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GOAT PRODUCTION SYSTEMS-CASE STUDY OF BURUNDI- LITERATURE REVIEW

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Abstract: In Burundi, the number of goats is high, with an estimate of 3.2 million heads, against 3.4 million for poultry, 1.1 for cattle, 0.8 for pigs, and 0.5 for sheep (MINAGRI, 2017). It is expected that this number will continue to increase as it tends to follow the growth of the human population. Indeed, in the 50 least developed countries, the annual growth rates of goat and human populations are 2.6% and 2.4%, respectively (Devendra, 2010). Goat production systems can be classified into three categories, as follows: extensive systems, intensive systems, and systems integrated with crops. Goats under extensive systems in semi-arid and arid areas move in search of feed and water under pastoralists in nomadic and transhumance fashions (Devendra, 1999). Goats are raised in common property grazing marginal lands and forest margins. Boer goat is considered to be one of the best goats for meat production. It has gained worldwide popularity during the last two/decades in Australia New Zealand, the USA, and Africa (Bowman, 2012). Boer goats are known to have a higher growth rate than other breeds of goats. The factors that affect reproductive performance include; feeding, nutrition, housing, diseases, and intersex association. According to the FAO report (1998), the most important diseases of goats included helminthiasis, trypanosomosis, and small ruminant pests, contagious caprine pleuro-pneumonia, mange, abortion, metritis, mastitis, stillbirth, broncho-pneumonia, caseous lymphadenitis, contagious exanthema, and enteritis. Helminthiasis in small ruminants is of considerable importance in Africa as it leads to mortality, reduced weight gain, and other production losses. The type and impact of disease on production vary with the level of management where some animals are raised under a cut and carry system of management and are housed in a better shelter, get more or less balanced nutrition and better health care for them to achieve higher productivity. In this study effects of management factors on reproduction ranged from reproductive wastage, reduced feed intake, morbidity, and mortality to the production of infertile female goats.

IndexTerms **– boer goat, local goat**

1.Importance of Goats

Goats have been recognized as having a high potential for poverty alleviation and improved livelihoods for farmers in remote areas in arid and semi-arid areas (LLP, 2006; Nyathi, 2008). In the development aspect, goats can play a big role in enhancing food security, increasing household incomes, and economic growth (Van Rooven and Homann, 2008). The role of livestock in sub-Saharan Africa is increasingly becoming more important. As elsewhere in the world, there is increasing demand for animal products caused by increased urban population with rising incomes which is associated with changing of dietary regimes towards consumption of more animal proteins (Delgado et al. 1999; LLP, 2006; Van Rooven and Homann, 2008). This means that there is a need to develop strategies for increased meat production; this can only be done through boosting goats' productivity to meet the market demand (LLP, 2006; Van Rooven and Homann, 2008). More than 95% of the world's goat population is found in fragile ecosystems in drylands and mountainous areas of Africa and Asia (Nyathi, 2008) where a high incidence of poverty is observed (Devendra, 1999). Globally, the goat population is increasing in number. There has been a recording of an 8.1% growth rate between 1990 and 1996 (Van Rooven and Homann, 2008). Goats were found to contribute a significant proportion towards national economies of several countries and across the world; the contribution of goats towards the livelihoods of over a billion people has been acknowledged (MINAGRI, 2017). Small scale farmers in rural areas and those that are landless have found goats as a solution to their poor resource endowments (Peacock and al., 2005). At the household level, goats are a source of income generation, food production, and security, employment, manure; goats also positively utilize crop residues, have social values, and are used for recreation (Devendra, 1999; LLP, 2006). For many of the rural poor communities and especially those with small pieces of land, the ownership of goats provides the means for survival as food and cash income (Devendra, 1999; LLP, 2006). The latter also enables the diversification of incomes. Cash money from goat sales can be used for buying household needs, other needed foodstuff and by so doing, improve food security. In the long run, the poor households may aspire to buy or barter goats for large stock like a cow (LLP, 2006).

In marginal areas, goats provide the basic insurance for agricultural activities, food and economic security, and stable households. Additionally, in a common household, poor farmers' goats act as insurance against drought because their low body mass and low

metabolic requirements minimize their maintenance and water consumption. It has been shown that goat ownership increases as land gets scarcer (Devendra, 1999). On the gender scale, women and children are interested in the ownership and management of goats throughout all developing countries (Devendra, 1999). Goats keeping is taken as a route for these groups to escape from poverty (LLP, 2006). Goats make a significant contribution to the maintenance of household stability, even for distressed women. In Bangladesh, goats distributed to such women provided more security (Saadullah et al., 1996). The experience learned from various studies suggests that the distribution of goats to women is similar to extending rural credit. The benefits of goat ownership to women are direct and more permanent. These benefits include improved household nutrition and alleviation of hunger, better livelihoods, more effective utilization of unpaid family labour, more stable households, and increased self-reliance (Devendra, 1996). Goats are being promoted for empowering those affected by HIV/AIDS (Van Rooven and Homann, 2008). This has been done in Zimbabwe. In Uganda and Rwanda, goats support social networking among poor rural households through bonding, bridging, and linking (IFAD, 2004). It creates ties among immediate family members and friends as they can be given as gifts, loaned, or kept for absentee owners. In many societies, goats are used for the payment of dowry (Devendra and al., 1999).

2. Current Situation of Goat Production in Burundi

In Burundi, the number of goats is high, with an estimate of 3.2 million heads, against 3.4 million for poultry, 1.1 for cattle, 0.8 for pigs, and 0.5 for sheep (MINAGRI, 2017). It is expected that this number will continue to increase as it tends to follow the growth of the human population. Indeed, in the 50 least developed countries, the annual growth rates of goat and human populations are 2.6% and 2.4%, respectively (Devendra, 2010).

The reasons for this increase are multiple, but the two most important reasons are that goats necessitate a lower initial investment and are easier to sell compared to larger animals. As such, poor smallholders often consider goats as a means to be financially secure (Peacock, 2005; Kosgey et al., 2006). Additionally, the feed efficiency of goats is higher than that of other ruminants, so they are best suited to small-scale farming (Darcan and Silanikove, 2018). Finally, indigenous goats are perceived as more resilient to climate changes than other ruminant species (Pragna et al., 2018).

Despite these advantages, goat production in smallholding systems continues to face many issues among which the fact that policy-makers are often more interested in developing enhanced breeding of large ruminants to the detriment of that of goats (Mueller et al., 2015). As a consequence, goat production remains extensive and productivity levels are low (Devendra, 2010).

It is however possible to increase goats' productivity by implementing genetic improvement programs as it is done in many countries. To plan for such programs, a good understanding of breed characteristics under specific production systems is required (FAO, 2012).

According to Otte and Chilonda (2002), livestock production systems may be classified according to different criteria, including the agro-ecological zone (AEZ), farming systems, and breeds of animals kept.

Burundi, where the study was conducted, is divided into five agro-ecological zones (Bidou et al., 1991), fitting into two groups. On one side, the dry lowlands of western Imbo, the western escarpment of Mumirwa, and the Depressions of the northeast are characterized by dry seasons varying between 5 and 6 months per year, 800 to 1150 m of altitude, 800 to 1200 mm of annual rainfall and average temperatures of 24°C or above. On the other side are the humid highlands of Congo-Nil-Crest and the Central Highlands. In these zones, dry seasons vary between 3 and 4 months per year, 1400 to 2500 m of altitude, 1500 to 2000 of rainfall, and average temperatures between 10 and 20°C. In terms of demography, the central highland has the highest population pressure (more than 300 inhabitants/ km^2) while the other zones are relatively less populated (less than 300 inhabitants/ km^2) (Ministère de l' Intérieur, 2010).

3. Goat Production Systems

Traditional goat production systems are determined by land availability, the intensity of crop cultivation, and the availability of young family members for underpaid herdsmen to attend to the goats (Siefert and Opuda–Asibo, 1993). Goat production systems can be classified into three categories, as follows: extensive systems, intensive systems, and systems integrated with crops. Goats under extensive systems in semi-arid and arid areas move in search of feed and water under pastoralists in nomadic and transhumance fashions (Devendra, 1999). Goats are raised in common property grazing marginal lands and forest margins. Goats are often mixed grazed with other species, especially cattle and sheep. Goats can be raised under intensive systems as zero-grazing units or tethering (Siefert and Opuda -Asibo. 1993; Devendra, 1999). Goats under intensive or zero-grazing systems are fed on forage obtained by the cut and carry method. Fodder plants like fodder legume trees e.g.: *Leucaena* and *Calliandra* species can be grown and cut to be fed to goats. Where the land under fallow and marginal are small, tethering is the predominant practice. Goats are usually tethered using a rope on the rangeland to graze and browse (Siefert and Opuda-Asibo, 1993). Goats are raised under mixed crop-livestock production systems. Crop residues become available for goat feeding after crop harvesting.

The main crops used for this purpose in Burundi are sorghum, cowpeas, maize, and some tubers (MINAGRI, 2017). During the dry season, crop residues can constitute 40 to 60% of the total DM intake by goats (Williams et al., 1997).

4. Characteristics and performance of local goats

According to Wilson (1991), the "Chèvre commune Burundaise", the "Common Burundian goat" originated from the small East African goats. The performance of local Burundian goats in terms of weight at different ages according to Wilson (1986) is shown in Table 1. This Burundian local goat is small with no specific colour. The common colours are black hair coat, white and black hair coat, as well as brown hair coat. It has a short hair coat. This goat type also has a small udder and is mainly reared for meat.

Figure 1: local goat

5. Characteristics and Production Performance of Boer Goats

Boer goat is considered to be one of the best goats for meat production. It has gained worldwide popularity during the last two/decades in Australia New Zealand, the USA, and Africa (Bowman, 2012). It is a hardy, very adaptable meat animal that could survive the varied conditions of the African landscape while still maintaining a high growth rate, high birth rate, and high survival rate, and high-quality marketable meat carcass. This goat breed has been proven to improve the performance of many indigenous breeds through cross breeding (Lu, 2001). It has strongly impacted the goat meat industry globally (Bowman, 2012). The origin of the Boer goat is not very clear. It is believed to be a genetic mix between indigenous goats, Indian goats, Angora goats, and also European dairy breeds (Lu, 2001). It resembles Nubian goats but with a much larger size. It has also been shown that the indigenous origin of this goat could be traced to Namaqua Hottentots and from southward migrating Bantu tribes. The current Boer goat appeared in South Africa among the Cape Ranchers in the early 1900 after selective breeding.

The Boer goat standards were first established when South African Goat Breeders Association was formed in 1959. There are five types of Boer goats recognized by the South African Goat Breeders Association. These are: Ordinary Boer goats, Long hair Boer goats, Polled Boer goats, Indigenous Boer goats, and improved Boer goats. It is the improved Boer goats that the breeders been have selected in South Africa. The breed standards for improved Boer goats include body conformation, head, neck and forequarters, barrel, hindquarters, legs, skin and covering, sexual organs, size, colouring, tail, general appearance, and fertility (Lu, 2001). In 1970, the Boer goat was incorporated into the National Mutton Sheep and Goat Performance Testing Scheme, which made the Boer goat the only known goat breed involved in a performance test for meat production in South Africa. In 1977, the Boer goat was imported into Germany. In 1987, Land Corporation Ltd. imported Boers into New Zealand, and in 1988 they were imported into Australia. The first Boer embryos to reach the North American Continent were implanted into recipient does at Olds College in Canada. These goats stayed in quarantine until April 1993, when Boer goats were released into Canada and the United States. Currently, virtually all states in the USA have Boer goats (Bowman, 2012). The Boer goats are strong and fat, their horns are heavy and females have very nice udder. The ears are average long and large falling down. Sometimes, both sexes lack horns, while they both possess them sometimes. Males have heavy horns black in colour and they are spiral in nature; their necks are averagely long. They possess or have very large chests, short legs-and their hindquarter is long and large. The testicles are in a well-developed scrotum. The skin colour is white but it is brown on the head and neck. Males have got beards. Boer goats have superior traits for meat production that is heavier body weight and faster growth (Lu and Potchoiba, 1988; Lu, 2001). The birth weight of Boer kids ranges from 3-4 Kg with males weighing 0.5 Kg heavier (Lu 2000). Kids at weaning can weigh 20-25 Kg (Lu and Potchoiba, 1988). At 7 months of age, bucks weigh 40-50 Kg while does weigh 35-45 Kg. At 12 months (yearlings) bucks weigh 50-70 Kg and does weigh 45 to 65 Kg. At a mature age, bucks weigh 90-130 Kg against 80-100 Kg for does (Lu, 2001).

Boer goats are known to have a higher growth rate than other breeds of goats (Lu, 2001; King, 2009). The growth rate at the first 1 - 2 months can be 200g per day under good pastoral conditions. In studies by Lu (2001) and Van Niekerk and Casey (1988), the corresponding rates were 272, 240, 204, and 186g/day for females. Boer goats are every prolific (Lu, 2001). Their average litter size is close to 2. About 50% of the does produce twins and 10-15% produce triplets. Oestrus synchronization, artificial insemination, and embryo transfer have successfully been done on Boer goats (Greyling and Van der Nest, 2000; Lu, 2001).

Milk production in Boer goats is generally considered adequate for rearing multiple kids. The lactation period is shorter than that of dairy breeds. Milk fats are higher than in dairy breeds. The daily milk production ranges from 1.8 to 2.5 Kg for the first 12 weeks (Haas et al., 1978). Because of their good genetic traits for meat production Boer goats have been used worldwide to improve the production performance of indigenous goat breeds through cross-breeding. Improvements have been noticed in birth weight, growth weight, weaning weight, breeding, and body weight, kidding rate, and carcass quality (Haas, 1978; Bowman and al., 2012; Waldron et al., 1997; Cameron et al., 2001; King, 2009). Boer goats have been known to fetch high prices both at local and international

markets (Lu, 2001). The market price is related to the mature weight trait of the Boer goat (King, 2009). This is because the main income is gotten from the sale of meat.

Figure 2: Male boer goat

6. Age at first kidding (AFK)

Kidding will occur approximately 147 days after the successful service of a female in oestrus. Various goat breeds in the tropics have their age at first kidding between 15-26 months (Devendra and Mcleroy; 1982). Bafawy et al. (1972) found that young does born as single had their first kidding at an average age of 194.38 days while twins averaged 296.50 days. Delayed oestrus in this case was associated with the growth rate. The age at first kidding is usually 12 months provided goats have good nutritional management. The earlier a doe starts to kid the longer her reproductive lifespan will be. The age at first kidding will significantly influence the period of kidding. In those born as twins, the period of kidding and the season of previous kidding will affect the kidding interval.

7. Kidding Interval (KI)

This is the period between two consecutive kidding dates and it is composed of the service period and gestation period. Kidding interval ranging from 240 to 390 days though intra breed differences at given geographical latitudes will reflect differences in management. While studying the reproductive performance of West African dwarf goats in Nigeria Adeoye (1985) realized that kidding interval was associated with management. Gestation length has been found to be fairly consistent at around 146 days although it is reported to range from 143 to 153 days (Devendra, 1962). Shelton suggested that short gestation periods may be characteristic of small breeds of goats but the exact causes were unknown in detail. However, in analogy with other species, it was probably affected by the sex of the fetus, parity, and environmental variation. Okeyo et al. (1994) in a study of SEA and Gala goat breeds reported a kidding interval of 10 months. A study carried out in Venezuela and Cuba on Toggenburg goats according to Devendra and Burns (1970) indicated a kidding interval of 407.2± 81.58 and 306 respectively.

8. Services per conception

This refers to the number of services required to get a female pregnant. Devendra and al. (1970) reported 1.8 services per conception for Anglo-Nubian, Alpine, Saanen, and Toggenburg, while Wilson (1957) recorded 2.3 services per conception, for the SEA.

9. Kidding rate

Kidding rate relates to the number of breeding does which have been mated in relation to the number of kids born over a given period of time. In the tropics, three kidding in two years is practiced but two kidding per year is more theoretical. Annual kidding in European goats and in Uganda has been surveyed. On the contrary, Devendra (1970) reported three kidding in two years in Anglo-Nubian and British Alpines in the West Indies after crossbreeding.

10. Post-partum resumption of does

The interval between the last kidding and the first observed oestrus is a close measure of prolificacy. The interval may be as short as five to six weeks or as long as 27 weeks in does of some breeds of goats (Hafez, 1993). Apart from seasonal influence, factors that influence the resumption of ovarian activities include suckling, goat breed, nutrition, and environmental temperature. Fertility is depressed during hot weather, in undernourished or overtly fat males, in young and old females when the estrogen content of

forage is high and when females are parasitized or suffering from diseases or other stress factors. Heat stress and insufficient nutrition depress the reproductive performance of temperate breeds of goats. This depression can however be alleviated by crossing them with tropical breeds.

11. Pre-weaning mortality rate

Kid mortality in the dry tropics is one of the main factors adversely affecting goat production. Mittal (1976) studied kid mortality on Barbari and Jamnapari kids in India and the mortality at weaning was 18.1% in Barbari against 16.6% in Jamnapari. Birth weights averaged 2.01kg and 3.50kg in these breeds respectively. There was a significant mortality rate in kids born with a birth weight below average. Okeyo et al.; 1994) attributed 46% of adult and kid mortalities to helminthiasis and survival depended entirely on feed availability at the time of birth in Kenya.

12. Abortions

Abortion is slightly more common in goats than in other species (Peacock, 1996). The exact explanation for this is not known but the fact that goat is a *corpus luteum* dependent species, any interference or absence of a functional *corpus luteum* may predispose the animal to abort.

In the past, habitual abortions at 3 to 4.5 months of gestation in Angora goats were attributed to a hereditary defect of the anterior pituitary gland. However, new evidence indicates that these abortions are rather associated with two different syndromes. The first one is related to nutritional stress (hypoglycemia) in the doe and the fetus which activates the fetal hypothalamic-pituitary axis and alters the placental endocrine function such that prostaglandin released by the placenta causes regression of the *corpus luteum* of pregnancy resulting in the expulsion of the recently dead fetuses. The second one is related to other non-infectious causes which include chemicals, drugs, poisons (e.g. lead, nitrate, local weeds, sweet clover, onion grass *veratrum)* nutritional (e.g. lack of TDN, Vitamin A, copper, Iodine, and selenium), physical stress and others like twinning (Hafez, 1993). Abortion occurring in response to stress takes place around 90 to 110 days of gestation. Infectious causes of abortion include brucellosis, chlamydiasis, listeriosis, foot and mouth disease, helminthiasis, and other febrile infections. According to Peacock (1996), any disease that raises body temperature or causes shock to a pregnant doe may lead to abortion.

13. Type of birth

In small East Africa goats, twinning is considered to occur in 10-15% of births (Mason and Maule, 1960). It is estimated that twinning occurred in 30% of Mubende goats in Uganda. Multiple births were found to be higher with parity. Singh and Singh (1974) recorded 84% at the fourth kidding in Barbari goats and in females of 3 to 4 years old 78%. The weight of does was also found to influence prolificacy; it was indeed found to increase with age. Prolificacy remains high for several years then slowly declines. The levels of reproductive performance indices varied from goat genotype to genotype and from one study to another by different scientists.

Figure 3: Female boer goats with kids

14. Factors affecting reproductive performance

The factors that affect reproductive performance include; feeding, nutrition, housing, diseases, and intersex association.

15. Feeding and nutrition

Estimates indicate that areas of Mbale (old Mbale district), Pallisa, Tororo, and Kabale in Uganda are deficient in TDN because of small portions of available land for grazing. Inadequate nutrition suppresses oestrus in young growing females than in adults. Low energy level has a significant effect on ovarian activity, whereas deficiency of minerals or vitamins (especially A and E) will also cause anoestrous (Hafez, 1993).

According to Okeyo et al. (1994), inadequate nutrition coupled with a high level of parasite infestation contributes to high reproductive wastage in small ruminant herds regardless of size and production system.

Providing adequate intake of energy and proteins, vitamins and minerals is important in minimizing breeding problems.

Energy intake is however reflected by dry matter content of which in the tropical pastures has been considered constant and only varying from 17.2 to 18.7mj/kg of dry matter. Dry matter (DM) content in the tropics ranges from 23.4% to 39.3% ranging depending on wet to dry season respectively (Devendra and Burns, 1993). The determination of protein requirement is rather complicated but always calculated against a conversion factor on energy (Devendra, 1967). The dry matter intake of goats is a factor of primary importance since their capacity for voluntary feed intake is a basic limiting factor to feed utilization. Daily dry matter intake for the British Alpine on forage alone in the tropics was recommended at 4.7% of body weight or 133.4gms per kg of body weight (Devendra and Burns, 1970) and for others, a range of 2.8-4.9% was recommended. Minerals e.g. calcium and phosphorous are important in minimizing breeding problems. Tropical pastures unlike temperate pastures are poor in phosphorous, copper, zinc, cobalt, manganese which deficiencies reduce sperm formation.

Water requirement is affected by environmental factors, dry matter eaten, and the nature of the feed, physiological condition, the temperature of drinking water, ambient temperature, and frequency of drinking as well as genotype. In Anglo-Nubian goats increasing the ambient temperature from 20°C to 40°C results in a decrease in herbage consumption and an increase in the frequency and time spent on water consumption. On the other hand, by decreasing ambient temperature from 20°C to 0°C the reverse change occurred. Mackenzie (1980) suggested that the ratio of dry matter to total water intake required in dairy goats is 1:4 to 1:5.

16. Housing

Two kinds of housing, the ground level, and stilted types, are used in the tropics. Their roofs are either of a lean type where it triangularly slopes from the apex or a double roof with a complete roof. Floors can be made out of rough concrete, rammed earth, or clay and slatted floors in the stilted type. Given high temperatures and rainfall in the tropics and the sensitivity of goats to wet floor and parasitism, the most practical goat houses are those elevated from the ground level, well ventilated, and having long eaves to prevent rain beating from the sides. The floor must be strong and the roof material should provide effective insulation from solar radiation. Whatever type of housing, it must provide adequate access to light, be well ventilated, well-drained, and easily cleaned (Devendra and Burns, 1970).

Figure 4: local goats in housing

17. Diseases

The effect of diseases on the output may be direct or indirect. Direct losses include mortality and morbidity. Losses related to morbidity are reduced growth, lactation, and reproduction (judged by kidding interval, kidding percentage, and delayed puberty). Among the indirect effects of diseases are the inability of farmers or producers to utilize favourable feed resources, adopt new systems of goat management, introduce more productive genotypes, or utilize specific animal products like goat milk because the presence of disease increases fear of subsequent morbidity and mortality. Although indigenous breeds of goats and sheep are fairly well adapted to the tropical environment the majority of animals are raised traditionally under extensive management systems with little input (or no input) to disease treatment and prevention. A serious constraint to small ruminants' productivity in Africa has been the high prevalence of diseases and parasites in these humid areas. The severity of diseases is strongly influenced by humid conditions prevailing in the tropical environment. This causes high cases of mortality among kids diminishing the benefit of their reproductive performance. Pre-weaning mortality of up to 40% was documented in kids and lambs in Nigeria. According to the FAO report (1998), the most important diseases of goats included helminthiasis, trypanosomosis, and small ruminant pests, contagious caprine pleuro-pneumonia, mange, abortion, metritis, mastitis, stillbirth, broncho-pneumonia, caseous lymphadenitis, contagious exanthema, and enteritis. Helminthiasis in small ruminants is of considerable importance in Africa as it leads to mortality, reduced weight gain, and other production losses. Opuda and Siefert (1991), without conclusive evidence, suggested other diseases like brucellosis, dermatitis, dermatophilosis, and contagious ecthyma to be part of the above list. A Kenyan analysis

demonstrated that goats receiving monthly chemoprophylaxis against trypanosomosis had decreased mortality rate, increased weight gains, and improved reproductive performance compared to the untreated goats. The same study showed inherent tolerance of indigenous goat breeds in East Africa with no evidence of genetic resistance being observed in Small East Africa goat crossbreeds with the Toggenburg goats. Okeyo et al. (1994) also credited indigenous goat breeds and strains for their high resistance to parasitic diseases and harsh environmental conditions. The type and impact of disease on production vary with the level of management where some animals are raised under a cut and carry system of management and are housed in a better shelter, get more or less balanced nutrition and better health care for them to achieve higher productivity.

Figure 5: boer goat with deasese

18. Intersexes

Within breeds originating from Western Europe, there is a well-known association between the natural absence of horns and intersex conditions. Genetically, female homozygous polled are intersex goats (Smith and Sherman, 1994). In this study effects of management factors on reproduction ranged from reproductive wastage, reduced feed intake, morbidity, and mortality to the production of infertile female goats.

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