range of management conditions and feeding regimes.

Peranakan Etawah goats originally descend from crossings between the Kacang (Lokal) with Etwah (Jamnapari) goats (imported from India). Animals of this population are distinclty different from the Kacang goats.

The general aim in the management of an animal production unit is to increase the productivity. This goal may be achieved by one of, or as a combination of two approaches. These are:

- to improve average production by improving aspects of management so that the genetic potential of the animals may be expressed as fully as possible,
- to change the production potential of the animal population by the introduction of new genotypes.

The purposes of the studies are:

- To find out the production and reproduction levels of the two goat breeds under the village production system.
- To identify factors affecting the production and reproduction level of the two goat breeds.

Mr. Akhmad Sodiq started his research with goats in December 1999 and finished it with his thesis in March 2004.

Prof. Dr. Ezzat S. Tawfik

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Akhmad Sodiq

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

Small ruminants like sheep and goats are important for a larger part of the tropical rural population (Tawfik, 2001) and especially for Indonesia (Sabrani and Knipcheer, 1982). Goats are kept as an important component of farming activities, particularly by smallholders. Nearly ninety nine percent of small ruminants in Indonesia are found in the hands of smallholders. This fact indicates an important role for smallholders. Small ruminants' production plays an important role as an income generating activity, particularly for smallholders, whilst being a source of animal protein to support the national programme (Soedjana, 1993). The biological and economic functions of goats have long been recognized. Besides producing animal products, they also provide manure to maintain soil fertility (Suradisastra, 1993). The contribution of goats within the total farming income for the holders of small goats is substantial (Sabrani and Siregar, 1981).

The existing husbandry management systems in tropical countries, such as Indonesia, are normally the result of hundreds of years of tradition (Chaniago, 1993). Goats are kept primarily for meat production, so production traits of interest are the number of young weaned per breeding female per year and their growth rate (Bradford, 1993). The number of goats raised per farm is relatively small (Soedjana, 1993) about two to ten head (Adjisoedarmo, 1991; Sodiq et al., 2001). The common productive systems for small ruminants in Indonesia are (1) cut and carry, where forage and other feeds are brought to continuously housed animals (Djajanegara and Setiadi, 1991; Sodiq et al., 1998); and (2) grazing under tree crops, along roadsides and in temporarily idle croplands, etc. (Bradford, 1993).

The majority of goats in Indonesia is concentrated on the Island of Java (DGLS, 1999), the major breeds being the Kacang and Peranakan Etawah goat (Djajanegara and Setiadi, 1991; Edey, 1983). Kacang is a local (indigenous) breed of goat found in Indonesia. It is called locally 'Kambing Kacang'. Kacang goats are relatively small with a compact body frame, have erect ears and short

horns in both sexes. Most of the animals are black and brown; although the pattern of colour is not necessarily uniform. This population is adapted to a wide range of management conditions and feeding regimes in the region. Peranakan Etawah goats are descended originally from crossings between the Kacang with Etawah (Jamnapari) goats. Generally known simply as PE goat, animals of this population are distinctly different from the Kacang goats. They have a larger body frame, long hanging ears, a convex face and larger horns.

The general aim in the management of an animal production unit is to increase the productivity. This goal may be achieved by one of, or as a combination of, two approaches (Bray, 1983). These are: (a) To improve average production by improving aspects of management so that the genetic potential of the animals may be expressed as fully as possible, and (b) to change the production potential of the animal population by the introduction of new genotypes.

The Indonesian breeds of goats are small and relatively slow growing. Consequently there has been some interest in introduction of other genotypes, for example, the Etawah goat has already been widely crossed with the Kacang goat. Genetic improvement programmes may be based on crossbreeding between local breeds or between local and exotic stock. The introduction of specialized breeds for meat or milk productivity may be a rapid solution for increasing productivity (Edey, 1983; Tawfik, 2001). The biological productivity of livestock is determined by the fundamental processes of reproduction, growth and development, and death (Lindsay et al., 1982; O'Shea, 1983; Lawrence and Fowler, 1997; Bearden and Fuquay, 2000).

Increasing the productivity of goats in Indonesia will enhance national development planning for increasing rural income and also increasing the level of protein consumption (Bradford, 1993). Key production traits considered for improving productivity in meat goats are adaptability and productivity conditions, reproductive rate, growth rate and carcass value (Gipson, 1996; McGowan and Nurce, 2000; Luginbuhl, 2002).

The objectives of this study are: (1) To find out the production and reproduction levels of Kacang and Peranakan Etawah goats under the Village Production System. The doe reproduction traits studied were: litter size, litter weight at birth, litter weight at weaning, survival rate till weaning, kidding interval, and doe productivity index. The production traits of the kids studied were: birth weight, growth rate till weaning, weaning weight, body condition score, and leg conformation; (2) To identify factors affecting the production and reproduction level of Kacang and Peranakan Etawah goats under the Village Production System. Some factors were examined in this study: parity, type of birth, sex, birth weight, litter weight at birth and at weaning.

2 REVIEW OF THE LITERATURE

2.1 Litter Size (Type of Birth)

Litter size was defined as the number of kids born per kidding doe (Alexandre et al., 1999 and Steele, 1996). Litter size born or prolificacy has a very significant influence on reproduction efficiency. A number of biological factors influences the actual litter size in a flock of goats (Lindsay et al., 1982; O'Shea, 1983; Bearden and Fuquay, 2001).

The age or parity of the doe and year or seasonal effects' influences have been studied with respect to the litter size under tropical conditions. Urdaneta et al. (2000) working on Alpine and Nubians goats in Venezuela found that prolificacy was significantly affected by the year of kidding. Mellado et al. (1991) studies on native goats in Mexico demonstrated that the litter size was positively correlated with parity with mean litter size for the first, second, third and fourth parity at 1.5, 1.5, 1.8 and 1.8 kids per kidding.

Amoah and Gelaye (1990) studies on reproductive performance in South Pacific countries concluded that the litter size (LS) was related to doe age (A): LS = 1.8402 + 0.0002A and parity (P): LS = 1.2290 + 0.121P. Litter size varied among breeds. Results of Awemu et al. (1999) showed that parity, season and year in Nigeria significantly influenced litter size at birth, whereas at weaning, parity and year had important influences. Litter size increased with parity, with the largest litters at the fifth parity. Litter size for the Red Sakoto does in 1, 2, 3, 4, 5 and 6 parity were 1.8, 2.0, 1.8, 1.8, 1.9 and 1.8, respectively.

Awemu et al. (2002) working with Red Sokoto goats in Nigeria found that litter size at birth (1.8 kids) was significantly affected by parity. Litter size increased by parity, with the largest litter at the fifth parity. Crepaldi et al. (1999) reported that prolificacy of Alpine goats in Italy was affected by parity. Das and Sendalo (1990) working on meat goats in Malya, Tanzania, reported that prolificacy tends to increase from the first parity and a reduction in the sixth parity.

Litter size at birth was affected by parity with the first kidding being the smallest (Song et al., 2001). The trend of the effect of season on litter size at birth was not clear. These results were similar to those published by other workers (Galina et al., 1995; Odubate, 1996, Silva et al., 1998). Odubote (2000) demonstrated that litter size of West African Dwarf goats had been significantly affected by parity. Mean litter size at birth was 1.79 $\pm$ 0.05 kids.

Findings of Thumrong et al. (2000) showed that litter size and multiple birth rate increased with parity. Litter size and multiple birth rate increased from 140-148 and 39-45% for parity 1-3 to 163-167 and 55-60% for parity greater than 3. Litter size and multiple birth rate for Thai native and Anglo Nubian does were 141-144 and 40%. Odubote (1990) studies on the West African Dwarf goat demonstrated that litter size at birth tended to improve over the years and with parity. This may be due to the efficiency of reproduction as the doe matures.

Results of Galina et al. (1995) investigated on Mexican goats under various management systems found that the number of kids per parturition can be partially explained by the age of the dam and number of parturition, first kidding having the smallest prolificacy.

Alexandre et al. (2001) studied Creole goats and found that their prolificacy reached 1.98 kids per kidding, and these traits varied essentially with rank of kidding. The litter size at birth increased from 1.65 to 2.35 total kids born, from the first to the seventh kiddings, respectively. Marai et al. (2002) studies of reproductive traits of Nubian goats found that effects of parity was significant on the litter size. The same results also were reported by Armbruster and Peters (1993) who observed that litter size was significantly affected by the age of doe.

Silva et al. (2002) working on Alpine goats, observed that litter size averaged 1.69 $\pm$ 0.5 with the goats kidding for the first time at 14 months. Song et al. (2001) reported that the birth ratio of the Korea native goat does was 102 (2.4%): 277 (63.5%): 21 (11.7%): 6 (1.4%) for single, twin, triplets and quadruplets, respectively.

2.2 Weight at Birth and at Weaning and Growth Rate till Weaning

Birth weight of kids is regarded as one of the most important contributory factors for improving growth performance (Husain et al., 1996). Birth weight of kids is considered to be a very important criterion as it is strongly correlated with the growth rate, adult body weight and kid viability and hence a determinant factor for overall productivity (Devendra and Burns, 1983) and the first indicator of the future growth rate (Boggs and Merkel, 1993).

Coffey (2002) stated that weaning weights are crucial and indicate the milking ability of the herd as well as the growth potential of the kids. According to Boggs and Merkel (1993) weaning weight can be used to estimate growth rate, and weaning weight is an excellent indicator of productivity because it reflects both litter size, mothering ability and milking ability. Weaning weight would reflect mothering ability of does as well as the inherent growth potential (Das and Sendalo, 1990).

Findings of Amoah and Gelaye (1990) showed that there was a negative association between birth weight and litter size. Birth weight could be described by the multiple regression equation: BW = 2.7564 – 0.3316LS + 0.1863BP where BP is the period of breeding. Amoah et al. (1996) found that the birth weight decreased with the litter size by approximately 0.45 kg/kid. Song et al. (2001) reported that the mean birth weight of a kid of the Korean native goat was 2.04 kg with a variety 2.28, 2.11 and 1.64 kg for single, twin and triplet over of birth type, respectively.

Single and twin-born kids have higher birth weight than triplets, hence, a better chance for survival (Nawarz and Khalil, 1998). Mourad and Anous (1998) reported that the birth weights of kids in the Common African and Alpine crossbred goats were 3.1, 2.8, 2.3 and 2.3 kg for single, twin, triplets and quadruplets, respectively.

Das et al. (1990) working with Blended goats showed that birth weight and live weight at all ages were significantly affected by the type of birth. Generally the birth weight decreased with the increase in litter size. Okello (1993) working with Mubende goats reported that single kids were heavier at birth than twins and males were heavier than females. Another researcher reported that the effect of the birth type was persistent from birth to yearling age. Kids in single birth maintained the highest weight followed by twins and triplets (Husain et al., 1996).

Result of Kochapakdee et al. (2000) working with native Thai and their crosses with Anglo Nubian goats showed that male kids were significantly heavier at birth and at weaning compared with female animals (2.1 vs. 1.9kg and 8.2 vs. 7.4 kg) and single kids were also significantly heavier at birth and at weaning compared with multiple kids (2.1 vs. 1.9 kg and 9.2 vs. 7.2 kg).

Alexandre et al. (1999) studies on Guadeloupean Creole goats reported that body weight at birth and at weaning were 1.73 $\pm$ 0.34 and 7.75 $\pm$ 1.76 kg, respectively. Birth weight and weaning weight were 10% and 8% higher for males than females, respectively. Both traits were 15% higher for single than for multiple kids. Das (1993) investigations on Blended goats revealed that male kids were heavier at birth than female kids. Weight at birth and at weaning were significantly affected by sex and type of birth.

Ikwuegbu et al. (1995) studies on African Dwarf goats under village conditions showed that the birth weight was affected by year, season, sex of kid and birth type. Mourad (1993) showed that single born kids were heavier than twins in Alpine and Zaraibi goats. Results of Zhou et al. (2003) revealed that body weight of male Inner Mongolia cashmere goats was significantly heavier than adult females.

Marai et al. (2002) studies of reproductive traits of Nubian goats found that the effects of sex were significant at litter weight at birth and at weaning. A survey of goats showed that both sex and breed had significant effects for live weight (Lusweti, 2000). Amoah et al. (1996) found that birth weight was varied among

breeds, and males were heavier than female kids. Alexandre et al. (1999) working on Creole goats reported that body weight at birth and body weight at weaning was higher for males than for females.

Findings of Silva et al. (1998) showed that kid birth weight of the Alpine dairy goats was varied, 3.3-4.5 kg with males, 2.5-3.7 kg with females, and single was 15% heavier. This was in agreement with those reported by Nawarz and Khalil (1998) for ewes. Single kids' weight was higher than that of twins and triplets. The birth weight of kids varied according to sex. The male kids had higher birth weight than female kids (Nawarz and Khalil, 1998). The same results were also reported by Gerstmayr and Horst's (1995) studies on Angora goats and concluded that male kids were heavier, especially at birth, than female kids.

Results of Husain et al. (1996) revealed that there was a tendency to increasing weight with the advance of parity at least up to the 3rd parity. Mellado et al. (1991) studies on native goats in Mexico demonstrated that birth weights were positively correlated with parity. The same results also demonstrated by Osinowo et al. (1992) who found weaning weights were significantly affected by parity, litter size and sex. Weaning weight increased consistently from the first to fifth parity, and both single and male lambs had a higher weaning weight than twins and females. Marai et al. (2002) studies of reproductive traits of Nubian goats found that the effects of parity were significant at litter weight at birth and at weaning.

Growth is the increase in size and change in body composition (Steele, 1996, Gatensby, 1991) and depends on the multiplication of cells (*hyperplasia*) and the increase of cell size (*hypertrophy*) (Edey, 1983). True growth is frequently described as an increase in the structural tissue (bone, muscle and the connective tissues associated with muscle (Boggs and Merkel, 1993). Taylor (1995) stated that growth is an increase in body weight until mature size is reached. Development is defined as the directive coordination of all diverse processes until maturity is reached. Growth, cellular differentiation and change in body shape and form are involved.

Some criteria used to evaluate growth, development and fattening consist of: weight (on live animal and carcass), muscle and fat (Boggs and Merkel, 1993). Representation of growth and development consists of: (1) Cumulative growth curve, (2) Average rate of gain which is commonly used, (3) Daily rate of gain against age, (4) Relative growth rate, and (5) Indices of development (Edey, 1983).

Growth rate can be effectively divided into two periods (Luginbul, 2000; Edey, 1983): pre-weaning average daily gain and post-weaning daily gain. A high pre-weaning average daily gain reflects the genetic potential of the growing animal and mothering ability of the doe. Rapid growth is an essential criterion for the improvement of meat production in goats (McGowan and Nurce, 2000). In some production systems, kids are sold at weaning and therefore pre-weaning average daily gain is an important production trait to consider (Luginbul, 2002). Growth during the pre-weaning period is largely determined by maternal milk production and competition for it amongst litter mates.

The major factors affecting the pre-weaning growth are: genotype, birth weight, milk production and litter size (Edey, 1983), sex, nutrition, maturing rate (Boggs and Merkel (1993). The growth rate of kids was influenced by the energy level offered to the doe during lactation (Sibanda et al., 1999).

Results of Das and Sendalo (1990) working on meat goats in Malya, Tanzania, reported that single born kids exhibited a higher growth than the twins from birth to weaning. Male goats were significantly heavier and grew faster than females. Gebrelul et al. (1994) revealed that the sex of kids had a significant effect on weaning weight and pre-weaning average daily rate on Alpine, Nubian and crossbred single-born or multiple-born kids, reared as single were heavier at weaning and grew faster in the pre-weaning average daily gain than multiple-born and reared kids.

Das et al. (1990) working with blended goats showed that single-born and male kids grew faster than twin-born and female kids. Mourad and Anous (1998)

demonstrated that type of birth with African and Alpine crossbred goats affected body weight and the average daily gain of kids. Montaldo et al. (1995) studies on local goats in Mexico demonstrated that goats with two or more kids at birth had greater milk production, efficiency and body weight than goats with one kid.

Okello (1993) reported that single kids of Mubende goats grew faster than twins and males had a higher growth rate than females. Das's (1993) investigations on blended goats revealed that single-born kids exhibited a faster growth rate than the twin born kids.

Results of Alexandre et al. (1999) studies on Creole goats showed that the daily weight gain from 10 to 30 days of age varied from 95 g for single kids to less than 70 g for multiples, and from 91 g for males to 86 g for females. Madibela et al. (2002) working in Tswana goats concluded that kid birth weight was positively correlated with the growth rate. Karua and Banda (1990) reported that male kids were heavier than female kids. Single and male had a higher average daily gain than twins and females (Osinowo et al. 1992).

Inyangala et al. (1990) concluded that parity was a significant source of variation for the growth rate. The age of the dam had a significant effect on weaning weight and pre-weaning average daily rate on Alpine, Nubian and crossbred (Gebrelul et al., 1994). Ikwuegbu et al. (1995) studies on African Dwarf goats under village conditions showed that the rate of gain and body weight up to weaning were affected by year, parity and birth type.

Kochapakdee et al. (2000) working on Native Thai and their crosses with Anglo Nubian goats showed that male kids grew significantly faster, compared with female kids (67.1 vs. 60.5 g/d) and single kids also grew significantly faster, compared to multiple kids (57.7 vs. 57.2 g/d). Thai native kids also had a lower pre-weaning growth rate than Anglo Nubian goats. Results of Osinowo et al. (1992) showed that pre-weaning average daily gain was significantly affected by parity, litter size and sex.

The study on comparative productivity of Thai native and crossbred goats by Surapol et al. (2000) found that under improved management crossbred goats grew faster and had higher mature body weight than native animals. Does and kids fed with concentrate and hay in the intensive system grew faster and were heavier than those raised on pasture and fed supplementary amounts of corn (McGowan and Leong, 1998). Similar findings were also reported by Sodiq et al. (2001) that under the village production system, the growth rate can be increased by improving feeding and housing management systems. Ogebe et al. (1995) studies on West African Dwarf goats concluded that a modification of the traditional system of management was essential in order to obtain steady and optimum growth.

Christopher (2001) reported that among all superior traits for goat meat production, heavier body weight and faster growing rates were the most notable. Jiabi et al. (2001) studied the improvement effect of crossbreeding Boer goats and Sichuan native goats and revealed that the crossbred F_1 goats grew faster than local breeds with the advantages of better meat production, great potential of improvement in production, good mating ability and significant hybrid vigor.

2.3 Survival Rate till Weaning (Pre-weaning Mortality)

High mortality of young stock is the major cause of low productivity (Awemu et al., 1999). The successful end of the reproductive process depends on the born animal surviving (Lindsay et al., 1982). Kid survival is important in a meat goat enterprise. Kid losses occur during 3 distinct periods of time: at birth, from birth to weaning, and from weaning to maturity or breeding age. The period from birth to weaning is the most critical (McGowan and Nurce, 2000).

It is common experience that multiple births in goats are associated with a high mortality rate (Devendra and Burns, 1983). The environmental factors exerted

significant influences on the pre-weaning mortality (Awemu et al.,1999). Survival rates of Black Bengal kids were affected by birth weight of kids and milk yield of dams. Higher survival rates were noticed for male kids. This is mainly due to significantly higher birth weight of male kids (Husain et al., 1994).

Birth weight of kids had a relationship with survivability during the pre-weaning period. Single kids always had a higher survival rate than twins and triplets. The effect of sex was significant with male kids having a higher survival rate than females (Husain et al., 1995). Mtenga et al. (1992) working on Small East African goats reported that twins exhibited a higher pre-weaning mortality rate than single animals (48.3% vs 38.5%). There was a tendency for the mortality rate to be higher for twins than for single births. Okello (1993) working with Mubende goats reported that the overall mortality rate till weaning was 17 percent and the mortality rate of twins was significantly higher than single animals.

Awemu et al. (2002) working on Red Sokoto goats found that mortality was significantly affected by the type of birth. Alexandre et al., (1999) reported that kids' pre-weaning mortality on Creole goat averages 13.6%, 60% of which occurred from birth to 15 days *post partum*. It increased with litter size and was 5% higher for males than for females. Madibela et al. (2002) found that survival rates were similar (91.9 vs 93.9) between multiples and singles in Tswana goats. The initial low birth weight of multiples was not of the magnitude that would predispose them to higher mortality. Survival rates and growth rates can be improved by supplementation.

Results of Husain et al. (1995) concluded that the effect of parity was significant but survivability increased gradually with the increase in the parity number having the highest survival rate in the 5^{th} parity. Awemu et al. (1999) reported that the mortality rate generally decreased with the increasing parities. This may be attributed to the physiological maturity of older does and their ability to provide enough milk for the kids. Other researchers, Steve and Marco (2001), reported that kid survival to 1 year was unrelated to maternal age (mean age was 7.9 $\pm$ 0.4 years for 49 females whose kid survived to 1 year, and 8.4 $\pm$ 0.4

years for 45 females whose kid died). The same results were also reported by Awemu et al. (2002) working on Red Sokoto goats who found that the mortality tended to decrease with birth weight, but decreased as parity increased. Ingo (2002) reported that the parity of dam was not found to have a significant effect on the mortality rate. This is in contrast with the findings of other studies, which identified the parity of the dam to be a significant source of variation in kid mortality (Wilson et al., 1985).

Awemu et al. (2002) reported that the mortality of Red Sokoto goats was significantly affected by birth weight. Other researchers reported that due to low birth weight and poor nutrition, the mortality rate is high (Banerjee and Banerjee, 2000). Mortality generally decreased as the birth weight of kids increased. Mortality tended to increase with a larger size litter (Awemu et al., 1999). Bradford et al. (1983) reported that the litter size affected survival mainly through its effect on birth weight. Lower birth weight and lack of husbandry knowledge were considered the main factors responsible for higher kid mortality (Husain et al., 1995).

Mtenga et al. (1992) working on Small East African goats reported that the lowest pre-weaning mortality rate occurred in animals with a birth weight greater than 2.6 kg. Birth weight had a significant effect on the mortality rate of kids, the mortality rate decreased with increasing birth weight. Results of Rattner et al. (1994) revealed that the combination of low birth weight with hybridization of the goat and ibex resulted in increased mortality. Other findings of Madibela et al. (2002) stated that the initial low birth weight of multiples was not of the magnitude that would predispose them to higher mortality. Survival rates can be improved by supplementations.

Steve and Marco (2001) found survival to weaning of mountain goat kids appeared higher for males (90%) than for females (78%), but survival to 1 year was 65% for both sexes. Overall kid survival was 70.5% to weaning and 60.3% to 1 year. Ingo (2002) reported that sex did not exert significant influences on kid survival. Alexandre et al. (1999) studies on Guadeloupean Creole goats reported that kids´ pre-weaning mortality averaged 13.6%, 60% of which

occurred from birth to 15 days post-partum. It increased with litter size and was 5% higher for males than females.

Results of Fuah et al. (1994) studies of local goats in West Timor reported that most kid mortality occurred between one to four weeks of age with 80% under 3 weeks of age. The higher kid mortality might be due to poor management of animal health practice. Ameh et al. (2002) studies on mortality in Sahelian goats showed that mortality was higher in kids (less than 6 months) than in adults. Gastrointestinal and respiratory diseases were the most common causes of mortality.

2.4 Kidding Interval and Gestation Period

The kidding interval is defined as the period of time in days between two consecutive kiddings of a dam (Steele, 1996). This trait gains importance when describing reproductive efficiency under tropical conditions, where goats breed all year round (Lindsay et al., 1982; Saithanoo and Norton, 1991). The number of parturitions during the lifetime of a goat is determined by longevity. The interval between kiddings is of great importance for the economics of production (Song et al., 2001). The interval between parturition and the first post partum oestrus is an important trait which contributes to the productive efficiency (Greyling, 2000).

Kidding interval and gestation length are traits influenced by genetic, environmental and management factors (Urdaneta et al., 2000). Kidding intervals have been reported to be affected by a number of environmental factors including parity, year and season of previous kidding (Awemu et al., 1999). Awemu et al. (2002) reported that kidding interval of Red Sokoto goats was significantly affected by parity. As parity increased, so kidding interval decreased. Ndlovu and Simela (1996) studies on smallholder East African goat herds in Zimbabwe found that the kidding intervals were 321 $\pm$ 23.6, 325 $\pm$ 30.9

and 259 ± 50.1 days for does kidding in the hot dry, hot wet and cool dry seasons, respectively.

Odubote's (2002) studies on West African Dwarf goats showed that the effect of parity and season was significant for the kidding interval, with the mean kidding interval being 275.68 ± 6.08 days. Christopher (2001) reported that the mean gestation length of the Boer goat was approximately 148 days. Does with multiple births tend to have a shorter gestation length with 1 to 2 days difference between twins and triplets.

The effect of birth type, age, sex and parity on gestation length and kidding interval of Boer and blended goats has been studied. In Boer goats Greyling (2000) reported that there was no significant difference in the gestation length between does bearing singletons or triplets and the season of mating had no significant effect on the gestation length. Das (1993) demonstrated that old does (3-4 years) tended to have lower kidding intervals than the younger (1-2 years) and older does (>5 years). This is probably due to the reproductive physiology function being more active in 3-4 years old does compared to lower activity in younger and older does. Amoah et al. (1996) reported that the gestation period decreased as the litter size of the doe increased (b = -0.92 d/kid) and increased slightly with increasing parity (b = 0.22 d/parity). The gestation period was significantly affected by breed, litter size and parity. Other researchers Wright and Wildeus (1996) reported that the litter size at birth affected litter birth, but not the gestation length on Myotonic, Pygmy and Spanish breeds.

Results of Odubote's (1990) studies on West African Dwarf goats demonstrated that the range and mean kidding interval were 187 to 478 days and 275.68 ± 6.08 days, respectively. The kidding interval was significantly affected by parity. There was a significant decrease in the kidding interval from the fifth parity. Akusu and Ajala (2000) reported that the mean gestation length of West African Dwarf goats was 144.9 days and was not significantly affected by season of birth. Does with single kids had a longer gestation than those with twins and triplets. The mean gestation length in dams giving birth to only female kids was

1.13 days longer than in does with only male kids. Results of Öztürk and Akta (1996) studies on Merino sheep showed that for triple births the gestation length (153.7 ± 0.73 days) was longer than for twin births (152.8 + 0.16), and twins were carried longer than single lambs (151.6 + 0.22 days). Heavier lambs had a longer gestation length.

The length of gestation in goats is fairly constant at 146 to 151 days (Ensminger and Parker, 1986). There was no significant difference in the post partum anoestrus interval for does giving birth to different numbers of offspring (Greyling, 1998, 2000). Results of Urdaneta et al. (2000) revealed that no significant breeding effect (between Alpine and Nubian goats) was found for the kidding interval, Alpine averaged 390.7 vs 414.4 days for the Nubian. Gestation length was 151.6 days for Alpine does and 149.2 days for Nubian does.

Greyling (2000) investigated reproductive traits in the Boer goat doe and showed that multiple births had no significant effect on the gestation length, the mean gestation length being 148.2 ± 3.7 days. The mean interval from partus to conception recorded was 62 ± 20.2 days. Results of Karua and Banda (1990) revealed that the sex of kids and the litter size did not affect the gestation length. Gestation length in dams kidding single kids (147.14 ± 2.86 days) was about the same as in dams kidding multiple kids (147.09 ± 3.05 days). Similarly, the gestation length in those kidding male kids (146.94 ± 2.7 days) was the same as those kidding female kids (147.34 ± 2.98 days).

Results of Galina et al. (1995) working with Mexican goats under various management systems showed that the interval between kidding was 347 days (±56 days) with the first time birth at about 14 months. Another researcher, Mellado et al. (2002) reported that the mean parturition interval of Nubian goats was 302 days. Alexandre et al. (1999) studies on Guadeloupean Creole goats reported that the mean kidding interval was 8.5 ± 1.2 months, with the age at first kidding averaging 17.2 ± 3.1 months.

The time between kiddings of local does under traditional systems in the Banyumas area was about 0.75 to 1.25 years (Sodiq et al., 1998). Song et al.

(2001) reported that the gestation period was 150.69 ± 6.14 days for Korean native does where parities had no significant effect on the gestation length. The mean interval between parturitions was 207.78 ± 1.72 days with parities, and birth type, having no significant effect on the kidding interval.

2.5 Doe Productivity Index

Reproductive performance is one of the main determinants of productivity of goats. This applies to breeding of animals for meat production (O`Shea, 1993). High reproduction rates are essential for profit in meat goat production (Ezekwe and Lovin, 1996). Much of the profit to be realized will depend on the frequency with which litters are produced, the size of litters and the survival to weaning of multiple litters (Wildeus, 2000). Reproductive efficiency contribution to net profit occurs not only by increasing the total population proportion that is producing and the number of animals for sale, but also by reducing non-productive life periods within the population (Pariacote, 1992).

Reproductive efficiency in does is characterized by the individual and compound parameters. These parameters can be measured and can be combined into an index of biological productivity (Steinbach, 1988). Several reproductive traits and the pre-weaning growth rate can be combined into an index (productivity index) to give a measure of productivity (Das, 1993; Gipson, 2000). In animals kept primarily for meat production, the reproduction rate is the single most important factor contributing to the efficiency of production (Luginbul, 2002).

Reproductive efficiency as such can be measured and expressed as the kidding rate, weaning rate, kidding interval, liveweight of kids born or weaned and the length of the reproductive cycle (Greyling, 1998). Offpring survival is one of the most important sources of variation in a lifetime reproductive success in mammals (Steve and Marco, 2001). Twinning percentage and kid survival are important components of profitability (Coffey, 2002).

The level of reproductive performance is dependent on the interaction of genetic and environmental factors (Greyling, 2000). Meat production in animals is affected by such variables as growth, weight at different ages, mortality, parturition interval, milk yield and mothering ability (Awemu et al., 2002). Reproductive traits of Nubian goats demonstrated that effects of sex and parity were significant on weight of kids produced at weaning/doe life time and litter weight at weaning (Marai et al., 2002). Due to the slow growth rates and long kidding intervals the flock productivity in terms of weaned live kid weight (kg) per doe per year was low (Ndlovu and Simela, 1996).

In order to optimize the reproductive potential of the goat, it is essential that a reproductive management programme be implemented that takes into account all the reproductive physiology aspects (Greyling, 2000). High rates of pre-weaning mortality in goats have been reported to be a major constraint on improving productivity in traditional husbandry systems (Devendra and Burns, 1983). High postnatal mortality indices rates have been associated with, among other factors, sex of kid, multiple birth, low birth weight and suboptimal feeding levels during gestation, parity and age of dam, low milk production, and season of birth (Rattner et al., 1994). Reproductive success may be positively correlated with maternal age. Kid production increased with age (specific maternal age), but decreased slightly after 9 years of age. It was indicated that the relationship between age and kid production was curvilinear (Steve and Marco, 2001).

Productivity index (kg/doe/year) for Red Sakoto goats in parity 1, 2, 3, 4, 5 and 6 were 20.9, 21.4, 22.5, 23.6, 27.9 and 33.4 kg, respectively (Awemu et al., 2002). Doe productivity index reported by Anggraeni et al. (1995) and Sodiq (2001) was 13.2 and 16.7 kg/doe/year, respectively. Awemu et al. (1999) reported that the parity and type of birth significantly influenced the productivity index. The effect of type of birth was highly substantial in goats, with quadruplets' births producing 32.8 kg more meat at weaning than single births.

Survival rates and growth rates were improved by supplementation, resulting in a higher productivity index. Where nutritional supplementation is introduced it is biologically sensible to encourage multiple births since the productivity index from the resultant twinning would double. The effect of the nutritional state on the reproductive and production performance was also reported by Rhind (1991) and Rook and Kopcha (2002). Similar findings were also reported by Madibela et al. (2002) working on Tswana goats clearly show that the potential of improving the feeding management on the productivity index.

2.6 Body Condition Score

The term body condition refers to fleshiness of an animal (Luginbuhl, 2002, Thompson and Meyer, 1994) and describes the degree of fatness (Mangione, 2002) or an index to the degree of fatness expressed in the anatomy of the animal that can be viewed by the human eye (GAN Lab, 2001). Condition scoring is a system of describing or classifying animals by differences in relative body fatness (Thomas and Kott, 2002, Skea, 1990). The advantage of a condition score measurement is that it is easy to learn, fast, simple, cheap, does not require specialized equipment and is sufficiently accurate for many research and management situations (Rutter et al., 2002), it is useful not only for research scientists but also for farmers and development planners (Nicholson and Butterworth, 1986; Cisse et al, 1990).

Steele (1996) stated that the body condition scoring is a method of assessing the body condition. Due to the fact that goats have very little body fat under the skin, this system really gives a good estimate of the goats` muscle cover. Santucii et al. (1991) reported that body condition scoring of goats is a measurable parameter and was regularly included in the research programmes of several countries. A system for giving a number or score to describe the degree of fatness was started in Australia and then widely accepted in the UK (Gatenby, 1991). The purpose of giving numbers to the condition is to allow a

statistical analysis of the data and to facilitate codification on computer files (Nicholson and Butterworth, 1986).

Several authors and researchers described the methods of allocating a score or index of body condition. The principle of the body condition scoring method, according to Santucii et al. (1991) is to use a scale from 0 to 5. The score is given to an animal obtained by palpation of 2 anatomical regions: the sternum and the lumbar vertebrae. A similar scale was also used by Gatenby (1991) for sheep, (score 0 = starving, score 1 = very thin, score 2 = thin, score 3 = moderate, score 4 = fat and score 5 = very fat), and by Steele (1996) for goats. The fingers and thumbs were used to feel three points on the goat´s back: spinous processes, transverse process and loin muscle. IBGA (2002) on the South African Boer Goat developed the scoring 0-50 consisting of emaciated (0-5), thin (5-10), somewhat thin (10-15), moderate (15-20), conditioned (15), fleshy (30-35), fat (35-40), extremely fat (40-45), grossly fat (45-50). A 1-5 scale score on the Sahel goats was used by Cisse et al. (1990).

Thompson and Meyer (1994) stated that scoring was based on the feeling of the level of muscle and fat deposition over and around the vertebrae in the loin region. The body condition in scoring of the sheep system used was based on the scale of 1 to 5. The five scores consist of: condition 1 (emaciated), condition 2 (thin), condition 3 (average), condition 4 (fat) and condition 5 (obese). Thomas and Kott (2002) developed body condition scores in the ewes ranging from 0 to 5, with 0 being a dead and a 5, a big fat animal. The scoring is based on feeling by hand in the loin region. Morrical (1986) under sheep management used five condition scores: condition score 1 (very thin), condition score 2 (thin), condition score 3 (average), condition score 4 (fat), and condition score 5 (very fat).

Luginbuhl (2002) on monitoring the body condition of meat goats used a 1 to 9 point graduated scale. Scale 1 to 3 is thin, 4 to 6 is moderate and fat is 7 –9 with the areas to be monitored: tail, head, pins, edge of loin, back bone, ribs, hocks, shoulder and longissimus dorsi. Cornell University (2002) reported that the live condition scores assigned in Australia are as follows: score 1 (covering over carcass site <0.16 inch, score 2 (covering over carcass site <0.25), score 3

(covering is <0.4 inch), score 4 (covering over carcass site is about a half inch) and score 5 (covering is more than 0.5 inch thick). The same model was also developed by Hinton (1993) for sheep in Australia. They used five scores, score 0 (not fat) to score 5 (very fat), and the condition score be translated into actual millimeters of fat at slaughter. Corner University (2002) developed the fat score for Alberta, Canada and rely more on feeling the spine and short ribs of the goat. They are as follows: very lean - body angular, lean – backbone raised and barely covered, medium – backbone slightly raised, fat- smooth rounded appearance.

Many researchers' studies on the relationship between the body condition score and adipose tissue weight, e.g., Poisot (1998) working on Creole goats, Branca and Casu (1987) working on Sardinian goats and Santucii et al. (1991) working on Corsian goats. Their research showed that the correlation coefficient between the value of body condition scoring and subcutaneous adipose tissue weight of goat was 0.84; 0.76 and 0.62 on Creole, Sardinian and Corsian goats, respectively. The correlation coefficient between the value of the body condition scoring and the internal adipose tissue weight of goat was 0.76 and 0.91 on Creole and Sardinian goats, respectively. Nicholson and Butterworth's (1986) studies on condition score of cattle at slaughter demonstrated that among animals of the same age and sex, live weights, carcass weights, and edible tissue yield were high correlated with condition score.

Aumont et al. (1994) studied the precision and accuracy of the scoring method of the body condition for Creole does. Their results showed that repeatability of the body condition scoring was 88% and reproducibility was 80%. The body condition scoring appeared as the best predictor of the total adipose tissue in an empty body weight and total adipose tissue of carcass.

Sodiq's (1997) studies in the Banyumas region of Indonesia found that there was a relationship between the value of the body condition scoring and the carcass weight on local goats. Most of the local goats under the village management systems have the score 1 (thin condition) and 2 (moderate condition) with the minimum score 0 and maximum score 5. Santucii et al.

(1991) reported that the body condition score was closely correlated with carcass fat contents (r = 0.91) in Sardinian goats. Sternal fat was correlated with the body condition score and the total quantity of visceral adipose tissues on Corsian, Sardinian and Creole goats.

Lawrence and Fowler (1997) indicated that the body condition scoring can be a very useful management aid in predicting body composition. Condition scoring were related to all carcass dimensions (Clemets et al., 1981). The relationship between body weight and condition score on the Rasa Arganesa breed was semilogarithmic, and that between carcass fat depots and condition score was logarithmic (Teixeira, 1989). The correlation of the body condition scores with body weight was also reported by Sanson et al. (1993) who reported that body weight and condition scores were highly correlated (0.89) and an analysis indicated that each unit increase in condition scores resulted in an increase of 5.1 kg in body weight.

The applying of the body condition score has been reported by some researchers. Mangione (2002) reported that the body condition scoring system in beef cattle can improve herd health, feed-resources management, reproductive performance and weaning weight. All these benefits associated with the body condition scoring can improve profit. Other researchers stated that body condition scoring is most useful at a critical period such as prior to breeding, weaning time and near calving Gill (2002) and an indicator to predict herd fertility and to determine the feeding programme (Rutter et al., 2002). Thomson and Meyer (1994) reported that body condition scoring can be used to evaluate the status of the animal and a potential tool for producers to increase production efficiency.

Thomas and Kott (2002) stated that the use of both body weight and body condition scoring can help producers make important feed management decisions. Ferguson (1996) implemented a body condition scoring system in dairy cattle. Otto et al. (1991) examined carcass composition in relation to body condition scoring in cows. They found that one unit change in condition was equivalent to 56 kg of body weight. Total carcass dry matter increased 7.23

percent for each unit increased in the body condition score. Their work demonstrated that the body condition score correlated with body composition and was a useful tool in the field to assess carcass composition. Results of Aumont et al. (1994) studies on Creole goats indicated that composition of muscle and adipose tissue was significantly influenced by body condition scoring.

2.7 Leg Conformation Index

Conformation can be defined as the visual shape of the body of an animal, particularly the relationship between the skeleton and the covering of muscle and fat (Alliston, 1983). Conformation describes how an animal is constructed or put together (Owen, 2002) and refers to the physical form of an animal, its shape and arrangement of parts (Taylor, 1995). Live animal conformation in slaughter stock defined as the thickness of muscle and fat in relation to skeletal size. Carcass conformation measured by the relationship between length of leg relative to carcass weight (Butterfield, 1988). Conformation is the manner of formation of the carcass with particular reference to the relative development of the muscular and skeletal system. Muscling in the leg may be evaluated in term of its conformation in an unribbed carcass to obtain an assessment of overall muscling. Weight and frame size indicate both the growability and the relative composition of the animal (Boggs and Merkel, 1993).

Gebrelul's (2002) studies on selection and evaluation of live meat goats and grade standards stated that several characteristics including conformation, general appearance, muscling and condition should be looked at when evaluating a live animal for slaughter purposes. Edmudo et al. (2002) stated that judging meat goats should be evaluated on type and market desirability, and refer to frame size, and skeleton correctness. Meat production potential can be estimated from growth capacity (mature weight), growth intensity (average daily gain), and carcass quality of weaned male kids and lambs (Steinbach, 1988).

The circle of leg (circle of the *vastus lateralis*, in cm) divided by length leg (length between *patella* to *tarsus*, in cm) indicated the leg conformation index (Pulungan, 1983). Rismaniah et al. (1990) working in the Tegal Subdistrict in Indonesia concluded that both length and circle of leg can be used to assess the body weight on post weaning goats. The average lengths of leg of female and male post weaning goats were 14.29 $\pm$ 1.84 cm (ranged 12-18 cm) and 14.39 $\pm$ 1.58 cm (ranged 12.5-18 cm), respectively. The average circumferences of leg of female and male post weaning goats were 24.32 $\pm$ 1.84 cm (ranged 17-28.5 cm) and 25.10 $\pm$ 1.58 cm (ranged 12.5-18 cm), respectively.

Some researchers on evaluation of meat goats and sheep investigated both the conformation and leg length; Stanford et al. (1997) studies on lamb carcass, Wolf et al. (2001) studies on Texel lamb, Sanz et al. (2002) studies on kids goats and lamb, VDACS (2000) studies on yield grade and quality grades for lamb carcass, and Tatum et al. (1992) studies on leg conformation as factors considered determining yield grades for lamb carcass. Soedjadi et al. (1989) reported that leg conformation index of post weaning goats with the body weight (9.4 till 20.8 kg) in the Cilacap region ranged from 84.6 till 133.3, with the average 104.77 $\pm$ 11.13.

Sodiq and Soedjadi (1998) and Haryanto et al. (1990) reported that the method of palpation on the leg region of the cattle, goats and sheep is very commonly used by butchers in abattoirs and livestock markets. The methods were used to classify the grade (thin-fat) and also to predict the body and carcass weight of certain livestock. Purnama and Sodiq's (1998) studies on local goats in Banyumas` slaughtering houses (abattoir) found a relationship between leg conformation and carcass weight.

3 METHODOLOGY

3.1 Study Location

This study was carried out by on-farm research commencing in December 1999 and finishing in July 2002, located in the Grobogan and Purworejo region, Central Java, Indonesia. Indonesia is situated roughly between 6° to 11° north latitudes and 95° and 141° east longitudes. The temperature in Indonesia, as it is a tropical country, stays within a constant range, differing only a few degrees between the hot and cool months: 23-31°C daily in the low plains and 18-27 in the inferior plateau. Indonesia consists of over 17.000 islands spread around 5600 km from east to west and 1600 km from north to south. The land area covers 1.8 million km^2 surrounded by sea. Java Island represents only 6-7% of the total land area, however, it is the most densely populated island in terms of both human and animal populations.

3.2 Animal Types

The research concentrates on two breeds of goat in Indonesia, namely: the Kacang goat (Figure 1 and 2) and the Peranakan Etawah goat (Figure 3 and 4). The Kacang goat is a local (indigenous) breed of goat found in Indonesia. The Peranakan Etawah goat descended originally from crossings between the Kacang goat with Etawah (Jamnapari) goat.

Figure 1: Doe of Kacang goat

Figure 2: Kid of Kacang goat

Figure 3: Doe of Peranakan Etawah goat

Figure 4: Kid of Peranakan Etawah goat

3.3 Data Collection and Procedures

On-farm research conducted under smallholders (private farms) involved 480 does and 2000 kids of Peranakan Etawah and Kacang goats. The study commenced with primary visits to identify herd and individual female goats. The herds were monitored (visited) regularly. Each herd was visited at the commencement of the study and does were identified with a neckband tag. The following data were collected during the initial visits: (1) Herd details including numbers and breeds, type of operation and management practice; (2) individual female goat details including breed, age and parity. Herd owners and village staff (or head of cooperation and extension worker) were issued with scales to help record birth and doe weight. Breeding record cards were also prepared, so that they could help to collect data related to date of mating, kidding date and sex of kids. Some equipment required in this work:was livestock record (form), breeding record card, identification (marking) tool, weight scale (balance) and neckband tag.

In this research, reproduction and production traits of Kacang and Peranakan Etawah goats were studied;

(a) Reproduction traits: (1) type of birth, (2) litter weight at birth, (3) litter weight at weaning, (4) survival rate till weaning, (5) kidding interval, and (6) doe productivity.
(b) Production traits: (1) average birth weight, (2) average weaning weight, (3) average growth rate till weaning, (4) body condition score, and (5) leg conformation.

Some factors affecting reproduction and production traits of Kacang and Peranakan Etawah goats were examined;

(a) Reproduction factors: parity, type of birth, litter weight at birth and litter weight at weaning.
(b) Production factors: parity, type of birth, sex and birth weight.

Some definitions (terminology) used in this study;

1) Type of birth: single, twin (twin) or triplet.
2) Litter size (head): the number of kids born to each doe at each birth
3) Birth weight (kg): the weight of each kid at birth, kids were weighed immediately after birth using scales to the nearest 0.1 kg.
4) Litter weight at birth (kg): the weight of total kids born.
5) Weaning weight (kg): the weight of each kid at weaning, kids were weighed at weaning time (120 days of age) using scales to the nearest 0.1 kg.
6) Growth rates of kids (gram/day): derived by taking the difference in weight within the period and dividing it by the time interval in days (analysed from birth until 4 months).
7) Survival rate till weaning (percentage weaning live) (%): the total number of live kids at weaning divided by the total number of kids born (litter size).
8) Kidding interval (year): number of days between two successive kiddings.
9) Parity: defined based on the number of times the does had kidded (parities 1, 2, 3, 4, 5, 6).
10) Doe Productivity index (kg/doe/year): the weight of kids weaned by each doe during a year. This is to express the ability of the goat for meat production.

$$\textit{Doe productivity index (kg/doe/year)} = \frac{\textit{Number of kids at weaning}}{\textit{Kidding interval (in year)}} \; X \; \textit{Weaning weight}$$

11) Body Condition Scoring (score 0, 1, 2, 3, 4, 5): classifying the body condition of goat by assessing the physical characteristics. The scoring system is summarized in Table 1.
12) Leg conformation (leg conformation index): the circumference of *vastus lateralis* (in cm) divided by the length between *patella* to *tarsus* (in cm).
13) **S**mall **R**uminant **U**nit (SRU): livestock unit for small ruminant, doe (more than 12 months) = **1 SRU**, young (4-12 months) = **0.7 SRU**, kid (less than 4 months) = **0.25 SRU**.

Table 1: Body condition scoring of goat *(Steele, 1996)*

Condition score	**Description**
Score 0	Extremely thin; nearly dead; no muscle between skin and bone
Score 1	The spinous processes are sharp and stick up Transverse processes are sharp and fingers can easily be pushed under their ends There is a hollow between the end of each process Loin muscles are shallow
Score 2	The spinous processes feel less sharp; fingers can be pushed under the transverse processes with a little pressure Loin muscle are of moderate depth
Score 3	The spinous processes only stick up very slightly; they are smooth and rounded Firm pressure is needed to detect each one separately Transverse processes are smooth and well covered; firm pressure is required to push fingers under the ends Loin muscles are full
Score 4	Spinous processes can just be felt, with firm pressure, as a hard line and are level with the flesh on either side The ends of the transverse processes cannot be felt Loin muscles are full
Score 5	Spinous processes cannot be felt at all Transverse processes cannot be felt Loin muscles are very fully developed

*Notes : The **spinous processes** are the bony points rising from the backbone
The **transverse processes** are the horizontal bones coming out from either side of the backbone
The **eye muscle** is the muscle along each side of the backbone

3.4 Statistical Data Analysis

All information obtained was used to examine the reproduction and production traits. Various models were developed for these variables. The type of birth was assessed by parity affect. For litter weight at birth, the variables of parity and birth type were evaluated. For survival rate till weaning, kidding interval, and doe productivity, the following effects were assessed: parity, birth type, and litter at weaning. The following effects: parity, birth type, sex, and birth weight were used to assess the production traits (weaning weight, growth rate till weaning, body scoring, and leg conformation). For birth weight, the following effects: parity, birth type, and sex were evaluated (see the matrix on Table 2 and 3). The number of livestock in a flock (converted in **S**mall **R**uminant **U**nit) was used as a co-variate.

The data were analysed statistically according to the analysis of variance procedure using the General Linear Model (GLM) of Statistical Product and Service Solution software (SPSS Inc., 1998). Duncan's multiple range and Tukey's honestly significant difference test were used to identify significant differences. SigmaPlot 4.0 for Windows software (SPSS Inc., 1997) was used to produce the exact graphs that represent reproduction and production traits under certain factors according to the results of statistical analysis.

The linear regression on litter weight at birth was calculated to access the litter weight at weaning. The linear regression on litter weight at weaning was calculated to predict the survival rate till weaning, kidding interval and doe productivity. The linear regression on birth weight of kid was also calculated to predict some traits of kid production: weaning weight, growth rate till weaning, condition scoring and leg conformation.

Table 2: Matrix of factors affecting reproduction traits under study

Trait under study	Reproduction factor			
	Parity	Type of birth	Litter weight at birth	Litter weight at weaning
Type of birth	X			
Litter weight at birth	X	X		
Litter weight at weaning	X	X	X	
Survival rate till weaning	X	X		X
Kidding interval	X	X		X
Doe productivity index	X	X		X

Table 3: Matrix of factors affecting productivity traits under study

Trait under study	Production factor			
	Parity	Type of birth	Sex	Birth weight
Birth weight	X	X	X	
Weaning weight	X	X	X	X
Growth rate till weaning	X	X	X	X
Condition scoring	X	X	X	X
Leg conformation	X	X	X	X

In detail (each variable investigated) the models were used in this study:

(a) Variables investigated on does

Type of birth

$$Y_{ij} = \mu + P_i + \text{co-variate} + e_{ij}$$

where

Y_i = observation of an individual animal (i-th individual)

μ = the overall mean for the trait investigated

P_i = the effect due to the i-th parity number (i = 1, 2, 3, 4, 5, 6)

co-variate = number of livestock in a flock (**S**mall **R**uminant **U**nit)

e_{ij} = random error particularly to ij-th observation

Litter weight at birth

$$Y_{ijk} = \mu + P_i + T_j + \text{co-variate} + (PT)_{ij} + e_{ijk}$$

where

Y_{ijk} = observation of an individual animal (ijk- th individual)

μ = the overall mean for the trait investigated

P_i = the effect due to the i-th parity number (i = 1, 2, 3, 4, 5, 6)

T_j = the effect due to the j-th type of birth (j = 1, 2, 3)

co-variate = number of livestock in a flock (**S**mall **R**uminant **U**nit)

$(PT)_{ij}$ = the effect due to the interaction between parity and birth type

e_{ijk} = random error particularly to ijk-th observation

Litter weight at weaning

$$Y_{ijk} = \mu + P_i + T_j + bXLB_{ijk} + \text{co-variate} + (PT)_{ij} + e_{ijk}$$

where

Y_{ijk} = observation of an individual animal (ijk th individual)

μ = the overall mean for the trait investigated

P_i = the effect due to the i-th parity number (i = 1, 2, 3, 4, 5, 6)

T_j = the effect due to the j-th type of birth (j = 1, 2, 3)

$bXLB_{ijk}$ = the linear regression coefficient of the observation of the ijk-th kidding difficulties (or litter weight at weaning) on litter weight at birth

co-variate = number of livestock in a flock (**S**mall **R**uminant **U**nit)

$(PT)_{ij}$ = the effect due to the interaction between parity and birth type

e_{ijk} = random error particularly to ijk-th observation

Survival rate till weaning, kidding interval, doe productivity index

$$Y_{ijk} = \mu + P_i + T_j + bXLW_{ijk} + \text{co-variate} + (PT)_{ij} + e_{ijk}$$

where

Y_{ijk} = observation of an individual animal (ijk th individual)

μ = the overall mean for the trait investigated

P_i = the effect due to the i-th parity number (i = 1, 2, 3, 4, 5, 6)

T_j = the effect due to the j-th type of birth (j = 1, 2, 3)

$bXLW_{ijk}$ = the linear regression coefficient of the observation of the ijk-th survival rate till weaning (or kidding interval or doe reproduction index or doe productivity index) on litter weight at weaning

co-variate = number of livestock in a flock (**S**mall **R**uminant **U**nit)

$(PT)_{ij}$ = the effect due to the interaction between parity and birth type

e_{ijk} = random error particularly to ijk-th observation

(b) Variables investigated on kids

Birth weight

$$Y_{ijkl} = \mu + P_i + T_j + S_k + \text{co-variate} + (PT)_{ij} + (PS)_{ik} + (TS)_{jk} + e_{ijkl}$$

where

Y_{ijkl} = observation of an individual animal (ijkl th individual)

μ = the overall mean for the trait investigated

P_i = the effect due to the i-th parity number (i = 1, 2, 3, 4, 5, 6)

T_j = the effect due to the j-th type of birth (j = 1, 2, 3)

S_k = the effect due to the k-th sex (k = 1, 2)

co-variate = number of livestock in a flock (**S**mall **R**uminant **U**nit)

$(PT)_{ij}$ = the effect due to the interaction between parity and type of

$(PS)_{ik}$ = birth

$(TS)_{ik}$ = the effect due to the interaction between parity and sex

e_{ijkl} = the effect due to the interaction between type of birth and sex

random error particularly to ijkl-th observation

Weaning weight, Growth rate till weaning, Condition scoring, and Leg conformation index

$$Y_{ijkl} = \mu + P_i + T_j + S_k + bXLB_{ijkl} + \text{co-variate} + (PT)_{ij} + (PS)_{ik} + (TS)_{jk} + e_{ijkl}$$

where

Y_{ijkl} = observation of an individual animal (ijkl th individual)

μ = the overall mean for the trait investigated

P_i = the effect due to the i-th parity number (i = 1, 2, 3, 4, 5, 6)

T_j = the effect due to the j-th type of birth (j = 1, 2, 3)

S_k = the effect due to the k-th sex (k = 1, 2)

$bXLB_{ijkl}$ = the linear regression coefficient of the observation of the ijkl-th weaning weight (or growth rate till weaning, condition scoring, leg conformation) on birth weight

co-variate = number of livestock in a flock (**S**mall **R**uminant **U**nit)

$(PT)_{ij}$ = the effect due to the interaction between parity and birth type

$(PS)_{ik}$ = the effect due to the interaction between parity and sex

$(TS)_{ik}$ = the effect due to the interaction between type of birth and sex

e_{ijkl} = random error particularly to ijkl-th observation

The number of livestock in a flock (converted in **S**mall **R**uminant **U**nit) as a source of variance for all traits in this study was absorbed in the calculation of statistical analysis.

4 RESULTS

4.1 Reproduction Traits of Kacang and Peranakan Etawah Does

4.1.1 Type of Birth

The least squares analysis of variance on type of birth (litter size) of Kacang and Peranakan Etawah goat is presented in Table 4. The table shows that the effect of parity on the type of birth of both breeds was significant ($P \leq 0.01$).

Table 4: Least squares analysis of variance for type of birth of Kacang and Peranakan Etawah goats

Source of variance	Kacang goat		Peranakan Etawah goat	
	d.f.	Mean Square	d.f.	Mean Square
Parity	5	2.40**	4	1.66**
Residual	167	0.43	184	0.31

** = $P \leq 0.01$; * = $P \leq 0.05$ and n.s. = not significant ($P > 0.05$)

Least squares means of factors affecting type of birth of Kacang and Peranakan Etawah goats are presented in Figure 5. The figure shows that the average litter sizes of both breeds gradually tend to increase with the advance in parity up to the 4th parity and then slightly decreased in the 5th parity.

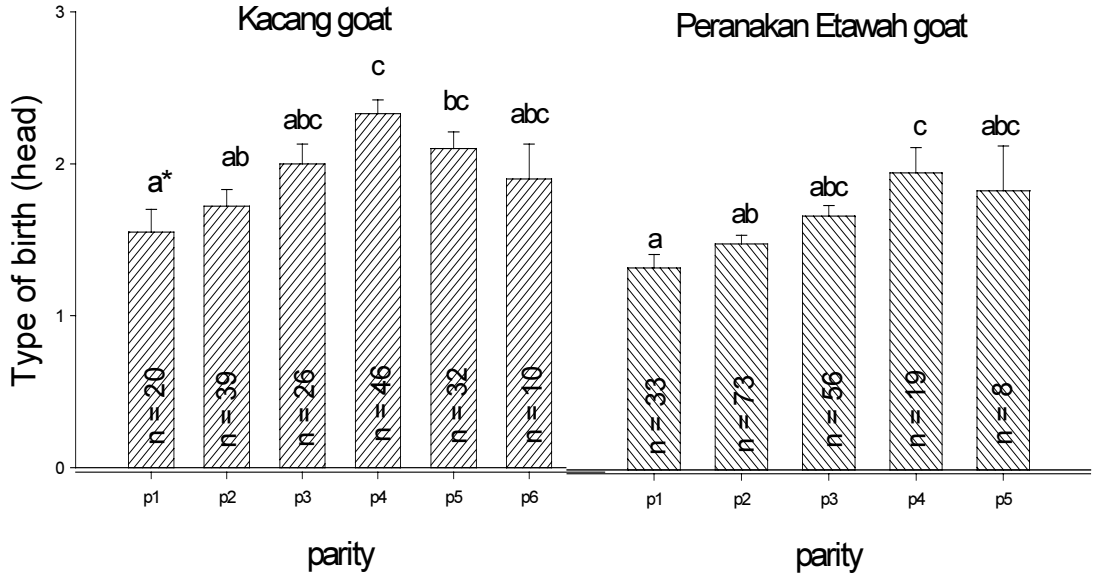

Figure 5: Average litter size of Kacang and Peranakan Etawah goats at different parities.
**Means, within the same classification followed by different letters are significantly different (P≤0.05), otherwise they are not.*
n = number of does

4.1.2 Litter Weight at Birth

The least squares analysis of variance on litter weight at birth of Kacang and Peranakan Etawah goat are presented in Table 5. The table shows that the effect of interaction between parity and type of birth on litter weight at birth of both breeds was not significant (P>0.05). Effect of parity and type of birth on litter weight at birth of both breeds was significant (P≤0.01).

Table 5: Least squares analysis of variance for litter weight at birth of Kacang and Peranakan Etawah goats

Source of variance	Kacang goat			Peranakan Etawah goat		
	d.f.	Mean Square		d.f.	Mean Square	
Parity	5	1.60	**	4	9.63	**
Type of birth	2	78.81	**	2	95.69	**
Parity X Type of birth	10	0.46	n.s.	6	1.96	n.s.
Residual	154	0.11		175	0.96	

** = P≤0.01; * = P≤0.05 and n.s. = not significant (P>0.05)

The least squares means of factors affecting litter weight at birth on Kacang and Peranakan Etawah goats are presented in Table 6.

Table 6: Least squares means ± standard errors of factors affecting litter weight at birth of Kacang and Peranakan Etawah goats

Factors	Kacang goat			Peranakan Etawah goat		
	No.	Mean ± S.E.		No.	Mean ± S.E.	
Parity:						
Parity 1	20	2.91 ± 0.26	a	33	3.75 ± 0.21	a
Parity 2	39	3.35 ± 0.20	ab	73	5.00 ± 0.19	ab
Parity 3	26	4.05 ± 0.23	bcd	56	5.84 ± 0.24	c
Parity 4	46	4.94 ± 0.18	d	19	6.97 ± 0.73	c
Parity 5	32	4.36 ± 0.18	cd	8	5.48 ± 0.14	abc
Parity 6	10	3.48 ± 0.26	abc			
Type of birth:						
Single	45	2.15 ± 0.05	a	82	3.50 ± 0.08	a
Double	87	4.09 ± 0.04	b	98	6.38 ± 0.12	b
Triplet	41	5.85 ± 0.08	c	9	8.80 ± 0.41	c

Means, within the same classification followed by different letters are significantly different (P≤0.05), otherwise they are not

Table 6 shows that the average litter weight at birth of Kacang and Peranakan Etawah goats increased with the advance in parity up to the 4th parity and slightly decreased thereafter. Average litter weight at birth of both breeds increased progressively with the advance in type of birth.

4.1.3 Litter Weight at Weaning

The least squares analysis of variance on litter weight at weaning of Kacang and Peranakan Etawah goat are presented in Table 7. The table shows that the effect of interaction between parity and type of birth on litter weight at weaning of both breeds was not significant (P>0.05). The effect of parity and type of birth on litter weight at weaning of both breeds was significant (P≤0.01). The regression of litter weight at birth on litter weight at weaning was significant (P≤0.01).

Table 7: Least squares analysis of variance for litter weight at weaning of Kacang and Peranakan Etawah goats

Source of variance	Kacang goat			Peranakan Etawah goat		
	d.f.	Mean Square		d.f.	Mean Square	
Parity	5	25.75	**	4	118.42	**
Type of birth	2	12.56	*	2	366.96	**
Parity X Type of birth	10	11.69	n.s.	6	74.23	n.s.
Regression on litter weight at birth	1	148.20	**	1	122.38	**
Residual	153	9.39		174	41.89	

** = P≤0.01; * = P≤0.05 and n.s. = not significant (P>0.05)

The least squares means of factors affecting litter weight at weaning on Kacang and Peranakan Etawah goats are presented in Table 8.

Table 8: Least squares means ± standard errors of factors affecting litter weight at weaning of Kacang and Peranakan Etawah goats

Factors	Kacang goat		Peranakan Etawah goat	
	No.	Mean ± S.E.	No.	Mean ± S.E.
Parity:				
Parity 1	20	13.04 ± 1.05 [a]	33	20.23 ± 1.12 [a]
Parity 2	39	15.64 ± 0.90 [ab]	73	24.81 ± 1.01 [ab]
Parity 3	26	19.08 ± 1.16 [b]	56	28.90 ± 1.18 [bc]
Parity 4	46	23.60 ± 0.95 [c]	19	33.46 ± 2.44 [c]
Parity 5	32	20.56 ± 1.11 [bc]	8	27.86 ± 3.78 [abc]
Parity 6	10	14.94 ± 1.70 [ab]		
Type of birth:				
Single	45	10.50 ± 0.19 [a]	82	19.22 ± 0.24 [a]
Double	87	19.13 ± 0.38 [b]	98	30.84 ± 0.91 [b]
Triplet	41	27.02 ± 0.82 [c]	9	39.71 ± 2.59 [c]
Regression on litter weight at birth		4.4796 ± 0.1745		3.3728 ± 0.2637

Means, within the same classification followed by different letters are significantly different ($P \leq 0.05$), otherwise they are not

Results presented in Table 8 show that average litter weight at weaning of both Kacang and Peranakan Etawah goats increased with the advance in parity up to the 4th parity and slightly decreased thereafter. Average litter weight at weaning of both breeds increased progressively with the advance in type of birth. The table also revealed that for each 1 gram increase in litter weight at birth there is an increase of 4.48 and 3.37 gram litter weight at weaning of Kacang and Peranakan Etawah goats, respectively.

4.1.4 Survival Rate till Weaning

The least squares analysis of variance on survival rate till weaning of Kacang and Peranakan Etawah goats is presented in Table 9. The table shows that the effect of interaction between parity and type of birth on survival rate till weaning of both breeds was not significant (P>0.05). The effect of type of birth on survival rate till weaning of both breeds was significant (P≤0.01). Effect of parity on survival rate till weaning of the Kacang goat was significant (P≤0.01), but of the Peranakan Etawah goats was not significant (P>0.05).

Table 9: Least squares analysis of variance for survival rate till weaning of Kacang and Peranakan Etawah goats

Source of variance	Kacang goat			Peranakan Etawah goat		
	d.f.	Mean Square		d.f.	Mean Square	
Parity	5	194.79	**	4	45.67	n.s.
Type of birth	2	7734.12	**	2	12390.14	**
Parity X Type of birth	10	34.44	n.s.	6	9.43	n.s.
Regression on litter weight at weaning	1	14390.05	**	1	36151.07	**
Residual	153	43.64		174	53.60	

** = P≤0.01; * = P≤0.05 and n.s. = not significant (P>0.05)

The least squares means of factors affecting survival rate till weaning of Kacang and Peranakan Etawah goats are presented in Table 10. Table 10 shows that the average survival rate till weaning of Kacang and Peranakan Etawah goats increased with the advance in parity up to the 4th parity and then slightly decreased. The average survival rate till weaning of both breeds decreased progressively with the advance in the type of birth.

Table 10: Least squares means ± standard errors of factors affecting survival rate till weaning of Kacang and Peranakan Etawah goat

Factors	Kacang goat		Peranakan Etawah goat	
	No.	Mean ± S.E.	No.	Mean ± S.E.
Parity:				
Parity 1	20	94.17 ± 3.26 [a]	33	89.40 ± 3.61 [a]
Parity 2	39	95.72 ± 2.09 [a]	73	91.78 ± 2.19 [ab]
Parity 3	26	97.22 ± 1.97 [a]	56	93.16 ± 2.28 [b]
Parity 4	46	97.29 ± 1.56 [a]	19	93.86 ± 3.43 [b]
Parity 5	32	96.24 ± 2.15 [a]	8	91.67 ± 5.45 [ab]
Parity 6	10	91.67 ± 5.69 [b]		
Type of birth:				
Single	45	100.00 ± 0.00 [a]	82	100.00 ± 0.00 [a]
Double	87	95.98 ± 1.47 [b]	98	86.22 ± 2.27 [b]
Triplet	41	91.87 ± 2.26 [c]	9	81.48 ± 5.86 [b]
Regression on litter weight at weaning		0.3919 ± 0.1332		0.6433 ± 0.1324

Means, within the same classification followed by different letters are significantly different ($P \leq 0.05$), otherwise they are not

The result also demonstrated that survival rate till weaning of Kacang and Peranakan Etawah goats was significantly affected by litter weight at weaning. The result indicated that for each 1 gram increase in litter weight at weaning there is an increase of 0.39 and 0.64 percent survival rate till weaning of Kacang and Peranakan Etawah goats, respectively.

4.1.5 Kidding Interval

The least squares analysis of variance on kidding interval of Kacang and Peranakan Etawah goat is presented in Table 11. The table shows that effect of interaction between parity and type of birth factors on the kidding interval was not significant (P>0.05). The effect of parity and type of birth on kidding interval of both breeds was significant (P≤0.01). The effect of litter weight at weaning on the kidding interval of Kacang and Peranakan Etawah goats was insignificant (P<0.05).

Table 11: Least squares analysis of variance for kidding interval of Kacang and Peranakan Etawah goats

Source of variance	Kacang goat			Peranakan Etawah goat		
	d.f.	Mean Square		d.f.	Mean Square	
Parity	5	6562.77	**	4	2354.02	**
Type of birth	2	1817.13	**	2	10806.93	**
Parity X Type of birth	10	98.21	n.s.	6	179.27	n.s.
Regression on litter weight at weaning	1	141.09	n.s.	1	676.83	n.s.
Residual	153	287.95		174	5.39.18	

** = P≤0.01; * = P≤0.05 and n.s. = not significant (P>0.05)

The least squares means of factors affecting kidding interval on Kacang and Peranakan Etawah goats are presented in Table 12. The table shows that the average kidding interval of both breeds extended with the advance in parity up to the 4th parity and slightly shortened thereafter. The average kidding interval of both breeds shortened progressively with the advance in type of birth.

Table 12: Least squares means ± standard errors of factors affecting kidding interval of Kacang and Peranakan Etawah goats

Factors	Kacang goat		Peranakan Etawah goat	
	No.	Mean ± S.E.	No.	Mean ± S.E.
Parity:				
Parity 1	20	271.75 ± 3.50 [a]	33	334.48 ± 5.57 [a]
Parity 2	39	262.10 ± 3.22 [a]	73	312.21 ± 3.46 [b]
Parity 3	26	242.83 ± 4.18 [b]	56	301.43 ± 3.83 [b]
Parity 4	46	217.21 ± 2.56 [c]	19	277.95 ± 7.69 [c]
Parity 5	32	222.45 ± 2.23 [bc]	8	290.75 ± 11.22 [bc]
Parity 6	10	239.60 ± 6.66 [b]		
Type of birth:				
Single	45	261.58 ± 3.40 [a]	82	333.67 ± 2.84 [a]
Double	87	237.99 ± 2.61 [b]	98	292.48 ± 2.38 [b]
Triplet	41	221.90 ± 3.35 [c]	9	254.67 ± 7.48 [c]
Regression on litter weight at weaning		- 2.1215 ± 0.2549		- 2.0253 ± 0.2181

Means, within the same classification followed by different letters are significantly different ($P \leq 0.05$), otherwise they are not

4.1.6 Doe Productivity Index

The least squares analysis of variance on doe productivity index (kg/doe/year) of Kacang and Peranakan Etawah goat is presented in Table 13. The table shows that effect of interaction between parity and type of birth factors on doe productivity index of both breeds was not significant ($P>0.05$). Effect of parity and type of birth on doe productivity index of both breeds was significant ($P \leq 0.01$). The regression on litter weight at weaning on doe productivity of both breeds was significant ($P \leq 0.01$).

Table 13: Least squares analysis of variance for doe productivity index of Kacang and Peranakan Etawah goats

Source of variance	Kacang goat		Peranakan Etawah goat	
	d.f.	Mean Square	d.f.	Mean Square
Parity	5	91.58 **	4	18.10 **
Type of birth	2	24.79 **	2	148.77 **
Parity X Type of birth	10	7.83 n.s.	6	2.61 n.s.
Regression on litter weight at weaning	1	3692.05 **	1	12111.82 **
Residual	153	4.87	174	7.39

** = P≤0.01; * = P≤0.05 and n.s. = not significant (P>0.05)

The least squares means of factors affecting doe productivity index of Kacang and Peranakan Etawah goats are shown in Figure 6 and 7. Figure 6 shows that the average doe productivity index of both breeds increased with the advance in parity up to the 4th parity and slightly decreased thereafter. Figure 7 shows that the average doe productivity index of both breeds increased progressively with the advance in type of birth.

The result also demonstrated that doe productivity index of Kacang and Peranakan Etawah goats was significantly affected by litter weight at weaning. The result indicated that for each 1 kg increase in litter weight at weaning there is an increase of 1.806 and 1.442 kg/doe/year doe productivity index of Kacang and Peranakan Etawah goats, respectively.

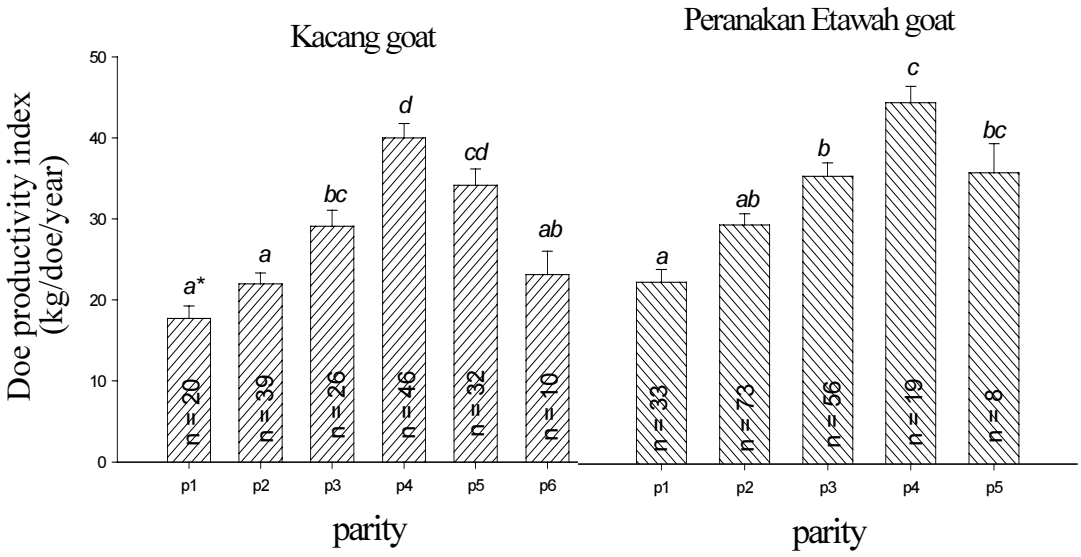

Figure 6: Average doe productivity index of Kacang and Peranakan Etawah goats at different parities

**Means, within the same classification followed by different letters are significantly different (P≤0.05), otherwise they are not.*

n = number of does

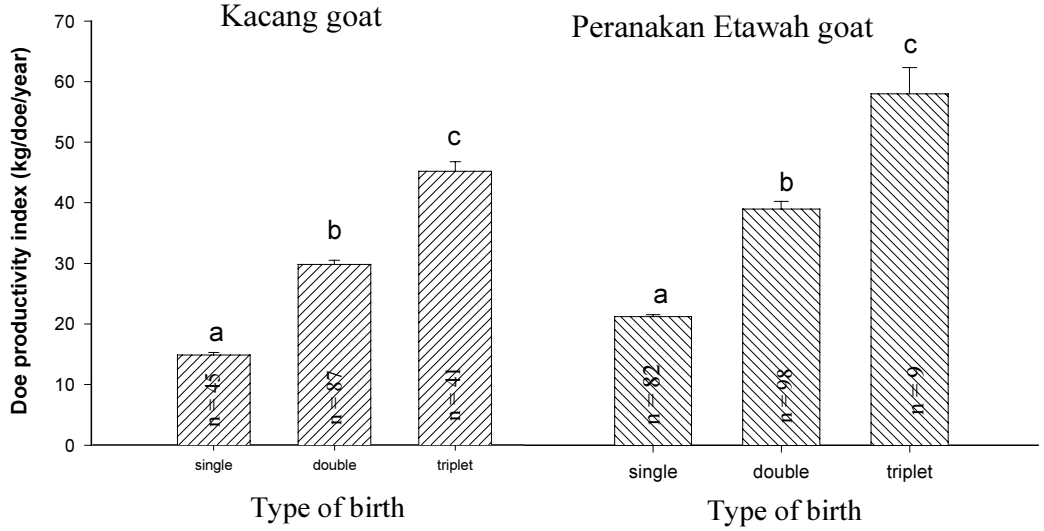

Figure 7: Average doe productivity index of Kacang and Peranakan Etawah goats at different types of birth.

**Means, within the same classification followed by different letters are significantly different (P≤0.05), otherwise they are not.*

n = number of does

4.2 Production Traits of Kacang and Peranakan Etawah Kids

4.2.1 Birth Weight

The least squares analysis of variance for birth weight of Kacang and Peranakan Etawah goat is presented in Table 14. The table shows that effect of interaction among parity, type of birth and sex, the effect of interaction between parity and type of birth and interaction between type of birth and sex on birth weight of both breeds were not significant (P>0.05). The effect of interaction between parity and sex factors on birth weight of Kacang goat was significant (P≤0.01), however the effect was not significant (P>0.05) on birth weight of the Peranakan Etawah goat. The effect of parity, sex and type of birth on birth weight of both breeds was significant (P≤0.01).

Table 14: Least squares analysis of variance for birth weight of Kacang and Peranakan Etawah goats

Source of variance	Kacang goat			Peranakan Etawah goat		
	d.f.	Mean Square		d.f.	Mean Square	
Parity	6	0.70	**	6	5.67	**
Type of birth	2	0.66	**	2	3.48	**
Sex	1	2.87	**	1	0.73	*
Parity X Type of birth	12	0.03	n.s.	7	0.19	n.s.
Parity X Sex	6	0.08	**	6	0.11	n.s
Type of birth X Sex	2	0.01	n.s.	2	0.10	n.s.
Parity X Type of birth X Sex	12	0.04	n.s.	7	0.20	n.s.
Residual	620	0.03		593	0.12	

** = P≤0.01; * = P≤0.05 and n.s. = not significant (P>0.05)

The least squares means of factors affecting birth weight of Kacang and Peranakan Etawah goats are presented in Figure 8 and 9.

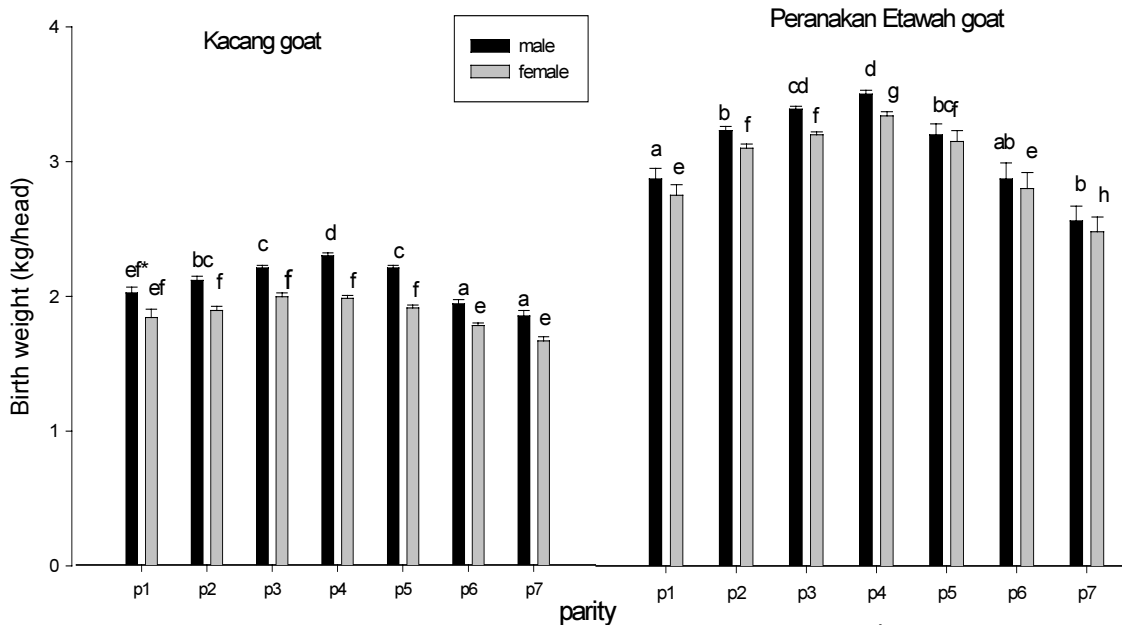

Figure 8: Average birth weight at of Kacang and Peranakan Etawah goats at different parities and sex

**Means, within the same classification followed by different letters are significantly different (P≤0.05), otherwise they are not.*

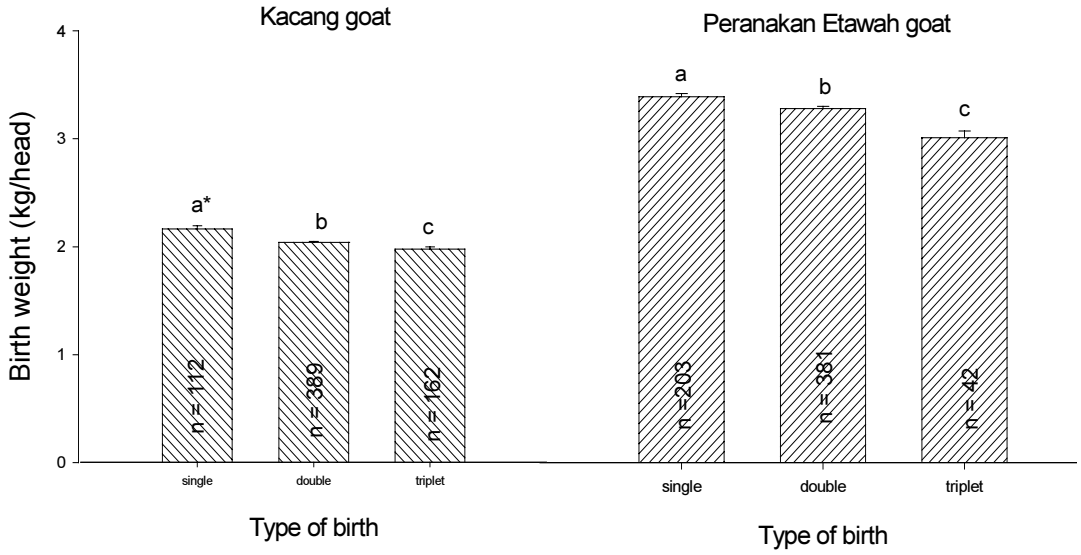

Figure 9: Average birth weight of Kacang and Peranakan Etawah goats at different types of birth

**Means, within the same classification followed by different letters are significantly different (P≤0.05), otherwise they are not.*

n = number of kids

The least square means as shown in Figure 8 show that average birth weight of male and female Kacang and Peranakan Etawah goats increased with the advance in parity up to the 4th parity and slightly decreased thereafter. Average birth weights of male goats tend to be higher than those of female goats in all parities. Figure 9 shows that average birth weight of both breeds decreased with the advance in type of birth.

4.2.2 Weaning Weight

The least squares analysis of variance of weaning weight of Kacang and Peranakan Etawah goats are presented in Table 15.

Table 15: Least squares analysis of variance for weaning weight of Kacang and Peranakan Etawah goats

Source of variance	Kacang goat			Peranakan Etawah goat		
	d.f.	Mean Square		d.f.	Mean Square	
Parity	6	3.24	**	6	13.79	**
Type of birth	2	3.13	**	2	35.24	**
Sex	1	14.19	**	1	9.15	**
Parity X Type of birth	12	0.06	n.s.	7	1.35	n.s.
Parity X Sex	6	0.49	n.s.	6	2.54	n.s.
Type of birth X Sex	2	1.50	*	2	0.53	n.s.
Parity X Type of birth X Sex	12	0.39	n.s.	7	0.82	n.s.
Regression on birth weight	1	88.49	**	1	193.21	**
Residual	619	0.43		592	1.23	

** = P≤0.01; * = P≤0.05 and n.s. = not significant (P>0.05)

The table shows that the effect of interaction among parity, type of birth and sex, the effect of interaction between parity and type of birth and between parity and sex on weaning weight of both breeds were not significant (P>0.05). The effect of interaction between type of birth and sex on weaning weight of Kacang

goat was significant (P≤0.05), however the effect was not significant (P>0.05) on the weaning weight of the Peranakan Etawah goat. The effect of parity, type of birth and sex on weaning weight of both breeds was significant (P≤0.01). The regression on birth weight was by both breeds significant (P≤0.01).

The least squares means of factors affecting weaning weight of Kacang and Peranakan Etawah goats are presented in Figures 10 and 11.

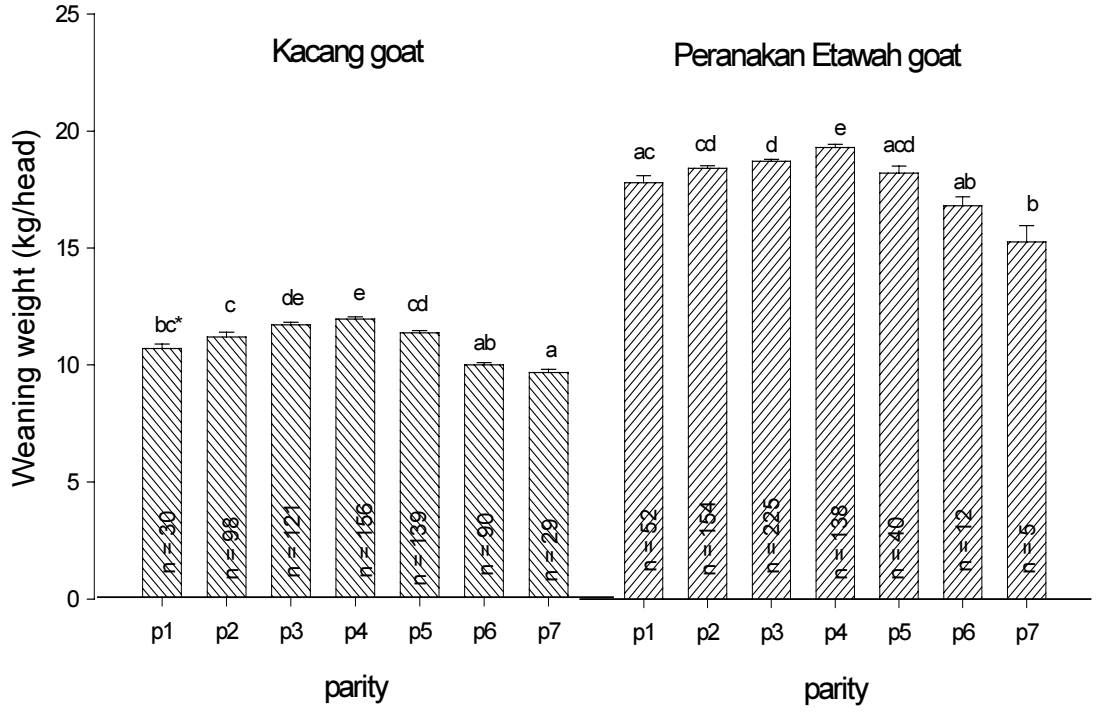

Figure10: Average weaning weight at of Kacang Peranakan Etawah goats at different parities

**Means, within the same classification followed by different letters are significantly different (P≤0.05), otherwise they are not.*

n = number of kids

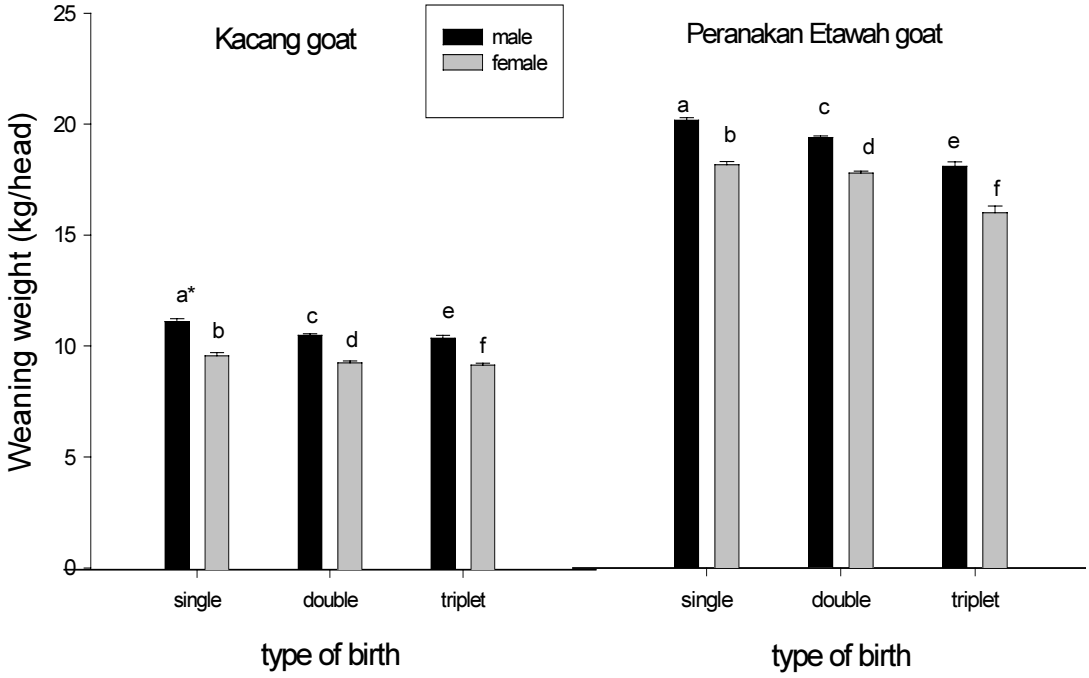

Figure 11: Average weaning weight of Kacang and Peranakan Etawah goats at different types of birth and sex

**Means, within the same classification followed by different letters are significantly different ($P \leq 0.05$), otherwise they are not.*

The least square means as shown in Figure 10 show that the average weaning weight of Kacang and Peranakan Etawah goats increased with the advance in parity up to the 4th parity and slightly decreased thereafter. Figure 11 shows that the average weaning weight of both breeds decreased with the advance in type of birth. The average weaning weight of male goats tends to be higher than those of female goats in all types of birth.

The results also reveal that the weaning weight of Kacang and Peranakan Etawah goats was significantly affected by birth weight. The results indicate that for each 1 gram increase in birth weight there is an increase of 3.71 and 11.96 gram weaning weight of Kacang and Peranakan Etawah goats, respectively.

4.2.3 Growth Rate till Weaning

The least squares analysis of variance on growth rate till weaning of Kacang and Peranakan Etawah goats is presented in Table 16 and shows the same result as for the weaning weight. The table shows that the effect of interaction among parity, type of birth and sex, the effect of interaction between parity and type of birth and between parity and sex on growth rate till weaning of both breeds was not significant (P>0.05). The effect of interaction between the type of birth and sex on growth rate till weaning of the Peranakan Etawah goat was not significant (P>0.05), however it was significant (P≤0.05) on growth rate till weaning of the Kacang goat. The effect of parity, type of birth and birth weight on growth rate till weaning of both breeds was significant (P≤0.05). The regression on birth weight was by both breeds significant (P≤0.01).

Table 16: Least squares analysis of variance for growth rate till weaning of Kacang and Peranakan Etawah goats

Source of variance	Kacang goat			Peranakan Etawah goat		
	d.f.	Mean Square		d.f.	Mean Square	
Parity	6	224.98	**	6	957.30	**
Type of birth	2	217.61	**	2	2447.32	**
Sex	1	985.68	**	1	635.28	**
Parity X Type of birth	12	40.71	n.s.	7	93.85	n.s.
Parity X Sex	6	34.16	n.s.	6	176.12	n.s.
Type of birth X Sex	2	104.71	*	2	36.94	n.s.
Parity X Type of birth X Sex	12	27.30	n.s.	7	69.58	n.s.
Regression on birth weight	1	1931.13	**	1	2191.71	**
Residual	619	30.13		592	69.58	

** = P≤0.01; * = P≤0.05 and n.s. = not significant (P>0.05)

The least square means of factors affecting growth rate till weaning of Kacang and Peranakan Etawah goats are presented in Figure 12 and 13.

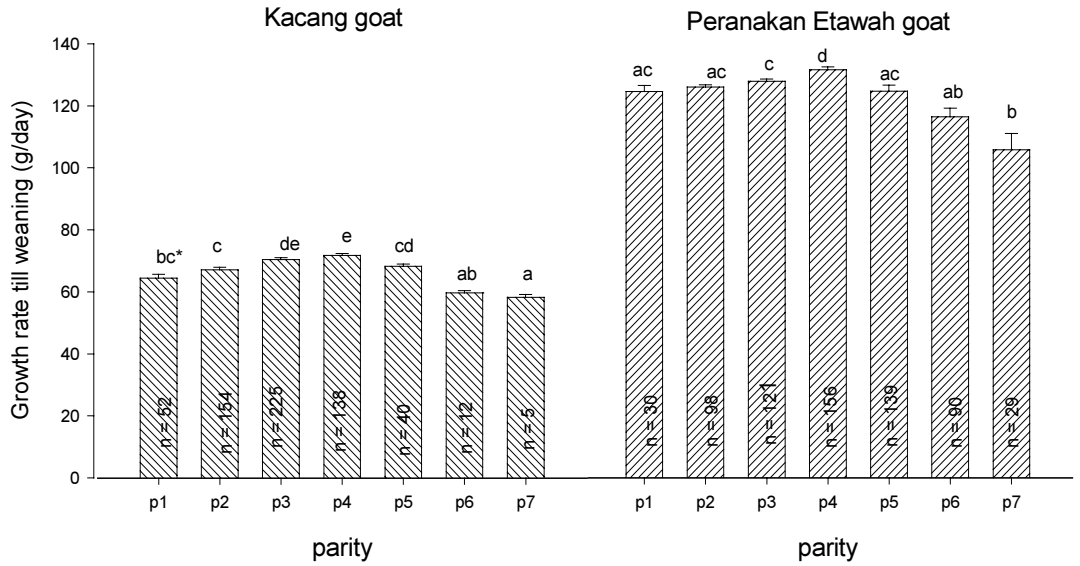

Figure 12: Average growth rate till weaning of Kacang and Peranakan Etawah goats at different parities:

**Means, within the same classification followed by different letters are significantly different (P≤0.05), otherwise they are not.*

n = number of kids

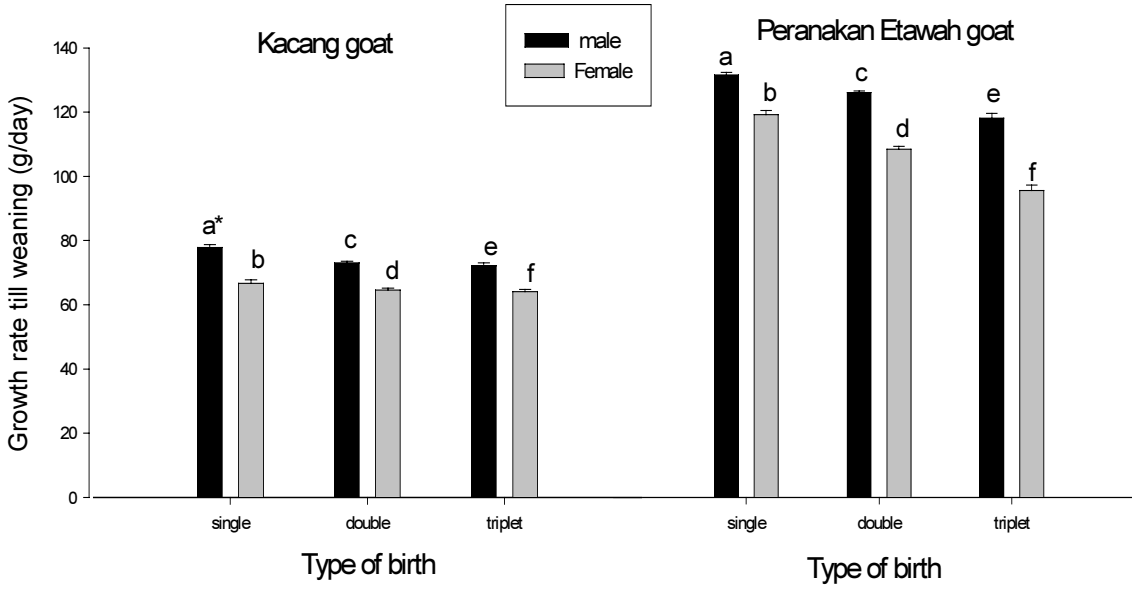

Figure 13: Average growth rate till weaning of Kacang and Peranakan Etawah goats at different types of birth and sex

**Means, within the same classification followed by different letters are significantly different (P≤0.05), otherwise they are not.*

Figure 12 shows that the average growth rate till weaning of Kacang and Peranakan Etawah goats increased with the advance in parity up to the 4th parity and slightly decreased thereafter. Figure 13 shows that the average growth rate till weaning of male goats tends to be higher than those of female goats in all types of birth. The average growth rate till weaning of both breeds decreased with the advance in the type of birth. The results also reveal that the birth weight has a significant effect on growth rate till weaning of Kacang and Peranakan Etawah goats. The results indicate that for each 1 gram increase in birth weight there is an increase of 22.56 and 11.96 gram growth rate till weaning of Kacang and Peranakan Etawah goats, respectively.

4.2.4 Body Condition Score

The least squares analysis of variance on body condition score of Kacang and Peranakan Etawah goats is presented in Table 17.

Table 17: Least squares variance analysis of body condition score of Kacang and Peranakan Etawah goats

Source of variance	Kacang goat		Peranakan Etawah goat	
	d.f.	Mean Square	d.f.	Mean Square
Parity	6	5.15 **	6	957.30 **
Type of birth	2	4.26 **	2	2447.32 **
Sex	1	0.27 n.s.	1	635.28 **
Parity X Type of birth	12	0.64 **	7	93.85 n.s.
Parity X Sex	6	0.34 n.s.	6	176.12 n.s.
Type of birth X Sex	2	1.19 *	2	36.94 n.s.
Parity X Type of birth X Sex	12	0.33 n.s.	7	69.58 n.s.
Regression on birth weight	1	6.25 **	1	2191.71 **
Residual	619	0.25	592	69.58

** = P≤0.01; * = P≤0.05 and n.s. = not significant (P>0.05)

The table shows that the effects of interactions for body condition score were only significant between parity and type of birth ($P<0.01$) and between type of birth and sex ($P<0.05$) and only for Kacang goats. For Peranakan Etawah goats the effects of the interactions between the sources of variance were not significant ($P>0.05$). The effect of birth weight on body condition score of both breeds was significant ($P\leq0.01$). The effect of parity and type of birth on body condition score of both breeds was significant ($P\leq0.01$). The difference between males and females was only on the body condition score of Peranakan Etawah goat significant ($P\leq0.01$).

The least square means factor affecting body condition scoring of Kacang and Peranakan Etawah goats presented in Figure 14 and 15.

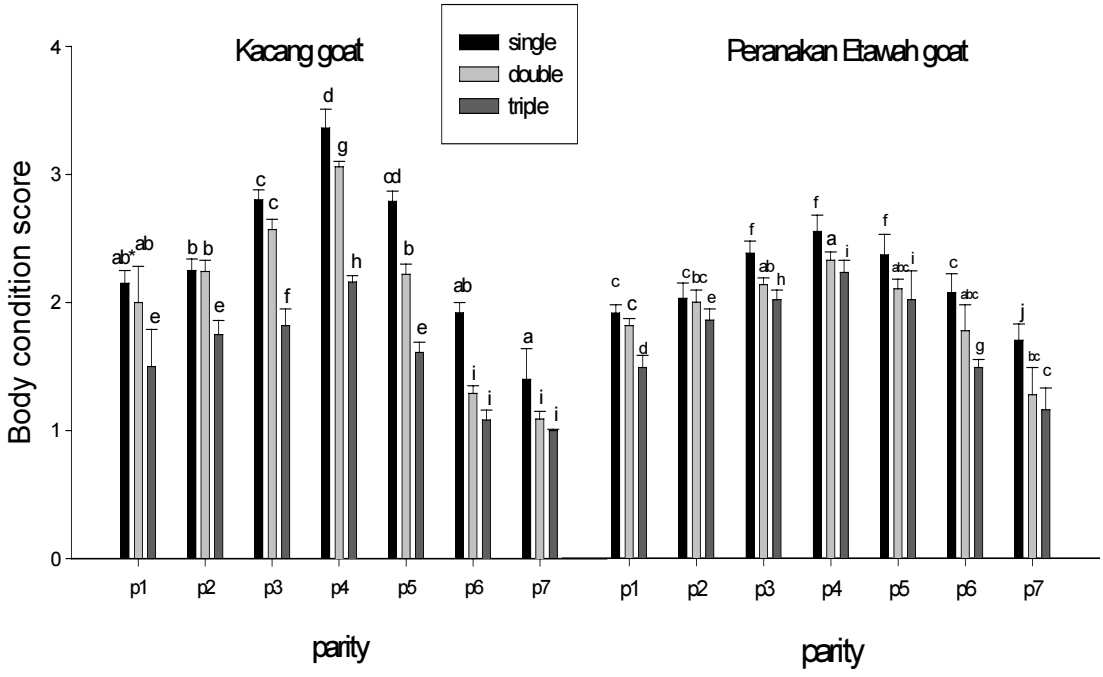

Figure 14: Average body condition score of Kacang and Peranakan Etawah goats at different parities and types of birth

**Means, within the same classification followed by different letters are significantly different ($P\leq0.05$), otherwise they are not.*

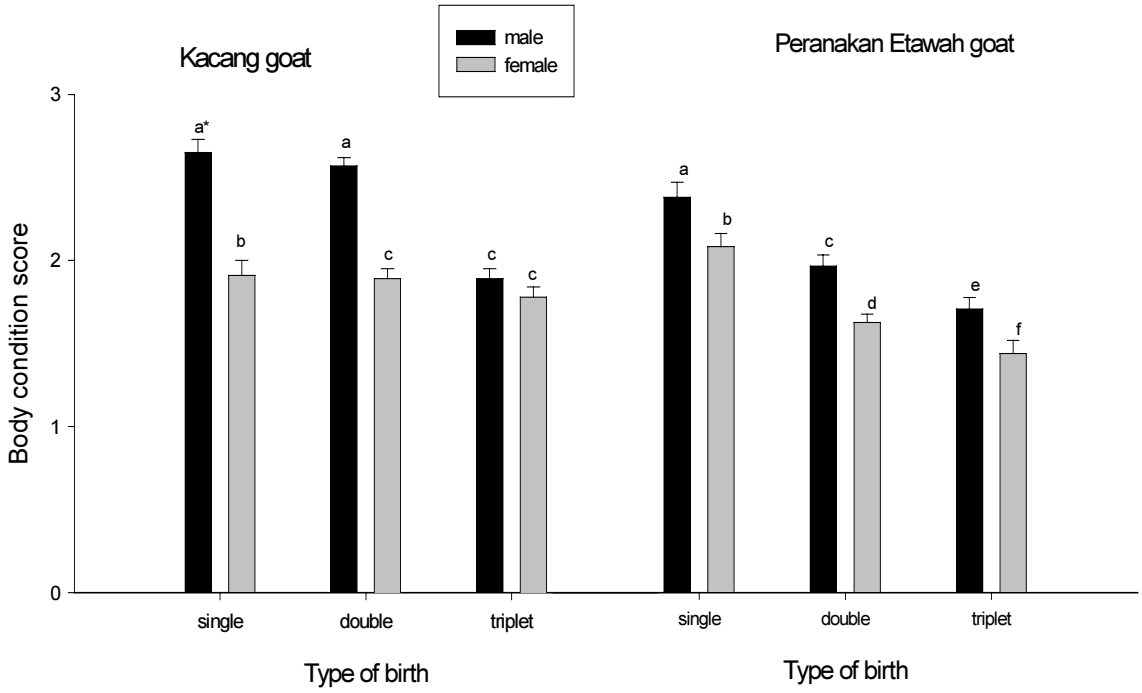

Figure 15: Average body condition score of Kacang and Peranakan Etawah goats at different types of birth and sex
**Means, within the same classification followed by different letters are significantly different ($P \leq 0.05$), otherwise they are not.*

Figure 14 shows that the average body condition scoring of both breeds for all birth types tends to increase with the advance in parity up to the 4th parity and slightly decrease thereafter. Figure 15 shows that the average body condition scoring of male and female of both breeds tends to decrease with the advance in type of birth. The average body condition scoring of male goats in all birth types was higher than that of female goats. The results also demonstrated that the body condition scoring of Kacang and Peranakan Etawah goats significantly was effected by birth weight. The results indicate that for each 1 gram increase in birth weight there is an increase of 1.89 and 1.75 body condition scoring of Kacang and Peranakan Etawah goats, respectively.

4.2.5 Leg Conformation Index

The least squares analysis of variance on leg conformation index of Kacang and Peranakan Etawah goats is presented in Table 18. For the Kacang goats, the table shows that the effect of interaction between parity and sex on the leg conformation index was not significant (P>0.05). The effect of interaction between parity and birth type, and effect of interaction between birth type and sex was significant (P≤0.05). For the Peranakan Etawah goat, the table shows that the effects of interactions among parity, birth type and sex on leg conformation index were not significant (P>0.05). The effect of parity and birth type on leg conformation index of both breeds was significant (P≤0.01). The difference between males and females was only significant on the leg conformation index of Peranakan Etawah goat (P≤0.01). Table 18 also indicated that the leg conformation index of both breeds was significantly (P≤0.01) affected by birth weight.

Table 18: Least squares analysis of variance for leg conformation index of Kacang and Peranakan Etawah goats

Source of variance	Kacang goat			Peranakan Etawah goat		
	d.f.	Mean Square		d.f.	Mean Square	
Parity	6	340.83	**	6	81.86	**
Type of birth	2	425.58	**	2	274.18	**
Sex	1	50.67	n.s.	1	215.06	**
Parity X Type of birth	12	63.81	*	7	32.28	n.s.
Parity X Sex	6	57.44	n.s.	6	17.85	n.s.
Type of birth X Sex	2	121.05	*	2	13.04	n.s.
Parity X Type of birth X Sex	12	51.09	n.s.	7	42.03	n.s.
Regression on birth weight	1	1704.83	**	1	3354.36	**
Residual	619	32.56		592	36.72	

** = P≤0.01; * = P≤0.05 and n.s. = not significant (P>0.05)

The least square means factor affecting the leg conformation index of Kacang and Peranakan Etawah goats is presented in Figure 16 and 17.

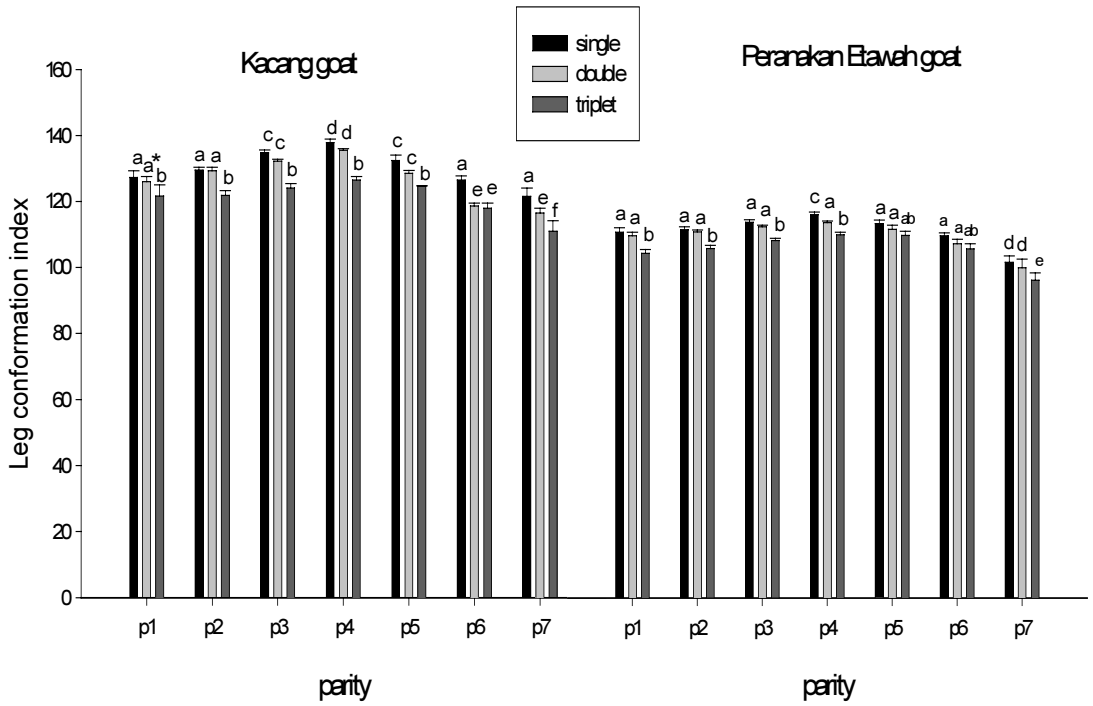

Figure 16: Average leg conformation index of Kacang and Peranakan Etawah goats at different parities and types of birth

**Means, within the same classification followed by different letters are significantly different (P≤0.05), otherwise they are not.*

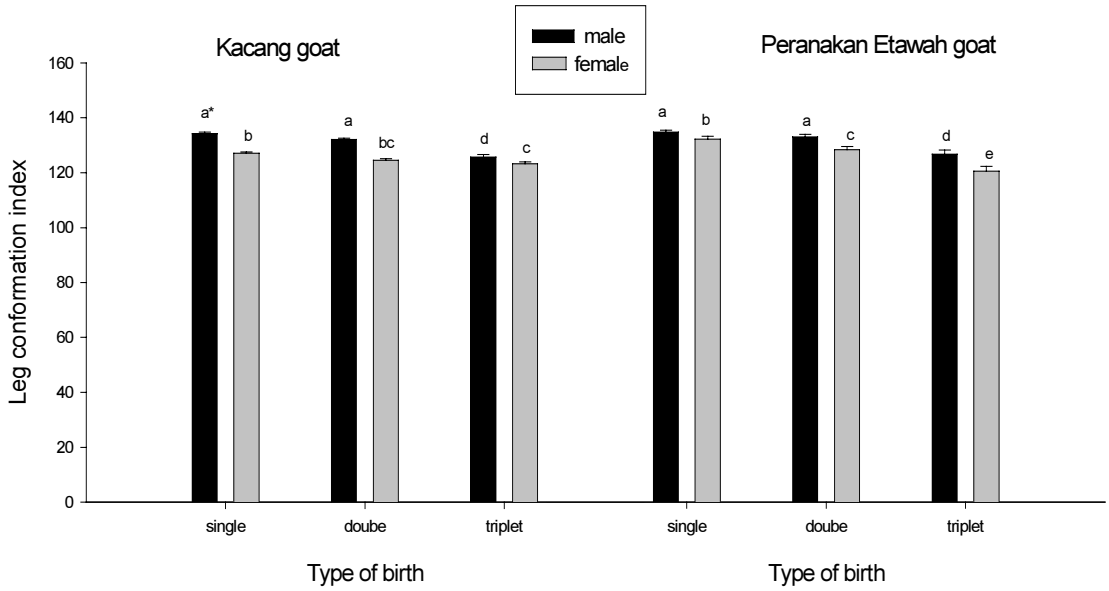

Figure 17: Average leg conformation index of Kacang and Peranakan Etawah goats at different types of birth and sex

**Means, within the same classification followed by different letters are significantly different (P≤0.05), otherwise they are not.*

Figure 16 shows that the average leg conformation index of both breeds for all birth types tend to increase with the advance in parity up to the 4th parity and slightly decrease thereafter.

Figure 17 shows that average leg conformation index of males and females of both breeds tend to decrease with the advance in type of birth. The average leg conformation index of male goats in all birth types was higher than that on female goats.

The results also demonstrated that the leg conformation index of Kacang and Peranakan Etawah goats was significantly affected by birth weight. The results indicate that for each 1 gram increase in birth weight there is an increase of 21.36 and 8.47 leg conformation index of Kacang and Peranakan Etawah goats, respectively.

5 DISCUSSION

5.1 Reproduction Traits of Kacang and Peranakan Etawah Does

5.1.1 Type of Birth

The average litter size of Kacang goats in this study was 1.93 kids (SE = 0.13). This value is close to those reported by Sumarti (1991), Amsar et al. (1992) and Sodiq et al. (1997), which ranged from 1.92 to 1.95 kids. The average litter size of Peranakan Etawah goat in this study was 1.69 kids (SE = 0.15). This value is close to those obtained by Astuti et al. (1984), Sodiq et al. (1998), Adiati et al. (1998) and Setiadi et al. (1999), which ranged from 1.65 to 1.82 kids. The values reported in this study are higher than those reported by Subandriyo et al. (1986) and Bell et al. (1982) whose studies in West Java showed that averages of the litter size of Peranakan Etawah goat was 1.45 kids.

Least squares analysis of variance presented in Table 4 revealed that the litter size at birth was significantly ($P \leq 0.01$) affected by parity. These results agree with Amoah and Gelaye (1990), Awemu et al. (1999, 2002), Crepaldi et al. (1999), Song et al. (2001), Galina et al. (1995), Odubate (1996, 2000), Silva et al. (1998), Thumrong et al. (2000), Alexandre et al. (2001), Marai et al. (2002) and Armbruster and Peter (1993), who found that the effect of parity was significant on litter size of the goat.

Average litter sizes of Kacang and Peranakan Etawah goat (Figure 5) gradually tend to increase with the advance in parity up to the 4^{th} parity and then slightly decreased in the 5^{th} parity. Similar trends were also obtained by some researchers. Results of Mellado et al. (1991) studies on native goats in Mexico demonstrated that the litter size was positively correlated with parity with mean litter size for the first, second, third and fourth parity at 1.5, 1,5, 1.8 and 1.8 kids

per kidding. In Red Sakoto does (Awemu et al., 1999) found the litter size at 1, 2, 3, 4, 5 and 6 parity were 1.8, 2.0, 1.8, 1.8, 1.9 and 1.8, respectively. Das and Sendalo (1990) reported that prolificacy of meat goats in Malya, Tanzania, tends to increase from the first parity and a reduction in the sixth parity. In a research of Creole goats Alexandre et al. (2001) found that the litter size at birth increased from 1.65 to 2.35 total kids born, from the first to the seventh kiddings, respectively. Litter size and multiple birth rate increased from 140-148 and 39-45% for parity 1-3 to 163-167 and 55-60% for parity greater than 3 (Thumrong et al., 2000).

This study shows that the litter size increased with parity, with the largest litters at the fifth parity. These findings are consistent with those of Wilson and Light (1986), Das and Sendalo (1990) and Awemu et al. (2002). Prolificay was influenced by parity with the least square means increasing from 1.2 kids in goats kidding for the first time, to 1.5 kids in second parity and about 1.7 kids in goats of 4^{th} parity (Crepaldi et al., 1999). Lower prolificacy of primiparous does may be associated with an underdeveloped state of the reproductive features required for successive litter bearing compared with those of multiparous does that have reached physiological maturity.

5.1.2 Litter Weight at Birth

Results of this study (Table 5) show that litter weight at birth of Kacang and Peranakan Etawah goats was significantly ($P \leq 0.01$) affected by parity. This confirms the findings of Devendra and Burn (1983), Husain et al. (1996), Mellado et al. (1991) and Marai et al. (2002) who reported that there was a relation between parity and litter weight at birth of the goat. Figures presented in Table 6 demonstrated that averages of litter weight at birth of both breeds increased with the advance in parity up to the 4^{th} parity and slightly decreased thereafter. Similar trends were also obtained by Mellado et al. (1991) whose studies on native goats in Mexico demonstrated that birth weights were

positively correlated with parity. Husain et al. (1996) reported that there was a tendency to increasing weight with the advance of parity at least up to the 3rd parity. This may be attributed to physiological maturity of older does and their ability to provide enough milk for the kids.

Results of variance analysis presented in Table 5 revealed that the litter weight at birth of Kacang and Peranakan Etawah goat was significantly ($P \leq 0.01$) affected by the type of birth. This study agrees with Amoah and Gelaye (1990), Ikwuegbu et al. (1995) and Das et al. (1990). Averages of litter weight at birth of both breeds (Table 6) increased progressively with the advance in type of birth. This is possibly related to the number of litter and birth weight of the kid. Litter weight at birth for triplets of Kacang and Peranakan Etawah goat (5.9 and 8.8 kg) tended to be heavier compared to those of twins (4.1 and 6.4 kg) and singles (2.2 and 3.5 kg), respectively.

5.1.3 Litter Weight at Weaning

The least squares analysis of variance presented in Table 7 revealed that the litter weight at weaning of Kacang and Peranakan Etawah goat was significantly ($P \leq 0.01$) affected by parity. This results are in agreement with other findings (Husain et al., 1996; Mellado et al., 1991; Osinowo et al., 1992; Marai et al., 2002). Figures in Table 8 show that averages of litter weight at weaning of both breeds tend to increased with the advance in parity up to the 4th parity and slightly decreased thereafter. As already mentioned this may be attributed to physiological maturity of older does and their ability to provide enough milk for the kids. Coffey (2002) reported that weaning weights are crucial and indicate the milking ability of the herd. Another research reported that the weaning weight would reflect mothering ability of does as well as the inherent growth potential (Das and Sendalo, 1990).

The effect of birth type on litter weight at weaning of kids agrees with the results published by Das et al. (1990), Okello (1993), Husain et al. (1996), Okello

(1993), Kochapakdee et al. (2000), Alexandre et al. (1999), Mourad (1993), Nawarz and Khalil (1998) and Osinowo et al. (1992). Table 7 revealed that the litter weight at weaning of Kacang and Peranakan Etawah goat was significantly ($P \leq 0.01$) affected by type of birth. Averages of litter weight at weaning of both breeds increased progressively with the advance in type of birth. This is possibly related to the number of litter at weaning and the weaning weight of the kid. Litter weight at weaning of triplets for Kacang and Peranakan Etawah goat (10.5 and 19.2 kg) tended to be heavier compared to those of twins (19.1 and 30.8 kg) and singles (27 and 39.7 kg), respectively.

Birth weight of kids is considered to be a very important criterion as it is strongly correlated with the adult body weight and hence a determinant factor for overall productivity (Devendra and Burn, 1983; Boggs and Merkel, 1993). Table 8 shows that the regression of litter weight at birth on litter weight at weaning was highly significant ($P \leq 0.01$). The results demonstrated that for each 1 gram increase in litter weight at birth there is an increase of 4.48 and 3.37 gram litter weight at weaning of Kacang and Peranakan Etawah goats, respectively.

5.1.4 Survival Rate till Weaning

The overall survival rate till weaning of Kacang goats was close to values reported in studies carried out in villages of Central Java (Astuti et al., 1984; Amsar et al., 1992; Sodiq et al., 1997). The overall survival rate till weaning of Peranakan Etawah goat was close to values reported by Bell et al. (1982) and Anggraeni et al. (1995).

The least squares analysis of variance presented in Table 9 shows that the survival rate till weaning was significantly ($P \leq 0.01$) affected by type of birth. These findings are in agreement with Devendra and Burns (1983), Husain et al. (1995), Mtenga et al. (1992) and Okello (1993), Awemu et al. (1999, 2002), Alexandre et al. (1999) and Madibela et al. (2002).

Averages of survival rate till weaning of Kacang and Peranakan Etawah goats (Table 10) demonstrated that they decreased progressively with the advance in the type of birth. Results of Husain et al. (1995) and Okello (1993) found that single kids always had a higher survival rate than twins and triplets. Survival rate till weaning tended to decrease with larger size litters which also agrees with the observations of Awemu et al. (1999) and Mtenga et al. (1992). Kids from multiple births are often weak at birth as a result of physiological starvation in the uterus and lower energy reserves. Curtis (1969) concluded that animals with low birth weights had lower energy reserve and were therefore less able to withstand a harsh environment; also if the dam has a poor milk yield, she may be unable to provide adequate nutrition for twins, thus increasing their susceptibility to disease.

The least squares analysis of variance presented in Table 9 shows that the survival rate till weaning of Kacang goats was significantly ($P \leq 0.01$) affected by parity. The least squares means (Table 10) demonstrated that averages of survival rate till weaning of Kacang and Peranakan Etawah goats increased with the advance in parity up to the 4^{th} parity and then slightly decreased. Results of Husain et al. (1995) concluded that the survivability increased gradually with the increase in the parity number having the highest survival rate in the 5^{th} parity. Awemu et al. (1999) reported that the mortality rate generally decreased with the increasing parities. This may be attributed to the physiological maturity of older does and their ability to provide enough milk for the kids. Awemu et al. (2002) working on Red Sokoto goats found that the mortality tended to decrease as parity increased. The same results were also reported by Wilson et al. (1985) who identified that the parity of dam was a significant source of variation in kid mortality.

The significant effect of the litter weight at weaning on survival rate till weaning was also demonstrated in this study (Table 9). Similar trends on the effect of litter weight at weaning on survival rate till weaning of goats were also obtained by Husain et al. (1995), Husain et al. (1994), Awemu et al. (1999), Awemu et al. (2002). Table 9 revealed that regression of survival rate till weaning on litter weight at weaning was highly significant ($P \leq 0.01$). The result (Table 10)

indicated that for each 1 gram increase in litter weight at weaning, there is an increase of 0.39 and 0.64 percent survival rate till weaning of Kacang and Peranakan Etawah goats, respectively. Results of Husain et al. (1994) investigated on Black Bengal kids found that the survival rates were affected by birth weight of kids and milk yield of dams.

Awemu et al. (2002) working on Red Sokoto goats found that the mortality tended to decrease with birth weight. Other researchers reported that due to low birth weight and poor nutrition, the mortality rate is high (Banerjee and Banerjee, 2000). Mortality generally decreased as the birth weight of kids increased (Awemu et al., 1999). Bradford et al. (1983) reported that the litter size affected survival mainly through its effect on birth weight. Lower birth weight and lack of husbandry knowledge were considered the main factors responsible for higher kid mortality (Husain et al., 1995). Mtenga et al. (1992) working on Small East African goats reported that the lowest pre-weaning mortality rate occurred in animals with a birth weight of greater than 2.6 kg. Birth weight had a significant effect on the mortality rate of kids, the mortality rate decreased with increasing birth weight. Results of Rattner et al. (1994) revealed that the low birth weight of the goat resulted in increased mortality. Bradford et al. (1983) reported that the litter size affected survival mainly through its effect on birth weight. Lower birth weight and lack of husbandry knowledge were considered the main factors responsible for higher kid mortality (Husain et al., 1995). These results are in agreement with the observations of Curtis (1969) and Mtenga et al. (1994) that animals with low birth weight have lower energy reserves and are therefore less able to withstand harsh environmental conditions.

5.1.5 Kidding Interval

Average kidding intervals of the Kacang goat (Table 12) were close to values reported by Sumarti (1991), Amsar et al. (1992) and Sodiq et al. (1997). Average kidding interval of the Peranakan Etawah goat (Table 12) was close to

values reported by Bell et al. (1982), Sandhi (1992), Sodiq et al. (1998) and Setiadi et al. (1999).

Analysis of variance for kidding intervals presented in Table 11 revealed that the effect of parity was significant ($P \leq 0.01$). Similar results were also obtained by Awemu et al. (1999, 2000), Odubote (1990, 2002), Christopher (2001), Greyling (2000), Das (1993), Amoah et al. (1996) and Das (1993).

The least squares means (Table 12) demonstrated that averages of kidding interval of Kacang and Peranakan Etawah goats extended with the advance in parity up to the 4^{th} parity and were slightly shortened thereafter. Results of Awemu et al. (2002) studies on Red Sokoto goats concluded that as parity increased, so the kidding interval decreased. Amoah et al. (1996) reported that the gestation period increased slightly with increasing parity (b = 0.22 d/parity). Results of Odubote's (1990, 2000) studies on West African Dwarf demonstrated that there was a significant decrease in the kidding interval from the fifth parity. These results are also consistent with the report of Wilson and Light (1986) that females at earlier parities take longer than older ones to return to reproductive status. Das (1993) demonstrated that old does (3-4 year) tended to have lower kidding intervals than the younger (1-2 years) and older does (>5 years). This is probably due to the reproductive physiology function being more active in 3-4 years old does compared to lower activity in younger and older does.

Results of variance analysis (Table 11) revealed that the kidding interval was significantly ($P \leq 0.01$) affected by the type of birth. The same results were also reported by Christopher (2001), Greyling (2000), Amoah et al. (1996), Öztürk and Akta (1996) and Akusu and Ajala (2000). Figures presented in Table 12 demonstrated that the averages of the kidding intervals of Kacang and Peranakan Etawah goats shortened progressively with the advance in the type of birth. Results of Christopher (2001) found that the does with multiple births tend to have a shorter gestation length with 1 to 2 days difference between twins and triplets. Amoah et al. (1996) reported that the gestation period decreased as the litter size of the doe increased (b = -0.92 d/kid). Results of Öztürk and Akta (1996) studies on Merino sheep showed that for triple births

the gestation length (153.7 ± 0.73 days) was longer than for twin births (152.8 ± 0.16), and twins were carried longer than single lambs (151.6 ± 0.22 days). Akusu and Ajala (2000) investigated on West African Dwarf goats concluded that does with single kids had a longer gestation than those with twins and triplets.

The length of gestation in goats is fairly constant at 146 to 151 days (Ensminger and Parker, 1986). In Boer goats Greyling (2000) reported that there was no significant difference in the gestation length between does bearing singletons or triplets. There was no significant difference in the post partum anoestrus interval for does giving birth to different numbers of offspring (Greyling, 2000). This study (Table 11) shows that the effect of litter weight at weaning was insignificant ($P>0.05$) on the kidding interval of Kacang and Peranakan Etawah goats.

5.1.6 Doe Productivity Index

One of the most favorable attributes of goats as meat producing animals is their high rate of reproduction (Wildeus, 1996; Naude and Hofmeyr, 1981) and determined by the number of progeny delivered in a given period of time (Greyling, 2000). The overall doe productivity index (kg/doe/year) of Kacang and Peranakan Etawah goats was 29.8 (SE = 1.9) and 33.7 (SE = 2.8) kg/doe/year, respectively. The values reported in this study are higher than those reported by Sutama (1995), Anggraeni et al. (1995) and Sodiq et al. (1998). Ingo (1999), Awemu et al. (1999), Bearden and Fuquay (2000) and Das (1993) demonstrated that the environmental factors exerted a significant influence on the productivity.

Results of variance analysis (Table 13) show that doe productivity index (kg/doe/year) of Kacang and Peranakan Etawah was significantly ($P\leq0.01$) affected by type of birth. Similar results also were reported by Awemu et al. (2002) that the type of birth of goat significantly influenced the productivity. The

results (Figure 7) demonstrated that averages of doe productivity index of both breeds increased progressively with the advance in type of birth. Awemu et al. (1999) reported that increasing litter size at birth and at weaning can improve the productivity of goats. Awemu et al. (2002) found that the effect of type of birth was highly substantial in goats, with quadruplets births producing 32.8 kg more meat at weaning than single births.

The productivity of goat depends on the number of litter at birth, survival rate till weaning and interval between kiddings (Sutama, 1995; Gatenby, 1995). The effect of the type of birth was highly substantial in goats, with multiple births producing more than single births and the prolonged kiddings' interval was responsible for a decrease in reproduction and productivity of goats (Awemu et al., 1999). The interval between parturition and the first post partum oestrus is an important trait which contributes to the productive efficiency (Greyling, 2000).

The least squares analysis of variance for doe productivity index of Kacang and Peranakan Etawah (Table 13) revealed that the doe productivity index was significantly ($P \leq 0.01$) affected by parity. Greyling (2000) and Marai et al. (2002) reported that the productive performance is dependent on the interaction of genetic and environmental factors and the effects of parity were significant. Results of Ndlovu and Simela (1996) showed that due to the slow growth rates and long kidding intervals the flock productivity in terms of weaned live kid weight (kg) per doe per year was low. Awemu et al. (2002) reported that the parity significantly influenced the productivity index.

Data presented in Figure 6 demonstrated that the averages of doe productivity index of both breeds increased with the advance in parity up to the 4^{th} parity and slightly decreased thereafter. Results of Steve and Marco (2001) showed that the goat productivity may be positively correlated with maternal age, but decreased slightly after 9 years of age. It was indicated that the relationship between age and kid production was curvilinear. Awemu et al. (2002) investigation on Red Sakoto goats found that the productivity indexes (kg/doe/year) in parity 1, 2, 3, 4, 5 and 6 were 20.9, 21.4, 22.5, 23.6, 27.9 and 33.4 kg, respectively.

The lower doe productivity index may be related to the interval between kiddings which is consistent with the report of Awemu et al. (1999), Wilson and Light (1986), Wilson et al. (1985) and Mtenga et al. (1994). This study revealed that parity significantly affected the kidding interval of Kacang and Peranakan Etawah goats (Table 11) which generally decreased with parity till the 4^{th} parity. The kidding interval of Kacang goat in the 1^{st}, 2^{nd}, 3^{rd}, 4^{th}, 5^{th} and 6^{th} parities were 271, 262, 243, 217, 223 and 239 days, respectively (Table 12). The kidding interval of Peranakan Etawah goats in the 1^{st}, 2^{nd}, 3^{rd}, 4^{th} and 5^{th} parities were 334, 312, 301, 278 and 291 days, respectively (Table 12). The kidding interval itself has been reported to be affected by a number of environmental factors including parity (Wilson and Light, 1986; Mtenga et al., 1994). Wilson and Light (1986) reported that females at early parities take longer than older animals to return to their reproductive status. Wilson et al. (1985) have shown that prolonged kidding intervals were responsible for a decrease in the overall productivity of goats and sheep on a Masai group ranch in South Central Kenya.

Boggs and Merkel (1993) and Das and Sendalo (1990) reported that weaning weight can be used to estimate growth rate, and weaning weight is an excellent indicator of productivity because it reflects both litter size, mothering ability and milking ability. The result of variance analysis presented in Table 13 revealed that doe productivity index of Kacang and Peranakan Etawah goats was significantly ($P \leq 0.01$) affected by litter weight at weaning. Similar results were also obtained by Triwulaningsih (1989), Sutama (1995) and Awemu et al. (1999), who reported that the productivity of goats can be improved by increasing litter at weaning. The result indicated that for each 1 kg increase in litter weight at weaning there is an increase of 1.806 and 1.442 kg/doe/year doe productivity index of Kacang and Peranakan Etawah goats, respectively.

5.2 Production Traits of Kacang and Peranakan Etawah Kids

5.2.1 Birth Weight

The overall birth weight of Kacang goats was 2.1 kg (SE = 0.02). This value is close to those reported by Astuti et al. (1984) and Setiadi and Sitorus (1984). The overall birth weight of Peranakan Etawah goats was 3.2 kg (SE = 0.03). This value is close to those reported by Triwulaningsih (1989) and Sutama et al. (1995).

The least squares analysis of variance for birth weight of Kacang and Peranakan Etawah goats presented in Table 14 revealed that the birth weight was significantly ($P \leq 0.01$) affected by parity. This confirms the findings of Husain et al. (1996), Mellado et al. (1991), Osinowo et al. (1992), Marai et al. (2002), who reported that the effects of parity was significant at litter weight at birth of goat.

Averages of birth weight of males and females of Kacang and Peranakan Etawah goats (Figure 8) increased with the advance in parity up to the 4^{th} parity and slightly decreased thereafter. Results of Husain et al. (1996) revealed that there was a tendency to increasing weight with the advance of parity at least up to the 3^{rd} parity. On native goats in Mexico Mellado et al. (1991) demonstrated that birth weights were positively correlated with parity. This may be attributed to physiological maturity of older does and their ability to provide enough milk for the kids.

The analysis of variance for birth weight of Kacang and Peranakan Etawah goats (Table 14) revealed that birth weight was significantly ($P \leq 0.01$) affected by the type of birth. These results were similar with Amoah and Gelaye (1990), Amoah et al. (1996), Song et al. (2001), Nawarz and Khalil (1998), Mourad and Anous (1998), Das et al. (1993, 1990), Okello (1993) and (Husain et al., 1996), Kochapakdee et al. (2000), Alexandre et al. (1999), Ikwuegbu et al. (1995),

Mourad (1993), who reported that the birth weight of goats was significantly affected by the type of birth.

The results (Figure 9) demonstrated that averages of the birth weight of Kacang and Peranakan Etawah goats tend to decrease with the advance in type of birth. Findings of Amoah and Gelaye (1990) showed that there was a negative association between birth weight and litter size. Birth weight could be described by the multiple regression equation: BW = 2.7564 – 0.3316LS + 0.1863BP where BP is the period of breeding. Amoah et al. (1996) found that the birth weight decreased with the litter size by approximately 0.45 kg/kid. Song et al. (2001) reported that the mean birth weight of a kid of the Korean native goat was 2.04 kg with a variety 2.28, 2.11 and 1.64 kg for single, twin and triplet over of birth type, respectively.

Averages of birth weight of goats tend to decrease with the advance in the type of birth (Figure 9), and similar trends have been reported elsewhere. Nawarz and Khalil (1998) and Das et al. (1993, 1990), Okello (1993), Husain et al. (1996), Kochapakdee et al. (2000), Ikwuegbu et al. (1995), Mourad (1993) concluded that generally the birth weight decreased with the increase in litter size. Mourad and Anous (1998) reported the birth weights of kids in the Common African and Alpine crossbred goats were 3.1, 2.8, 2.3 and 2.3 kg for single, twin, triplets and quadruplets, respectively. Alexandre et al. (1999) studies on Guadeloupean Creole goats reported that body weight at birth was 15% higher for single than for multiple kids.

Figure 8 shows that birth weight of male goats in all parities of Kacang and Peranakan Etawah goats tends to be higher than those of female goats. Results of Okello (1993) working with Mubende goats reported that male kids were heavier than females. Result of Kochapakdee et al. (2000) working with native Thai and their crosses with Anglo Nubian goats showed that male kids were significantly heavier at birth and at weaning compared with female animals (2.1 vs. 1.9kg and 8.2 vs. 7.4 kg) and single kids were also significantly heavier at birth and at weaning compared with multiple kids (2.1 vs. 1.9 kg and 9.2 vs. 7.2 kg).

Alexandre et al. (1999) studies on Guadeloupean Creole goats reported that body weight at birth was 1.73 ± 0.34 kg. Birth weight was 10% higher for males than for females. Das (1993) investigations on Blended goats revealed that male kids were heavier at birth than females kids. Ikwuegbu et al. (1995) studies on African Dwarf goats under village conditions showed that the birth weight was affected by sex of kid and birth type. Mourad (1993) showed that single born kids were heavier than twins in Alpine and Zaraibi goats. Results of Zhou et al. (2003) revealed that the body weight of male Inner Mongolia cashmere goats was significantly heavier than females.

Marai et al. (2002) studies of reproductive traits of Nubian goats found that the effect of sex was significant at litter weight at birth. A survey of goats showed that both sex and breed had significant effects for live weight (Lusweti, 2000). Amoah et al. (1996) found that birth weight was varied, and males were heavier than female kids. Alexandre et al. (1999) working on Creole goats reported that body weight at birth and body weight at weaning was higher for males than for females. Findings of Silva et al. (1998) showed that kid birth weight of the Alpine dairy goats was varied, 3.3 – 4.5 kg with males and 2.5-3.7 kg with females. The male kids had higher birth weight than female kids (Nawarz and Khalil, 1998). The same results were also reported by Gerstmayr and Horst's (1995) studies on Angora goats and concluded that male kids were heavier, especially at birth, than female kids.

5.2.2 Weaning Weight

The overall weaning weight of the Kacang goat was 9.5 kg (SE = 0.11). This value is close to those reported by Ngadiono et al. (1984) and Setiadi and Sitorus (1984). The overall birth weight of the Peranakan Etawah goat was 17.8 kg (SE = 0.0.28). The values reported in his study are higher than those reported by Setiadi and Sitorus (1984), Setiadi et al. (1987), Setiadi (1989), Triwulaningsih (1989) and Sutama et al. (1995). This value may be due to the

Peranakan Etawah goat in the village breeding centre at Purworejo having better management.

The least squares analysis of variance for the the weaning weight of Kacang and Peranakan Etawah (Table 15) revealed that the weaning weight was significantly ($P \leq 0.01$) affected by parity. Averages of weaning weight of both breeds (Figure 10) increased with the advance in parity up to the 4^{th} parity and slightly decreased thereafter. The effect of parity was significant at weaning weight of goat. This was also demonstrated by Marai et al. (2002) who investigated on Nubian goats and Gebrelul et al. (1994) on Alpine, Nubian and crossbred and also Ikwuegbu et al. (1995) on African Dwarf goats. Another researcher also found the similar trends that weaning weights were significantly affected by parity and the weaning weight increased consistently from the first to fifth parity (Osinowo et al., 1992). This may be attributed to the physiological maturity of older does and their ability to provide enough milk for the kids. Some researchers (Zeng and Escobar, 1995; Haenlein, 2000; Urdaneta et al., 2000; Kennedy et al., 1992) reported that the ability of does to produce milk was significantly affected by parity. The ability to produce milk had a almost steady growing trend from the first to fifth lactation and the maximum is attained in the fifth parity (Crepaldi et al. 1999).

The least squares analysis of variance for the weaning weight of Kacang and Peranakan Etawah goats (Table 15) revealed that the weaning weight was significantly ($P \leq 0.01$) influenced by type of birth. Averages of weaning weight of both breeds (Figure 11) decreased with the advance in type of birth. The effect of birth type on the weaning weight of goat, and that the weaning weight tends to decrease with the increasing litter were also documented by Gebrelul et al. (1994), Das et al. (1990), Okello (1993), Husain et al. (1996), Kochapakdee et al. (2000), Alexandre et al. (1999), Das (1993) and Osinowo et al. (1992). Coffey (2002) stated that weaning weights are crucial and indicate the milking ability of the herd. Das and Sendalo (1990) reported that the weaning weight would reflect mothering ability of does as well as the inherent growth potential. Weaning weight is an excellent indicator of productivity because it reflects both litter size, mothering ability and milking ability (Boggs and Merkel, 1993).

Growth during the pre-weaning period is largely determined by maternal milk production and competition for it amongst litter mates (Luginbul, 2002).

The least squares of variance analysis of Kacang and Peranakan Etawah goats presented (Table 15) revealed that the weaning weight was significantly ($P \leq 0.01$) affected by the sex of the kid. Average of weaning weight of male from both breeds (Figure 11) tends to be higher than those of female goats. Sex of kid influenced the weight at weaning and male kids tend to be heavier than female, was also reported by Okello (1993), Kochapakdee et al. (2000), Alexandre et al. (1999), Das (1993), Zhou et al. (2003), Marai et al. (2002), Lusweti (2000), and Osinowo et al. (1992).

Table 15 demonstrates that the weaning weight of Kacang and Peranakan Etawah goats was significantly ($P \leq 0.01$) affected by birth weight. The regression of birth weight on weaning weight was highly significant ($P \leq 0.01$). The results indicate that for each 1 gram increase in birth weight there is an increase of 3.71 and 11.96 gram weaning weight of Kacang and Peranakan Etawah goats, respectively. Devendra and Burn (1983) and Boggs and Merkel (1993) reported that birth weight of kids is considered to be a very important criterion and strongly correlated with the adult body weight.

5.2.3 Growth Rate till Weaning

The average growth rate till weaning of the Kacang goat was 63.1 kg (SE = 0.77). This value is close to those reported by Astuti et al. (1984) and Sitorus et al. (1985). The average growth rate till weaning of the Peranakan Etawah goat was 123.1 kg (SE = 0.1). The values reported in his study are higher than those reported by by Astuti et al. (1984) and Sutama et al. (1995). The higher growth rate of Peranakan Etawah goats in this study may be related to the management, in which the management of keeping of Peranakan Etawah goats

in the village breeding centre at the Purworejo Regency was better than other locations.

The least squares analysis of variance for growth rate till weaning of Kacang and Peranakan Etawah goats (Table 16) revealed that the growth rate till weaning was significantly ($P \leq 0.01$) affected by parity. Parity was a significant source of variation for the growth rate of goat, also obtained by Inyangala et al. (1990), Gebrelul et al. (1994), Ikwuegbu et al. (1995), Osinowo et al. (1992), Das et al. (1990). Averages of growth rate till weaning of both breeds (Figure 12) increased with the advance in parity up to the 4^{th} parity and slightly decreased thereafter. This may be attributed to physiological maturity of older does and their ability to provide enough milk for the kids. Crepaldi et al. (1999) reported that the ability of does to produce milk had on almost steady growing trend from the first to fifth lactation and the maximum is attained in the fifth parity. Some researchers (Zeng and Escobar, 1995; Haenlein, 2000; Urdaneta et al., 2000; Kennedy et al., 1992) reported that the ability of does to produce milk was significantly affected by parity.

The least squares analysis of variance for the growth rate till weaning of Kacang and Peranakan Etawah goats (Table 16) revealed that the growth rate till weaning was significantly ($P \leq 0.01$) affected by type of birth. Averages of growth rate till weaning of both breeds (Figure 13) decreased with the advance in the type of birth. Single-born kids exhibited a faster growth rate than the twin born kids, also obtained by Das and Sendalo (1990), Gebrelul et al. (1994), Das (1993), Das et al. (1990, 1993), Okello (1993) Alexandre et al. (1999), Osinowo et al. (1992), Ikwuegbu et al. (1995), and Kochapakdee et al. (2000). Growth potential would reflect mothering ability of does (Das and Sendalo, 1990), and growth during the pre-weaning period is largely determined by maternal milk production and competition for it amongst litter mates (Luginbul, 2002; Steve, 2001).

The analysis of variance for growth rate till weaning of Kacang and Peranakan Etawah goats (Table 16) also showed that growth rate till weaning was significantly ($P \leq 0.01$) affected by sex of kid. Results of this study (Figure 13)

showed that pre-weaning average daily of male goats tends to be higher than those of female goats. The sex of kids had a significant effect on the pre-weaning average daily rate, and male goats were significantly heavier and grew faster than females, also reported by Boggs and Merkel (1993), Das et al. (1990), Okello (1993), Alexandre et al. (1999), Osinowo et al. (1992), Kochapakdee et al. (2000), Osinowo et al. (1992) and Karua and Banda (1990).

Results of this study (Table 16) also demonstrated that the birth weight has a significant effect ($P \leq 0.01$) on growth rate till weaning of Kacang and Peranakan Etawah goats. The regression of birth weight on growth rate till weaning was highly significant ($P \leq 0.01$). The results indicate that for each 1 gram increase in birth weight there is an increase of 22.56 and 11.96 gram growth rate till weaning of Kacang and Peranakan Etawah goats, respectively. The major factors affecting the pre-weaning growth are genotype and birth weight (Edey, 1983; Boggs and Merkel, 1993). Madibela et al. (2002) working on Tswana goats concluded that kid birth weight was positively correlated with the growth rate.

5.2.4 Body Condition Score

In the evaluation of live meat goats, body condition scoring can be used as an production parameter. Lawrence and Fowler (1997), Aumont et al. (1994) and Otto et al. (1991) reported that body condition scoring can be a very useful management aid in predicting body composition. Body condition refers to fleshiness an animal (Steele, 1996; Santucii et al., 1991; Luginbuhl, 2002; Thompson and Meyer, 1994; Mangione, 2002; Thomas and Kott, 2002; Thomas and Kott, 2002, Skea, 1990) and is related to all carcass dimensions (Clements et al., 1981). Report of Nicholson and Butterworth's (1986) investigation on animals of the same age and sex demonstrated that live weights, carcass weights edible tissue yield high are correlated with condition score.

Results of this study revealed that the overall value of body condition scoring for all parities was in a moderate condition (score 2). These results are similar to the findings of Sodiq (1997) who investigated the local goats under the village management systems in the Banyumas region of Indonesia.

The analysis of variance for body condition scoring of Kacang and Peranakan Etawah goats (Table 17) revealed that body condition scoring was significantly ($P \leq 0.01$) affected by parity. Average of body condition scoring of both breeds for all birth types (Figure 14) tends to increase with the advance in parity up to the 4^{th} parity and slightly decrease thereafter. This may be due to increasing the growth rate of kid and associated with the physiological maturity of does, particularly in producing milk.

The analysis of variance for body condition scoring of Kacang and Peranakan Etawah goats (Table 17) also revealed that body condition scoring was significantly ($P \leq 0.01$) affected by the type of birth. Averages of body condition scoring of male and female of both breeds (Figure 15) tends to decrease with the advance in the type of birth. The higher body condition scoring in a smaller litter may be due to the low growth rate of kid as a result of the decrease in the share of each kid in milk production of their mother during the suckling period. The average body condition scoring of male goats in all birth types (Figure 15) was higher than that on female goats. The difference between males and females is significant by the Kacang goats. Nicholson and Butterworth (1986) reported that body condition scoring was affected by the sex of animal.

The results (Table 17) also demonstrated that the body condition scoring of Kacang and Peranakan Etawah goats was significantly ($P \leq 0.01$) affected by birth weight. The regression of birth weight on body condition scoring was highly significant ($P \leq 0.01$). This study indicates that for each 1 gram increase in birth weight there is an increase of 1.89 and 1.75 body condition scoring of Kacang and Peranakan Etawah goats, respectively. Similar results on the effect of birth weight on body condition scoring was also reported by Nicholson and Butterworth (1986), Aumont et al. (1994), Teixeira (1989) and Sanson et al. (1993). Sodiq et al. (1997) found that there was a relationship between body

condition scoring and the carcass weight of local goats in the Banyumas region of Indonesia. The relationship between body weight and condition score on the Rasa Arganesa breed was semilogarithmic (Teixeira, 1989), and the relationship between carcass fat depots and condition score was logarithmic. The relationship between body weight and condition scores was high (0.89) and an analysis indicated that each unit increase in condition scores resulted in an increase of 5.1 kg in body weight (Sanson et al., 1993). The correlation of condition scores with carcass fatness was also reported by Otto et al. (1991).

5.2.5 Leg Conformation Index

In the evaluation of live goats particularly for meat production, leg conformation is an important indicator. Conformation reflects the relationship between the skeleton and the covering of muscle and fat (Alliston, 1983) and the thickness of muscle and fat in relation to skeletal size (Butterfield, 1988). Leg conformation indicates both the growability and the relative composition of the animal (Boggs and Merkel, 1993) particularly the unribbed carcass to obtain an assessment of overall muscling.

The analysis of variance for leg conformation index of Kacang and Peranakan Etawah goats (Table 18) revealed that leg conformation index was significantly ($P \leq 0.01$) affected by parity. Averages of leg conformation index of both breeds for all birth types (Figure 16) tend to increase with the advance in parity up to the 4^{th} parity and slightly decrease thereafter. The increasing leg conformation up to the 4^{th} parity could be related with the increasing growth rate of the kid (Figure 12). This may be attributed to physiological maturity of older does and their ability to provide enough milk for the kids. Some researchers (Zeng and Escobar, 1995; Haenlein, 2000; Urdaneta et al., 2000; Kennedy et al., 1992) reported that the ability of the doe to produce milk was significantly affected by parity. The ability to produce milk was almost a steady growing trend from first

to fifth lactation and the maximum is attained in the fifth parity (Crepaldi et al. 1999).

The analysis of variance for leg conformation index of Peranakan Etawah goats (Table 18) also revealed that leg conformation index was significantly ($P \leq 0.01$) affected by sex. Averages of leg conformation index of male goats in all birth types of both breeds was higher than that on female goats (Figure 17). The effect of sex on leg conformation of kid was also obtained by Soedjadi et al. (1989) and Rismaniah et al. (1990). The average lengths of leg of female and male post weaning goats were 14.29 $\pm$ 1.84 cm (ranged 12-18 cm) and 14.39 $\pm$ 1.58 cm (ranged 12.5-18 cm), respectively. The average circumferences of leg of female and male post weaning goats were 24.32 $\pm$ 1.84 cm (ranged 17-28.5 cm) and 25.10 $\pm$ 1.58 cm (ranged 12.5-18 cm), respectively.

The least square analysis of variance for leg conformation index of Kacang and Peranakan Etawah goats (Table 18) also revealed that leg conformation index was significantly ($P \leq 0.01$) affected by the type of birth. Average leg conformation index of males and females of both breeds tends to decrease with the advance in type of birth (Figure 17). The higher leg conformation index in smaller litter was associated with the higher growth rate of kid in smaller litter (Figure 12). This is possibly related to the share of each kid in milk production of their mother during the suckling period.

The analysis of variance (Table 18) revealed that the leg conformation index of Kacang and Peranakan Etawah goats was, as the body scoring, significantly ($P \leq 0.01$) affected by birth weight. Results of this study demonstrated that for each 1 gram increase in birth weight there is an increase of 21.36 and 8.47 leg conformation index of Kacang and Peranakan Etawah goats, respectively. Results of Purnama and Sodiq (1998) whose studies on local goats in Banyumas found a relationship between leg conformation and carcass weight. Rismaniah et al. (1990) found that there were relation between leg conformation and body weight on local goats in the Tegal Subdistrict of Indonesia.

6 SUMMARY AND CONCLUSIONS

Small ruminants like sheep and goats are important for a larger part of the Indonesia. Nearly ninety nine percent of goats in Indonesia are found in the hands of smallholders. Goats play an important role as an income generating activity, particularly for smallholders, whilst being a source of animal protein to support the national programme. The number of goats raised per farm is relatively small with the cut and carry, and grazing system. Goats are kept primarily for meat production, so production traits of interest are the number of young weaned per breeding female per year and their growth rate.

The majority of goats in Indonesia is concentrated on the Island of Java with the major breeds being the Kacang and Peranakan Etawah goat. Kacang is a local breed of goat found in Indonesia. This population is adapted to a wide range of management conditions and feeding regimes in the region. Peranakan Etawah goats are descended originally from crossings between the Kacang with Etawah (Jamnapari) goats. The Indonesian breeds of goats are small and relatively slow growing. There has been some interest in introduction of other genotypes, for example, the Etawah goat has already been widely crossed with the Kacang goat.

This thesis aims at describing the level of production and reproduction of Kacang and Peranakan Etawah goats under the village production system, and also describing factors affecting them. Litter size, litter weight at birth, litter weight at weaning, survival rate till weaning, kidding interval, and doe productivity index were studied on the doe reproductive traits. The production traits of the kids studied were: birth weight, growth rate till weaning, weaning weight, body condition score, and leg conformation. Factors of parity, type of birth, sex, birth weight, litter weight at birth and at weaning were examined in this study.

This study was carried out by on-farm research commencing in December 1999 and finishing in July 2002, located in the Grobogan and Purworejo region, Central Java, Indonesia. On-farm research conducted under smallholders (private farms) involved 480 does and 2000 kids of Peranakan Etawah and Kacang goats. The herds were monitored (visited) regularly. Each herd was visited at the commencement of the study and does were identified with a neckband tag. Herd owners and village staff (or head of cooperation and extension worker) were issued with scales to help record birth and doe weight. Breeding record cards were also prepared, so that they could help to collect data related to date of mating, kidding date and sex of kids.

The data were analysed statistically according to the analysis of variance procedure using the General Linear Model (GLM). Duncan's multiple range and Tukey's honestly significant difference test were used to identify significant differences. SigmaPlot 4.0 was used to produce the exact graphs. The linear regression on litter weight at birth was calculated to access the litter weight at weaning. The linear regression on litter weight at weaning was calculated to predict the survival rate till weaning, kidding interval and doe productivity. The linear regression on birth weight of kid was also calculated to predict some traits of kid production: weaning weight, growth rate till weaning, condition scoring and leg conformation.

Results obtained could be summarized as follows:

1.1 Type of Birth

Type of birth (litter size) of Kacang and Peranakan Etawah goat was significantly affected by parity. Average litter sizes of both breeds gradually tend to increase with the advance in parity up to the 4^{th} parity and then slightly decreased in the 5^{th} parity. Litter size of Kacang goat tends to be higher than those of Peranakan Etawah goat.

1.2 Litter Weight at Birth

Litter weight at birth of of Kacang and Peranakan Etawah goat was significantly affected by parity and type of birth. Averages of litter weight at birth of both breeds increased with the advance in parity up to the 4th parity and slightly decreased thereafter. Average litter weight at birth of both breeds increased progressively with the advance in type of birth. Litter weight at birth of Kacang goat tends to be lighter than those of Peranakan Etawah goat.

1.3 Litter Weight at Weaning

Litter weight at weaning of Kacang and Peranakan Etawah goat was significantly affected by parity, type of birth and litter weight at birth. Averages of litter weight at weaning of both breeds tend to increase with the advance in parity up to the 4th parity and slightly decrease thereafter. Averages of litter weight at weaning of both breeds increased progressively with the advance in type of birth. The regression of litter weight at birth on litter weight at weaning was highly significant, and with each 1 gram increase in litter weight at birth there is an increase of 4.48 and 3.37 gram litter weight at weaning of Kacang and Peranakan Etawah goats, respectively. Litter weight at weaning of Kacang goat tends to be lighter than those of Peranakan Etawah goat.

1.4 Survival Rate till Weaning

Survival rate till weaning of Kacang and Peranakan Etawah goats was significantly affected by type of birth, parity and litter weight at weaning. Averages survival rate till weaning both breeds decreased progressively with the advance in the type of birth. Average of survival rate till weaning of both breeds increased with the advance in parity up to the 4th parity and then slightly decreased. The regression of survival rate till weaning on litter weight at weaning was highly significant. The result indicated that for each 1 gram increase in litter weight at weaning there is an increase of 0.39 and 0.64 percent survival rate till weaning of Kacang

and Peranakan Etawah goats, respectively. Survival rate till weaning of Kacang goat tends to be higher than those of Peranakan Etawah goat.

1.5 Kidding Interval

Kidding interval of Kacang and Peranakan Etawah goats was significantly affected by type of parity and type of birth. The kidding interval of both breeds extended with the advance in parity up to the 4^{th} parity and slightly shortened thereafter. Averages of kidding interval of both breeds shortened progressively with the advance in type of birth. The effect of litter weight at weaning was insignificantly on kidding interval of Kacang and Peranakan Etawah goat. Kidding interval of Kacang goat tends to be shorter than those of Peranakan Etawah goat.

1.6 Doe Productivity index

Doe productivity index (kg/doe/year) of Kacang and Peranakan Etawah was significantly affected by the type of birth, parity and litter weight at weaning. Averages of doe productivity index of both breeds increased progressively with the advance in type of birth. Averages of doe productivity index of both breeds increased with the advance in parity up to the 4^{th} parity and slightly decreased thereafter. The regression of litter weight at weaning on doe productivity index was highly significant. The result indicated that for each 1 kg increase in litter weight at weaning there is an increase of 1.806 and 1.442 kg/doe/year doe productivity index of Kacang and Peranakan Etawah goats, respectively. Doe productivity index of Kacang goat tends to be lower than those of Peranakan Etawah goat.

2 Production Traits of Kacang and Peranakan Etawah Kids

2.1 Birth Weight

Birth weight of Kacang and Peranakan Etawah goats was significantly affected by parity, type of birth and sex of kid. Averages of birth weight of both breeds increased with the advance in parity up to the 4th parity and slightly decreased thereafter, and male goats tend to be higher than those of females. Average of birth weight of both breeds tend to decrease with the advance in the type of birth. Birth weight of Kacang goat tends to be lower than those of Peranakan Etawah goat.

2.2 Weaning Weight

Weaning weight of Kacang and Peranakan Etawah goats was significantly affected by parity, type of birth, sex and birth weight. Averages of weaning weight of both breeds increased with the advance in parity up to the 4th parity and slightly decreased thereafter. Averages of weaning weight of both breeds decreased with the advance in type of birth, and weaning weight of males tends to be higher than those of females. The regression of birth weight on weaning weight was highly significant. The results indicate that for each 1 gram increase in birth weight there is an increase of 3.71 and 11.96 gram weaning weight of Kacang and Peranakan Etawah goats, respectively. Weaning weight of Kacang goat tends to be lower than those of Peranakan Etawah goat.

2.3 Growth Rate till Weaning

Growth rate till weaning of Kacang and Peranakan Etawah goats was significantly affected by parity, type of birth, sex and birth weight. Averages of growth rate till weaning of both breeds increased with the advance in parity up to the 4th parity and slightly decreased thereafter. Averages of growth rate till weaning of both breeds decreased with the

advance in the type of birth, and male goats tends to be higher than those of females. The regression of birth weight on growth rate till weaning was highly significant (P≤0.01). The results indicate that for each 1 gram increase in birth weight there is an increase of 22.56 and 11.96 gram growth rate till weaning of Kacang and Peranakan Etawah goats, respectively. Growth rate till weaning of Kacang goat tends to be slower than those of Peranakan Etawah goat.

2.4 Body Condition Score

Body condition scoring of Kacang and Peranakan Etawah goats was significantly affected by parity, type of birth, sex and birth weight. Average of body condition scoring of both breeds tends to increase with the advance in parity up to the 4^{th} parity and to slightly decrease thereafter. Averages of body condition scoring of both breeds tends to decrease with the advance in type of birth, and male goats was higher than that of female. The regression of birth weight on body condition scoring was highly significant. Results indicate that for each 1 gram increase in birth weight there is an increase of 1.89 and 1.75 body condition scoring of Kacang and Peranakan Etawah goats, respectively. Body condition scoring of the Kacang goat tends to be higher than those of the Peranakan Etawah goat.

2.5 Leg Conformation Index

Leg conformation index of Kacang and Peranakan Etawah goats revealed that leg conformation index was significantly affected by parity, type of birth, sex and birth weight. Averages of leg conformation index of both breeds tend to increase with the advance in parity up to the 4^{th} parity and slightly decrease thereafter. Average leg conformation index of males and females of both breeds tend to decrease with the advance in type of birth, and male goats was higher than that of female goats. The regression of birth weight on body condition scoring was highly significant. Results indicated that for each 1 gram increase in birth weight

there is an increase of 21.36 and 8.47 leg conformation index of Kacang and Peranakan Etawah goats, respectively. Leg conformation index of the Kacang goat tends to be higher than those of the Peranakan Etawah goat.

The study has demonstrated that the tested factors (parity, type of birth, sex, birth weight, litter weight at birth and at weaning) exerted significant influences on the level of production and reproduction of Kacang and Peranakan Etawah goats under the village production system. The results call for management efforts in order to improve the production and reproduction level :

1. Curb mortality especially in a higher litter
2. Increase litter size at birth and at weaning
3. To reduce intervals between kiddings, especially in Peranakan Etawah goat
4. Increase the body weight (at birth and at weaning) especially for the Kacang goat.

Improvement genetically by selection based on criteria of the weaning weight (for the Kacang goat) and the litter size (for the Peranakan Etawah goat) are also recommended.

7 RINGKASAN DAN KESIMPULAN

Ternak ruminansia kecil seperti domba dan kambing berperanan sangat penting pada pada sebagain besar negara Indonesia. Mendekati 99 persen ternak kambing di Indonesia berada di tangan petani kecil. Peranan ternak kambing sebagai sumber pendapatan khususnya bagi petenai kecil adalah sangat nyata, disamping itu juga berperanan sebagai salah satu sumber protein hewani untuk mendukung program Nasional. Jumlah kepemilikan ternak kambing pada setiap peternak adalah relatip kecil dengan sistem pemeliharaan pada umumnya dikandangkan dan juga digembalakan. Tujuan utama pemeliharaan ternak kambing pada umumnya adalah untuk produksi daging, sehingga karakteristik produksi yang diprioritaskan adalah produksi cempe setiap induk dalam setiap tahun serta karakteristik pertumbuhannya.

Di Indonesia, mayoritas ternak kambing terkonsentrasi di Pulau Jawa dan bangsa kambing yang ditemukan adalah bangsa Kambing Kacang dan Peranakan Etawah. Kambing Kacang adalah jenis kambing lokal dan merupakan bangsa kambing asli yang ditemukan di Indonesia. Populasi dari Kambing Kacang telah beradaptasi dengan kindisi lingkungan pemeliharaan dan pakan setempat. Kambing Peranakan Etawah merupakan kambing hasil persilangan antara Kambing Kacang dengan Kambing Etawah (Jamnapari). Bangsa kambing Indonsia berakarakteristik ukuran tubuhnya relatip kecil dan laju pertumbuhannya relatip lambat. Alasan itulah yang menjadikan ketertarikan untuk mengintroduksi genotipe kambing yang lain seperti telah dilakukan persilangan natara Kambing Etawah dengan Kambing Kacang.

Tujuan dari penelitian ini adalah untuk mengetahui tingkat produksi dan reproduksi dari Kambing Kacang dan Peranakan Etawah pada sistem pemeliharaan di pedesaan dan juga untuk mengetahui beberapa faktor yang mempengaruhi tingkat produksi dan reproduksinya. Karakteristik reproduksi yang diamati pada induk kambing adalah jumlah anak sekelahiran, total bobot cempe saat lahir, total bobot cempe saat disapih, kemampuan hidup cempe

hingga di sapih, jarak beranak dan indeks produktivitas induk. Adapun karakteristik produksi yang diamati pada cempe adalah bobot lahir, bobot sapih, laju pertubuhan, nilai kondisi tubuh dan konfoormasi paha. Beberapa faktor yang diidentifikasi berpengaruh terhadap produksi dan reproduksi adalah tingkat beranak, tipe kelahiran, jenis kelamin, bobot lahir dan bobot sapih.

Untuk menjawab tujuan penelitian ini maka telah dilakukan penelitian lapangan dengan sasaran ternak Kambing Kacang dan Kambing Peranakan Etawah yang dipelihara pada sistem pedesaan. Untuk ternak Kambing Kacang dilakukan di Kecamatan Gundi Kabupaten Grobogan, sedangkan untuk ternak Kambing Peranakan Etawah dilakukan di kecamatan Kaligesing Kabupaten Purworejo Propinsi Jawa-Tengah, Indonesia. Penelitian lapangan pada peternakan rakyat ini melibatkan sekitar 480 ekor induk kambing dan 2000 ekor cempe. Pada awal tahap penelitian dilakukan identifikasi terhadap populasi ternak dalam kanadang dan individu induk. Pengamatan dilakukan secara reguler dan berkesinambungan. Pada tahap awal dicatat bebrapa data berikut ini (1) Rincian data populasi termasuk jumlah danbangsa ternak serta tipe pemeliharaan, (2) Rincian data individu induk seperti bangsa, umur dan tingkat kelahiranDisediakan kartu catatan produksi untuk setiap induk dan beberapa alat penelitian seperti timbangan dan tali untuk menimbang. Untuk memperlancar proses pengumpulan data pada penelitian ini, dilibatkan pula para tokoh masyarakat dan kelompok petani ternak setempat.

Seluruh data yang terkumpul dianalisis dengan Sidik Ragam menggunakan prosedur General Linear Model (GLM) dari perangkat lunak Statistical Product and Service Solution (SPSS). Uji lanjut dilakukan dengan menggunakan Duncan’s multiple range dan Tukey’s honestly. Untuk memproduksi grafik digunakan program Sigma Plot versi 4.0. Analisis Regresi Linier juga diterapkan untuk memprediski bobot sapih dengan parameter bobot lahir. Analisis Regresi Linear juga diterapkan untuk memprediksi daya hidup cempe hingga umur disapih, jarak beranak dan indeks produktivitas induk dengan menggunakan prediktor total bobot cempe saat disapih. Analisis serupa juga dilakukan untuk memprediksi bobot sapih, laju pertumbuhan cempe, kondisi

tubuh dan konformasi paha yang diprediksi dengan menggunakan prediktor bobot lahir cempe.

Dari hasil penelitian ini dapat disimpulkan beberapa hal sebagai berikut:

1 Karakteristik produksi Kambing Kacang dan Peranakan Etawah

1.1 Tipe Kelahiran

Tipe kelahiran atau jumlah anak sekelahiran pada Kambing Kacang dan Peranakan Etawah nyata dipengaruhi oleh paritas induk. Rataan jumlah anak sekelahiran untuk kedua bangsa kambing tersebut akan meningkat sesuai dengan tingkat paritas hingga paritas ke-4 dan kemudian akan menurun mulai paritas ke-5. Kambing Kacang cenderung memiliki jumlah anak sekelahiran relatip lebih banyak dibandingkan dengan Kambing Peranakan Etawah.

1.2 Total Bobot Cempe Saat Lahir

Total bobot cempe saat lahir pada Kambing Kacang dan Peranakan Etawah nyata dipengaruhi oleh paritas induk dan tipe kelahiran. Rataan total bobot cempe saat lahir untuk kedua bangsa kambing tersebut akan meningkat sesuai dengan tingkat paritas hingga paritas ke-4 dan kemudian akan menurun mulai paritas ke-5. Total bobot cempe saat lahir untuk kedua bangsa kambing tersebut juga akan meningkat seiring dengan meningkatnya jumlah anak sekelahiran. Kambing Kacang cenderung memiliki total bobot cempe saat lahir relatip lebih ringan dibandingkan dengan Kambing Peranakan Etawah.

1.3 Total Bobot Cempe Saat Sapih

Total bobot cempe sapih pada Kambing Kacang dan Peranakan Etawah nyata dipengaruhi oleh paritas induk, tipe kelahiran dan total bobot cempe lahir. Rataan total bobot cempe sapih untuk kedua bangsa kambing tersebut akan meningkat sesuai dengan tingkat paritas hingga paritas ke-4 dan kemudian akan menurun mulai paritas ke-5. Total bobot cempe saat sapih untuk kedua bangsa kambing tersebut juga akan

meningkat seiring dengan meningkatnya jumlah anak sekelahiran. Setiap peningkatan 1 gram total bobot cempe saat lahir akan diikuti oleh peningkatan total bobot cempe saat sapih masing-masing sebesar 4.48 dan 3.37 gram untuk Kambing Kacang dan Peranakan Etawah. Kambing Kacang cenderung memiliki total bobot cempe saat sapih relatip lebih ringan dibandingkan dengan Kambing Peranakan Etawah.

1.4 Daya Hidup Cempe sampai Sapih

Daya hidup cempe sampai sapih pada Kambing Kacang dan Peranakan Etawah nyata dipengaruhi oleh paritas induk, tipe kelahiran dan total bobot cempe saat sapih. Rataan daya hidup cempe sampai sapih untuk kedua bangsa kambing tersebut akan meningkat sesuai dengan tingkat paritas hingga paritas ke-4 dan kemudian akan menurun mulai paritas ke-5. Daya hidup cempe sampai sapih untuk kedua bangsa kambing tersebut juga akan meningkat seiring dengan meningkatnya jumlah anak sekelahiran. Setiap peningkatan 1 gram total bobot cempe saat sapih akan diikuti oleh peningkatan daya hidup cempe sampai sapih masing-masing sebesar 0.39 dan 0.64 persen untuk Kambing Kacang dan Peranakan Etawah. Kambing Kacang cenderung memiliki daya hidup cempe sampai sapih relatip lebih tinggi dibandingkan dengan Kambing Peranakan Etawah.

1.5 Jarak Beranak

Jarak beranak pada Kambing Kacang dan Peranakan Etawah nyata dipengaruhi oleh paritas induk and tipe kelahiran. Jarak beranak untuk kedua bangsa kambing tersebut akan semakin pendek seiring tingkat paritas hingga paritas ke-4 dan kemudian akan memanjang mulai paritas ke-5. Jarak beranak untuk kedua bangsa kambing tersebut juga akan memendek seiring dengan meningkatnya jumlah anak sekelahiran. Jarak beranak pada Kambing Kacang dan Peranakan Etawah nyata tidak dipengaruhi oleh total bobot cempe saat sapih. Kambing Kacang cenderung memiliki jarak beranak relatip lebih pendek dibandingkan dengan Kambing Peranakan Etawah.

1.7 Indeks Produktivitas Induk

Indeks produktivitas induk (kg/induk/tahun) pada Kambing Kacang dan Peranakan Etawah nyata dipengaruhi oleh paritas induk, tipe kelahiran dan total bobot cempe saat sapih. Indeks produktivitas induk untuk kedua bangsa kambing tersebut akan meningkat sesuai dengan tingkat paritas hingga paritas ke-4 dan kemudian akan menurun mulai paritas ke-5. Indeks produktivitas induk untuk kedua bangsa kambing tersebut juga akan meningkat seiring dengan meningkatnya jumlah anak sekelahiran. Setiap peningkatan 1 kg total bobot cempe saat sapih akan diikuti oleh peningkatan indeks produktivitas induk masing-masing sebesar 1.806 dan 1.442 kg/induk/tahun untuk Kambing Kacang dan Peranakan Etawah. Kambing Kacang cenderung memiliki indeks produktivitas induk relatip lebih rendah dibandingkan dengan Kambing Peranakan Etawah.

2 Karakteristik produksi Kambing Kacang dan Peranakan Etawah

2.1 Bobot Lahir

Bobot lahir pada Kambing Kacang dan Peranakan Etawah nyata dipengaruhi oleh paritas induk, tipe dan jenis kelamin. Bobot lahir untuk kedua bangsa kambing tersebut akan meningkat sesuai dengan paritas hingga paritas ke-4 dan kemudian akan menurun mulai paritas ke-5. Bobot lahir cempe untuk kedua bangsa kambing tersebut juga akan menurun seiring dengan meningkatnya jumlah anak sekelahiran. Kambing Kacang cenderung memiliki bobot lahir relatip lebih rendah dibandingkan dengan Kambing Peranakan Etawah.

2.2 Bobot Sapih

Bobot sapih pada Kambing Kacang dan Peranakan Etawah nyata dipengaruhi oleh paritas induk, tipe, jenis kelamin dan bobot lahir. Bobot sapih untuk kedua bangsa kambing tersebut akan meningkat sesuai dengan paritas hingga paritas ke-4 dan kemudian akan menurun mulai paritas ke-5. Bobot sapih untuk kedua bangsa kambing tersebut juga

akan menurun seiring dengan meningkatnya jumlah anak sekelahiran. Setiap peningkatan 1 gram bobot lahir cempe akan diikuti oleh peningkatan bobot sapih cempe masing-masing sebesar 3.71 dan 11.96 gram untuk Kambing Kacang dan Peranakan Etawah. Kambing Kacang cenderung memiliki bobot sapih relatip lebih rendah dibandingkan dengan Kambing Peranakan Etawah.

2.3 Laju Pertumbuhan Cempe sampai Umur Sapih

Laju pertumbuhan sampai umur sapih pada Kambing Kacang dan Peranakan Etawah nyata dipengaruhi oleh paritas induk, tipe, jenis kelamin dan bobot lahir. Laju pertumbuhan sampai umur sapih untuk kedua bangsa kambing tersebut akan meningkat sesuai dengan paritas hingga paritas ke-4 dan kemudian akan menurun mulai paritas ke-5. Laju pertumbuhan sampai umur sapih untuk kedua bangsa kambing tersebut juga akan menurun seiring dengan meningkatnya jumlah anak sekelahiran. Setiap peningkatan 1 gram bobot lahir cempe akan diikuti oleh peningkatan laju pertumbuhan cempe sampai umur sapih masing-masing sebesar 22.56 dan 11.96 gram untuk Kambing Kacang dan Peranakan Etawah. Kambing Kacang cenderung memiliki laju pertumbuhan sampai umur sapih relatip lebih rendah dibandingkan dengan Kambing Peranakan Etawah.

2.4 Nilai Kondisi Tubuh

Nilai kondisi tubuh pada Kambing Kacang dan Peranakan Etawah nyata dipengaruhi oleh paritas induk, tipe, jenis kelamin dan bobot lahir. Nilai kondisi tubuh untuk kedua bangsa kambing tersebut akan meningkat sesuai dengan paritas hingga paritas ke-4 dan kemudian akan menurun mulai paritas ke-5. Nilai kondisi tubuh untuk kedua bangsa kambing tersebut juga akan menurun seiring dengan meningkatnya jumlah anak sekelahiran. Setiap peningkatan 1 gram bobot lahir cempe akan diikuti oleh peningkatan nilai kondisi tubuh masing-masing sebesar 1.89 dan 1.75 untuk Kambing Kacang dan Peranakan Etawah. Nilai kondisi tubuh Kambing Kacang relatip lebih tinggi dibandingkan dengan Kambing Peranakan Etawah.

2.5 Indeks Konformasi Paha

Indeks konformasi paha Kambing Kacang dan Peranakan Etawah nyata dipengaruhi oleh paritas induk, tipe, jenis kelamin dan bobot lahir. Indeks konformasi paha untuk kedua bangsa kambing tersebut akan meningkat sesuai dengan paritas hingga paritas ke-4 dan kemudian akan menurun mulai paritas ke-5. Indeks konformasi paha untuk kedua bangsa kambing tersebut juga akan menurun seiring dengan meningkatnya jumlah anak sekelahiran. Setiap peningkatan 1 gram bobot lahir cempe akan diikuti oleh peningkatan indeks konformasi paha masing-masing sebesar 21.36 dan 8.47 1.89 untuk Kambing Kacang dan Peranakan Etawah. Indeks konformasi paha pada Kambing Kacang relatip lebih tinggi dibandingkan pada Kambing Peranakan Etawah.

Dari dari kajian pada penelitian ini telah dibuktikan dan diidentifikasi berapa faktor secara nyata berpengaruh terhadap tingkat produksi dan reproduksi Kambing Kacang dan Peranakan Etawah pada sistem pemeliharaan di pedesaan. Adapun faktor tersebut adalah peringkat kelahiran, tipe kelahiran, jenis kelmain, bobot lahir cempe, bobot sapih cempe, total bobot cempe saat lahir dan saat disapih. Dari hasil temuan ini, ada beberapa rekomendasi untuk meningkatkan tingkat produksi dan reproduksi antara lain:

(1) Meminimalkan angka kematian cempe sebelum sapih terutama pada tipe jumlah anak sekelahiran yang tinggi

(2) Meningkatkan jumlah anak sekelahiran pada saat dan disapih

(3) Memperpendek jarak beranak terutama pada Kambing Peranakan Etawah

(4) Meningkatkan bobot badan pada saat lahir dan disapih terutama untuk Kambing Kacang.

Disarankan pula usaha perbaikan melalui peningkatan mutu genetik dengan menerapkan sistem seleksi dengan menggunakan kriteria seleksi bobot sapih cempe (untuk Kambing Kacang) dan kriteria seleksi jumlah anak sekelahiran (untuk Kambing Peranakan Etawah).

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