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**Review article**

## **Genetic parameters and environmental factors influencing weaning weight in livestock production**

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### ABSTRACT

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This is a review paper that focuses on genetic parameters and various environmental factors affecting weaning weight in animal production. Animal production is affected by both genetic and non-genetic factor, and level of weaning weight performance depends on their interaction. The estimates of direct heritability of weaning weight vary from medium to high which makes it a suitable selection candidate trait, however cognisance should be taken of the antagonism of genes controlling direct and maternal effects. The variation in genetic parameter estimates may be due to a variety of factors which include breed differences, management, data preparation and methods of estimation. Estimates of genetic parameters for weaning weight is partly model dependent and ignoring of maternal genetic effect in the model leads to overestimation of direct heritability. Whilst genetics is a major influence on weaning weight, there are also a large number of environmental, nutritional and management factors that impinge on weaning weight of an individual. Estimation of reliable estimates of genetic parameters for weaning weight need to take into account the adjustment of performance data for environmental factors hence this will increase the accuracy of selection of breeding animals. An understanding of environmental factors which affect weaning weight will direct changes in the breeding and management programs to minimise influences which reduce production efficiency.

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Most environmental factors are significant source of variation for weaning weight and play an important role in expression of genetic potential. Management system is one of the many factors which could affect weaning weight in livestock since in a farm situation young ones will be subjected to the same season, parity, climatic conditions in terms of availability of feed, medication and vaccination. The review paper therefore, concludes that a number of environmental factors affect weaning weight can directly obscure recognition of genetic potential of individuals.

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## 1. Introduction

Appropriate knowledge on variance components and genetic parameters for production traits such as weaning weight in animal production is paramount (Franke et al 2001; Intaratham et al., 2008; Vergara et al., 2009). Weaning weight of an animal is determined not only by its genetic potential but also by the maternal environment (Ribeiro et al., 2001; Atil et al., 2005; Hwange et al., 2008) hence accurate estimates for maternal genetic effects and their contribution with direct effects are essential (Speidel et al., 2007; Canas et al., 2008). Different estimates of direct and maternal heritability for weaning weight, which are low to high have been reported in literature for different animals species by Meyer, (1993) in cattle, Assan and Makuza, (2005) in sheep, Gholizadeh et al., (2010) in goats and Fernandez et al.,(2008) in pigs.

Weaning weight is the most important economic trait determining economic returns from any animal production enterprise and provide a good example of a trait subject to both genetic and environmental variation (Assan and Makuza, 2005). Weaning weight would reflect mothering ability of dam as well as the inherent growth potential of individuals animal. In addition to knowledge on genetic parameters, environmental factors influencing weaning weight in livestock is of interest to farmers as well as the animal breeders, because weaning weight is of great economic importance in livestock production. Both genetic parameters and information on environmental factors affecting weaning weight may be of value in general livestock management decision making and animal selection. Production traits such as weaning weight are affected by various non-genetic factors like sex, year, type of birth, dam age and management (Kumar et al., 2007; Paul et al., 1990). The review paper looks at the genetics and influences of environmental factors which might obscure recognition of genetic potential of individuals for weaning weight performance in animal production.

## 2. Genetic parameters for weaning weight

### 2.1. Cattle

Different models and methods have been used in estimating direct and maternal genetic parameters for weaning weight data in cattle (Meyer, 2001; De Mattos et al., 2000; Maiwashe et al., 2002; Beffa, 2005; Choi et al., 2000; Bosso et al., 2009; Palacios-Espinosa et al., 2010) and previously the ranking of models was mostly done by log likelihood ratio test (Dobson, 1990). Mohhiuddin et al., (1993) weighting various published estimates by the number of records used in each analysis obtained average values for weaning weight of 0.22 for direct genetic effect, 0.13 for maternal genetic effect and -0.15 for the genetic correlation between these parameters. Koots et al., (1994a) weighting various published estimates by the inverse of their sampling variance obtained mean heritabilities of the direct effect of 0.24 for weaning weight. The heritability estimates reported by several authors in cattle ranged from 0.80 to 0.25 depending on the model used and breed studied (Mattos et al., 2000; Guitierrez et al., 2007; Vostryt et al., 2007; Dezfuli et al., 2009). It was observed that estimates of direct heritability depended much on the model used with a range of zero to 0.68. The range of direct heritability estimates of 0.8 to 0.25 which were depended on the model used and breed of calves were reported in literature (Mercadante et al., 1997; Dodenhoff et al., 1999; DeMattos et al., 2000; Gutierrez et al., 2007; Vostryt et al 2007; Dezfuli et al., 2009;). Low direct heritability estimates for weaning weight were reported by some

authors for various breeds (Waldron et al., 1993; Lee et al., 1997). Goyache et al (2003) working with beef cattle reported high direct heritability of weaning weight of 0.67 which coincide with the direct heritability reported by Assan (2010) fitting different animal models in Tuli cattle. In this study the inclusion of additive maternal and/or maternal permanent environmental effects to the models reduced the direct heritabilities for weaning weight. The same result was observed in previous reports which compared models by Dodenhoff et al., (1999) and Vostry et al., (2007). Depending on the model used maternal heritability ranged from 0.09 to 0.26 for weaning weigh (Assan 2010). Lower maternal heritability for weaning weight was reported by Atil et al. (2005).

Low and positive estimate of direct-maternal correlation for weaning weight were reported by Assan (2010). The same result was also reported by Dodenhoff et al., (1999) for Angus cattle. The positive direct-maternal genetic correlation may suggest that relationship between the genetic structure of the calve and genetic structure of the dam has a certain effect on the calve weaning weight. Elsewhere negative direct-maternal genetic correlation has been reported in cattle for weaning weight (Atil et al., 2005). Meyer (1992) compared results from different studies of direct-maternal genetic correlation for weaning weight in beef cattle and argued that less than sufficient environment may impose a negative correlation. Koch (1972). suggested that excess milk production by her daughters, also resulting in a negative dam-offspring correlation. He suggested that high weaning weight impede milking potential of the developing animal, which may not be the case with the livestock indigenous to the harsh tropical environment hence the low and positive direct-maternal correlation in indigenous Tuli calves(Assan, 2011). Meyer (1997) suggested that inflated estimates of direct-maternal correlations for weaning weight might be caused to some extent by unaccounted sources of variation in the model used. A negative genetic covariance between direct and maternal genetic effects has been observed in cattle (Norris et al., 2004; Iwaisaki et al., 2005). However, other studies found covariance between direct and maternal genetic effects to be positive for weaning weight (Plasse et al., 2002; Assan 2011). The reason for the positive relationship in previous studies on growth traits could not conclusively be explained by authors (Dodenhoof et al., 1999).

Foulley and Lefort (1978) suggested that the estimation of maternal effects and their respective genetic parameters is inherently problematic and, due to the confusion of direct and maternal effect, subject to large sampling errors. Meyer (1994) attributed them also to a large extent, to sampling co-variation. Whilst Shi et al., (1993) thought there could also be a covariance between direct and maternal environments. Robinson (1996b) showed a dramatic increase in likelihood along with a substantial reduction in estimate of covariance of direct and maternal when additional effects such as sire\* herd effect or regression on maternal phenotypic were included in the model of analysis. An investigation conducted by Dodenhoff et al., (1999) on several breeds of beef cattle indicates that dependences between direct and maternal genetic effects are determined by breed. Swalve (1993) suggested that the negative covariance between direct and maternal genetic effects may be the result of management system. Gutierrez et al., (1997) reported antagonism between direct and maternal genetic effects for weaning weight for Zebu cattle and suggested that this antagonistic relationship should be compensated by improving managerial practices and using supplemental feeding when necessary. In contrary, Maniatis and Pollot (2003) reported that estimation of the correlation between direct and maternal genetic effects is dependent on key pedigree relationships where a high proportion of both dams and maternal grand dams with their own records are essential. Meyer (1997) found that large, negative estimates of direct and maternal genetic covariance are associated with overestimating of additive direct and maternal variance.

## **2.2. Sheep**

Direct heritability estimates in the range of 0.07 to 0.18 have been reported in literature (Abboud, 1989; Notter, 1998) and in a summary, Wiener (1994) from 12 studies reported direct heritability range of 0.08 to 0.68 for weaning weight. Direct heritability estimates of preweaning growth and of weaning weight in lambs ranged from 0 (Butcher et al., 1964) to 0.84 (Botkin, 1955). Reason for higher estimates of heritability may be differences in statistical methods used, or differences in methods (e.g. paternal half sibs versus regression of offspring on parent) and sampling error. Comparable estimates of direct heritability estimates for weaning weight were also observed by Babaret al., (1998) and Maria et al., (1993, 1993) for sheep. Literature estimates for direct heritability are variable and range from low to high. Both extensive and intensive management system heritability estimates are within the ranges reported above for sheep by Olivier et al., (1994). The maternal heritability estimates were lower than direct heritability estimates (0.09 vs 0.38) for weaning weight in sheep (Assan et al., 2011). The

maternal heritability estimates reported for weaning weight ranged from 0.6 to 0.14 (Larsgard et al., 1998; Khaldi et al., 1989; Snyman, 1996). Assan et al., (2005) reported total heritability estimates of 0.69 for weaning weight in Sabi sheep, which were higher than the range of estimates by other researchers (Burfenig and Kress, 1993; Van Wyk et al., 1993a; Tosh and Kemp, 1994; Snyman, 1996) which were 0.18 to 0.22 weaning weight. Understanding of the relationship between direct and maternal effects will facilitate formulation of optimum breeding programmes and improvement of selection efficiency (Robison, 1981). The size of maternal effects and their relationships among themselves and with direct genetic effects, however are less clear (Hagger, 1998). The results in literature dealing with the genetic correlations between direct and maternal effects for weaning weight in sheep vary (Neser et al., 2001). Strong negative covariances were reported in literature (Burfenig and Kress, 1993; Maria et al., 1993). The correlations estimates reported are mostly negative in contrast to the positive estimates reported by Assan et al., 2005). Genetic correlations of direct and maternal effects of -0.74 to 0.01 were reported by other authors (Burfenig and Kress, 1993; Mousa et al., 1999; Tosh and Kemp, 1994) while the results of Oku et al. (1999) reported estimates ranging from -0.99 to 0.99. The high positive direct- maternal additive genetic correlation could probably be the result of a small size of the data set used in different studies. However, it cannot be ruled out that the high positive direct-maternal additive genetic correlation is an indication of a possibility to improve maternal effect while selecting for weaning weight. Yazidi et al. (1997) observed positive direct- maternal correlations for weaning weight of approximately 0.50 for weaning weight. Nasholm and Danell (1996) concluded that selection for increased growth traits in sheep will also improve the maternal ability in the case of positive correlation between direct and maternal genetic effects. Higher estimates of permanent environmental effects have been reported and have been associated with permanent environment maternal effects of the uterus and the multiple births in small ruminants (Synman, 1996). The influences of environment factors in different locality have a bearing on the estimation of genetic factors (Meyer, 1992). Breeders may have used genetic parameters borrowed from other populations which have a different environment and management system, this may give false results (Assan et al., 2011). The nature of the genetic correlation between direct and maternal genetic effects and its size are far from being known. For sheep a recent estimate of this parameter to about weaning was -0.99 (Maria et al., 1993) contrast with another estimate for daily weight gain to 3 week of age of 0.12 (Nasholm and Danell, 1996). In related studies reason for large negative estimates obtained could not be conclusively be explained (Hagger, 1998). Robinson (1996a) found that seemingly unrelated effects, such as additional sire variance or sire- mating season effects, led to large negative estimates of direct and maternal correlation. It seems both positive and negative correlation between direct and maternal effects are possible (Tosh and Kemp, 1994; Robinson 1996b; Nasholm and Danell, 1996). The genetic correlation of direct and maternal effects estimated by Tosh and Kemp (1994) for Hampshire, Polled Dorset and Romanov lambs was negative and ranged from -0.13 to -0.56 while Maria et al., (1993) reported higher negative estimates which they attributed to small number and structure of the data. Cundiff (1972) argued that the negative covariance between direct and maternal genetic effects, explained from an evolutionary point of view, prevents species from becoming increasingly larger. The findings of Nasholm and Danell (1994) were not in agreement with this assumption, but also several authors mentioned that possible existence of a negative environmental covariance between dam and offspring could result in a biased estimation of genetic correlation between direct and maternal effects (Meyer, 1992). A review by Robison (1981) indicated that covariance between direct and maternal effects for growth traits were generally negative in beef and swine. A few estimates of this relationship are available for sheep (Burfenig and Kress, 1993). While Chang and Rae (1972), Eikje (1975) and Jonmundsson (1981) found the relationship to be negative, Hanrahan (1976) found it to be positive.

### **2.3. Pigs**

A survey of published estimates of heritability for weaning weight in pigs reveals a range from zero to 0.24 within an average value of 0.08 (Ward et al., 1964). This figure was in close agreement with the estimate suggested by Craft (1953) in his review, however different from the same author, Craft (1958) in other assessment of 0.17. Litter weaning at 21d heritability estimate ranged from 0.15 to 0.22 (Fernandez et al., 2008). Cockerham (1952) reported estimates of 0.03 for weaning weight in pigs, however suggested that the amount of data surveyed and its critical evaluation was paramount to any estimates. Nugent (2003) reported a heritability estimate range of 0.19 to 0.27 in Landrace, Yorkshire, Duroc and Hampshire purebreds of pigs for weaning weight. The estimate of heritability at weaning of crosses of Nigerian indigenous and exotic breeds of pigs was 0.36 (Okoro et al., 2013). Litter weight at 21 d of age was also low, 0.10 (Peskovico et al., 1999). Different parities had effect on the

estimation of heritability, for first and second parity the heritability estimates were 0.05 and 0.07, respectively. Maternal effects of most litter traits, such as litter weaning weight were from 0.20 to 0.50 lower than their direct counterparts. Lundgren et al., (2010) concluded that heritability estimates for weaning to service interval were 0.08 and 0.03 in the Landrace sows population, as well as in Chansomboon et al., (2009) investigation in Landrace and Large White population weaning to the first service interval heritability estimated was low, 0.024. Weaning weight heritability estimates for direct genetic effect were greater than those of maternal genetic effect, suggesting that the direct genetic effect was clearly expressed at the age at weaning (Tomiya et al., 2009). Heritability of litter size at weaning was generally low (Pandey and Singh, 2010). Low estimates of heritability of litter size at weaning was also reported by Milojevic and Petrovic in Landrace. Khalkho (2004) recorded low to medium heritability value of litter size at weaning in Tamworth, Desi and their crosses. In contrary, to low heritability estimates, Craft (1985) suggested that the better nutrition of the suckling pig following the advent of balanced creep feeds may be responsible for higher heritability of weaning weight at 56 days. This would come about because creep fed pigs should have more opportunity to express their genetic potential for growth during the pre weaning period.

### **3. Environmental factors**

#### **3.1. Birth status and parity influencing weaning weight**

Weaning weight of single born kids were higher than twins born kids, however the effect was non significant (Barathidhasan et al., 2006). Buvanendran et al. (1992) reported similar findings that lambs born and reared as singles were heavier at weaning than those born and reared as twins in Dorper sheep in Zimbabwe. As expected single born lambs as well as male lambs were heavier at birth than multiple born or female lambs, respectively. This was attributed to the fact that the maternal uterine space has finite capacity to gestate lambs and as litter size increases individual birth weight decline due to a maternal constraint of fetal development. Their weaning weight and average daily gain also follow the same trend (Dickson-Urdaneta et al., 2004; Selaive-Villarreal et al., 2008). Litter weight at weaning was controlled by the number of kits survived at weaning (Risam et al., 2006). Competence between twins to feed from their dam's milk causes them to receive less milk than singles. Therefore, it is a good reason that singles are heavier than twins, when weaning (Dixit et al., 2001); Rashidi et al., 2008). But, Shahroudi et al., (2001) reported that birth type had no significant effect on body weight in Kurdish sheep. Elsewhere weaning weight were higher in second parity than the first parity in goats (Nelsen and Kress, 1981). Weaning weight increased with calving number till fourth calving as consequences in nursing ability between developing and adult dams. Results from other studies showed that weaning weight variation was more prominent in young ewes (Notter et al., 2005). The trend of effect of parity and birth type was not clear on weaning weight for intensive and extensive management systems in goats (Adenaike and Bemji, 2011). The author suggested that this was probably due to variation in size of kids' dams. Since dam with big body size is expected to consume more feed which would transient to more available milk for its kids irrespective of its parity. The same observation was made by Gatenby (2002) and Akusu (2003) among other factors parity and type of birth had a significant effects on weaning weight of kids. The weaning weight and average pre-weaning daily gain had increased in second parity than the first parity (Bharathidhasan et al., 2009). In contrary, parity did not affect both weaning weight and daily average gain in lambs probably because lambs had access to concentrate for the most part of the pre-weaning period (Bermejo et al., 2010).

#### **3.2. Year and seasonal effects on weaning weight**

It is well established that year of weaning causes variation on weight and performance of livestock due to climatic variations. Birth year causes vacillations over body weight in different ages by the effect of climate condition (rate of rainfall, humidity and temperature), environmental and management conditions. Climate and environmental changes have effect on the quality and quantity of pasture forages, which also affect the provision of food and other requirements for animals (Mohammadi et al., 2010). Dams maintained in good body condition throughout the year may perform at or near their production potential which would explain the lack of seasonal effect on weaning weight of progeny from different dams. Weaning weight at south west monsoon showed the highest value over weaning weights of other seasons. Paul et al., (1990) observed that the body weight at 3 months was significantly affected by season. The variation in weaning weight due to season were attributed to

feed intake accompanied by physiological stress caused by excessive heat in hot seasons and also inadequate environmental conditions. In this connection Ghaly (1988) reported a decrease of 40% of milk yield of the does under high ambient temperature. Variation in the weather, nutrition and farm management from year to year might be responsible for the increased variation in weaning weight (Bharathidhasan et al., (2009). Das et al., (1995) reported that year of birth had a significant influence on weight gain up to weaning (6 months of age) were more goats are weaned. It may be suffice to say that this phenomenon is expected because birth weight is highly correlated with weaning weight. Yaqoob et al., (2009) reported that the effects of fodder availability and prolificacy on weaning weight was significant in Dera Din Panah goats. The same author concluded that goat productivity was affected by the variation in fodder due to sporadic rains in the area and suggested a change in cropping practices such as growing more fodder during rainy season by introducing new fodder varieties and then conserve it for scarcity period. The effects of birth month on planning kidding season would improve production efficiency. Variation in supply and composition of feeds and fodder affects weight of kids at different life stages (Sundaram et al., (2012). The year effects main effect will show on amount of milk the dams will produce for the young ones. This has a direct influence on weaning weight due to the changes in the dam's environment and differences in feeding.

Month of kindling effects were highly significant on litter size at birth and litter size at weaning (Abdel-Azeem et al., 2007). The rise in ambient temperature during May and June caused a decrease litter weight at birth and weaning in rabbits (Garcia et al., 2000; Zaky 2001; Zerrouki et al., 2005). The depression in litter size born during May- June was attributed to effects of the high ambient temperature that results in decrease in each of feed consumption by the does ( Sallam et al., 1999), ovulation rate, fertilization rate and prenatal survival, and the embryonic mortality (Cifre et al., 1994). The hot climatic conditions (temperature and relative humidity), especially in open or semi open rabbitries, decrease milk production of the dam, that result in low amount of milk suckled by each kit and depression of the mean kit weight at weaning (Abdel-Azeem et al., 2007).

In beef cattle month of calving and age at weaning as a quadratic covariate did not influence weaning weight (Goyache et al., (2003). Calves born in the first part of the year were heavier at weaning than those born in the last months of the year. This was attributed to the fact that calves born at the last months of the year were sold slightly older in the spring market after a little grazing period in which nursing ability of the cow increases, hence reaching higher weaning weights. In sheep, season of year affected weaning weight with the lowest weights being for lambs born in winter. This effect occurred despite no obvious difference in flock management and nutrition (Bermejo et al., 2010). Thus external environment or climate during early growth may have influenced overall pre-weaning growth rate, as it had been observed in hair sheep in tropical areas (Rastogi, 2001).

### **3.3. Age of dam and weaning weight performance**

The performance of progeny improved in kids in the third and fourth year of dams which was attributed to adaptability of dams to the region with time and also with the fluctuations in rainfall in the region during the years (Banerjee and Jana, 2010; Verma et al., (1991). The same was attributed to the genotypic environmental interactions amongst the different animals within the same breed. Weaning weight would reflect mothering ability of dam as well as the inherent growth potential, thereafter growth potential would predominate. Age of dam was found to have a non-significant effect on live weight at 72 weeks of age, only showing that the mothering ability of does had carried over effect up to 48 weeks of age. Wilson (1987) found that the effect of age of dam was significant on birth weight and growth rate at pre-weaning and that young ewes tend to produce smaller progenies at birth. It is generally known that mothering ability, especially milk production, increases with parity. Older ewes are larger in body and tend to be better milkers (Stobart et al 1986). The effect of parity of dam on kids is thus imparted as maternal influence whose direct influence is limited to the nursing period. In cattle maximum weaning weight appeared to be observed at 8 years of age of the dam. Previously eight years was reported as the age of maximum production by Sawyer et al., (1948) and Rollins and Gilbert (1954). Burgess et al., (1954), Nelms and Borgart (1956). Mc-Cormick et al., (1956) found maximum production was reached between 6 and 10 years, and Marlowe and Gaines (1958) reported 7 years as the age of maximum production. Weaning weights were lowest among calves from 2 year old cows and showed the largest change between ages of 2 and 3 years. The mean weaning weight increased at a diminishing rate from 2 to 6 years of age and showed a uniform decline between the ages of 9 and 12 years (Brown (1958). The lack of decline in production among older cows was probably the result of selection in the herd. The few cows remained beyond the age of 12 years would have survived many years of culling and represent the very best producers of their age group. Milk production of the

sow is potentially a limiting resource in growth of piglets causing competition among piglets because the voluntary feed intake of piglets keeps increasing, whereas milk production of the sow reaches a rather constant level after 8 to 10d (Harrel et al., 1993). This may have a serious effect on sows with a larger litter size.

### **3.4. Management influencing weaning weight**

Management system will affect weaning weight since progeny will be subjected to the same season, parity and climate (Adenaik and Bemji, 2011). Management group and age at weaning as a linear covariate influenced weaning weight in beef cattle (Goyache et al., 2003). Comparing rotationally grazed lambs and set-stocked managed lamb, the later had heavier weaning weight at 4, 6 and 18 weeks (Geenty, 1980). Under a traditional management production system the growth ability of calves was affected by lesser nursing ability of the mother in the last months of the lactating period within the dry season that can not be balanced by the calf by increasing the grass intake (Wright and Russel, 1987) hence influencing the weight at weaning. The significant effect of other environmental factors on weaning weight have been found in sheep of temperate breeds with the degree of effect varying with management (Eltavil et al., 1970; Sidwell et al., 1964; De Baca et al., 1956). There was a significant effect of year of birth on birth weight due to improvement in management and feeding of the ewes during pregnancy, but no significant difference in weaning weight between years was detected (Combellas et al., 1980).

The great advantage of extensive over intensive production is that it gives the goats some opportunity to supplement the diet provided for them under zero grazing and thus some chance of using selective grazing habits to overcome any dietary deficiency (Devendra and Burns, 1983). Under extensive management system animals are allowed to roam about while in intensive management system animals are confined or kept under cultivated pasture at a high stocking density or zero grazing with concentrate supplement. The overall weaning weight under intensive management system was significantly higher than that of extensive management system (Adenaik and Bemji, 2011). This may be probably due to the feed supplementation to dams and kids raised under intensive management system. The other possible reason is that confined animals may consume more milk than their counterparts in extensive system. The young ones have limited access to dams milk in extensive management system because there are only fed when they have started making noise. The quantity of milk fed to young ones may be the contributing factor in variation in weaning weight in intensive system versus extensive management systems. The quantity of milk from the dam is a primary factor which contributes to growth in offspring, however this depends on parity, type of birth and level of nutrition given to the mothers.

### **3.5. Sex of animal and weaning weight**

Average weaning weight of female kids at 3 months was 2.28% higher than male kids (Bharathidhasan et al., 2009). Thiruvankadan et al., (2009) reported that sex, the period of birth and type of birth of kids were the major factors affecting growth rate in Tellichery goats. Similar findings were reported for male body weight at 3 months age which were higher than females body weight (Das et al., 1995). In cattle males were heavier at weaning and grew faster than females (Nelsen and Kress, 1981). Also Josefina et al., (1980), Gonzalez et al., (1972) and Reveron et al., (1978) observed that male lambs being heavier at weaning in comparison with females. Sex, season, parity and type of birth for both intensive and extensive management systems had a significant effects on weaning weight (Adenaik and Bemji, 2011). Gatenby (2002) and Akusu (2003) among other factors sex had a significant effects on weaning weight of kids. The difference in weaning weight between males and females were 1.5, 2.4 and 2.3 kg for indigenous Sabi, Mutton Merino and Dorper sheep (Assan and Makuza, 2005).

The differences in sexual chromosomes, probably in the position of genes related to growth, physiological characteristics, differences in endocrinal system (type and measure of hormone secretion especially sexual hormones) leads to difference in animal growth (Mohammadi et al., 2010). In relation to endocrinal system, estrogen hormone has a limited effect on the growth of long bones in females. That could be one of the reason in which females have smaller body and lighter weight against males (Shhroudi et al., 2001 Rashidi et al., 2008). Differences in body weight between males and females with the advanced age might be due to the increasing differences in the endocrine system between males and females (Swenson and Reece, 1993) These sex differences are consistent with results from other investigations (Mandal et al., 2003; Mokhtari et al., 2008).

### **3.6. Early weaning versus late weaning in nutrient utilization**

Weaning weight was largely dependent on the age at weaning that in turn dependent on month of birth of the calf (Goyache et al., 2003). Utilization of dietary nitrogen indicated higher nitrogen intake by early weaned

lambs due to the higher dry matter intake which led in turn to higher nitrogen retention due to well developed rumination and fermentation in comparison with the later weaned lambs (Abou-Ward et al., 2008). Favourable reasons for early weaning include reduction of carcass fat and removal of competition by ewes under conditions of feed shortage (Geenty, 1980). Age at weaning affected average daily gain and feed conversion efficiency in favour of early weaning in sheep in spite of higher dry matter intake in comparison with late weaned sheep (Alhadrami et al., (2000). The lower body weight for pups weaned at two weeks of age could be attributed to stress accompanying early separation of pups from does as well as the level of efficiency of early weaned grasscutter to digest and utilize the dry matter content of feeds (Henry et al., 2012). Studies have shown that fibre levels in the diet of grasscutters is associated with digestibility of dry matter, protein and fat which could lead to reduction in growth rate (Vanzyl et al., 1999). Xicatto et al., (2000) and Tumova et al., (2006) opine that digestive tract development does not affect feed consumption of early weaned rabbits. Changes in management practices such as early weaning have been investigated as a possible means of intensifying lamb production (Ruttle and Everett, 1969). Lambs can be successfully weaned as early as 3-5 weeks of age (Jagusch et al., 1970; Rattray et al., 1976). This has been associated with a reduction in fat levels immediately following weaning due to fat mobilization (Fennessy et al., 1972) and increased requirement of energy for protein deposition in lambs consuming pasture alone (Rattray and Jagusch, 1977). Early weaning may be defined as the withdrawal of milk supply before the time when weaning would normally occur. Gallois et al., (2003; 2004) demonstrated that feed consumption was higher for early weaned rabbits in comparison to those weaned at 35 days of age, although weaning age differed between both studies. The success of early weaning is depended partly upon the speed with which the rumen develop in both lambs and calves and partly upon the level of milk production of the dams (Wardrop, 1960). Fonteh et al., (2005) observed that early weaned kits overcome weaning stress and also developed the capacity to handle efficiently solid and fibrous feed than the late weaned kits. Rumen function develops rapidly after birth until at about 8 weeks of age, the grazing lambs can digest herbage with efficiency of an adult (Abou Ward et al., 2008). The rumen microorganisms of 3 week old lambs can digest as wide a variety of carbohydrates and proteins as can those found in adult sheep (Walker and Walker, 1961). Pigs that were weaned at an older age had more value than pigs weaned at a younger age due to the lower mortality and increased growth rate in nursery and finished period. The early weaning management practice is to increase efficiency of production and no useful end is achieved by early weaning in situation where young ones can be satisfactorily fattened by suckling the dam, unless the milk is rarely produced or required for commercial purposes. Geenty (1980) recommended that the conventional lamb weaning age be reduced to about 9 weeks. Using coincident pregnancy, lambs were weaned in the beginning of spring where they derive the benefit from spring pasture with high quality (Saghi et al., 2007).

### **3.7. Genotype and weaning weight**

The sire breed\*dam breed interaction was an important source of variation for weaning weight in goats (Browning et al., 2007). Differences in weaning weight due to breed were reported by Bodisco et al., (1973) and Gonzalez (1972). Sundaram et al., (2012) suggested that the variation in body weight can be attributed to adaptations of kids to the region with time and environmental conditions with changes in weather parameters with interactions amongst different animals within the same breed. The genotype of both the mother and the fetus play a vital role in determining the birth weight, while the consequent litter weights basically depend, beside the foetuses genotype, on the suckled milk from the dam (Abdel- Azeem, 2006). In general crossbred litter showed higher litter weight at weaning than those of purebred litter (Abdel-Azeem et al., 2007). These results were in agreement with those reported by Seleem (2005). Superiority of crossbred litters weight may be due to hybrid vigour which appeared in different ages of kits and to superiority in litter size traits. Olivier et al. (1987) found that the between sire variance terms were significant for weaning weight in their study on Grootfontein Merino flock and similarly found variation between sires for type traits. Sire effect had non significant effect on weaning weight in the exotic sheep breeds while highly significant in the indigenous Sabi sheep (Assan and Makuza, 2005). This could have been due to the ram exchange program were new rams were occasionally introduced into the flock from surrounding farmers. This resulted into high phenotypic and genetic variability in the indigenous Sabi flock could be exploited for genetic gain in weaning weight through mass selection. The non significant effect of sire in the exotic sheep breeds could have been a result of inbreeding depression due to continued use of same rams in the flocks for a long time due to unavailability of rams of the exotic sheep breeds under the ram exchange program. The importance of the random effect of sires within breeds on weaning weight suggest that selection of rams should be given a priority in any sheep production system making it useful in the



improvement of overall economic efficiency. The significance of sire effect could also suggest that there is a possibility of high generic variance weaning weight in sheep.

#### 4. Conclusion

The review conclude that in order to improve breeding value and selection for weaning weight must be based on genotypic rather than environmental superiority. Thus variation due to definable environmental effects must be removed by use of suitable adjustment factors. It is necessary that all known sources of variation influencing weaning weight should be included in the model of analysis, otherwise the results may not be reliable. Both direct and maternal genetic effects seem to be very important for weaning weight. A negative correlation between direct and maternal genetic effects could be an indication of genetic antagonism between genes and it may therefore be important to consider the both direct and maternal genetic effect in selection for weaning weight to improve selection response. In order to design optimal breeding programs targeting weaning weight breed specific genetic parameters need to be considered to enhance selection response.

The significant influences of environmental factors on weaning weight can be explained in part by differences in years, male and female endocrine system, competition for milk between twins, maternal effects and maternal ability of dam in different ages. In pigs the antagonistic relationship between litter size and piglets weaning weight was confirmed, subsequently it may be reasonably to conclude that inclusion of birth weight as a selection criteria is recommended.

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