Weight gain of calves under sylvo-pastoral and agro-sylvo-pastoral farms

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Abstract

The search for better performance is one of the main reasons for the diversification of farming practices. The objective of the present study was to situate the growth performance of young cattle reared under four types of farmers previously identified: Small sylvo-pastoralists (SSP), Large sylvo-pastoralists (LSP), Small agro-sylvo-pastoralists (SASP) and Large agro-sylvo-pastoralists (LASP). For this purpose, the weights at specific age at birth, at 3 months and at 6 months as well as the average daily gains (ADG) between 0-3 months and 0-6 months were collected on young cattle for the period from 0 to 6 months. The data were subjected to an analysis of variance with the type of farm as the main variation factor and the means were compared by the Student t-test using the R software. The results showed that the calves of LASP and SASP were heavier at birth, at 3 months and at 6 months compared to those of SSP and LSP (p<0.05) for all breeds studied. The same trends were observed for the ADGs of the different breeds except for those of the crossbreds which did not show any significant difference for the period from 0 to 3 months (p>0.05). The results of this study highlight that agro-sylvo-pastoral practices induce better performance in cattle compared to those of sylvo-pastoral farms.

Keywords: sylvo-pastoralism; climate change; cattle; weight; Benin

Introduction

Agricultural systems face the challenge of adapting to climate change, to produce more and better in a rapidly changing world. Future agricultural systems must therefore become more productive, if they are to feed a growing population, more efficient in the use of available resource bases (Stark et al., 2018; Paut et al., 2021). This has therefore favored the integration of crop farming with livestock farming, which has become one of the most widespread agro-ecological practices. This consists of a range of resource-efficient practices that promote efficient recycling of natural resources by creating a beneficial synergy between plant and animal production. In the Beninese context, animal husbandry, in particular that of ruminants, is practiced in various forms depending on the production objectives of the farmers and environmental constraints (Youssao et al., 2013; Assani and Alkoiret, 2015; Worogo et al., 2020; Idrissou et al., 2020) . These farms are increasingly moving towards sylvo-pastoral and agro-sylvo-pastoral practices, but few studies provide information on the productivity of these practices with respect to animal performance. Growth parameters are among the traits that have been studied the most for better management of livestock insofar as they reflect the adaptation of these animals to environmental conditions as well as their contribution to farm incomes (Ngoucheme et al., 2019; Siddo et al., 2018). The growth potential of animals therefore depends on the management and feeding methods in force at the farm level (Alkoiret et al., 2016; Worogo et al., 2018; Alassane et al., 2018). In Benin, some studies have mentioned the use of parts of trees and shrubs increasingly used in the diet of ruminants to fill the food deficit caused by the scarcity of natural pasture (Assani, 2017; Idrissou et al., 2020b). In fact, a recent study conducted by Hessa et al. (2023) identified four types of farms, namely the Small sylvo-pastoralists (SSP), Large sylvo-pastoralists (LSP), the Small agro-sylvo-pastoralists (SASP) and the Large agro-sylvo-pastoralists (LASP). These types of farms presented a variety of cattle breeds whose weight characteristics need to be assessed to account for the yields that can be obtained by integrating trees and shrubs as well as agri-food by-products on the diet of animals. The objective of this study is therefore to evaluate the effect of the type of farm on the weight productivity of calves from these four types of farms.

Materials and methods

Study environment

This study was carried out in the six municipalities where the previous data were collected for the characterization of sylvo-pastoral and agro-sylvo-pastoral systems by Hessa et al. (2023). These localities are geographically distributed in two agro-ecological zones of Benin (between 6° and 12°50'N and 1° and 3°40'E) (Figure 1). The first agroecological zone (cotton zone of northern Benin, ZCNB) groups the municipalities of Banikoara, Kandi and Gogounou. The ZCNB presents a sudanian climate with an influence of the sudano-Sahelian climate in the northern part of the zone. This zone is characterized by ferruginous soils (Lixisols), vertisols and hydromorphic soils (Gleysols) and the rainfall oscillates between 800 and 1200 mm with very irregular rains. The second zone (cotton zone of central Benin, ZCCB) groups the municipalities of Bantè, Savè and Djidja. The climate is sudano-Guinean with 2 rainy seasons, with a tendency towards the sudanian type with a single rainy season in the northern sector of the area. This zone is characterized by leached tropical ferruginous soils which are more or less concretionary (Leptosols and Luvisols); ferrallitic soils with a sandy to sandy-clay texture (Acrisols) and hydromorphic soils of the valleys (Fluvisols). The rainfall in the ZCCB oscillates between 600 and 1400 mm and the average temperature is around 27°C (Aholoukpè et al., 2020).

Data collection

The data were collected from July 2021 to February 2022 in the four types of farms identified by Hessa et al. (2023) as mentioned above. SASP were distributed in the cotton zone of central Benin and were mainly from the Fulani ethnic group with an average age of 38 years. They are poorly educated (10.90%). They had mainly purchased their land and all of them integrated livestock with crops and trees/shrubs. However, the area occupied by trees and shrubs was around 0.5 ha and that of crops 3 ha. The cattle herd size of this group of herders averaged 23 heads. SSP were also mainly encountered in the cotton-growing area of central Benin and were mainly from the Fulani ethnic group and relatively young (36 years old). They were not educated. The agricultural land exploited by these farmers was mainly acquired by purchase (87.50%). The majority of these farmers integrated animals with trees and/or shrubs (87.50%) versus a minority who integrated animals with crops and trees/shrubs (12.50%). The area occupied by trees/shrubs was 2 ha against 1 ha occupied by crops. The cattle herd size of this group was 25 heads. As for LSP, they were mainly located in the cotton-growing area of northern Benin (66.70%). They were made up of the Gando (55.55%) and Bariba (33.33%) ethnic groups and were not educated (88.80%). In this group, agricultural land was mainly acquired by inheritance (87.85%). The majority of respondents integrated livestock with trees/shrubs, against a minority (18%) who associate crops with these two elements. The area allocated to these crops was on average 2 ha and the area occupied by trees/shrubs was about 5 ha. Cattle herd size in this group averaged 65 heads. With respect to LASP, they were mostly from the Fulani socio-cultural group (65.70%), followed by the Gando (20.20%) and were largely located (84.80%) in the cotton-growing area of northern Benin. Very few of them have been educated (12.20%). The average age of herders in this group was 50

years old. The main mode of access to land in this group was purchase (79.89%). All herders in this group incorporated animals into crops and trees/shrubs. The cattle herd size of this group was similar to that of LSP. The area occupied by crops in this group averaged 8 ha and that occupied by trees/shrubs averaged 3 ha. These farms presented a variety of trees comprising *Khaya senegalensis, Pterocarpus erinaceus, Vitellaria paradoxa, Ficus umbellata, Mangifera indica* etc.; fodder shrubs comprising *Leucaena leucocephala, Acacia auriculiformis, Cajanus cajan, Gliricidia sepium*, etc. and some forage plants made of *Brachiaria ruziziensis, Panicum maximun, Stylosanthes guianensis, Pennisetum purpureum*, etc.
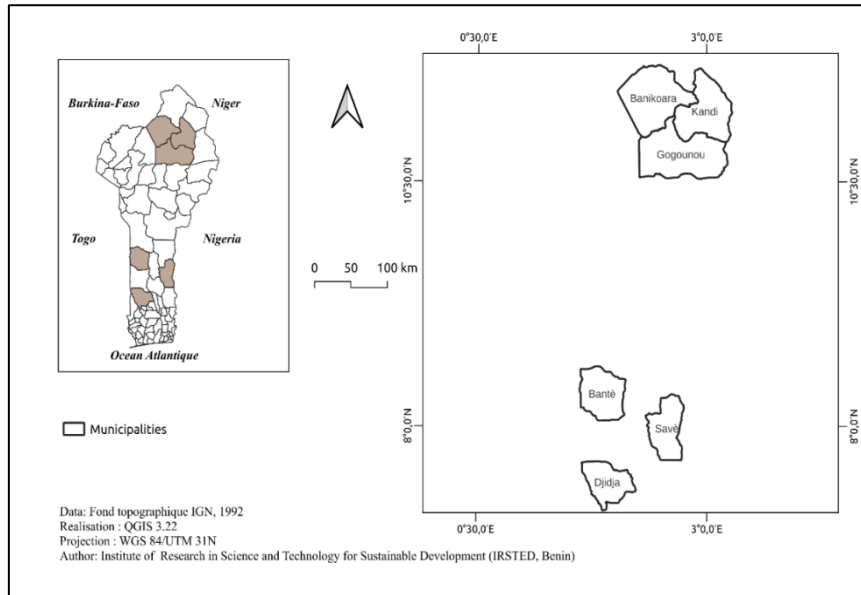

Fig. 1 Study Area

Data were recorded on sixty (60) young animals distributed among the 4 types of farms at the rate of 10 calves in Small Sylvo-pastoralists (SSP), 17 in Large Sylvo-pastoralists (LSP), 10 in Small Agro-sylvo-pastoralists (SASP) and 23 in the Large Agro-sylvo-pastoralists (LASP). The calves whose weight performance was monitored were made up of Borgou, Mbororo, Goudali breeds and crossbreds. Given the low range of the scale (100 ± 0.1 kg) and the difficulties of weight measurement of cattle in rural areas, the limit of weight age was set at six (06) months. Thus, the weights of the animals were recorded at birth (P 0), at 3 months (P 3) and at 6 months of age (P 6). The weights of the animals were recorded every month very early in the morning before any access to feed and water. The animals monitored are those whose births were observed during the phase preceding the present study (Hessa et al., 2023).

Statistical analysis

The data collected were presented taking into account the breed and by type of farm. The type of farm was retained as the only variation factor. The means were subjected to an analysis of variance and then compared by Student's t test when $p<0.05$. Values are presented as mean $\pm$ standard deviation. Analyzes were performed using R software (R Core Team, 2023).

Results

Weight ranges of calves on sylvo-pastoral and agro-sylvo-pastoral farms

Borgou calves from small agro-sylvo-pastoral (SASP) and large agro-sylvo-pastoral farms (LASP) showed higher weights than those from small sylvo-pastoral (SSP) and large sylvo-pastoral farms (LSP) ($p<0.05$) (Table 1). At 3 and 6 months, the highest weights were recorded in Borgou calves from SASP and LASP, while the lowest weights were recorded in Borgou calves from SSP ($p<0.05$). At birth, Mbororo breed calves from SASP and LASP had higher weights than those from SSP and LSP. At 3 months and 6 months, the highest weights were observed in Mbororo calves from SASP and LASP while the lowest weights were recorded in Mbororo calves from SSP ($p<0.05$). As for Goudali cattle breed, at birth, calves from SASP and LASP had higher weights than calves from SSP and LSP. At 3 months, calves from SSP were less heavy while those from LASP presented the best performance ($p<0.05$). At 6 months, baseline trends (at birth) were observed. As for the crossbreds, at birth, calves from the SSP, LSP and SASP had similar weights ($p>0.05$) but lower than those of the calves from the LASP. At 3 months, the LSP and SASP calves caught up with the LASP calves and the lowest weights were

observed in the SSP calves. At the age of 6 months, the calves from the different farms maintained the same trends as at 3 months of age.

Average daily weight gains of cattle on sylvo-pastoral and agro-silvo-pastoral farms

Borgou calves from SASP and LASP between 0-3 months and between 0-6 months of age were higher than those of SSP and LSP ($p<0.05$) (Table 2). No significant difference was observed between the ADGs of calves from SSP and LSP ($p>0.05$) on the one hand and between the ADGs of calves from SASP and LASP on the other hand ($p>0.05$). As for Mbororo calves, the ADG presented by calves from SASP and LASP between 0-3 months and between 0-6 months of age were higher than those of calves from SSP and LSP ($p<0.05$).

Table 1: Weight (kg) at specific age of calves according to the type of farm

Breeds	Farm type	0 months	P 3 months	P 6 months
Borgou	SSP	15.47 ±1.24[b]	31.47 ±2.81[b]	52.23 ±3.68[b]
	LSP	16.11 ±1.11[b]	33.27 ±1.92[ab]	55.17 ±3.25[ab]
	SASP	18.36 ±1.97[a]	35.56 ±3.36[a]	57.31 ±4.72[a]
	LASP	18.88 ±2.02[a]	36.78 ±3.69[a]	58.39 ±4.85[a]
Significance		*	*	*
Mbororo	SSP	20.52 ±1.48[b]	42.77 ±3.29[b]	78.95 ±3.89[d]
	LSP	21.16 ±1.39[b]	44.26 ±3.91[ab]	80.24 ±4.07[c]
	SASP	22.18 ±1.87[a]	45.95 ±3.66[a]	83.46 ±4.49[b]
	LASP	22.94 ±2.17[a]	47.97 ±4.44[a]	84.66 ±5.18 [a]
Significance		*	*	*
Goudali	SSP	20.36 ±1.06[b]	44.53 ±2.35[c]	79.75 ±4.18[b]
	LSP	20.69 ±1.11[b]	47.20 ±3.15[b]	80.50 ±3.87[b]
	SASP	21.82 ±2.09[a]	49.43 ±4.84[a]	82.65 ±4.77[a]
	LASP	22.23 ±2.39[a]	49.22 ±5.24[a]	83.15 ±4.94[a]
Significance		*	*	*
Crossbreds	SSP	19.03 ±1.82[b]	37.03 ±4.37[b]	65.17 ±3.36[b]
	LSP	19.16 ±1.93[b]	38.87 ±3.83[a]	67.19 ±3.57[a]
	SASP	19.23 ±2.22[b]	39.32 ±4.47[a]	69.41 ±4.79[a]
	LASP	19.97 ±2.48[a]	40.51 ±4.27[a]	71.69 ±5.24[a]
Significance		*	*	*

a,b,c,d : the mean values indexed with the same letter on the same column are not significantly different at the 5% threshold (p>0.05); SASP: Small Agro-sylvo-pastoralists ; SSP: Small Sylvo-pastoralists ; LASP: Large Agro-sylvo-pastoralists ; LSP: Large sylvo-pastoralists

Table 2: Average daily gain (g/day) of calves according to farm type

Breeds	Farm type	ADG 0-3 months	ADG 0-6 months
Borgou	SSP	176.43 ±10.44[b]	214.56 ±17.64[b]
	LSP	178.84 ±9.17[b]	217.57 ±18.73[b]
	SASP	198.96 ±12.55[a]	224.63 ±15.24[a]
	LASP	202.17 ±11.06[a]	226.37 ±16.11[a]
Significance		*	*
Mbororo	SSP	251.52 ±13.31[b]	335.28 ±20.34[b]
	LSP	256.47 ±14.01[b]	333.26 ±21.55[b]
	SASP	274.09 ±14.54[a]	340.91 ±18.40[a]
	LASP	280.78 ±17.66[a]	345.77 ±17.34[a]
Significance		*	*
Goudali	SSP	272.27 ±19.18[d]	332.90 ±19.50[c]
	LSP	298.47 ±18.75[c]	340.41 ±20.05[b]
	SASP	305.19 ±20.29[b]	348.78 ±18.67[a]
	LASP	311.73 ±18.58[a]	349.83 ±15.64[a]
Significance		*	*
Crossbreds	SSP	200.58 ±13.46[a]	252.80 ±13.06[b]
	LSP	202.34 ±11.21[a]	257.02 ±12.73[b]
	SASP	205.18 ±11.53[a]	275.23 ±19.46[a]
	LASP	205.94 ±12.49[a]	278.32 ±14.52[a]
Significance		NS	*

a,b,c,d : the mean values indexed with the same letter on the same column are not significantly different at the 5% threshold (p>0.05); SASP: Small Agro-sylvo-pastoralists ; SSP: Small Sylvo-pastoralists ; LASP: Large Agro-sylvo-pastoralists ; LSP: Large sylvo-pastoralists

No significant difference was observed between the ADGs of calves from SSP and LSP (p>0.05) on the one hand and between the ADGs of calves from SASP and LASP on the other hand (p>0.05). With respect to Goudali calves, the highest ADG values between 0-3 months were recorded in the LASP calves followed by those of the SASP calves. The lowest ADG values for this age group were observed in the SSP calves (p<0.05). Between 0-6 months, the ADG performance of SASP calves equaled that of LASP calves (p>0.05). On the other hand, the lowest ADG values were observed in the SSP calves (332.90 ±19.50 g/d; p<0.05). At the level of crossbreeds, the ADGs recorded at the level of the four types of farms showed no significant difference for the age group of 0-3 months (p>0.05). On the other hand, a differentiation in performance was observed for the period from 0 to 6 months. The ADGs of SASP and LASP calves were higher than those of SSP and LSP calves (p<0.05).

Discussion

Calf weight productivity

The present study consisted in determining and comparing the weights as well as the average daily gains of calves aged at most 6 months following four types of farms. Overall, for weights at specific age, the best performances were recorded for calves on agro-sylvo-pastoral farms for all the breeds considered. This could be justified by the fact that agro-sylvo-pastoral farms provide more food resources from crops compared to sylvo-pastoral farms whose efforts to supplement animal feed are mainly based on the use of trees and shrubs. The LASP and SASP calves presented similar values for the weights at 0, 3 and 6 months for all the breeds considered with the exception of the weights of the Mboraro calves at 6 months and the weights of the crossbred animals at birth for which the calves of the LASP showed a superiority compared to the calves of the SASP. The weights obtained at birth for Borgou calves in all the systems studied (15.47 to 18.88) are higher than those reported (14.28 to 17.11) by Idrissou (2021) on herds whose weight performances were assessed according to their practices for adapting to climate change. For the weights at 3 months, the performances recorded in the present study at the level of the Borgou calves of the LSP are similar to those of the Borgou calves of the farms characterized by a "Reinforced Feeding in Concentrate and Forages" (33.58 kg) as reported by Idrissou (2021). The lowest values recorded in the present study (31.47 kg) at the SSP level are higher than those of the "Pastoral Mobility farms" (30.75 kg) studied by Idrissou (2021). The lowest weights and the highest weights recorded in the present study in Borgou calves (15.47 and 18.88 kg) are lower than those reported by (Worogo et al., 2018)on the same breed at the Okpara Breeding Farm (16.11 and 22.28 kg respectively for the lowest and highest weights) in Benin. This could imply that animals on station are more productive than those encountered in uncontrolled environments. At 6 months of age, the Borgou calves presented a variation of 52.23 kg (SSP) to 58.39 kg (LASP). These results are much higher than the variations observed by Idrissou (2021) at the level of farms characterized by "Pastoral Mobility" (48.33 kg) and farms with "Reinforcement with Concentrate and Forage Feeds" traits (55.08 kg). For the Mboraro breed, the weights recorded at birth (20.52 to 22.94 kg) are of the same order as those reported by Idrissou (2021) on farms adopting climate change adaptation strategies: "Crop- Livestock Integration", "Reinforcement with Concentrate and Forage Feeds" and "Pastoral Mobility" (20.82 to 22.87 kg).

The weights recorded at birth for the Goudali breed calves in the present study (all types combined) are lower than those reported (23.8 kg) by (Assani et al., 2016)on the same breed in transhumance farms in the Classified Forest of Upper Alibori in Benin. Similarly, the weights recorded at birth for Mboraro calves in the present study for the four types are lower than those reported (23.1 kg) by these same authors. These variations may be due both to the variability of feed resources over the years as well as to the difference in the study areas. Furthermore, the weights recorded at birth in crossbred calves on SSP, LSP and SASP farms are lower than those reported by Assani et al. (2016)on crossbreds (19.3 kg); while the crossbred calves from LASP showed higher weights (19.97 kg). At birth, the weights of Borgou, Mboraro, Goudali and crossbred calves are lower than those reported by (Siddo et al., 2018)Azawak calves (22.3 kg) at birth in Niger; with the exception of Mboraro calves from LASP which showed better weight (22.94 kg).

Average daily gains

Given the sparse literature adapted to the context of our study, this section is limited to taking into account only a few sources for the comparisons. In the present study, the best ADGs were observed in calves from agro-sylvo-pastoral farms for all the breeds studied. This implies the ADGs presented a proportional evolution to the age-type weights at the level of the four systems studied. The ADGs recorded from 0 to 3 months for the Borgou breed in the present study (176.43 to 202.17g/day) for the four types studied are lower than that reported (220 to 233g/day) by (Youssao et al., 2013b). They are also lower than those reported (196.5 to 220g/day) by (Alkoiret et al., 2016)on the same breed in the station and for the same age group. These results also show that the animals in the sylvo-pastoral and agro-sylvo-pastoral systems benefit from a less abundant diet than those encountered in the station. The ADGs of Mboraro , Goudali and crossbred cattle showed higher values than those reported (246.8 to 261.62g/d) by (Koussou et al., 2017) on Arab zebu calves in Chad.

Conclusion

Agro-sylvo-pastoral practices induce various animal performances. Practices involving the combined use of feed resources from crops and those from the exploitation of trees and shrubs (agro-sylvo-pastoral farms) presented animals with better performance. This implies that agriculture-livestock-tree integration is presented as an alternative to be promoted for better zootechnical performance and better resilience in the face of climate change.

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