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Factors affecting reproduction and growth performances in West African Dwarf sheep in sub-Saharan Africa

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Abstract

The West African Dwarf (WAD) sheep is a hairy sheep breed found over the south area of the 14th parallel of West Africa and Central Africa. It is a compact breed with a small mature size and short horizontal lop ears. WAD sheep are capable of limiting parasite multiplication and remain productive in tsetse-infested areas**.** The dwarf sheep is mainly reared according to traditional rearing system in West Africa and met alone or generally associated with other animal species in almost all households. West African dwarf sheep have low productivity and weak reproduction and growth performance. Weight gain of lambs is characterized by two phases. The first phase extends from birth to three months of age with a moderate increase followed by a second phase where weight increase more fastly from the third month to the seventh month. The birth weight varies between 1.67 kg and 2.70 kg in conventional rearing system to on average 1.88 kg in traditional rearing system. Average daily gains vary between 78.32 ± 3.18 g and 120 g ± 3.2 during the first post-lambing month and then decrease gradually in the following months. The West African Dwarf sheep are reared primarily for meat production. The carcass yield varies from 43.6% to 55.8% of the live weight of the animal. Factors affecting reproductive and growth performance in WAD are both genetic and non-genetic and include genotype, race, sex, age, birth environment, litter size, production system, season, diet and health follow-up.

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Introduction

According to Fournier (2006), the sheep is a herbivore ruminant belonging to the Animalia kingdom, Chordata phylum, Vertibrata sub-phylum, Mammalia class, Ungulata order, Artiodactyla sub-order, Bovidae family, Caprinae sub-family, *Ovis* genus and *aries* species.

The sheep Djallonke native from Fouta Djallon has today spread over the south area of the 14th parallel of West Africa and Central Africa. It is found in Mali, Senegal, Guinea, Benin, Nigeria, Ghana, Togo, Niger, Cameroon, Ivory Coast, Central African Republic, Burkina Faso and Tchad.

This Dwarf sheep is characterized by exceptional reproductive abilities such as high prolificacy, sexual precocity and good fertility (Faye and Alary, 2001). Thanks to its adaptation to different agro-ecological regions in sub-Saharan Africa (International Centre for Africa, 1979; Mawuena, 1986, 1987; Bengaly *et al*., 1993), the West African dwarf sheeps are particularly useful to help in the improvement of food security of the populations (Faye and Alary, 2001) and thus escape poverty (FAO, 2009).

Reproductive parameters are often the main determinant of biological and economic efficiency of animal production in the tropics. Fertility is one of the most important parameters of sheep productivity, the litter size per lambing is a good indicator, and according to some authors (Petrović, 2000), it is more important than weight gain of lambs. This means that biological efficiency of sheep in regard to meat, milk and wool production is conditioned by fertility (Notter *et al*., 2000). Several factors (genetic and non-genetic) can affect the reproductive and growth performances in dwarf sheep and may be highlighted. This work aims to review the various research work on the characterization of reproductive and growth performances West African dwarf sheep and variation factors in order to better undertake a performance improvement program of this sheep breed by selection, by crossing or by improving the rearing system.

Djallonke dwarf sheep: systematic and ethnology

The sheep Djallonke native from Fouta Djallon (Fig. 1) has today spread over the south area of the 14th parallel of West Africa and Central Africa.

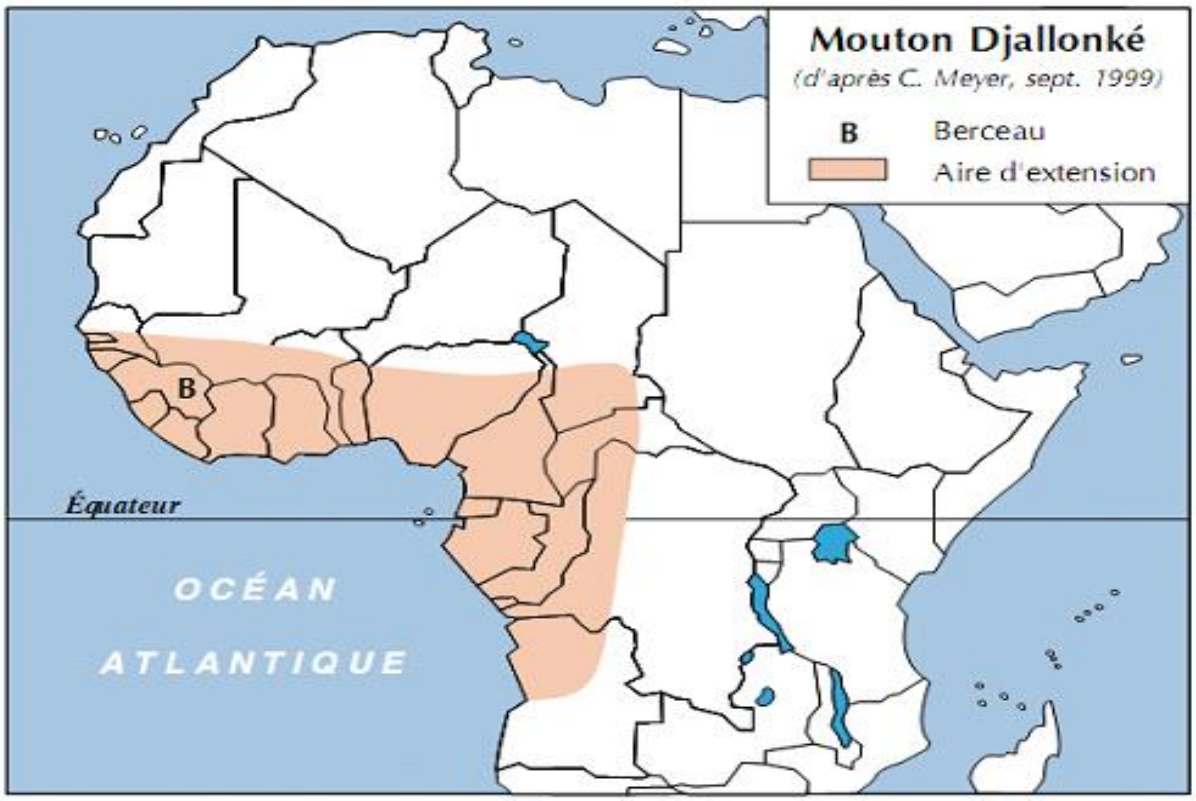

Fig. 1. Geographical distribution of Djallonke sheep in Africa (Meyer in CIRAD, 2002).

It is found in Mali, Senegal, Guinea, Benin, Nigeria, Ghana, Togo, Niger, Cameroon, Ivory Coast, Central African Republic, Burkina Faso and Tchad.

The sheep Djallonké has a straight profile, a short (hypometric) size and medium proportions. The tail is thin and of medium length. (Rumbold and Van Vlaenderen 1976; Pagot 1985; Larrat 1989; Gbangboche *et al*., 2005). The Djallonke sheep has good ability and is mainly reared for meat production. The carcass yield at slaughter varies from 43.6% to 55.8% of the live weight (Rumbold and Van Vlaenderen 1976; Amégé 1984; Gbangboche *et al*., 2005; Alkoiret, 2007).

Growth performance of West African dwarf sheep

According Doko Allou *et al.* (2013), the processes of weight gain of lambs is characterized by two phases. The first phase extends from birth to third month of age with a more or less stable moderate weight increase followed by a second phase where weight changes is very fast from the third month to the seventh month.

The birth weight varies between 1.67 kg and 2.70 kg (Senou *et al*., 2009) in station to 1.88 kg in traditional rearing system (Youssao *et al*., 2008). Under the same rearing conditions, males are heavier than females at the birth (Poivey *et al*., 1982; Fall *et al*., 1983; Abaffa *et al.,* 1992) but the sex effect tends to disappear at the age of 120 days (Abaffa *et al.,* 1992). Single lambs were heavier than those from multiple birth and no systematic compensatory growth is observed after weaning (Poivey *et al.,* 1982). Obviously, insufficient milk supply duplicates retards in their growth (Gbangboché *et al.,* 2005).

Average daily gains vary between 78.32 ± 3.18 g and 120 g ± 3.2 in the first month after lambing and decrease gradually in the following months until 65.42g between the 60th and the 90th day of age (Poivey *et al*., 1982; Symoens and Hardouin 1988 Abaffa *et al*., 1992; Yapi-Gnaoré *et al*., 1995). Gbangboche *et al.* (2005) reported average daily gains varying from 50g/day to 150g/days from the birth to the end of the first month old with variation according to the type of birth (single or twin).

However, Rombaut (1980) and Abaffa *et al.* (1992) had reported average daily gains of 110 g/day and 57.11g/d respectively from 0 to 60 days and from 30 to 120 days. Overall, average daily gain from birth to the age of 90 days is highly influenced by the type and environment of birth (Youssao *et al.,* 2008). Gbangboché *et al.* (2005) had found adult weights varying between 30 and 32 kg.

Reproductive performance of West African dwarf sheep

The sexual cycle of West African dwarf sheep is continuous and lasts from 14 to 19 days with an estrus of about 30 to 41 hours. The estrus of the West African dwarf sheep is hardly detectable in the absence of a male (Boly *et al.,* 1992; Gbangboché *et al.,* 2005).

Puberty is reached when the lamb weighs 40 to 50% of adult weight of its breed, corresponding to the age of 6 months. However, the lamb can be breeding later, when its live weight reaches 50 to 60% of the adult weight of its breed (Meyer *et al*., 2004). Age at puberty in Djallonke females varies between 5 and 13 months with a live weight varying from 2.1 kg to 15kg (Gbangboché *et al*., 2005).

The gestation period is about 150 days with some variations reported among the study area: 149 ± 2 days in Burkina (Boly *et al.,* 1993), 152 ± 1.47 days in Benin (Senou *et al.,* 2009).

Several authors reported that the age at first lambing in West African dwarf sheep varies between 11.5 and 23 months (Vallerand and Branckaert, 1975; van Vlaenderen Rombaut and 1976; Fall *et al.,* 1982; Amegee, 1983; Clement *et al.,* 1997; Missohou *et al.,* 1998; Gbangboche *et al.,* 2005).

The fertility rate varies between 114% and 132% in extensive farms but can reach 154% in improved rearing system (Berger and Ginisty 1980; Boly *et al.,* 1993). Fertility increases with the weight of females (Youssao *et al.,* 2008). In West African dwarf sheep, the fertility rate varies between 90 and 96% (Vallerand and Branckaert, 1975, Rombaut, 1980;

Berger and Ginisty 1980; Symoens and Hardouin, 1988 Boly *et al.,* 1993; Gbangboche *et al.,* 2004). However, lower fertility rates (50.3 to 85%) have been reported by Charray (1986).

Prolificacy varies between 1.17 and 1.57 (Missohou *et al.,* 1998 Gbangboché *et al.,* 2004, Youssao *et al.,* 2008; Senou *et al.,* 2009) in the West African dwarf sheep. Triple births are very rare. Moreover, Clement *et al.* (1997) report that the range of sizes increase with the rank of lambing and become higher for a longer lambing interval. The lambing interval ranged from 196.9 days to 307.14 days (Fall *et al.,* 1983; Charray 1986; Gbangboche, 2004). Rombaut and Van Vlaenderen (1976) had reported lambing interval of 9 months for the West African dwarf sheep.

Rearing system

The rearing of Djallonke sheep in West Africa is generally practiced under extensive system. The animals are raised in free range; enclosures are sometime used to house the animals during the night. In some farms, sheep are raised in combination with poultry and other animal species in the same shelter (Doko Allou *et al.,* 2013). Moreover, among the Fulani herdsmen, sheep are reared in the same herd with the cattle. So, they spend the night in their parks that can be built with solid materials or not. Some breeding farms such as public national farms and farms of experimental research or technical education and vocational training practice use a semi-improved rearing system (Boly *et al.,* 2001) where built shelters for animals are more or less the required standards (Sangare *et al.,* 2010).

In traditional farming, there is a lack of livestock equipment such as feeders and waterers. However in the semi-improved farms State farms and other training institutions, enclosures have feeders and waterers as rearing materials. These feeders and waterers are either built with cement or manufactured using local materials (Doko allocated *et al.,* 2013).

The diet consists mainly of forage from natural pasture. In rainy season, grazing is the unique source of animal feeding because of the availability of forage resources.

During the dry season, the feeding of the animals is complemented by crop residues such as cereal straw, cassava and yam peels, corn bran, sorghum and rice, and groundnuts as well as kitchen residues (Gbangboche, 2005; Gnanda *et al.,*2005; Alkoiret *et al.,* 2007; Gnanda *et al.,* 2012; Gongnet *et al.,* 2012). Sometimes, mineral blocks (licks) are provided to the animals (Boly, 2000; Sangare *et al.,* 2010; Doko Allou *et al.,* 2013).

In traditional breeding, animal health monitoring is generally poor. The animals are not vaccinated in most herds. The treatment is done by the shepherd on the basis of endogenous practices. Nevertheless, some farmers use the veterinary service agents for the vaccination of sheep in particular to prevent small ruminant plague but also for specific treatments based on clinical cases diagnosed (Doko Allou *et al.,* 2013).

Factors affecting reproduction and growth performances in West African dwarf sheep

The factors affecting reproduction and growth performances in West African Dwarf sheep are both intrinsic (genetic type, individual, age, sex, rank of birth, litter size, birth weight) and extrinsic (agroecological area, seasons, diet, production system, ovine pathologies, health follow-up etc).

The genetic type

Different lines or breeds of sheep reared under comparable conditions result frequently in different reproductive and growth performances parameters such as age and weight at puberty, age-type weights, average daily gains, fertility and fecundity (Glatzel, 1988; Boly *et al.,* 2000; Gbangboche, 2005; Doko Alou *et al.,* 2013). Moreover, the lambs from prolific breeds such as the D'man, the Finnoise or the Romanov reach puberty sooner than other less prolific breeds. The prolific breeds tend to have faster body and testicular growth (Hassan *et al.,* 1993; Derqaoui *et al.,* 2009). Indeed, the lambs from crossing with prolific breeds reach puberty at a later age than their non-prolific breed parents (Hassan *et al.,* 1993; Derqaoui *et al.,* 2009).

Thus, the crossing between races contributes to rapid onset of puberty and early sexual development (Bradford *et al*., 1990; Emsen, 2005; Kridli *et al*., 2006a), through the reduction of the unfavorable environment effect, the onset of puberty (Emsen, 2005) and by increasing the sexual transmission of genes of prolific breeds.

Live weight

The puberty depends mainly on the body growth than chronological age in sheep (Boussena, 2013). Similarly, the growth rate may influence the onset of puberty (Bonnes *et al.,* 2005). Indeed, puberty appears once a critical weight is reached (Loudon, 1987; Foster *et al*., 1988; Foster and Nagatani, 1999). Benseghir (1978) reported a minimum of 20 kg of body weight to reach puberty in D'man lambs. Moreover, the lambsborn single or reared sole reach puberty at a younger age and at a higher weight than those born or raised doubles (Boussena, 2013). However, a significant negative correlation (r = -0.45) between weaning weight and puberty age was observed in the lambs of Menz breed characterized by the fact that puberty is even earlier than the weaning weight is important (Awgichew, 2010).

Sex and type of birth

In sheep, sex affects significantly the productivity of sheep in favor of males. Males are usually born heavier than females and keep this trend up to the age of 12 months or more Gbangboché (2005). However, the ewes which lamb females have a lower lambing interval.

The type of birth also influences the growth performance of sheep. Single lambs were reported to be heavier than those from multiple births and no systematic compensatory growth is observed after weaning (Poivey *et al.,* 1982). Obviously, insufficient milk supply duplicates retards in the growth of the lambs (Gbangboche *et al.,* 2005). Single born animals had the advantage to avoid short lambing interval but the disadvantage of a weaker live weight at birth and at 12 months old than animals born doubles. According to Gbangboche *et al.* (2005), high parity leads on the reduction of sterility rate of ewes from 4.6% to 0.4% for the parities 2 and 4.

If Gbangboche *et al.* (2005) found that age of the sheep at the first lambing influences the lamb survival rate before weaning, Doko Allou *et al*., (2013) had reported that this influence is positive and beneficial for the survival of lambs. Abaffa (1992) shows that the season of birth of lambs influences their growth with animals born between November and December in the tropics show the best performance.

The birth season

Season of birth influences significantly body and testicular growth of the Lambs (Brown, 1994). Similarly, it influences the age at puberty (Amann and Schanbacher, 1983). Gbangboche *et al.* (2005) had reported that the rainy season is more favorable and beneficial by increasing the lambing rate in Djallon keewes, by increasing weight of lambs at birth and at 12 months old and promote a reduction of the age at the first lambing and the lambing interval. However, according Abaffa (1992) animals born between November and December (late rainy season, early dry season) show the best performance. The season may also have an indirect effect on growth performance of animals. Thus, the animals reared without rigorous health follow-up could be affected by parasitic diseases that develop during the rainy period (Attindehou *et al.,* 2012).

In small ruminants in general, lambs born during the normal birth season (spring season) in temperate zones tend to reach puberty in the following autumn (Boussena, 2013). Moreover, during the same season, lambs born at the beginning of the breeding season reachedearlier their puberty than those born at the end of breeding season (Boussena, 2013). Skinner and Rowson (1968) have linked the delay of puberty in Welsh Mountain × Suffolk lambs born late during the summer season compared to those born in the spring (with a delay of 21 days) to a growth delay due to energy restriction. Age at puberty depends on both growth rate and breeding season; if the critical weight is reached during the season, puberty occurs immediately (Bonnes *et al.,* 2005). According to Delgadillo *et al.* (2007), the season of birth changes the appearance of puberty with a predominance found in the females than in the males.

Rearing conditions

The production system strongly affects the growth and reproductive performance in sheep. In sheep Djallonkereared in tropical experimental station, lamb weaning is observed at 3 months of age, while in traditional breeding, it can intervene in the 5th month. The birth weight varies from 1.67 kg to 2.70 kg in station (Senou *et al.,* 2009) to 1.88 ± 0.32 kg in traditional rearing system (Youssao *et al.,* 2008). Among the farming conditions which strongly influence the sheep breeding activity ranks ram effect. Indeed, the introduction of a ram in a female group uprising estrus in the majority of these females and the resumption of the sexual cycle. For synchronization of estrus, the ram effect plays not only a role comparable to synthetic hormones (fluorogestone acetate and Pregnant Mare Serum Gonadotropin)but also has the advantage to induce a grouping of births with highest fertility rate (Boly *et al.,* 2000).

Puberty can be delayed as a result of high ambient temperatures (Marai *et al.,* 2008). Heat stress worsens even more, when associated with high relative humidity (Marai *et al.,* 2007). Generally, stress can participate in puberty triggering (Bonnes *et al*., 2005).Under identical feeding conditions and without a seasonal factor, the habitat can change the age-type weights and weight at puberty (Bonnes *et al.,* 2005).

Feeding

In feeding, it is generally accepted that good nutrition improves animal productivity. This factor affects not only the animal's body condition but also on the expression of its reproductive parameters and health (METR, 2011). Sheeps kept under poor diet rapidly lose weight and become a sure prey to pathogens. Tiema (2011) also reported poor diet as one of the factors that impact the morbidity and even lamb survival in village farms. Gongnet (1996) had already concluded that the major cause of lamb mortality before weaning is malnutrition. Doko Allou *et al.* (2013) have highlighted the beneficial effect of proper diet enhanced by an adequate health and medical prophylaxis in the survival and growth of lambs from the birth to the third month of age.

Moreover, the feeding supplied to the lambs before puberty influences significantly the uprising of puberty (Martinez *et al.,* 2012; Boussena, 2013). Therefore, young people subjected to a high-level diet reach puberty earlier than those subject to a low-level system (Martinez *et al.,* 2012; Boussena, 2013). In addition, puberty can be delayed for months or years until the availability of sufficient quantity of food (Boussena, 2013). In lambs from prolific breeds such as Djallonke and as in other races, testicular growth is closely linked to that of the body (Chafri *et al.,* 2008). Growth delay due to feeding or nutritional factors results in a chronological delay in the uprising of puberty (Bonnes *et al.,* 2005). Moreover, the weight and diameter of testicular of D'man lambs are closely linked to energy level of the feeding. Thus, the D'man lambs fed a high energy diet reach puberty at the age of 24 weeks with a scrotal circumference of 29 cm, while those maintained on a low energy level (40% of ingested concentrated the first batch) arrive at the same stage (puberty) at the age of 38 weeks with a scrotal circumference of 37 cm (Chafri *et al.,* 2008). Mukasa-Mugerwa and Ezaz (1992) and Boussena (2013) found the same result in tropical lambs; a high energy supplement protein increase the age at puberty to 1 to 2 months later.

Deficiencies in vitamins A, E and minerals (zinc) lead to testicular degeneration and growth retardation, impaired spermatogenesis, decreased in gonadotropin, reduced androgens and especially the delayed of puberty appearance (Boussena, 2013). Da Silva *et al.* (2001) found a delay of puberty of 5 weeks in male sheep of Suffolk breed who suffered dietary restriction during fetal life.

Pathologies

Different diseases affect the productivity of West African Dwarf sheep. Pathologies faced sheep are parasitic disease, viral infection, bacterial infection, etc. Among parasitic diseases, trypanosomiasis causes great damage both on production performance and on reproductive performance (Sangare *et al.,* 2010). On growth performance, trypanosomosis reduces the body weight and the sheep weight gains. Similarly its action on sheep rearing results in decreased libido

enhanced by a pronounced decline in sperm parameters (volume of ejaculate, sperm concentration, and normal rates of live sperm, individual and motilities) reflecting a large testicular dysfunction (Sangare *et al.,* 2010).

Conclusion

This article presents an overview of data on reproductive and growth performance of Dwarf Sheep of Djallonke breed in sub-Saharan Africa and the various factors of variation of these performances. The genetic type of animal, the individual, age, sex, lambing rank, the litter size, the birth weight, the agro-ecological area, season, feeding, production system, ovine disease, health follow-up are the main factors that influence the production and reproduction performance in West African dwarf sheep. To better appreciate these variations in growth performance of Djallonke sheep in Benin, it is necessary to conduct their evaluation simultaneously in different agro-climatic zones of the country.

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