World Journal of Agricultural Research, 2019, Vol. 7, No. 1, 14-20
Available online at http://pubs.sciepub.com/wjar/7/1/3
Published by Science and Education Publishing
DOI:10.12691/wjar-7-1-3

Effect of Cowpea Hay Supplementation on Milk Production Performances of Local Crossbred Cattle (*Bos indicus X Bos taurus*) in Extensive System in Burkina Faso

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Received November 17, 2018; Revised December 19, 2018; Accepted January 13, 2019

Abstract The aim of this study was to determine the effect of cowpea hay supplementation on milk production parameters. In each of the five farms involved, four lactating cows were selected, and assigned into two groups: group 1 was supplemented after grazing with 3 kg of cowpea hay, while group 2 was the control group with no feed supplementation. The experiment lasted three months. The body condition scores (BCS) of the cows and the live weight of the calves were measured at the beginning and at the end of the test. Daily feed intake were recorded, and milk samples were collected. Mean BCS of 2.90 ± 0.20 and 3.15 ± 0.22 were recorded for group 1 at the beginning and the end of the test, respectively; while these values were 3.0 ± 0.20 and 3.10 ± 0.22 for group 2 (controls) ($P > 0.05$). Average live weights of the calves at the end of the test were 49.3 ± 6.30 and 43.0 ± 6.30, respectively, for group 1 and 2 ($P < 0.05$). Mean daily consumption of the feed supplement was 2.25 ± 0.40 kg / cow, and daily milk production was 1378 ± 496 ml / cow (group 1), against daily milk production of 1079 ± 496 ml / cow (group 2) ($P > 0.05$). Crude fat, crude protein, lactose, dry matter and ash levels were 3.25 ± 0.22%, 3.35 ± 0.33%, 5.17 ± 0.37%, 12.4 ± 1.78% and 9.21 ± 1.58%, respectively for group 1, against 2.95% ± 0.22, 3.31 ± 0.33%, 5.12 ± 0.37% 12.0 ± 1.78% and 10.2 ± 1.58% respectively for group 2 ($P > 0,05$). A profit of about 22 FCFA per liter was found with the supplemented group compared to the control group. It was concluded that milk production and calves growth performances can be increased economically by using cowpea hay as feed supplement for lactating cows in extensive system.

Keywords: *cowpea hay, cattle, milk production, Burkina Faso*

Cite This Article: Salimata Pousga, Mamadou Traore, Adama Belem, Vinsoum Millogo, and Hassan Bismark Nacro, "Effect of Cowpea Hay Supplementation on Milk Production Performances of Local Crossbred Cattle (*Bos indicus X Bos taurus*) in Extensive System in Burkina Faso." *World Journal of Agricultural Research*, vol. 7, no. 1 (2019): 14-20. doi: 10.12691/wjar-7-1-3.

1. Introduction

The decline in soil fertility and the decrease in forage availability are leading to productivity and sustainability problems in agro pastoral systems of sub-Saharan Africa [1]. In livestock system, nutritional stress in dry season is a major constraint on ruminant productivity [2]. Indeed, in extensive systems, ruminant feeding is mainly based on natural pastures during the rainy season (June to September) [3,4], and on post-harvest residues after harvesting (September to December) [5]. These pastures have generally poor nutritive values, particularly in term of nitrogen, and are high in crude fibber, which limits the consumption and the digestibility of ruminants, resulting in a decrease in milk production and calve body weight gain [6] and this contribute to the exposure of pastoral communities to poverty and food insecurity [7]. However, agro-pastoral herders rarely practice feed supplementation during dry season because of the scarcity and the high cost of conventional commercial feed. However, in traditional dairy farming system where cattle depend almost exclusively on pastures and crop residues as feed sources, supplementation becomes compulsory in dry season if milk production and calve growth are expected to continue during this period [8,9]. Despite the development of many forage production and conservation techniques, the adoption of these technics by the majority of the farmers remains low, mainly because of land pressure and also the additional work load related to the fodder crop [10].

Many studies have highlighted the role of legumes in atmospheric nitrogen fixation, hence the importance of their cultivation to improve soil fertility [1,11,12,13] and their importance in animal nutrition [14,15]. The present study come in this framework to promoting the integration of cowpea in maize-based cropping systems. The aim was to help improving maize yield (through improved soil fertility) and to improve the available forage (in quantity and quality) during the dry season. The objective of this study, which focused only on the animal nutrition part of the program, was to evaluate the effect of supplementation with cowpea hay grown by livestock farmers on milk production performances and the economic profitability of dairy farms in the village of Bole.

2. Materials and Methods

2.1. Site of the Study

The study took place in Bole, a village about 30km from Banfora town (capital of Comoé province), on the way to Ivory Cost. The climate is South-Sudanian, characterized by two seasons: a rainy season that goes from April to October, and a dry season that goes from November to March. The plant species encountered among many others are mainly: *Parkia biglobosa, Pteleopsis suberosa, Vitellaria paradoxa, Terminalia sp, Bombax costatum, Khaya senegalensis, Terminalia avicennioides, Afzelia Africana, Daniellia oliveri, Khaya senegalensis, Acacia senegal, Andropogon gayanus, Pennisetum pedicellatum Trin*.

2.2. Farmers Selection Criteria

The choice of farmers was made according to their previous experience in the activities of the Association for the Promotion of Livestock in the Sahel and Savannah (APESS) which is a big livestock farmers union in West Africa. In any case, the availability of lactating cows in the farm and the willing of the farmers to follow the recommended conditions were also parts of the selection criteria. The conditions included the participation in the study throughout the period concerned, starting with the cultivation of the cowpea hay in combination with maize (maize is the staple food consumed by farmers). Five pilot farms (F1, F2, F3, F4 and F5) were then selected for the study, and each farmer received maize (*Zea maize*) seeds (local variety) and cowpea (*Vigna unguiculata*, variety KVX-745-11P) variety with high grain yield, but also high fodder yield for human consumption and be of great nutritional contribution for animals after pods harvesting [16]

The agronomic part of the maize and the cowpea hay yield was a topic in separate study [17], while the present study focused only on the use of the harvested cowpeas forage in the supplementation of lactating cows from March to end of May.

2.3. Experimental Treatment

The choice of the lactating cows concerned those whose calves were between 1 and 2 months old. The experimental set-up was as follows: in each farm, four cows were chosen, and randomly divided into two groups of two cows: group 1 (V1 and V2) were supplemented after grazing with 3 kg of cowpea hay forage, while group 2 (V3 and V4) were the control group with no supplementary feed after grazing. Every morning, the animals went for grazing from 7:00 am and returned around 5:00 pm. In total, twenty cows were involved in the study. Each morning the animals roamed about 3 to 4 km in the bush for pasture seeking. Sanitary prophylaxis, based on parasitic treatments, preventive and curative vaccination against trypanosomosis, were carried out. This sanitary prophylaxis concerned all livestock belonging to the producers involved in the study.

2.4. The Feeding System of the Calves

During the experiment, the calves concerned by the study did not go to pasture as they were still fragile. They had access to their mother only twice a day; firstly, they were put in contact with the mother in the morning to first stimulate the descent of the milk for the morning milking, and then after milking, they suckled for a while (about 1 hour) before the departure of the cows for grazing (4 to 5 km). Secondly, in the afternoon when the cows were back, the calves were again put in contact with their mother to stimulate the descent of the milk for the evening milking after which they suckled for about 3 hours. Then, they were isolated from their mother until the next milking (next morning). In addition, the calves were given drilling water, as well as some light fodder and cereal brans *add-libitum* during the day in absence of the cows.

2.5. Data Collection

The data collection started after the adaptation period which lasted two weeks.

2.5.1. Determination of Body Condition Score (BCS) of the Cows and Live Weight of the Calves

The body condition score (BCS) of the cows was estimated according to the technique of Edmonson and collaborators [18], a technique for estimating the animal's body condition by palpating some parts of the body. The live weight of the calves was measured with a measuring scale with maximum capacity of 200kg and 1kg precision, using different dimension of straps and gallows.

2.5.2. Determination of the Feed Intake from the Supplement

The intake from the supplement were recorded daily for 90 days. Therefore, feed refusals were weighed to obtain the quantity actually consumed, making the difference between the quantity offered and the remaining quantity.

2.5.3. Estimation of Milk Yield during the Experiment

Milk yield was estimated every two weeks in the mornings (7:00) and in the evenings (18:00) for six weeks (from mid-April to end of May). In each farm, milk was collected in a five-litter plastic bucket previously cleaned and numbered according to the cow's identification. After homogenization, samples of 15 ml were collected in tubes according to the identification of the cow, and the milking time for subsequent laboratory analyses. The tubes were immediately placed in a cooling container. The remaining milk in the bucket was measured using a 250 ml test tube. Then, morning milk yield was estimated by adding 15 ml to the quantity measured from the bucket. The same method was done to estimate evening milk yield. Daily milk yield per cow was calculated as the sum of evening and the following morning yield. Both morning and evening samples were kept the same day in a refrigerator at 4°C. The next morning they were sent to Bobo-Dioulasso (85km from Banfora) in the cooling container for proximate analysis. A total of 160 milk samples were analysed during the trial.

2.6. Laboratory Analyses

Two samples of the cowpea hay (weighing approximately 1 kg each) were collected with the 5 farmers (owners of the experimental cows) and sent to the laboratory for chemical analysis (10 samples). The analyses were carried out at Kamboinsin Animal Nutrition Laboratory in Ouagadougou. The analyses were done according to standard methods [19], and each sample was duplicated giving 20 samples. Chemical analyses of the milk were carried out at the Laboratory of Research and Training in Animal Health and Biotechnology (LARESBA) of the NAZI BONI University. The device used to determine milk parameters was "Farm Milk Analyzer, 2001, Miris AB" which uses the infra-red (IR) method to determine fat content, protein content, lactose , dry matter and ash contents.

2.7. Economic Analysis of the Supplementation

The economic evaluation was made on the basis of the estimate of the gross margin between cowpea hay production cost at farm level and milk price at farm level during dry season. Other advantages of the supplementation were appreciated trough the evolution of the body condition score of the cows and calve growth.

2.8. Statistical Analyses

Data were subjected to MINITAB statistical software, version 16. Analysis of variance (ANOVA) was performed in the General Linear Model Procedure (GLM). The comparison of means was done using the Tukey test at 5% confidence interval. Comparison of mean body condition score of the cows and the mean live weights of the calves were made by the student test.

3. Results

3.1. The Body Condition Score (BCS) of the Cows and the Live Weight of the Calve

The cows BCS informations are shown in Table 1. Mean BCS were 2.9 ± 0.21 and 3.15 ± 0.24 for group 1 at the beginning and the end of the test, respectively; these values were 3.0 ± 0.19 and 3.1 ± 0.21 for group 2 (controls) ($P > 0.05$).

Data recorded on calve body weights are shown in Table 2. At the beginning of the test, mean live weight of the calves in group 1 was 28.5 ± 7.7 and 29.2 ± 7.5 for group 2. At the end of the test, average live weights of the calves were 49.3 ± 6.5 and 42.7 ± 6.3, respectively, for group 1 and 2 ($P < 0.05$).

Table 1. Evolution of the body conditions score (BCS) (N = 20)

	Group 1	Group 2	SD
Before the experiment	2.90 [a]	3.0 [a]	0.20
After the experiment	3.15 [a]	3.10 [a]	0.22

Group 1 = Experimental group, Group 2 = Control group.
[a,]Means with the same superscript letters within a column are not significantly different ($P < 0.05$).

Table 2. Average body weight of the calve before and after the experiment (N = 20)

	Group 1	Group 2	SD
Before the experiment	28.5 [a]	29.2 [a]	7.50
After the experiment	49.3 [a]	43.0 [b]	6.30

Group1 = Experimental group, Group 2 = Control group.
[a,b]Means with different superscript letters within a column are significantly different ($P < 0.05$).

3.2. Chemical Composition and Daily Feed Intake of the Cowpea Hay

Average daily supplement intake in the supplemented group was 1962 ± 329 g of dry matter per cow. Chemical parameters of the hay according to farm is presented in Table 3 while mean daily nutrient intakes are given in Table 4.

Table 3. Chemical composition of cowpea hay (N = 20)

Paramètres (%)	Mean	SD
DM	86.52	1.2
Ash	11.7	1.2
OM	87.4	2.7
CP	15.1	1.3
CF	23.7	3.25
NDF	51.8	29
ADF	12.8	46
ADL	24.0	2.1
Fat	3.66	1
ME (Kcal/Kg)	2444	145

DM: Dry matter; OM: Organic Matter; CP: Crude protein; CF: Crude fibre; NDF: Neutral Detergent fibre; ADF: Acid Detergent Fibre; ADL: Acid Detergent Lignin; ME: Metabolizable Energy.

Table 4. Average daily nutrients intake from supplementary feed (gram/day/cow) (N= 900)

Parameters	Mean	SD
DM	1962	329
Ash	229	23
OM	1714	531
CP	295	25
CF	465	64
NDF	1017	580
ADF	251	91
ADL	470	42
Fat	72	18
ME (Kcal/day/cow)	4796	284

DM: Dry matter; OM: Organic Matter; CP: Crude protein; CF: Crude fibre; NDF: Neutral Detergent fibre; ADF: Acid Detergent Fibre; ADL: Acid Detergent Lignin; ME: Metabolizable Energy.

3.3. Evolution of the Daily Milk Yield

Daily milk yields recorded were 1378 ± 470 ml and 1079 ± 523 ml for group 1 and 2, respectively. Average morning milk yield was estimated to 866 ml / day / cow (group 1) against 517 ml / day / cow (control group). Evening milk quantity for the first group was found to be 512 ml / day / cow against 354 ml / day / cow for the second. No significant difference was observed between these data (P> 0.05). Within the different group, morning milk yield was significantly higher than evening yield (P < 0.05). Data on milk production are shown in Table 5.

Milk production of the supplemented group was higher compared to the control group.

Table 5. Average daily milk yield according to treatment and milking period (ml/d/cow)

	Group 1	Group 2	SEM
Mean daily yield	1378^{a}	1079^{a}	496
Mean morning yield	866^{a}	725^{a}	346
Mean afternoon yield	512^{b}	354^{b}	151

Group 1 = Experimental group, Group 2 = Control group.
^{a,b}Means with different superscript letters within a row are significantly different (P < 0.05).

Milk yield observed in the supplemented groups (1) was higher than that of the control groups (2) during the four checking period (sampling period) (P> 0.05), and this difference between the 2 groups was progressive. The gap in milk yield increased from 158 ml / day / cow during the first sampling to 563 ml / day / at the last sampling. Data on the evolution of milk yield are shown in Table 6.

Table 6. Evolution of milk yield within the four sampling periods (ml/d/cow)

Sampling period	Group 1	Group 2	SEM
S1	944^{bc}	786^{c}	343
S2	$1192b^{c}$	973^{bc}	312
S3	1496^{ab}	1147^{bc}	311
S4	1803^{a}	1240^{abc}	495

Group 1 = Experimental group, Group 2 = Control group.
S1 = 1st^{r} sampling, S2 = 2nd sampling, S3 = 3rd sampling, S4 = 4th sampling.
^{a,b}Means with different superscript letters within a row are significantly different (P < 0.05)

3.4. Chemical Composition of the Milk

Data on milk chemical composition are reported in Table 7 and Table 8. No significant difference was observed between the different groups, although the supplemented cows showed slightly higher values compared to the control cows.

Table 7. Milk chemical parameters (N =160)

Chemical parameters (%)	Group 1	Group 2	SEM
Fat	3.25^{a}	2.95^{a}	0.22
Crude protein	3.35^{a}	3.31^{a}	0.33
Lactose	5.17^{a}	5.12^{a}	0.37
Dry matter	12.4^{a}	12.0^{a}	1.78
Ash	9.21^{a}	10.2^{a}	1.58

Group 1 = Experimental group, Group 2 = Control group.
^{a}Means with same superscript letters within a row are not significantly different (P > 0.05).

Data on the changes observed in milk chemical composition according to treatment are presented in Table 9. Milk chemical parameters evaluated showed slight change between the groups, with chemical data of the experimental group being higher compared to the control group.

3.5. Economic evaluation of the supplementation

The economic evaluation was made on the basis of the estimate production cost of cowpea hay at farm level and farm price of milk in the dry season. In collaboration with farmers, cowpea seeds, labor costs and the amount of hay obtained in a given area were estimated. Production cost for 1kg of hay was estimated to 20 F CFA. Daily cost of the 3 kg of fodder that were given as supplement to the experimental animals was estimated to 60 F CFA. Since the average daily intake of the fodder was 2.23 kg, the supplementation cost per cow was estimated to 45 FCFA per day. Additional information in the village showed that milk price in the dry season was about 300 F CFA per liter (about 0.52 USD). Economic data are presented in Table 10. Daily milk production cost was 413 F CFA for group 1 and 324 F CFA for the control groups (group 2). A gross margin of 368 F CFA was recorded for group 1 and 324 F CFA for group 2. The difference in gross margin between the two lots was approximately 44 F CFA, and this represented the daily profit from the supplementation per cow and per day. This profit was estimated to 32 F CFA on milk liter basis.

Table 8. Evolution of the milk chemical composition (N = 160)

	Morning			Afternoon		
Parameters	Group 1	Group 2	SEM	Group 1	Group 2	SEM
Fat	3.37^{a}	3.14^{a}	1.20	2.86^{a}	3.04^{a}	1.26
Crude protein	3.40^{a}	3.31^{a}	0.32	3.14^{a}	3.30^{a}	0.33
Lactose	5.24^{a}	5.10^{a}	0.43	5.17^{a}	$5,08^{a}$	0.24
Dry matter	12.78^{a}	12.10^{a}	1.70	11.93^{a}	12.08^{a}	1.83
Ash	9.40^{a}	9.01^{a}	0.61	9.07^{a}	11.34^{a}	1.27

Group 1 = Experimental group, Group 2 = Control group.
^{a}Means with same superscript letters within a row are not significantly different (P > 0.05).

Table 9. Evolution of milk chemical composition within the four sampling periods (N =160)

Parameters	S1		S2		S3		S4		SEM
Fat	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	
Crude protein	3.11^{a}	2.96^{a}	2.78^{a}	2.85^{a}	3.41^{a}	2.99^{a}	3.72^{a}	2.30^{a}	1.18
Lactose	3.13^{a}	3.01^{a}	3.31^{a}	3.23^{a}	3.44^{a}	3.46^{a}	3.52^{a}	3.4^{a}	0.3
Dry matter	5.18^{a}	5.18^{a}	5.39^{a}	5.12^{a}	4.97^{a}	4.99^{a}	5.13^{a}	5.20^{a}	0.31
Ash	11.1^{a}	11.80^{a}	12.0^{a}	11.80^{a}	12.6^{a}	12.2^{a}	13.3^{a}	12.3^{a}	1.72
	8.90^{a}	8.80^{a}	9.07^{a}	8.90^{a}	9.30^{a}	9.21^{a}	9.60^{a}	13.9^{a}	0.79

Group 1 = Experimental group, Group 2 = Control group.
S1 = 1st^{r} sampling, S2 = 2nd sampling, S3 = 3rd sampling, S4 = 4th sampling.
^{a}Means with same superscript letters within a column are not significantly different (P > 0.05).

Table 10. Economic evaluation of the supplementation

Parameters	Group 1	Group 2
Daily milk yield (litter/cow)	1,378	1,079
Milk selling price at farm level (F CFA*/liter)	300	300
Total milk selling cost day/ cow	413	324
Daily cost of the supplement (F CFA/cow)	45	0
Gross margin (F CFA/day/cow)	368	324
Profit from supplementation (F CFA/day/cow)	44	-

*1 USD = 574.14 F CFA
Group 1 = Experimental group, Group 2 = Control group.

4. Discussion

4.1. The Body Condition Score (BCS) of the Cows and the Live Weight of the Calves

The evolution of the body condition score showed that the supplemented cows slightly improved their BCS at the end of the experimental period compared to the cow from the control groups. These results differ from those found by other authors who showed that lactating cows significantly increased body weight and BCS at the end of the experimental period in supplementation assay [20,21]. However, a similar study carried out in Mali with local breed lactating cows kept in extensive system reported that both supplemented cows and control cows lost weight during lactation in the dry season because of the poverty of natural forage during this season [22], and this could explain the non-significant increase in BCS observed in the present study with the supplemented cows compared to the control. In the present study, the low benefit of the supplementation could be explained by the fact that the cows roamed about 8 to 10 km / day (round trip) for grazing. This would increase the energy requirements associated with physical exercise, and as a result it is likely that the energy available for milk production will be reduced. Indeed, lactation is associated with an increase in basic metabolism but also a production of extra-heat related to the amount of feed that requires milk secretion. Therefore, since tropical fodder is of poor quality in general, it does not allow the animal to produce significant amount of milk [23].

In addition, the experiment was carried out when natural forage was not enough and of poorer quality, and this might have influenced the valuable effect of supplementation on milk production. The duration of the experiment was relatively short (3 months) and probably this did not allow better appreciation of the benefit from the supplementation. Finally the calves were suckling their mother for about four hours a day, which meant that much of the milk produced was also consumed by the calves. Thus, the benefit of the supplementation should be estimated from the quantity of milk collected after milking and also from the growth of the calves in the supplemented groups, as evidenced by the significant increase in the average live weight of the calves in this group. Similar results were reported by other authors who confirmed that rearing conditions and especially the feeding system of the cows influenced the growth rate of the calves [22], and that the calves of the supplemented cows had higher live weight compared to the calves in the control groups [24].

4.2. Chemical Composition of Cowpea Hay and Daily Amounts of Nutrients Intake

Organic matter (O M) and Crude Protein (C P) contents of the cowpea hay in this study are in agreement with the data obtained in Mali, neighboring country of Burkina Faso on cowpea hay (OM: 88.7% and CP: 14.1%) [22] However, the metabolizable energy value found in the present study was lower (2444 kcal / kg) compared to the data in Mali. This difference could be related to the variety of cowpea used in both cases or to the methods of conservation [25,26]. The average daily dry matter intake of 1962g / d / cow is slightly higher than the value obtained in Mali (1506g/d) with local crossbred cow (Zebu X taurins) supplemented after grazing [22]. This high consumption of dry matter in the present study, unlike the study in Mali on the same breed, could be explained by the fact that in the present study, the dietary supplement was only cowpea, while in Mali the supplement was composed of many elements in addition to the cowpea hay. Total daily metabolizable energy intake in this study was higher (4796 kcal / day / cow) than the value seen in Mali (3086 kcal / day / cow) although the supplement was composed of different feed. Dry matter intake was also higher compared to the results in Burkina Faso at INERA research station (1126g/d/cow) on zebu cows supplemented with Muccuna, which is also a legume [27].

4.3. Daily Milk Yield

Average daily milk yield found in this study was 1378 ml / cow for the supplemented groups and 1078 ml / cow for the control group. These values are also higher than the results found in Mali with the same breed (791 ml / d / cow for the supplemented group and 777 ml for the non-supplemented) [22]. In general, the study data are in line with the results of surveys carried on in Burkina Faso on milk production which would be between 1000 and 2000 ml / day / cow [4]. Average morning milk yield was 866 ml for the supplemented group and 724 ml for the control groups, while the evening values were 512 and 354 ml respectively, for batch 1 and batch 2. These data are below the values found by Millogo on average milk production in semi-intensive system of Burkina, probably because of the season, since the present study was done at the end of the dry season when the pastures were poor in nutrients. Milk yield in the morning was significantly higher than the evening yield, and this corroborates the results of [8]. Data showed average increase of 142 ml in morning milk yield, and this represented approximately

19.42% of the production of the control group. However, this increase in milk production was not statistically significant, probably because of the small amount of the daily supplement fed to the cow (3 kg), and also the poor quality and quantity of the pasture.

4.4. The Chemical Composition of the Milk

The concentration of some milk chemical parameters analyzed showed a slight increase during the experiment. In the supplemented batch, fat (3.25%), crude protein (3.35%) and lactose (5.17%) contents were similar to the data got by Millogo (3.8%, 3.4%, and 4.9%, respectively) [4] and Sidibé (4, 7%, 3.59% and 4.53%) [27] on local cow in Burkina Faso. The study also showed that the increase in chemical data seen with the supplemented groups was improving according to time, but with no significant difference compared to the control groups, meaning that the positive effect of the supplementation was progressive during lactation. This is probably due to the gradual improvement on pasture quality with the first rains that might have led to the emergence of young grass shoots as highlighted by Blauw and collaborators [28].

4.5. Economic Analysis of Complementation

The supplementation in the present study gave a profit of 32 F CFA / liter of milk sold. This profit could be estimated at the herd scale in a given farm. Indeed, previous study in the village showed that the average number of lactating cows per farm was about 10. In an average lactation period of 200 days, with a daily profit of 44 F CFA per cow, the estimated total profit would be around 88,000F and this is a good money in rural area in the dry season.

The production cost of 1 kg of cowpea hay was 20 FCFA while the market price for 1 kg of cowpea hay was 150 CFA francs, and this shows that economically, it is important that the farmer produce supplementary feed by themselves. This importance of livestock feed cultivation by the livestock farmers themselves was underlined in a study in Mali on the economic evaluation of milk production with local crossbred cows supplemented throughout the long dry season[29]. Another study in Cameroon concluded that dairy farmers with low incomes should concentrate their efforts on supplementing cows, especially at the beginning of lactation, to make the activity profitable [30]. Simulations study in Mali with the same cow breed as per the present study showed that milk could even replace cotton (considered as " The white gold" in Sahelian countries in general) in the future, if the price of cotton remained low (less than 0.35 USD / kg) and the price of milk increased (> 0.38 USD / kg), provided that farmers allocate certain cotton plots to forage for seasonal supplementation of livestock [29].

5. Conclusion

Supplementation with cowpea hay resulted in improving milk production and calve body weight performances, as well as improving milk chemical parameters in the present study. The economic analysis indicated that supplementation would become even more economical for the farmers if cowpea hay is produced by the farmers themselves.

In conclusion, cowpea hay can be a good supplement for local cows in extensive systems, in the framework of milk production improvement in western Burkina Faso.

Acknowledgments

The authors express their sincere thanks to the ISIAE/CORAF project actors who funded this research study.

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