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Review article

Indigenous goat as a potential genetic resource in Zimbabwe: A review

N. Assan

Zimbabwe Open University, Faculty of Science and Technology, Department of Agriculture Management, Bulawayo Region, Box 3550, Bulawayo, Zimbabwe.

*Corresponding author; Zimbabwe Open University, Faculty of Science and Technology, Department of Agriculture Management, Bulawayo Region, Box 3550, Bulawayo, Zimbabwe.

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ABSTRACT

Indigenous goat breeds should be considered as promising genetic resource taking into account that goats comprise a considerable proportion of livestock and contribute substantially to the economic requirement of small scale farmers in Zimbabwe. They are tropically adapted and suited to low input range conditions, furthermore are reputed to give birth every year which may be considered unique characteristic of indigenous goats. In order to improve the average level of indigenous goat breeds for economic valued traits by genetic means the flocks must be subjected to selection for specific traits or combination of traits required. The prime aim of selection is to identify superior animals and use them for breeding so that the efficiency of the flock is improved. Another viable option is crossbreeding where it has been used has a constant feature associated with the introduction of improved goat type breeds into local goat population. Selection and crossbreeding have not been utilized to any extent to improve productivity of local goats and it is highly recommended that if these are to be successful they should be invariably accompanied improvements in management. There is little point in seeking genetic improvement in indigenous goat breeds due to selection or crossbreeding if management and nutrition are inadequate.

1. Introduction

In recent years potential of indigenous goat breeds have been recognized and efforts are now being made to improve the production of local goats in a number of countries (Singh et al., 1991; Pratiwi, et al., 2006; Nsoso et al., 2004). World goat population was approximately 715 million in 2000 with over 60 percent of that found in Asia and more than 95 percent in developing countries mostly in Africa (FAO, 2001). Small ruminant especially goats comprise a considerable proportion of livestock in Zimbabwe and they contribute substantially to the economic requirement of small scale farmers (Homann et al., 2007). Indigenous goats are common in most small scale communal areas farming households which own more than 90% of the national goat flock (van Rooyen and Homann, 2008). Local goats are numerous hence their wider use can be expected to increase overall meat supply in both urban and rural areas where the supplies have dwindled over the years due to repossession of cattle commercial farm (Van Rooyen et al., 2007). Goats in communal areas have a strong potential to significantly contribute to household income because of an increased demand for livestock products in urban and rural areas (Delgado et al., 1999).

Indigenous goat breeds are well adapted to semi arid tropical conditions, with a high degree of heat tolerance and are partly resistant to many of the disease prevailing in the semi arid areas. Not to mention their ability to survive long periods of feed and water shortage. The breeds of goats at present reared in Zimbabwe can be divided into indigenous or local breeds, exotic breeds imported from outside the country, and crosses between exotic and indigenous. They are generally extremely hardy and self sufficient and where a selective breeding is practiced and management is good, has proved to be highly productive (Mhlanga et al., 1999 . The majority of goats are indigenous, either of the smaller type (East African goat) found in the eastern and central areas or the larger type under consideration in the present study (Matebele goat) of southern and western Zimbabwe (Van Rooyen and Homann, 2008). No attempts have been made to improve the genetic potential for meat production in the indigenous goats of through selection and crossbreeding however considerable research effort has been directed towards simple general management (e.g., housing, feeding, health management etc) of goats.

2. Goat production systems

Low input, small-scale cattle production remains a primary land use option in communal areas over most of southern Africa (Behnke, 1985; Cousins, 1994; Shackleton et al., 2002). Under traditional management systems, the performance of goats has been poor as a result contributing only a small proportion of the total national meat requirements despite goats' population in Zimbabwe having been estimated at 4.4 million and this number is known to be rising (CSO, 2000). Goat production in Zimbabwe occurs in two categories: subsistence farming and commercial production. Subsistence farming is practiced mainly by small scale goat producers in distinctly communal areas and approximately 97% of the goats are owned by smallholder farmers (Van Rooyen et al 2008). Before the full scale land reform programme started in 2000 the livestock sector had a dual structure (large scale commercial and small scale subsistence) where large scale commercial farmers concentrate on cattle ranching (van Rooyen and Homann, 2008) and less of goat production. Zimbabwe has an estimated 3 million goats of which the vast majority is owned by small scale farmers in mixed crop-livestock systems (FAO, 2005b). Livestock sector contributed 25% of the total value of agriculture output in 1999 of which the subsistence smallholder contributed 50% (Agrisystem, 2000). The smallholder production is low input systems are not highly productive households do realise most on farm income from livestock (FAO, 2005a). Goats specifically are utilised to supplement household food requirements and sold to purchase food items and fund educational expenses (Homann et al., 2007).

Goats are kept under traditional extensive system with no or minimal inputs and improved technologies which result in characteristically low productivity. In the majority of cases goats kept by small scale communal farmers receive very little attention and are virtually kept as scavengers particularly in the mixed crop livestock systems. Often they are allowed to wander to seek food with little if any supervision. If in areas of sparse vegetation they may have to travel quite long distance to find enough food and this in itself means a greater requirement of nutrients to cover energy loss. The majority of the world's rural poor depend on such systems (Thornton et al 2002). Complementary relationship's between crops and goats sometimes are exploited through nutrient recycling with animals feeding on crop residues, and returning manure to the soil. Not only is additional income earned from goats products but also benefits may be derived from increased in crop yield. Risks are mitigated by combining crop and goats production, since the goats may provide the means of subsistence if crop fails. Although small scale farmers increasingly recognize the value of goats the majority have not yet transformed into commercially oriented production system.

3. Choice of breeding strategy for genetic improvement of indigenous goats

3.1. Improvement by selection (pure breeding)

Populations of indigenous goats have been subjected to little or deliberate selection for productivity. Selection of indigenous goat breeds for traits of economic importance is necessary for increased efficiency of goat production. Within flock selection, conservation and utilization of local breeds, rather than introducing exotic breeds, can be done as a starting point in long-term breed improvement strategies (Mhlanga, 1999). Selection for locally adapted goat breeds enhances flock productivity at low investment cost and is quickest if few traits are considered. Local breeds are known to be better at coping with heat, walking long distance and surviving feed shortages in the dry season. Breeding programmes should therefore ensure the in situ selection of indigenous goats well adapted animal genetic resources to be sustained by proper feeding, good health care and housing strategies.

Pure breeding is genetic improvement through selection within a pure breed and changes additive genetic potential. A breed may contribute to commercial production as a straight bred (Dickerson, 1969). Relative efficiency of this breeding system has been studied for other domesticated species (Wilton and Morris 1976; Notter et al 1979). Dickerson et al., (1980) have discussed use of additive and non additive genetic variation by straight breeding. Selection within breed is the easiest breeding system to manage, however it does not provide for use of heterosis. Also to the extent that some breeds are adapted for use in breeding flocks where as others excel in carcass merit. Pure breeding does not provide for management of trade offs between matching genotypes to production resources and to market requirement.

It is important to realise that genetic progress from selection is a relatively slow process. Genetic change is however cumulative and in long term it can make an important contribution to more efficient production. The rate of genetic change for the trait of interest depends on heritability, selection intensity, generation interval and variability. Some characters are highly inherited while others are lowly inherited as their development in individuals is more dependent upon environmental effects. Heritability provides the magnitude of probable efficiency of selection. Variability in terms of coefficient of variation is often higher in local goats because of limited selection. As to heritability few studies in other tropical goat breeds based on insufficient amounts of data have been reported estimates which fall within the same range as those for improved goat types (Assan et al., 2011). Most effective programme for genetic improvement of specific traits where heritability are high would be mass selection of individuals showing desirable traits in indigenous goats. Progeny and performance tests may complement selection where heritability is low. The other augment which favours selection is that selected individuals are allowed to contribute more genes to the next generation which automatically improves the average level of desired traits in a particular population. Where heritability is high it means phenotype reflects the genotype as a result more attention would be given to individuals which exhibit the desirable traits and less to ancestry, sibs and other collateral relatives and to progeny tests. Intensity of selection in indigenous goats has been restricted by the reproductive rate and influenced by the rate of mortality which is high in smallholder goat production condition. It could have been better for goat population where twinning occurs, however twinning in indigenous goat breeds is rare. Rate of genetic progress from selection could be reduced by long generation interval. Considering the impressive results that have been achieved by selection in temperate goat breeds, there should also be good prospects for improvement by selection in the indigenous goat breeds in Zimbabwe (Nsoso et al., 2004; Pratiwi et al., 2006).

Breeding management is critical to improve goat production and subsequent marketing in small scale producers. Evaluation of indigenous goat breeds for performance of economic importance is necessary for effective selection of indigenous goat breeds for use in pure breeding. There can be little doubt that the opportunities for indigenous goat pure breeding breeders are great if goat breeders are willing to accept the challenges of a changing goat industry and realises the necessity for having to be competitive. Indigenous goat selection for performance must be approached systematically but expensive and requires considerably professional dedication at national level. Unfortunately at least one of these prerequisites is often lacking and as a result few accurate data on indigenous goats performance are as yet available to introduce suitable selection procedure (Tawonezvi and Ward, 1987). It seems clear that without a thorough understanding of smallholder goat production sector goals and without their fully participation in planning in animal selection, genetic improvement through selection for indigenous goat breeds is unlikely to be successful. Goat selection procedure must be based on empirically sound research if efforts are to be applicable, more often than not has been based on incorrect assumption about the needs of subsistence goat farming in small scale farming where goats are numerous.

Selection programmes in local goats should not compromise important adaptational qualities such as disease and parasite tolerance, ability to survive and reproduce in harsh environment and the ability to exist on low quality feed and limited water supply. Increased productivity through selection should enhance their potential for productive traits without weakening their adaptational characteristics. Ensuring the survival of the local goat by promoting their inherent genetic merit will minimise the competition to indiscriminate crossing. Another argument in favour of selection for indigenous goat's breeds may be an integral part of some crossbreeding where exotic and local goat breeds are used in rotation crossing. It is important to ensure that selection should always emphasise on traits of real economic value and use of improved goat breeds such as Boer goats illustrate what can be achieved if careful genetic selection is practiced and when optimum feeding is possible (Pratiwi et al., 2006).

3.2. Introduction of genes from outside (crossbreeding)

Superiority of improved goat type may be combined with the desirable properties of indigenous goat breeds through crossbreeding. Improved goat breeds have been selected for increased productivity over many generations and have reached a much higher genetic level than most tropical goats (Singh, et al., 1991). Crossbreeding has been widely used to exploit both goat breed differences and hybrid vigour. However the best way to exploit indigenous goat genetic resources would depend on climatic condition, level of management and mode of production. Goat for meat production are grass based and are often subjected to serious nutritional inadequacy where fertility and viability are more important than the growth rate of individuals animals. In such a scenario it seems logical to attempt and improve local goats by crossbreeding. The introduction of some exotic genes seems necessary to achieve a reasonable production level. The climatic conditions, disease prevalence and management level may play a pivotal role in determining the optimum proportion of exotic genes to be introduced in a population.

4. Productivity of indigenous goats

Previous studies on livestock productivity under range condition in Zimbabwe have emphasized beef and sheep production (Tawonezvi and Ward, 1987). Very little have been done on indigenous goats although the demand for goat meat appeared high (Cross, 1974). Mombeshora et al (1985) survey results suggested that indigenous goats outnumbered sheep and the potential economic advantages to small scale farmers of over cattle have been demonstrated (Mc Dowell and Bove, 1977; Anteneh, 1982) which agrees with a recent study by van Rooyen et al., (2007).

4.1. Carcass productivity in local goat

There was significant ($p<0.01$) differences of major carcass traits in castrated males and does in indigenous Matebele goat under range management. Hot carcass mass varied from 16.16 kg in castrated males to 13.64 kg in does, showed a significant ($p<0.01$) difference while a similar pattern was observed by Kanaujia et al., (1985) working with Beetal, Black Bengal and their crosses. The significant effects in the size of the prime cuts of hind barrel, front barrel, rib barrel and fat score in indigenous Matebele goat may reflect the possibility of differences in the dimension and composition of wholesale cuts in castrated males as opposed to does kept on range.

Castrated male (40.21 %) were superior to does (36.03 %) in dressing percentage which partly conforms with results reported in literature (Raghavan, 1988) who found that dressing percentage was higher in intact males than does. Similar findings were observed by Mahgoub and Lodge (1994) and Kirton and Morris (1989) in sheep and goats, respectively. It seems reasonably to assume that castrated males had more muscle than does as indicated by the greater size of heart girth and the prime cuts which may have translated into higher dressing percentage in castrated males. Elsewhere animals with more muscle gave higher dressing percentage (El-Hag and El-Shargi, 1992). The dressing percentage observed in castrated males and does were generally low as compared to those reported in literature (Dhanda et al., 1999) working with Capretto and Chevon goats. However the low dressing percentage observed in the present study may be expected on goats on range as reported in literature (Ryan et al 2007). Expression of dressing percentage on live weight rather than empty body weight basis tend to affect the reported magnitudes of estimated dressing percentage (Amin et al., 2000) and this has been a cause of some variation in literature reports on dressing percentage. Comparable estimates on dressing percentage have been reported by Dadi et al., (2000) studying Borana and Arsi-Bale goats under different durations of feedlot management. Generally low body slaughter weights in goats under semi-arid tropics kept for meat production may possibly be a result of reliance on utilization of natural pasture and hence animals are often subjected to serious nutritional stress (Leng, 1990). It seems reasonable to suggest that in the arid tropics range usually contain significant amount of unpalatable browse, which do not provide acceptable quality and quantity such that goats are unable to basically maintain high body weights (Ncube, 2005). For the goat breed under consideration here low slaughter weights seemed to be the more plausible explanation for low dressing percentage. Zimbabwean goats are raised under harsh environments (Van Rooyen et al, 2007) where feed shortages are the main constraint to optimal goat production in small scale communal areas of Zimbabwe (Homann et al., 2007). The available feed resources in the tropics are often low in energy (Ncube, 2005) and digestible protein (Leng, 1990) and fail to cover goat even maintenance requirements (Ben Salem and Nefzaoui, 2003). Level of intake and diet composition influence goat carcass composition (Warmington and Kirton, 1990). It has long been known that carcass fat deposition is directly related to energy density of diet (Berg and Butterfield, 1976). High energy diets in goats improved dressing percentage (Mahgoub et al., 2005), and high proportion of non carcass components resulting in low dressing percentage (Mahgoub, 1997). The apparent negative association between dressing percentage and condition score could not be fully explained. It remained unclear why there was non significant difference in condition score in does and castrated males, but castrated males had higher ($p<0.01$) mean fat score than does taking into cognizance that condition score and fat score may be highly correlated (Bell et al, 1970). In view of the above expectations are that animals with fat score would rank highly in terms of condition score. However, the anomaly may possibly have likely emanated from the inability of range to provide the necessary nutrients for adequate adipose tissue deposition within sexes which could have failed to influence differences in condition score. It is important to note that castration removes the gonads which are a source of male hormones as a result in the current study variation attributable to hormonal differences between castrated males and does is assumed absent. This may a plausible explanation for the non significant condition score in castrated males and does.

There was non-significant difference for cold carcass mass between castrated males and does which was unrealistic considering the differences in pre-slaughter mass and hot carcass mass of respective sexes. The non-significant difference in cold carcass did not reflect similarly to the hot carcass mass probably due to smaller differences in weight loss of hot carcass in castrated males compared to does. There was non-significant difference in body condition scoring in does and castrated males, but there was significant ($p<0.01$) difference in fat score which was higher in castrated males than in does. Location and quantity of fat in the body affects carcass quality Berg and Butterfield, 1976). A lower fat score in does indicated that fat deposition in abdomen and in carcass may be lower in does compared to castrated males and does may produce more lean meat than castrated males. In contrary to our observation Warmington and Kirton (1990) reported that due to a greater tendency to deposit fat females contain less muscle than males (intact) at similar weight. Tahir et al., (1994) working with carcasses on indigenous black goats in Iraqi found that castration had non significant effects on percentage of fat in the major cuts and the breed contained an average of 2.1 %. The castrated males had a higher proportion of non carcass components such as feet, empty gut, liver, etc and this is in line with reports on other goats managed extensively (Mahgoub, 1997). Higher proportion of non carcass components contributes to low dressing percent (Berg and Butterfield, 1976) which was partially disagree with our results.

Castrated males had significantly heavier offals as a percentage of live weight than does and where comparable to previously published values by Aduku et al., (1991) working with local goats in Nigeria. It was interesting to note that the proportion of internal organs (liver, heart, lungs, and kidneys) was similar in castrated males and does. The higher weight of offals in males may partially agree with literature reports (Mourad et al., 2001) who observed a decrease in offal weight with increase in live weight Exotic goats were found to have heavier weight of offal than local goats (El-Hag and El-Shargi, 1996) such variation with our study may be expected taking into account the differences in production conditions (i.e. range) (Ryan et al 2007; Legesse and Abebe, 2008; Dadi et al., 2005) and apart from sex (Lupton et al., 2008; Genandoy et al., 2002; Bayraktarolu, et al., 1988) differences in these studies, goats were slaughtered at different weight for age. Mature size of goats can vary ten-fold between breeds, with consequent variation in growth rates (Warmington and Kirton, 1990). This variation may be influenced by non genetic factors which include maturity, physiological state, nutrition, birth rank and sex as observed in the present study

The gut content in castrated males and does comprised about 19% and 16% of live weight, respectively however were non significant. The gut fill values as a proportion of live weight obtained in castrated males and does in indigenous Matebele goat were greater than the six to eight percent recorded for finished Sudan Desert goats (Gaili, et al., 1972) but fall within the range of ten to twenty three reported for same breed in a feedlot condition (Hatendi, et al., 1992) and coincide with fifteen to eighteen reported for indigenous Malawi and Boer goats (Owen and Norman, 1977).

4.2. Status of edible and saleable carcass components in local goat

The efficiency of goat to produce meat as influenced by sex on range may be measured by their carcass yield and the weight of non carcass components in relation to edible portions (Legesse and Abebe, 2008). In Zimbabwe it has not been fully established whether this low carcass productivity is due to genetic make up or effects of inefficient production system (Hatendi et al., 1992). Assan and Musasira (2010) revealed that the influence of sex exist on the proportion of edible and saleable components in local Matebele goats of Zimbabwe. The total edible components according to local criteria was 45.99 ±1.36, 48.04 ±0.74 and 53.79 ±1.04 for does, castrated males and intact males, respectively and the total saleable percentage of live weight were 48.60 ±1.27, 50.36 ±0.72 and 56.42±1.07 for does, castrated males and intact males, respectively . Intact males had higher ($p< 0.05$) edible and saleable live weights than both does and castrated males. However does have the least edible and saleable live weights. Edible and saleable weight increased curvillinearly with age of slaughter but not affected by sex (Chowdhury and Faruque, 2004). Goats studied were approximately 23 kg slaughter weight at an average weight for age at slaughter of 2 years and in a related study for Malaysian goats slaughtered at about 25 kg live weight, Devendra (1966) reported a higher (61%) total edible material which is on average higher than the edible material percentage observed in the present study. Elsewhere in indigenous East African goats slaughtered at approximately lower body weights (14 kg) than the breed considered in Zimbabwe, Wilson (1958) estimated that the total edible proportion of the live weight according to local criteria was 48% which is comparable to the percentage reported in indigenous Matebele goat of Zimbabwe for higher live weight, while the total saleable percentage of different age groups fell between the range of 55% to 61% in their study. Higher edible and saleable percentages according to local criteria than observed in the present study were reported in Malawi on local goats of 19.4 kg live weight was as much as 76 % (Owen, 1975). On the other hand, Owen and Norman (1977) reported 78 % to 81 % of saleable and 70 % and 74 % of edible percentages for indigenous Malawi goats and Boer goats which were higher than those reported in the present study. Studying the effect of sex on yield of edible and saleable components of Mahgoub and Lodge, (1996) reported 62 to 63 % of total edible and 69 to 70 % total saleable percentages for different sex groups of Omani Batina goats slaughtered at 28 kg. Feeding of local goats seems necessary in order to achieve desired total edible and saleable proportion of live weight for different sex groups (Mahgoub and Lodge, 1996). Legesse and Abebe, (2008) observed greater total edible and saleable proportion of live weight for different feeding systems where extensively managed goats had lower total edible and saleable proportion of live weight as compared with their browsing or grazing contemporaries. Mature size of goats can vary ten-fold between breeds, with consequent variation in growth rates hence comparison for total edible and saleable proportion of live weight with previous reports may be difficult because most of these studies were generally being made at substantially different weight for age (Wilson, 1958; Owen, 1975;) or differences in genotypes studied which could be larger size (Owen and Norman (1977) (Boer) or smaller size breeds than considered here (Wilson, 1958)(indigenous East African goats). There is a huge number of goat breeds in the world but few objective comparative data exist (Warmington and Kirton, 1990) and comparisons are confounded by the range of environmental conditions in which goats are kept. Most total edible and saleable proportion of live weight reported in other parts of the tropics are not far from those computed for indigenous Matebele goat, however computational procedure or methodology may definitely influence the magnitude of the total edible and saleable proportion of live weight reported in different studies and the definition of total edible and saleable proportion of live weight vary according to locality which may be based on cultural values.

There was no differences ($p<0.05$) for external non carcass components in castrated males and intact males, however castrated males had higher proportion of internal non carcass components than does and intact males. In contrast female goats had lower percentages of pelt and feet compared to other sex classes which are in agreement with the findings of Johnson et al., (1995). In line with findings in indigenous Matebele goat castration influenced internal and external non carcass components (Kebede et al., 2008; Moron-Fuenmayor, and Clavero, 1999). Elsewhere Legesse and Abebe, (2008) reported higher non carcass components as a proportion of EBW in goats which are browsing or grazing than intensively managed goats. Conversely goats managed intensively had higher edible and saleable proportions of live weight than those on range. Speculated that the lower edible and saleable proportions of live weight on goats managed on range was primarily due to their higher proportion of external non carcass components. Feeding improved edible and saleable proportions of live weight as it resulted in low proportion of external non carcass components (Legesse and Abebe, 2008) increasing the edible portion influencing the profit margin (Legesse et al, 2005).

The gut fill in does, castrated males and intact males comprised of 16.72%, 19.23% and 21.02 %, respectively. There was no differences in the proportion of gut fill as a percentage of live weight in castrated males and intact males which were significantly higher ($p<0.05$) than in does. The gut fill in does, castrated males and intact males comprised of 16.72%, 19.23% and 21.02 %, respectively, were greater than the six to eight percent recorded for finished Sudan Desert goats (Gaili et al., 1972) but fall within the range of ten to twenty three reported in Zimbabwe for similar breed (Hatendi et al., 1992) and comparable with fifteen reported for indigenous Malawi and Boer (Owen and Norman, 1977). Mahgoub (1997) reported an increase in offals with increase in age in goats, which resulted in reduction in overall edible portions mainly on extensively managed goats.

Discussing the concept of DP it is important to note that gastrointestinal contents can have a dramatic effect on DP of meat animals, therefore all comparisons involving this parameter should be made on the basis of EBW (i.e. live weight minus the weight of gastrointestinal gut content (Gall, 1982). Battacharyya and Khan, (1988) stated that EBW or the amount of rumen and intestine content indicated that DP might be affected by organs to be included in dressed carcasses as inclusion or removal of some visceral organs in hot carcass measurement might be resulted in different DP. The weight of gut fill in indigenous Matebele goat contribution may be regarded as relatively high (Aduku et al., 1991) the fact that DP was higher in does may not mean that a higher carcass yield may be expected, possibly because of low slaughter weights in females. In line with our observation Solomon et al (1991) observed significant differences in DP in which castrates (41.6%) where superior that intact males (39.50%) however Hopkins- Shoemaker (2004) in contrary DP was non significant in intact males with castrated males studying Boer x Spanish goat's crosses. Indigenous Matebele goat study although carried out under range management in semi arid tropics, the DP range obtained (38.95 to 52.93) was almost comparable to those reported by Dadi et al., (2005) (41.0 to 45.90) working with Borana and Arsi-Bale goats under different durations of feedlot management. Elsewhere estimated DP for local Matebele goats correspond with the reports of Nsoso et al., (2004) and Warmington and Kirton (1990). This coincidence may not be expected because expect differences in genotype could influence differences in dressing percent in goats (Dhanda et al., 1999; Mahgoub and Lodge, 1996); Amin et al., 2000). In Zimbabwe indigenous Matebele goat on range tend to have low DP than those on intensive management (Ryan et. al., 2007) possibly due to low slaughter weights and high proportion of non carcass components (Mahgoub, 1997). Owen, (1983) reported that as slaughter age increases the proportion of internal body organs minus gut content increased relative to external components which may have reduced the DP. Comparable DP to the range obtained by Assan and Musasira (2010) were reported for Borana and Arsi-Bale by Dadi et al., 2005 (41.0 to 45.9 %) and Boer crossbred goats on range by Ryan et al., (2007) (41.8 %), however in the same study concentrate fed goats had higher DP (48.2 to 51.3 %) (Ryan et al (2007). Elsewhere higher DP than in indigenous Matebele goat based on EBW were reported for Capretto and Chevon goats carcasses of 50 to 55% by Dhanda et al., (1999).

There was no differences ($p<0.05$) of kidney fat expressed as a percentage of EBW in does, castrated males and intact males, however intact males had lower proportion of both omental and mesenteric fat than does and castrated males. Contrast Wildeus et al (2007) observed that back fat and percentage kidney/pelvic fat were lower in bucks than in does. In support of indigenous Matebele goat of Zimbabwe sex class influenced carcass composition, with fat tissue being the most affected (Mahgoub et al., 2004). Fat score distribution were such that castration scored high (fatter) than rams (Lee, 1986). In related studies sex had an influence in intramuscular fat, the values being higher among female goats (Toro et 2000) and females had greater proportion of fat than males (Santos et al, 2008). Castration had an effect on fat deposition (Kebede et al., 2008). Bayraktaroylu et al., (1988) reported that castrated males had more mesenteric and kidney fat than intact males and carcasses from intact males had lower content of fat than carcasses from female goats (Colomer-Rocher et al., 1992), whereas carcasses of castrated males kid goats had lower amount of omental fat than carcasses from female kid goats and female East African dwarf kids goats had higher fat than male goats, with greater differences with increased age. The role of nutrition and stage of maturity in determining level and distribution of fat are poorly understood in Matebele goat on range in Zimbabwe. Due to tendency to deposit fat females contain less muscle than males at most weights (Warmington and Kirton, 1990) which may conform to the observation in indigenous Matebele goat.

4.3. Genetic evaluation for weaning weight in small ruminants in Zimbabwe

There are more reports on estimation of genetic parameters of direct and maternal effects in sheep weights (Bromley et al., 2000; Hanford et al., 2002; Ligda, et al., 2000; Al-Shorepy, 2001) than for goat weights (Ruvuna et al., 1991; Taddeo, et al.,1998). Covariance components and genetic parameters estimates for weaning weight in indigenous Matebele goat, indigenous Sabi sheep, Dorper sheep and Mutton Merino sheep were reported in Zimbabwe, where moderate heritability were obtained for weaning weight in indigenous Matebele goat (0.36) and indigenous Sabi sheep (0.38), and was high in Dorper sheep (0.48) and low in Mutton Merino sheep (0.28) (Assan et al., 2011). There are comparable estimates for weaning weights in small ruminants (Babar et al., 1998; Maria et al., 1993). Literature estimates for direct heritability for weaning weight in small ruminants are variable and range from low to high (Mousa et al., 1999; Notter and Hough, 1997). Lower direct heritability estimates for weaning weight than in small ruminants in Zimbabwe have been reported which ranged from 0.07 to 0.18 (Abbou, 1989; Notter, 1998). In a summary Wiener (1994) from 12 studies reported direct heritability range of 0.08 to 0.68 for weaning weight which makes estimates herein fall within this range. Direct heritability estimates of preweaning growth and of weaning weight in lambs ranged from 0 (Butcher et al., 1964) to 0.84 (Botkin, 1955).The heritability estimates obtained in sheep by Ricordeau et al., (1982) was 0.26 at 90 days of age. 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. After weaning kids/lambs growth rate is dependent on their genetic potential for growth, and subsequent weights are only minimally influenced by either maternal genetic or permanent environmental effects except for carryover effects which may support the observed higher direct heritability than maternal heritability in goat and sheep in Zimbabwe. Expected pre-weaning growth rate to be less heritable than post-weaning weight reflecting the higher total phenotypic variation observed during the pre-weaning weight period when factors such as mothering ability, maternal environment and other immeasurable sources of variation, may have a negative association with direct genetic effects for growth. Although the study was on goats and sheep kept under extensive management system observed genetic parameters are well within those exotic sheep and goats breeds under intensive management (Olivier et al., 1994). The authors were unable to find any recent published works for reference on estimation of covariance components and genetic parameters in small ruminants (Assan et al., 2011). Genetic parameters are population specific hence the need to estimate genetic parameters for different populations even if there are of the same species. 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. That's why most genetic evaluation program especially in Africa have failed to give appropriate results. Plans to implement genetic improvement programmes which utilizes adapted genotypes of both indigenous and exotic goats and sheep in Zimbabwe is the only way to secure sustainable meat production.

The maternal heritability was lower than direct heritability in indigenous Matebele goat, indigenous Sabi sheep and Dorper sheep but larger than direct heritability in Mutton Merino sheep. The higher maternal heritability than direct heritability for weaning weight in Mutton Merino obvious indicates that it may be worthwhile to utilize aggregate breeding values (direct and maternal) for accurate design of a breeding program for this sheep flock because both genotype of the calf and genotype of the dam showed had an influence on weaning weight. The maternal heritability observed for weaning weight in Zimbabwe are low in indigenous Sabi sheep and Dorper sheep, and are within the range reported in literature of 0.06 to 0.14 (Larsqard et al., 1998; Khaildi et al., 1989). A recent study on preweaning weight genetic studies in South Africa using Dorper sheep maternal heritability estimates varied from 0.07 to 0.20 (Neser et al., 2001). The proportion of variance due to permanent environmental effects showed that it was not important in goat and sheep in Zimbabwe. Higher estimates of permanent environmental effects have been associated with permanent environmental effects of the uterus and their effect on multiple birth in small ruminant (Synman et al., 1996), however multiple birth are rare in both indigenous goat and sheep in Zimbabwe.

The size of maternal effects and their relationships among themselves and with direct genetic effects; however are less clear (Hagger, 1998). 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 (Robinson 1996b). The genetic correlations of direct and maternal effects estimated by Tosh and Kemp (1994) for Hampshire, Polled Dorset and Romanov lambs were 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 foe sheep (Burfening 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.

Total genetic effects were higher in indigenous goat and sheep which may mean that few attempts have been made to improve the genetic potential of these breeds through selection. The genetic improvement of our indigenous goats and sheep is imperative considering the improvement in productivity that has been achieved by changes in management. Although there is increasingly international interest in indigenous livestock species for purpose of conservation and improvement, relatively little attention in the field of quantitative genetics has been given to small ruminants in Zimbabwe. The total heritability estimates are higher than the range of estimates by other researchers in sheep (Burfening and Kress, 1993; Van wyk et al., 1993; Tosh and Kemp, 1994) which ranged from 0.11 to 0.22. Estimated annual rate of response which could be expected were high in indigenous Sabi sheep and Dorper sheep, of 0.62 and 0.63 kg/yr, respectively.

Weaning weight is high to moderately heritable in sheep and goat population in Zimbabwe, indicating that comparatively high genetic variability can be exploited to improve weaning weight by mass selection. The positive correlation between direct and maternal genetic effects in goat and some sheep breeds may be cause of concern regarding increased kid/lamb birth weight and possible kidding/lambing difficulties. Because of the negative genetic correlation between direct and maternal effects for weaning weight in Dorper sheep, method of selection accounting for both direct and maternal genetic effects would result in greater economic selection response than selection based only on direct genetic effects.

5. Challenges in small scale goat production

5.1. Kid mortality

Kid mortality is one of the major obstacles in indigenous goat farm management under the semi arid areas of Zimbabwe. Pre-weaning kid mortality in indigenous goats is serious the farmers lose 26% of their goats to mortality whereas 11% were sold and 5% slaughtered for home consumption (van Rooyen and Homann, 2008). Loss due to kid mortality not affects economy of indigenous goat farming, but also reduces scope for improvement through selection. Apart from diseases, the other factors like temperature variation, improper management, age of kids and housing also play an important role in kid's mortality. Addressing these factors individually or collectively can substantially reduce kid mortality. Reducing kid mortality rates has thus been identified as the most effective strategy to increase productivity and herd size.

5.2. Nutritional requirements

The crude protein generally declined as the season progresses and this is what would be expected as vegetation matures through the summer. Contrary to the common assumption that goats can subsist solely on rangeland most goats keeper's experiences severe dry season feed resource shortages in semi arid areas of Zimbabwe. Feed shortages commence in July when rangeland resources are depleted reaching a peak in September/ October and phasing out in December/ January. The majority of the goat keepers use alternative locally available feed resources such as crop residues to supplement feeding during the dry season. Digestibility generally decline as would be expected as forage matured under normal conditions. In fact, one of the major reasons that goat farmers supplement protein on winter range or crop residues (true low-quality forages) is to stimulate digestion of the fibre in the forage. In a normal year, rangeland turns brown in the dry season after it has completed it entire process of growing and maturing. That process of maturing involves development from vegetative to flowering and finally the setting of seed. Nutrients like protein in the forage naturally decline throughout this process, while fibre and lignin naturally increase. Crop residues used are derived mainly from legumes such as groundnuts, bambara nuts and cowpeas. Cereals such as sorghum, millet and maize may be a source of energy for goats. Pods from acacia trees have been used to enhance protein in dry season feeding. Despite farmer's effort mainly using locally available material. Goat's body conditions during the dry periods deteriorate.

5.3. Disease and parasite prevalence

The incidence of disease and parasites is widespread and their effects are exacerbated by frequently meagre veterinary resources. Goat's diseases, poor management and lesser efforts provided to improve the performance of the animals are to be responsible for the reduced productivity. Goats can be infected by numerous internal parasites; the effect of infection by gastrointestinal parasites varies according to the parasite(s) involved, the degree of infection and other factors. The two most important internal parasites are the protozoan coccidian and the nematode *Haemonchus contortus.* Strategic deworming is important to break the life cycle of parasites. Control measures for internal parasites designed to reduce the intensity of parasitic infection, especially in the wet season when temperatures and humidity are favourable for development and survival of pre-parasitic stages, is important. Since parasites are usually non-pathogenic in goats their frequencies of infection are not likely to be serious threat to animal health but their accumulated effects may be detrimental if in multiple infections. Infestation with gastro-intestinal nematodes in goats can cause server economic losses and endanger animal welfare.

Goat keepers show a basic understanding of goat disease and parasites and their prevention and treatments. Most disease in small scale communal areas is location and season specific. Majority of farmers have reported increased goat disease problems during the dry season, which could be due to poor nutrition and subsequent poor body condition. In this case should be taught to optimize nutrition so that it improves the ability of goats to cope with the adverse effects of worm infestation. Protein nutrition proved to be playing a key role as it is needed for growing processes as well as for immune responses. Measures to recommend to goat farmers should include sufficient food supply for their goats at all times to avoid nutritional stress. Secondly, animals that are particularly susceptible can be helped by placing them on protein-rich supplements such as different types of legumes. For effective disease and parasites prevention and treatment goat keepers need access to information on farm level disease management and relevant government services. This entails increased government involvement by investing in infrastructure and supplying the necessary drugs.

6. Conclusion

The role which the indigenous goats can play in Zimbabwe's livestock revolution is not always recognised. Both pure breeding and crossbreeding are possible viable genetic breeding strategies option because of adverse climate and nutritional conditions in semi arid areas. Long term genetic improvement may be achieved by selection in a pure breeding system however it is a slow process. Selection for economic important traits within the indigenous goat breeds can be cost effective alternative but also requires more controlled breeding strategies. Crossbreeding may achieve the same results in one generation with little or no rise in input. The existence of improved goat breeds is an opportunity but maintaining them incurs higher management investment.

Most projects on local goats in the past had focused on promoting specific technologies and had largely failed because they ignored socioeconomic and institutional issues. Genetic improvement programmes for goats in developing countries have lagged behind chiefly because the infrastructural elements necessary for planned breeding programmes a more integrated approach by investigating challenges (and opportunities) from production to consumption along a value chain while also addressing policy and institutional factors affecting goat production may be applicable. Indigenous goats in communal areas may significantly contribute to small scale household incomes because of an increased demand for livestock products in urban and rural areas in Zimbabwe. It can be concluded that indigenous goats have tremendous potential for increased productivity and even in environments where food production is limited; much can be done with careful choice of breeding method coupled with good husbandry. Although indigenous goats are usually well integrated with the available feed resources some genetic improvement will be usually necessary if improved feeding is to be fully exploited. It will be interesting in the next decade to see whether the small scale indigenous goat producers will become better organized to exploit the benefit of hybrid vigour through crossbreeding of indigenous goats breeds with improved goat types in order to improve productivity. Breeders should take note that breeding systems choice must be related to defined production system and possible specific marketing environment but should also consider likely future trends. There seems little doubt that profitable goat production in future will rely increasingly upon appropriate breeding strategy designed to ensure efficient utilization on indigenous goat breeds resources.

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