Evaluation of West African Dwarf (WAD) sheep and F1 crossed West African Long Legged (WALL) rams with WAD ewes in Benin: Growth and Survival traits

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Abstract

The objective of this study was to compare growth and survival traits of purebred West African Dwarf (WAD) sheep *versus* F1 crossed West African Long Legged (WALL) rams with WAD ewes in the sub-humid region of Benin (West Africa).

Data were collected on 359 WAD and 183 F1 (WAD x WALL) lambs. Significant effects of sheep breed, year of birth, season of birth, sex of lamb, ewe parity and birth type were estimated using the mixed model procedure and Cox Proportional Hazards Regression, respectively for growth and survival traits analysis.

For growth trait, F1 (WALL x WAD) lambs performed better (P<0.05) than purebred WAD lambs at a constant age: birth weight, BW (+1.2 kg), 3-month weight, W3 (+1.6kg), 6-month weight W6 (+3.6kg), 9-month weight, W9 (+7.5kg), 12-month weight, W12 (+10.2kg), average daily gain between W3 and W6, ADG2 (+19.5g/d), between W6 and W9, ADG3 (+44.3g/d), between W9 and W12, ADG4 (+29.2g/d). All fixed effects were significant in WAD sheep. For F1 (WALL x WAD) sheep, significant effects were recorded in: season of birth for BW; ewe parity for BW, W3, W12 and ADG3; birth type for BW, W3 and W12, ADG1 and ADG3 and sex of lamb for BW to 12W and for ADG4.

Comparison plots of the Kaplan - Meier estimate of survival function, from birth to 360 days of age, was not significant between F1 (WALL x WAD) and WAD sheep. The Cox Proportional Hazards showed the significant effects of year of birth and ewe parity in the instantaneous mortality rate of WAD and F1 (WALL x WAD) sheep respectively.

This study provides non-genetic effects on growth and survival traits of WAD *versus* F1 (WALL x WAD) lambs and their potential use in crossbreeding systems.

Key words: Breed/sheep/Growth/Survival/West Africa

Introduction

Over the next 20 years, meat demand is projected to double in developing countries, and parasitic disease is argued to be the most important constraint in animal production in the subhumid and non-forested portions of the humid zone of Africa. The breeding of trypanotolerant livestock such as West African Dwarf (WAD) sheep [36, 37, 41] has been more economic and more sustainable, than combatting trypanosomosis and worm disease. Many programs were developed to improve the growth performance of WAD sheep through selection [1, 12, 24, 43, 52, 55 and 56].

No single breed excels in all traits of importance, and sheep producers in Benin are under increasing pressure to exploit new sheep breeds in order to match genetic potential with divergent climates, feed resources and market preferences. Due to their biological characteristics (low growth rate, body conformation, small mature size...), the WAD sheep, as a source of meat production, is limited and could alter gross income [4]. Sheep breeders in Gambia [41] and in Benin [30] have shown continuous and growing interest to import West African Long-legged (WALL) sheep, because of their bigger size and the expectation of bigger carcass yields. Additionally, since recent decades, the relatively rapid expansion and multiplication of WALL sheep and their crossing with WAD sheep in subhumid region has been induced by (1) the pastoralists with WALL sheep and cattle breed such as zebu type (*Bos indicus*) which are settling and adapting crop farming under the relatively trypanosomosis-free portion of the subhumid area; and 2) the movement of pastoralists during the drier periods of the year towards the subhumid region where the natural pasture is more abundant and available for a longer period. The gene flow and the genetic relationships between WAD and WALL sheep have therefore been reported [32].

Birth weight and weaning weight, are economically important traits, and the crossbreeding of WALLxWAD) sheep (*i.e.* Mossi Sheep or Vogan sheep) was carefully practized in West African countries [5, 6, 11, 31, 33, 49] to maximize profit, despite their reduced trypanotolerance and lower resistance to helminthiosis as compared to the pure WAD sheep [33]. As reported for Benin, boosting mutton production in subhumid regions could therefore rightly hinged on the WALLxWAD sheep breed [30]. However, improvement of sheep breeding programs should considered survivability or stayability of elite animals, as an important economic trait. Indeed, dead animals are worthless, they increase replacement costs and decrease overall performance, expressed per animal born or kept in production [19]. Sizeable effects of sex, type of birth, contempory group, age of dam and type of birth on survival of lamb from composite breed sheep have been reported [47].

In 1997, the “Ecole Inter-Etats des Sciences et Medicine Vétérinaires de Dakar (West Africa)” and the Tropical Veterinary Institute of University of Liege (Belgium), initiated a research programme on F1 crossbreeding involving WAD ewes with WALL rams (figure 1). The choice of this crossbreeding experiment was based on a strong national sheep breeder interest in using WALL rams. The purpose of this study was to compare growth and survival traits of WAD purebred sheep *versus* F1 (WAD x WALL) crossbred sheep and to quantify the effects of some environmental factors on these traits.

Material and methods

Description of West African Dwarf (WAD) and West African Long-legged (WALL) sheep

The West African Dwarf sheep **(Figure1**) are commonly named Djallonke sheep. It is a hairy sheep breed found all over West and Central Africa south of 14° latitude, and widely distributed throughout the savannah and humid zones [26]. The characteristics of WAD sheep have been described by several authors [13, 23, 37, 45, 54, 55]. It is a compact breed with a small mature size and short horizontal lop ears. Coat colour varies from spotted black and white to solid black or white. Some have tan or brown coat colour and black bellies. Rams are horned and females usually polled. WAD sheep are capable of limiting parasite multiplication better than WALL sheep and WAD x WALL crossed sheep [8, 31] and remain productive in tsetse-infested areas where other breeds can not survive without treatment [17].

The West African Long-legged sheep (i.e. Fulani, Peul, Bali-Bali, Maure, Tuareg, Guinea Long-legged, Sahelian sheep) is widespread from the Guinea savannah through the Soudan to Sahel [15, 23, 26]. The WALL sheep (**Figure1**) is hairier, usually white, white and brown, or white and black with lop ears. The males display a long twisting pattern to the horns and the females are usually polled. WALL sheep were considered hardy and well adapted to the arid environment. Compared to the WAD sheep, the main difference is that the WALL sheep is taller, heavier and trypanosusceptible [10, 51].

Environment and animal management

The study was carried out at the Faculty of Agronomic Sciences station (University of Abomey Calavi) and Agriculture College farm of Adja–Ouere. The geographical classification of this region is Guinean with a mean annual rainfall of 1000-1200 mm within a period of about 250 days. The rain pattern divided the year into four seasons [2]: major rainy season (March to June), short dry season (July to August), short rainy season (September to October) and major dry season (November to February). There is no data on the trypanosomosis risk level of two sites. The WAD purebred sheeps were only kept at the Faculty of Agronomic Sciences Station. The management of the flock was quite typical, comparable to the participating farmers. Flocks were not genetically linked and not subjected to selection. Animals had been raised during the day (6-7h) on natural and cultivated pasture of *Andropogon, Hyparrhenia, Pennisetum, Setaria, Brachiaria, Panicum, Centrosema, leucaena, and*

Stylosanthes..... throughout the year with supplementation (e.g. cottonseed cake, maize straw, wheat bran and cassava peels, groundnut haulms, brewery draff) for the nursing ewe, and only in the dry season for the other animals. All lambs received an injection of Vitamins A, D3 and E in the first 30 days after birth. Weaned lambs had no particular access to feed other than that offered to the ewes. WALL rams and WAD x WALL crossed sheep, not appreciated the cotton cake and tended to claim more space on pasture during breeding. All animals were penned at night. Salt licks and water were provided *ad libitum*. During the experiment phase, health management involved annual vaccination against Peste des Petits Ruminants, strategically deworming (Panacur®10%, 5 mg/kg bodyweight) four times annually *i.e*. January-April-June and September. Monthly, treatments against external parasites during the rainy season were brought, and every two months in dry season (pour-on acaricide, Bayticol® 1%). Additionnal strict health care measures were taken for F1 (WALLxWAD) sheep, to limit trypanosomosis stress, involving systematic quarterly chemoprophylaxis (isometamidium chloride, *i.e.* samorin® as curative drugs dose of 0.5 mg/kg bodyweight). Sick animals were treated.

The mature WALL rams were purchased from Gao in Mali (West Africa) and weighed approximately 60-65kg. They were crossed with WAD ewes, after a 6 month acclimation period. Prior to experimentation, all animals were checked for trypanosome and helminthes infections. Trypanosome infection was detected by micrococoscopy and treated with diminazen aceturate (Veriben® at 3.5 mg/kg body weight) when the packed cell volume (PCV) reached 17% or below. The number of strongle eggs per gram of faeces (EPG) was determined and infested animals were treated with Panacur®10%. Natural mating was used to produce pure WAD sheep and F1 (WALLxWAD) lambs. Heavy rams may be responsible for dystocia due to feto-pelvic incompatibility [24, 28, 42], and only WALL rams were crossed with ewes from 2nd parity. Twenty five to thirty WAD ewes were assigned at random to WAD or WALL rams. Weaning was at 90-120 days post partum. To avoid F2 backcrossed lambs, all F1 (WALL x WAD) male weaned lambs were castrated (using rubber rings) and the females slaughtered after 12mo age. Young ewes were first exposed to rams at 1.2-1.5 years of age and lambed in 8mo breeding cycles. Lambing occurred all year round, as no strict breeding season was enforced.

Data collected

Data were consecutive growth and survival traits of WAD and F1 (WALL x WAD) sheep. Data on WAD sheep were the accumulated records over 1998 to 2003.

Growth traits

The birth weight was taken within 24 h of birth using a platform type dial balance of 10 kg capacity and 0.05 g accuracy. Every 3 mo from birth to 12 mo of age, the other weights were taken using a suspended spring balance of 25 or 50 kg capacity with 200 g accuracy. The average daily gain (ADG), was calculated as follows: ADG1, ADG between birth weight (BW) and 3mo weight (W3); ADG2, ADG between 3mo weight (W3) and 6mo weight (W6); ADG3, ADG between 6mo weight (W6) and 9mo weight (W9); ADG4, ADG between 9mo weight (W9) and 12mo weight (W12).The summary of the data is given on **Table1**.

Survival analyze

The survival time was estimated as the difference between the date of death and the date of birth. Live animal were considered as censored (code = 0) and death animals uncensored (code = 1). After editing, survival database included 359 WAD and 183 F1 (WAD x WAL) lambs, with 75 and 47 complete responses respectively, 284 and 136 censored responses respectively (**Table1**).

Statistical analyses

Growth traits were analyzed separately for each breed using the Mixed Procedure in SAS ® [46], with the statement repeated=age, the option sub=animal. Preliminary mixed analyses were applied to identify significant sources of variation. Herd, age, season of birth, year of birth, birth type, parity of ewe, sex and interactions between factors were included in the model. The Final mixed analyses included 4 to 5 significant fixed factors and 3 interactions (**Table1**). Least squares means and differences among fixed factors were calculed with the PDIFF statement in SAS®[46]. Additionnal student *t test* was conducted to compare least squares means between WAD and F1 WALL x WAD sheep.

The stayability was analyzed following the general strategy of Ducrocq [18], using the survival module of Statistica® 6.1 [46]. In the preliminary analysis, the observed distribution of survival time was estimate by the Kaplan-Meier method [34]. This observed distribution was the result of different factors effects involved in the survival process. Investigation of the factors (i.e. sex, year of birth, season of birth, ewe parity and type of birth) involved in the survival process was performed using Cox Proportional Hazards Regression [16].

Results and discussion

The basic statistics of the growth traits and the fixed factors are shown in **Table1**, and the result of variance Analysis (type 3 tests), **Table2**. The level of the significance factors with the least square means (±standard error) are reported in Table 3 for live body weight (LBW) and **Table4** for average daily gain (ADGs).

Growth traits

General performance

The growth performance of WAD sheep in this study was lower than those reported elsewhere: a mean BW of 1.9 kg and mean W3 of 10.2 kg in improved village flock [7]; 90-100 days weights of 12.7 kg and W6 of 15.1 kg [44]; BW of 2.2±0.02 in participating farms of an open nucleus improvement program in the Ivory Coast [54]; BW of 1.75 kg and W3 of 6.99-7.54 kg [35]; BW of 1.59 kg [25]. The ADG3 of 38.76 g of this study was lower than 69.6 g which is the pre-selection ADG value from birth to 80 days [55].

BW of F1 (WALLxWAD) sheep in this study was: higher than those previouly reported, in crossed WALL-WAD sheep: 1.76-2.69 kg [5]; 2.34±0.55 kg [33] in Nugua Black head sheep or WAD x Persian black headed sheep of Somalia; 2.2 ± 0.07 kg [38]: lower than 2.9-3.8 kg in purebreed WALL sheep breeds [44]; 2.8-3.1 kg [4, 53]. Heavier weaning weight of 9.8±24kg was reported [39] and mature weight of 30-55 kg [39] and of 45-80 kg [15, 35] in purebreed WALL sheep. The ADGs in WAD sheep and F1 (WALLxWAD) sheep, increased from ADG1 to ADG2 and thereafter decreased with the age. F1 (WALLxWAD) lambs show higher ADGs than 57.9±4.3g during the recovery phase of post trypanomose infection [31]. The performances differences observed of this study compared with other breeds, could be attributed to the breeding conditions (management, herdsman skills, levels of diseases and trypanosome risk….).

Fixed factors effects

Due to the effect of age, the live bodyweight (LBW) consistently increased of +22 kg and +32 kg from birth (d.0) to 12mo of age, respectively for WAD and F1 (WALL x WAD) sheep (**Table3**). Lambs were heavier and grew faster with increased parity of ewe in WAD lambs. In F1 (WALL x WAD) sheep, ewe parity show significant effect for BW, W3, W12 and ADG3. A similar trend of ewe parity status has been documented [1, 25, 27 and 55]. A relative competition for nutrients between the still growing ewes (*i.e*. 1st parity ewes) and the developing fetus, may be a depression of growing performance in lambs born to a 1st parity ewe. Significant effect of ewe parity on BW was reported in previous study [44]. However, the parity of ewe no longer significantly affected BW after correcting for sex and type of birth effects [38].

Sex effect was quite significant for all traits in WAD sheep: male lambs were heavier than female from birth up to 12 months. Sex effect was only significant from BW to 12mo weight and for ADG4 in F1 (WALL x WAD) sheep. Consistent superiority of male *versus* female lambs has been reported in WAD sheep [1, 7, 44], WALL sheep [21] and would be attributed to the structure of body and physiological difference [9].

Birth type effect was significant for all traits except ADG1 in WAD sheep, only for BW, W3 and W12, ADG1 and ADG3 in F1 (WALL x WAD) sheep. In all genetic groups, single lambs exhibited higher weights and ADGs than twins. This could be caused by the poor milk production of the local ewe. A similar effect of birth type has been well documented for WAD sheep [1, 7, 25, 44, 55] and WALL sheep [20, 21].

Year effect on WAD and F1 (WALL x WAD) lambs growth, may be caused by the variations in the production environment (management, herdsman skills, forage availability and other environmental changes during the year). These results were consistent with other studies [3, 21 and 35].

F1 (WALL x WAD) sheep were consistently heavier and weighed respectively +1.2 kg +1.6 +3.6 +7.5 kg and +10.2 heavier at BW, W3, W6, W9, and W12 than WAD purebred sheep (Table 3). ADGs were higher (+4.4 g) in F1 (WALL x WAD) than WAD lambs over 3mo of age (**Table4**) but was not better than +13.4 g (from 21 to 34 weeks of recovery period post trypanosomose infection of Djallonke-sahelian crossbreds) reported by a previous study [31]. The advantages of F1 (WALL x WAD) *versus* WAD sheep were respectively at BW and W12, +1.3 kg and +11.1 kg for single lambs, +1.0 kg and+9.3 kg for twin lambs, +1.2 kg and +10.9 kg for male lambs, +1.1 kg and +9.4 kg for female lambs, +0.7 kg and +10.00 kg for 2^{nd} parity ewes–lambs, +1.3 kg for BW and +8.8 kg for 3^{rd} parity ewes–lambs, +1.4 kg and +10.6 kg for 4^{th} parity ewes–lambs. Other studies have reported the superiority of crossbred lambs over purebred lambs for growth traits [5, 22, 29, 31] and could be attributed to heterosis and complementarity of genes from the parent, that could not be taken into account in this study. However, heterosis estimates for growth in sheep is about 3.2% and 5% for birth and weaning [40]. In this study, additional advantage due to the castration could be attributed to F1 (WALL x WAD) male lambs.

Survival of sheep

The Live and death animal from birth to 360 d of age are reported in **Table1**. The observed survival was not constant and decrease similarly from birth to 360 days of age in WAD and F1 (WAD x WAL) lambs considering birth as the initial point (**Figure 3**). The pre weaning period [0-120[days is consider to be the first critical period, and the survival rate is in agreement with several studies (Yapi et al., 1992; Mukasa-Mugerwa et al., 1994; Malik et al., 1998). The survival rate of the second critical period ([120-250[days) which follow a weaning stress, would be attributed to the predisposition of lambs to infection when immune system of the young animal is still developing (Nguti et al., 2003). The signs of the regression coefficient (β) reflect the direction of the factor involved in survival analyze (**Table4**). Year of birth and parity of ewe were significantly related to survival in WAD and F1 (WAD x WAL) lambs respectively (**Figure 5 and 6**). Lambs born to maiden ewe had shown lower survival than lambs from higher parities dams as reported in literature (Dalton et al., 1980; Morris et al., 2000; Dwyer, 2003).The effect of year on mortality was previously observed (Buge et al., 1993) and would be attributed to annual variations in climatic conditions and the quantity and quality availability of feed in different years. Sizeable effects of sex, type of birth, age of dam and type of upbringing on survival sheep breed were reported [47]. The lack of significance effects in this study would be due to the size of data use and the production environments. However, lamb survival is a complex trait affected by the lamb's own ability to survive and by its dam's rearing ability [14].

Conclusion

In this study, WAD and F1 (WAD x WALL) sheep weights increased progressively with age. The male and single lambs were heavier than female and twins respectively. Differences between WAD *versus* F1 (WALL x WAD) sheep, i.e. the lowest individual weights and growth rates from birth to 12 months of age for WAD lambs, may explain the potential use of WALL sire breeds to improve growth traits in a crossbreeding program in Benin.

Non genetic factors involved in this study need to be taken into account, to improve sheep production and accurate estimation of genetic parameters. Survival of F1 (WALLxWAD) and WAD lambs is quite similar. The lambs born to maiden ewe constitute a vulnerable group during the first day of life, and fostering them may improve survival. Management of husbandry and strict health care measures to limit trypanosmosis and helminthes stress, were therefore important.

To access the merit of F1 (WALLxWAD) *versus* WAD sheep for meat production, further carcass and economic studies would be useful. Future large data set, will likely help clarify survival factors effects and fully understand of genotype and breeding system interactions.

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References

[1] Abassa K. P., Pessinaba J., Adeshola-Ishola A., Croissance pré-sevrage des agneaux Djallonké au Centre de Kolokopé (Togo). Revue. Elev. Méd. Vét. Pays trop. 45 (1992) 49–54.

[2] Adam K. S., Boko M., Le Bénin. Paris, Edicef (1983) 96p.

[3] Adeleye I. O. A., Seasonal effects on lamb production under tropical conditions. Nigerian Journal of Animal Production 11 (1984) 168-174.

[4] Adu I. F., Ngere L. O., The indigenous sheep of Nigeria. World Review of Animal Production. Vol XV, 3 (1979) 51 – 61.

[5] Amege Y., Le mouton de Vogan (croisé Djallonké x Sahélien) au Togo. Revue Elev. Méd. Vét. Pays trop. 36 (1) (1983) 79–84.

[6] Amege Y., Le mouton de Vogan (croisé Djallonké x Sahélien) au Togo. I – Production lactée et ses relations avec la croissance des agneaux. Revue Elev. Méd. Vét. Pays trop. 37 (1) (1984) 82–90.

[7] Armbruster T., Peters K. J., Metz T., Sheep production in the humid zone of West Africa: II – Growth performance and live weigths of sheep in improved and traditional production systems in Côte - d'Ivoire. J. Anim. Breed. Genet. 108 (1991) 210-226

[8] Backer R. L., Genetic resistance against helminth infections in cattle, sheep and goats in the tropics. In: Proc. 6th Symp. Trop. Anim. Hlth. Prod., Faculty of Veterinary Medicine, Ulrecht. The Netherlands, 6 October 1995 (1995) pp 40-47.

[9] Bell G. H., Davison J. N., Scarborought H.,Textbook of Physiology and Biochemistry. Longman, Edinburgh, Scotland (1970).

[10] Bengaly Z., Clausen P. H., Boly H., Kwame A., Duvallet G., Comparaison de la trypanosomose expérimentale chez certaines races de petits ruminants du Burkina Faso. Revue Elev Méd Vét Pays trop. 46 (4) (1993) 563–570

[11] Boly H., Magagi L., Konate T., Viguier – Martinez M. C., Yenikoye A., Cycle oestral et croissance folliculaire de la brebis Djallonké variété « Mossi ». Revue Elev. Méd. Vét. Pays trop. 48 (1992) 321– 326.

[12] Bonfoh B., Traore A., Ayewa T., Contrôle de performances, sélection des mâles au sein de la race ovine Djallonké et création d'un flock-book. Proceedings of the third Biennial Conference of the African Small Ruminant Research Network Workshop.5 – 9 Dember 1994. International Livestock Research Institute (ILRI) P.O. Box 30709 Nairobi, Kenya (1996) p 71 – 78.

[13] Bradford E. G., Fitzhugh H. A., Hair sheep, a general description. In Hair sheep of Western Africa and the Americas. A genetic resource for the tropics (ed. H. A. Fitzhugh and G. E., Bradford). A Winrock International Study. West view Press, Boulder, Colorado (1983) pp. 3-22.

[14] Burfening P. J., Direct and maternal genetic effets of lambs survival**.** Small Rumin. Res. 11 (1993) 267-274.

[15] Carles A. B., Sheep Production in the tropics. English Language Books Society (ELBS)/Oxford. University Press. ISBN 01944 24 146 (1983).

[16] Cox D. R., Oakes D., Analysis of survival data. London: Chapman and Hall., UK, 1984.

[17] D'Ieteren G. D. M., Trypanotolerant livestock a sustainable option for increasing livestock production in tse-tse affected are. in Toward increased use of trypanotolerance: current status of research and future direction (ed.G.J. Rowlands and A.J.Teale). Proceedings of a workshop ILRAD(1994) pp.3-11.

[18] Ducrocq V. P., Survival analysis, a statistical tool for length of productive life data. 48th Annu. Mtg.Eu. Assoc. Anim. Prod., Vienna, Autria (1997).

[19] Ducrocq V., Besbes B., Protais M., Genetic improvement of laying hens' viability using survival analysis. Genet. Sel. Evol, 32 (2000) : 23 - 40

[20] Ebangi A. L., Nwakalor L. N., Mbah D. A., Abba D., Factors affecting the birth weight and neonatal mortality of Massa and Fulbe sheep breeds in a hot and dry environment, Cameroon. Revue. Elev. Méd. Vét. Pays trop. 49 (4) (1996) 349-353.

[21] Ebangi A. L., Njoya A, Ngo-Tama A. C., Awa D. N., Mbah D. A., Genetic and phenotypic parameters of birth weight traits in Fulbe sheep in Cameroon. Revue. Elev. Méd. Vét. Pays trop. 54 (2) (2001) 147-151.

[22] El Fadili M., Michaux C., Boulanouar B., Pascal P. L., Environmental and genetic effects on growth in Timahdite and crossbred lambs in Morocco. Revue. Elev. Méd. Vét. Pays trop. 53 (1) (2000) 75-83.

[23] Epstein H., The origin of domestic animals of Africa. Africana Publishing Corporation, New York, (1971) vols 1 and 2.

[24] Fahmy M. H., Robert S., Gastonguay F., Ewe and lamb behavior at parturition in prolific and non-prolific sheep. Canadian Journal of Animal Science 77(1997) 9-15.

[25] Fall A., Gueye E, Diop M, Sandford, J., Wissocq J. Y., Durquin J., Trail, J. C. M., Evaluation des productivités des ovins taurins et des taurins Ndama au Centre de Recherches zootechniques de Kolda,

Sénégal. Institut sénégalais de Recherches agricoles (ISRA)-Centre International pour l'Elevage en Afrique, Addis-Abeba (Cipea) (1982) 74p.

[26] FAO, Petits ruminants ; production et ressources génétiques en Afrique tropicale. Par Trevor R. et Wilson R. Etudes FAO, Production et Santé animales 88, ISSN – 1014 – 1197 (1992) 193 p.

[27] Filius P., Weniger J. H, Teuscher T., Investigations on the performance of Djallonké sheep. Animal Research and Development 24 (1986) 85-97.

Fischer T.M., Van der Werf J. H. J., Banks R. G., Ball A. J.. Description of lamb growth using random regression of field data. Livestock Production Science 89 (2004) 175 - 185.

[28] Gama L. T., Dickerson G. E., Young L. D., Leymaster K. A., Effects of breeds, heterosis, age of dam, litter size and birth weight on lamb mortality. Journal of Animal Science 69 (1991) 2727-2743.

[29] Gatenby R. M., Bradford G. E., Doloksaribu M., Romjali E., Pitono A.D., Sakul H., Comparison of Sumatra sheep and there hair sheep crossbreeds. I. Growth, mortality and wool cover of F1 lambs. Small Ruminant Research 25 (1997) 1-7.

[30] Gbangboche A. B., Abiola F. A., Laporte J.P., Salifou S., Leroy P. L., Amélioration des ovins dans l'Ouémé et le Plateau en République du Bénin. Enjeux de croisement des ovins Djallonké avec les moutons du Sahel. Tropicultura 20 (2) (2002) 70-75.

[31] Goossens B., Osaer S., Ndao M., Van Winghem J., Geerts S., The susceptibility of Djallonké and Djallonké-Sahelian crossbred sheep to Typanosoma congolense and helminth infection under different diet level. Vet. Parasitology. 85 (1999) 25-41.

[32] Ibeagha-Awenu E. M., Erhardt G., Genetic variations between African and German sheep breeds, and description of niew variant of vitamin D-binding protein. Small Ruminant Research 55 (2004) 33-43.

[33] Kabuga. J. D., Akowuah F., Reproductive performance of Djallonke x Sahelian crossbred ewes in Ghana. Small Ruminant Research 5 (1991) 245 – 254.

[34] Kaplan E. L., Meier P., Nonparametric estimation from incomplete observations, J. Amer. Stat. Ass. 53 (1958) 457 – 481.

[35] London J. C., Weniger J. H., Investigation into traditionnaly managed Djallonké-sheep production in humid and subhumid zones of Asante, Ghana. III. Relationship between birth weight, preweaning growth, and postweanning growth of lambs. J. Anim. Breed. Genet. 112 (1995) 431-453.

[36] Mawuena K., Trypanosomose des moutons et des chèvres de race naine Djallonké des régions sud guinéennes du Togo. Revue Elev Méd Vét Pays trop. 39 (3-4) (1986) 307 – 315.

[37] Mawuena K, Haut degré de tolérance à la trypanosomose des moutons et des chèvres de race Naine Djallonké des régions sud – guinéennes du Togo. Comparaison avec les bovins trypanotolérants. Revue Elev Méd Vét Pays trop. 40 (1) (1987) 55 – 58.

[38] N'gere L. O., size and growth rate of the west african dwarf sheep and new breed, the Nungua black head of ghana. Ghana J. Agric. Sci. 6 (1973) 113-117.

[39] N'gere L. O., Aboagye G., Reproductive performance of West African Dwarf and the Nungua Black head sheep of Ghana. Anim. Prod. 33 (1981) 249-252.

[40] Nitter G. (1978). Breed utilization for meat production in sheep. Anim. Breed. Abstr. 46: 131-143.

[41] Osaer S., Goosens B., Clifford D. J., Kora S., Cassama M., A comparison of the susceptibility of Djallonke sheep and West African Dwarf goats to experimental infection with two differents strains of *Trypanosoma congolense*. Vet. Parasitol. 51 (1994) 191-204.

[42] Osuagwuh A. I. A., Taiwo B. B. A., N'gere L. O., Crossbreeding in Tropical sheep, incidence of distocia and parturition losses. Trop. Anim Hlth Prod. 12 (1980) 85-89.

[43] Pessinaba L. Y., Programme de développement de l'élevage des petits ruminants au Togo : essai de mise au point des possibilités d'association de la production vivrière et de l'élevage ovin. In Rey B., Lebbie S. H.B., Reynolds L. (eds.) Proc of the 1st Biennial Conference of the African Small Ruminant Research Network, 10-14 December 1990, Nairobi, Kenya. International Livestock Centre For Africa, Nairobi, Kenya (1992) 545 -554.

[44] Poivey. J P., Landais E., Berger Y., Etude et amélioration génétique de la croissance des Djallonké. Résultats obtenus au Centre de Recherches Zootechniques de Bouaké (Côte – d’Ivoire). Revue Elev. Méd. Vét. Pays. Trop. 35 (4) (1982) 421 – 433.

[45] Rombaut D., Van Vlaenderen G., Le mouton Djallonké de Côte-d’Ivoire en milieu villageois: comportement et alimentation. Revue. Elev. Méd. Vét. Pays trop. 29 (2) (1976) 157– 172.

[46] Sas, Sas/Stat user’s guide, vers.6, 4th ed. Cary, NC, USA, SAS Inst (1989).

[47] Southey B. R., Rogriguez – Zas S. L., Leymaster K A., Discrete time survival analysis of lamb mortality in a terminal sire composite population. J. Anim. Sci. 81 (2003) 1399 – 1405.

[48] Statistica 6.1. Stat soft France 3.1. Edition 2001, Cours des Julliottes-94700 Maison Alfort, France.

[49] Taiwo B. B. A., Ngere L. O., Adeleye I. O A., Comparative growth performance of Nigerian dwarf sheep and its crosses with Permer, Uda and Yankassa. Word Rev. Anim. Prod. 18 (1982) 57– 63.

[50] Tawah C. L., Mbah D. H., Amélioration génétique : Bilan et perspectives dans les pays du Sud in Maîtrise de la Reproduction et Amélioration Génétique des Ruminants. Actualité scientifique (AS). Apports des Technologies nouvelles. Universités francophones. AUPELF. Les nouvelles éditions Africaines du Sénégal (1993) 290 p.

[51] Toure S. M., Seye M., Mbengue M., Dieye T., Trypanotolerance studies of comparative pathology on Dwarf Djallonké sheep and Sahelian Fulani sheep Dakar (1981) ISRA/LNERV.

[52] Troare A., Bonfoh B., Optimisation du programme de sélection chez les ovins au Centre d’appui technique de Kolokopé. Document technique N°2 (1993) 21p, Atakpamè, Togo.

[53] Tuah A. K., Baah J., Reproduction performance, pre-weaning growth rate and pre-weaning lamb mortality of Djallonke sheep in Ghana. Trop. Anim Hlth Prod. 17 (1985) 107-113.

[54] Vallerand F., Branckaert R., La race ovine Djallonké au Cameroun. Potentialités zootechniques, conditions d’élevage, avenir. *Revue.* Elev. Méd. Vét. Pays trop. 28 (4) (1975) 523–545.

[55] Yapi-Gnaoré C. V., Oya A., Rege J. E. O., Dagnogo B., Analysis of an open nucleus breeding programme for Djallonke sheep in the Ivoiry Coast. 1. Examination of non-genetic factors. Animal Science. 64 (1997a) 291-300.

[56] Yapi-Gnaoré C.V., Rege J. E., Oya A., Alemayenu N., Analysis of an open nucleus breeding programme for Djallonke sheep in the Ivoiry Coast. 2. Response to selection on body weights. Animal Science. 64 (1997b) 301-307.

Table I.
Sample size for each factors used for growth and survival traits analyse, from birth to 12 month weight or 360 days of age, for WAD and F1 (WALL x WAD) sheep

Factors		West African Dwarf (WAD) sheep						F1 (WAD x West African Long Legged) sheep					
Season of birth		BW	3W	6W	9W	12W	Unc	BW	3W	6W	9W	12W	Unc
	S1	152	147	135	124	123	28	101	90	85	79	77	24
	S2	89	87	78	65	65	24	25	24	21	19	17	8
	S3	74	71	62	57	57	17	24	24	20	19	19	5
	S4	44	42	41	40	39	6	33	30	27	23	23	10
Year of birth													
	1998	50	46	42	36	36	14	-	-	-	-	-	-
	1999	50	47	43	39	39	11	-	-	-	-	-	-
	2000	68	63	56	51	50	17	25	20	19	18	17	8
	2001	68	67	62	55	55	13	41	37	35	31	31	10
	2002	76	76	70	65	64	12	52	47	45	41	39	13
	2003	47	46	43	40	40	8	65	64	54	50	49	16
Parity of ewe													
	1	103	100	93	83	82	20	-	-	-	-	-	-
	2	77	74	66	55	54	23	40	36	31	18	23	17
	3	85	81	72	67	67	18	73	62	56	31	52	21
	4	94	92	85	81	81	14	70	70	66	41	61	9
Sex													
	Male	297	288	259	232	230	67	90	87	81	78	75	15
	Female	62	59	57	54	54	8	93	81	72	62	61	32
Birth type													
	Single	309	299	278	251	249	61	139	127	116	110	107	32
	Twins	50	48	38	35	35	14	44	41	37	30	29	15
Overall		359	347	316	286	284	75	183	168	153	140	136	47

The time of birth and at 12 month weight, correspond to the exposed and censored time respectively. Uncensored (Unc)

Table II

Least square means ±standard errors (s.e.) and level of significance of fixed effects for birth, at 3, 6, 9, and 12 months weight traits in pure West African Dwarf (WAD) sheep and F1 (WALL xWAD) sheep.

	West African Dwarf (WAD) sheep					F1 (WALL x WAD) sheep				
Fixed effects	BW	3W	6W	9W	12W	BW	3W	6W	9W	12W
Overal mean	1.35±0.03	7.49±0.08	14.15±0.12	17.66±0.16	22.07±0.21	2.51±0.07	9.07±0.24	17.78±0.48	25.16±0.51	32.25±0.53
Season of birth	**	**	**	**	**	**	ns	ns	ns	ns
S1	1.84±0.06^{a}	8.46±0.17^{a}	17.53±0.24^{a}	21.91±0.31^{a}	27.32±0.40^{a}	2.76±0.05^{a}	9.08±0.16^{a}	17.83±0.31^{a}	25.33±0.33^{a}	32.29±0.34^{a}
S3	1.31±0.03^{b}	7.69±0.07^{b}	13.87±0.11^{b}	17.28±0.14^{b}	21.58±0.18^{b}	2.24±0.09^{b}	9.06±0.29^{a}	17.43±0.60^{a}	24.44±0.64^{a}	31.79±0.68^{a}
S2	1.32±0.04^{b}	7.89±0.11^{b}	14.41±0.16^{c}	17.98±0.21^{c}	22.49±0.26^{c}	2.82±0.09^{c}	9.13±0.29^{a}	18.05±0.60^{a}	25.52±0.61^{a}	32.52±0.62^{a}
S4	0.95±0.05^{c}	5.92±0.12^{c}	10.80±0.18^{d}	13.48±0.23^{d}	16.90±0.29^{d}	2.23±0.08^{d}	9.00±0.25^{a}	17.79±0.52^{a}	25.33±0.56^{a}	32.39±0.57^{a}
Parity of ewe	**	**	**	**	**	**	*	ns	ns	**
1	1.16±0.04^{a}	7.91±0.10^{a}	13.36±0.15^{a}	16.71±0.20^{a}	20.91±0.25^{a}	-	-	-	-	-
2	1.28±0.04^{b}	6.48±0.12^{b}	13.54±0.18^{a}	16.91±0.23^{a}	21.13±0.28^{a}	1.99±0.07^{a}	8.59±0.23^{a}	17.47±0.48^{a}	23.49±0.64^{a}	31.13±0.56^{a}
3	1.40±0.05^{c}	6.95±0.13^{c}	14.91±0.20^{b}	18.61±0.26^{b}	23.19±0.32^{b}	2.58±0.06^{b}	9.02±0.22^{b}	17.49±0.44^{a}	25.32±0.53^{a}	31.98±0.48^{a}
4	1.58±0.04^{d}	8.62±0.10^{d}	14.79±0.15^{b}	18.43±0.20^{b}	23.06±0.25^{b}	2.96±0.06^{c}	9.58±0.20^{c}	18.37±0.40^{a}	24.66±0.45^{a}	33.63±0.43^{b}
Sex	**	**	**	**	**	*	**	**	**	**
Male	1.43±0.03	7.76±0.07	14.64±0.11	18.28±0.14	22.87±0.18	2.62±0.06	9.56±0.19	18.55±0.39	25.86±0.40	33.77±0.42^{a}
Female	1.28±0.04	7.22±0.11	13.66±0.16	17.05±0.21	21.28±0.26	2.41±0.05	8.57±0.16	17.01±0.33	24.45±0.36	30.73±0.37^{b}
Birth type	**	*	**	**	**	**	**	ns	ns	**
Single	1.41±0.02	7.60±0.04	14.48±0.07	18.08±0.08	22.61±0.11	2.67±0.05	9.37±0.16	18.09±0.33	25.52±0.34	33.70±0.36^{a}
Twin	1.30±0.03	7.39±0.09	13.82±0.14	17.24±0.19	21.54±0.24	2.35±0.07	8.76±0.23	17.46±0.46	24.79±0.51	30.80±0.52^{b}

Least square means ±standard errors, within a column not followed by the same letter differ ($p<0.05$). ** ($p<0.01$). * ($p<0.05$). ns (not significant).

Table III

Least square means ±standard errors (s.e.) and level of significance of fixed effects for average daily gain in pure West African Dwarf (WAD) sheep and F1(WALL xWAD) sheep.

	West African Dwarf (WAD) sheep				F1 (WALLx WAD) sheep			
Fixed effects	ADG1	ADG2	ADG3	ADG4	ADG1	ADG2	ADG3	ADG4
Overal mean	68.19±0.86	73.87 ±0.99	38.76±0.38	49.01±0.47	72.63±2.40	97.37±3.81	83.09±0.34	78.21±0.68
Season of birth	**	**	**	**	ns	ns	ns	ns
S1	73.65±1.69[a]	100.57±1.88[a]	48.17±0.71[a]	60.57±0.88[a]	69.86±1.57[a]	97.77±2.46[a]	83.07±0.22[a]	77.65±0.44[a]
S2	70.91±0.72[b]	68.61±0.83[b]	37.84±0.32[b]	47.92±0.39[b]	75.54±2.92[a]	94.77±4.75[a]	82.94±0.43[a]	78.87±0.88[a]
S3	72.95±1.10[c]	72.05±1.23[c]	39.47±0.46[c]	49.99±0.57[c]	69.92±2.89[a]	98.07±4.72[a]	83.28±0.41[a]	78.25±0.80[a]
S4	55.25±1.22[d]	54.26±1.37[d]	29.58±0.52[d]	37.56±0.65[d]	75.19±2.57[a]	98.85±4.11[a]	83.07±0.38[a]	78.05±0.74[a]
Parity of ewe	**	**	**	**	ns	ns	*	**
1	75.00±1.03[a]	60.43±1.16[a]	36.63±0.44[a]	46.47±0.55[a]	-	-	-	-
2	57.83±1.23[b]	78.10±1.36[b]	37.21±0.51[a]	46.93±0.63[a]	73.21±2.31[a]	99.90±3.81[a]	83.72±0.36[a]	65.23±0.73[a]
3	61.76±1.36[c]	88.21±1.53[c]	40.91±0.58[c]	51.39±0.72[b]	70.99±2.20[a]	94.20±3.47[a]	82.88±0.31[b]	81.25±0.62[b]
4	78.18±1.05[d]	68.75±1.19[d]	40.31±0.45[c]	51.25±0.55[b]	73.68±2.01[a]	98.00±3.19[a]	82.66±0.29[b]	88.14±0.56[c]
Sex	**	**	**	**	**	ns	ns	**
Male	70.30±0.74	76.28±0.84	40.02±0.32	50.82±0.39[a]	77.08±1.96	100.72±3.10	83.29±0.27	87.39±0.54
Female	66.08±1.12	71.47±1.25	37.51±0.46	47.20±.57[b]	68.18±1.64	94.01±2.62	82.89±0.24	69.02±0.48
Birth type	ns	**	**	**	*	ns	ns	**
Single	68.78±0.46	76.45±0.51	39.67±0.19	50.23±0.24[a]	74.23±1.59	96.05±2.59	82.90±0.23	90.07±0.47
Twin	67.60±0.96	71.30±1.11	37.86±0.42	47.79±0.52[b]	71.02±2.30	98.68±3.65	83.28±0.34	66.34±0.67

Least square means ±standard errors, within a column not followed by the same letter differ (p<0.05). ** (p<0.01). * (p<0.05). ns (not significant, p>0.05).

Figure1. West African Long-legged ram crossed with West African Dwarf (Djallonke) ewes.

Figure2. West African Dwarf (Djallonke) ewe in grazing field crossed with West African Long-legged ram.

Figure3. Male and female F1 crossed (West African Dwarf ewe x West frican Long-legged ram) at 7 days of age.

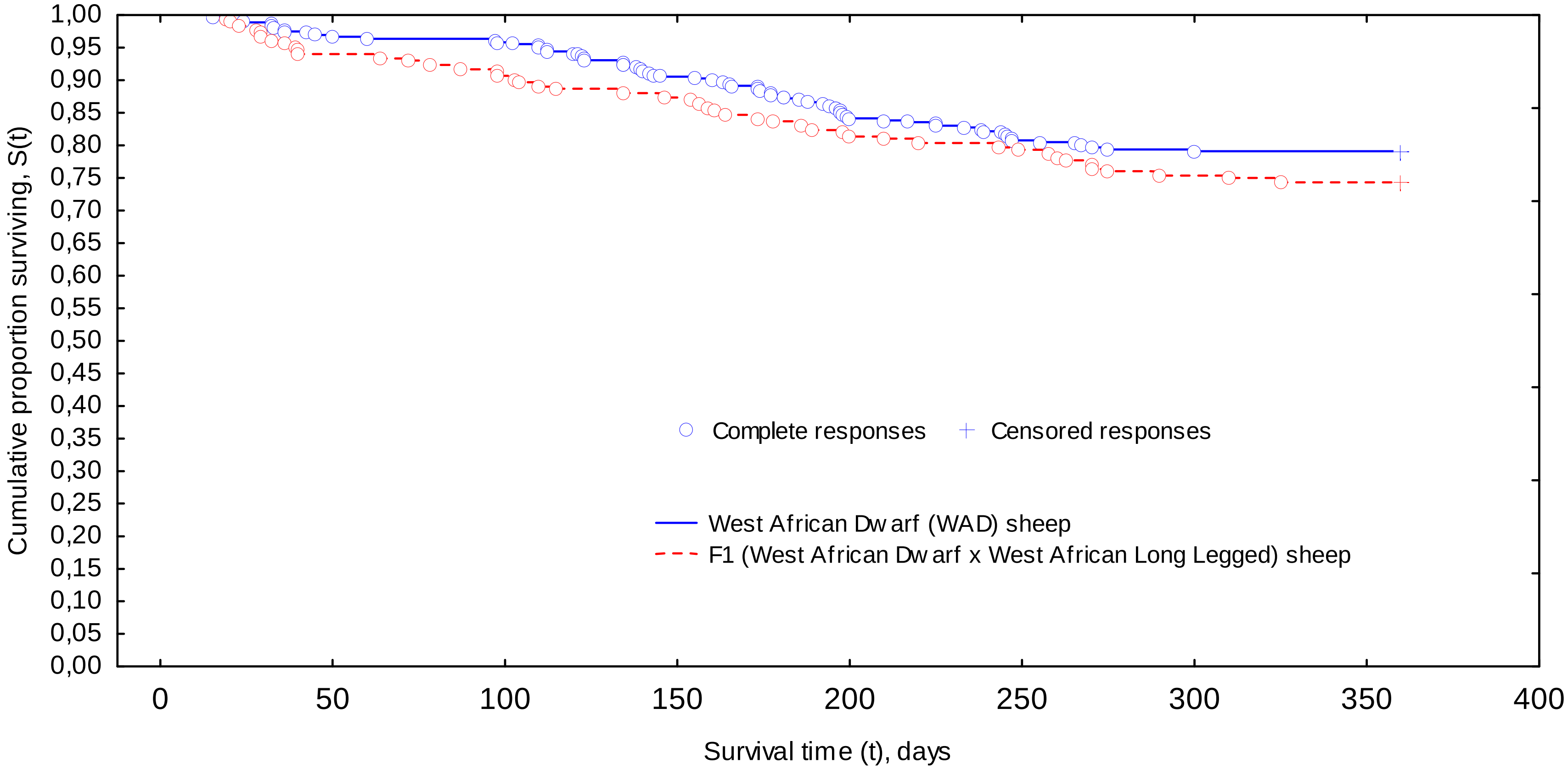

Figure 4. Kaplan – Meier survival curves related to the WAD and F1 (WALL x WAD) sheep from birth to 360 days of age.

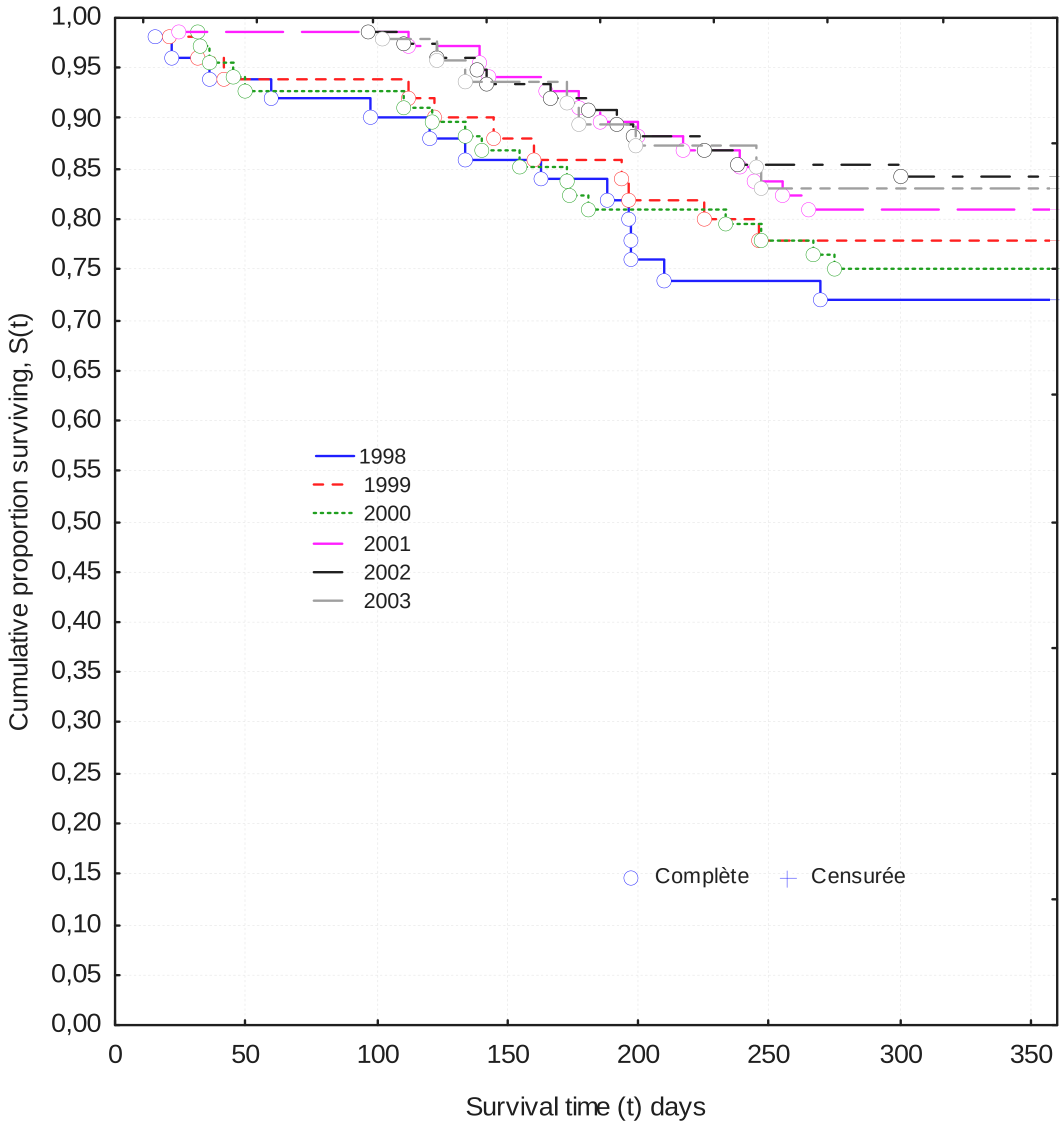

Figure 5. The influence of year of birth on WAD lambs survival time.

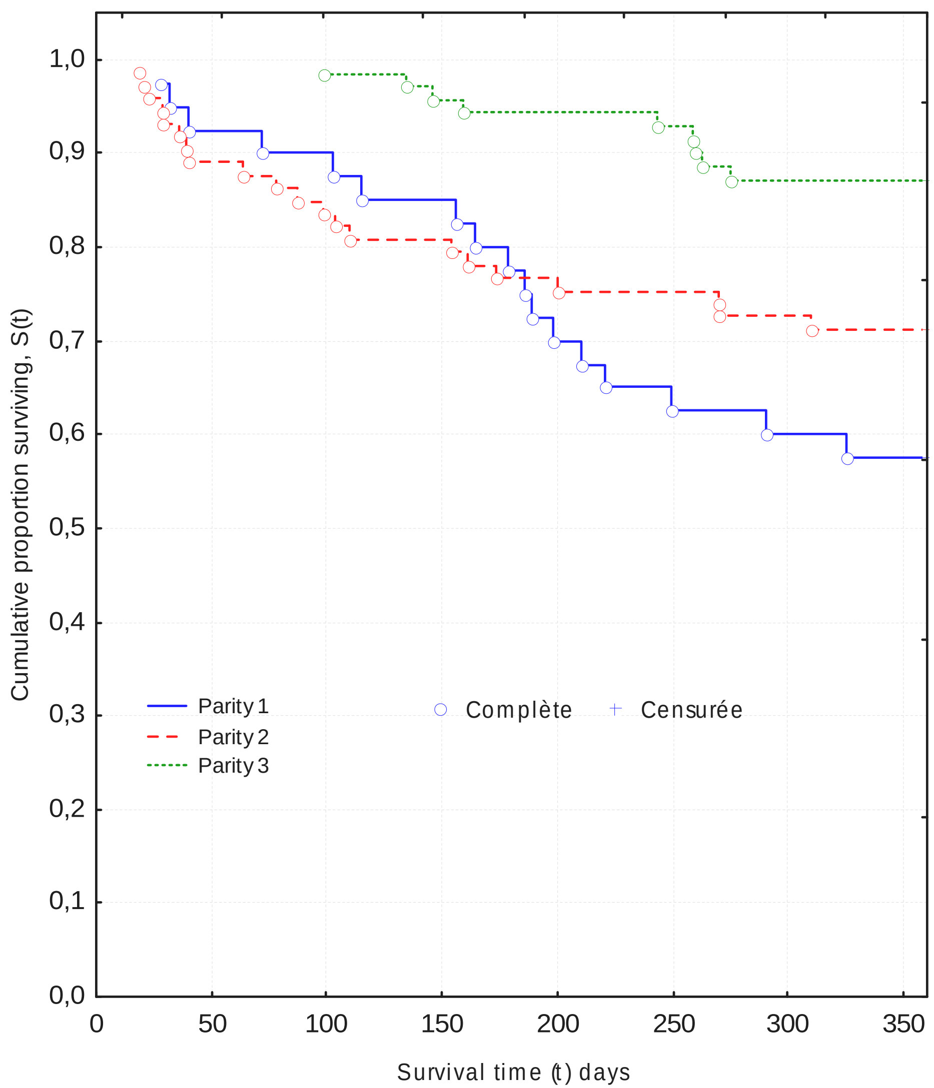

Figure 6. The influence of parity of ewe on F1 (WADxWALL) lambs survival time