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IMPROVEMENT OF ZEBU CATTLE PRODUCTIVITY IN THE SAHEL REGION: FEED SUPPLEMENTATION ON SMALLHOLDER FARMS IN PERI-URBAN DAKAR

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Abstract

IMPROVEMENT OF ZEBU CATTLE PRODUCTIVITY IN THE SAHEL REGION: FEED SUPPLEMENTATION ON SMALLHOLDER FARMS IN PERI-URBAN DAKAR.

Two studies were conducted in the peri-urban area of Dakar to collect baseline information on feeding, milk production, reproduction, body weight and body condition (Phase I), and to examine the influence of supplementation with local by-products on productive and reproductive parameters of indigenous cattle in traditional smallholder farms (Phase II).

Baseline data collected from smallholder farms between 1994 and 1996 indicated delayed first calving, long calving intervals, decreasing body condition score (BCS) and body weight and low milk yields as major problems associated with cattle productivity in the region. Fertility was related to forage availability; animals showed high fertility after the rainy season and low fertility during the dry season. Supplementation during the critical period of the dry season using agro-industrial by-products (brewer's grains, molasses, groundnut cake, oytser shell and salt) had beneficial effects on productivity. Supplementation reduced loss in body weight and body condition, maintained milk yield and growth rate of the calves during the dry season and reduced length of 'days open' and the calving interval.

1. INTRODUCTION

There is a paucity of research data on the performance of zebu cattle raised under traditional management conditions in Senegal. The little information available shows that these animals have poor reproductive performance [1-3] characterised by delayed puberty and first calving, prolonged post-partum acyclicity and high rates of mortality among calves. While inadequate nutrition has been identified as a major factor contributing to the poor performance of tropical cattle, there is a lack of information on the relationship between nutrition and reproduction of zebu cattle in the tropics.

The following studies were conducted in two phases. Phase I was aimed at collecting baseline data on feeding, milk production, reproduction, body weight and body condition of the animals. Phase II, examined the influence of supplementation with local agro-industrial by-products on productive and reproductive parameters of indigenous cattle on traditional smallholder farms.

2. MATERIALS AND METHODS

2.1. Phase I Baseline data collection

2.1.1. Location of farms

Five smallholder farms, located not far from Dakar (35-50 km) in the region of 'Niayes', were selected for the study. The climate in this region has four seasons, a rainy season (wet and warm, from July to September), post-rainy season (dry and warm, from October to November), dry and cool season (December to February) and dry and hot season (from April to June). The annual rainfall varies from 300 to 500 mm, there being only one rainy season, between July and September. Temperature ranges from 18°C (November-February) to 31°C (May-June) with a relative humidity varying from 30 to 90%.

2.1.2. Animals

Animals selected were of dual purpose (milk-meat) zebu type (crossbred with N'dama) and maintained on natural pastures. They sometimes received a supplement during the dry season, depending on the resources available to the owner. A total of 127 cows and heifers located on 5 smallholder farms (37 to 61 animals per farm) were selected for the study, which was carried out from October 1994 to February 1996.

2.1.3. Herd management

Animals on all farms were grazed from 0730 to 1700 h during the rainy and post-rainy seasons and from 0730 to 1900 h during the dry season, on natural grasslands. Some farms practised night grazing during the rainy season as well as the dry season. The grasslands consisted largely of *Parinari macrophylla* and *Pennisetum pedicellatum* species. All farms practised natural mating with service bulls running freely with the females. Calves were weaned at ages ranging from 8-14 months. Older calves were allowed to graze while younger ones were isolated and penned until the return of the dams. Cows were hand-milked after allowing the calf to suckle, to stimulate milk let-down. Milking was carried out twice a day, except during the dry season when milking was completely stopped. Routine disease prevention included annual vaccination against rinderpest and spraying regularly to control ectoparasites, mostly ticks. Deworming was done at three-month intervals.

2.1.4. Data collection, sampling and measurements

The parameters studied included, intervals from calving to resumption of ovarian cyclicity and post-partum mating, body condition score (BCS) and abortions. The age at puberty and the resumption of post-partum ovarian cyclicity were determined by measuring progesterone in plasma (heifers and dry cows) or in milk (lactating cows). Milk and blood samples were collected twice weekly. Potassium dichromate tablets were used as the preservative for milk. The samples were kept at ambient temperature and were subsequently stored at 4°C for about 30 min before being centrifuged at 4°C. Skim milk and plasma samples were stored at -20°C until assayed. Progesterone concentration of 1.0 nmol/L or more in plasma and of 6.0 nmol/L or more in milk was taken as evidence of ovarian activity. Pregnancy was confirmed by elevated progesterone levels at 21 and 42 days after mating. The occurrence of oestrus on all farms was detected by the herdsman with the aid of behaviourial signs. BCS, on a scale of 1-9, was assessed once a month according to the system developed by Nicholson and Butterworth [4]. Body weight was determined monthly by weighing, or by heart girth measurement. Calf milk intake was measured monthly (morning and evening) from November '94 onwards by weighing the calf before and after suckling. Feed samples were collected twice a month, from December '94 to May '95, for determination of dry matter, crude protein and ash. Milk and blood progesterone concentrations were determined by the radioimmunoassay (RIA) technique [5].

2.2. Phase II On-farm supplementation

2.2.1. Study site and experimental animals

The study was carried out from February to July '96 at the same site as in Phase I. Animals were selected from two of five farms monitored during 1993 to 1996 (Table I). They were randomly assigned to two groups in every farm; supplemented vs non-supplemented.

TABLE I. SELECTION OF ANIMALS FOR SUPPLEMENTATION TRIAL

	Farm 1 (Diamniado)	Farm 2 (Diakhirate)	Total
Lactating cows	21	22	43
Heifers	5	7	12
Calves	14	15	29
Total	40	44	84

2.2.2. Measurements

Cows and calves were weighed and BCS recorded every month in the morning before grazing. Milk production was recorded every week during the experimental period. The amount milked was recorded at each milking and the amount suckled was recorded weekly by weighing the calves before and after suckling.

To evaluate the resumption of ovarian activity, milk samples were collected from lactating cows and blood samples from dry cows and heifers, once a week. Milk and blood samples were prepared and stored for progesterone assay, as described previously [5]. The sensitivity of the assay was 1nmol/L, and intra and inter-assay coefficients of variation were 5.6 and 3%, and 12 and 10% for low and high control samples, respectively.

The first ovulation was considered to have occurred at the first progesterone rise of over 1 nmol/L in the plasma and 3 nmol/L in the milk.

2.3. Statistical analysis

The data were analysed by ANOVA. Scheffe's method for multiple comparisons was used to test significant differences between supplemented and non-supplemented groups.

3. RESULTS AND DISCUSSION

3.1. Phase I

3.1.1. Biomass production and chemical composition of pasture

Biomass production was saitisfactory in December (826 kg DM/ha.) but decreased with advancing dry season (209 kg DM/ha in May). Chemical analysis indicated clearly, that pasture was unsastifactory, both in quantity and quality, during this period. Although there was an increase in the crude protein content (Table II), which was due to the high proportion of leguminous plants, the forage was highly fibrous and presumably of low quality. The only periods when animals obtained their full requirement of nutrients were during the rainy and post-rainy seasons.

TABLE II. BIOMASS PRODUCTION AND CHEMICAL COMPOSITION OF FEEDS

Month	BP (kg DM/ha)	DM (%)	OM	CP
			(% DM)	
December	826	89.9	73.8	8.5
January	530	90.9	74.6	8.2
February	567	90.8	71.0	9.6
March	535	90.4	68.2	11.1
April	455	91.3	68.2	13.1
May	209	90.8	64.3	12.4
June	225	91.0	61.8	12.4

BP, Biomass production; DM, dry matter; OM, organic matter; CP, crude protein

3.1.2. Age at fisrt calving

The average age at first calving was 51 ± 9 months. This is in general agreement with data reported by other workers. Wagenaar *et al* [6] found that mean age at first calving was 50.2 ± 9.1 months for Fulani-type cattle in Niger, while Chicoteau [7] observed a mean of 55.8 months in African zebu under traditional management. Age at first calving of zebu cattle is generally longer than in *Bos taurus* [8]. Most reports [9-11] suggest that it is advantageous to feed heifers kept on pasture with a balanced concentrate supplement to reduce age at first calving. Minimum age at first calving was 3 years and was seen only in 15% of the heifers. 54% of heifers calved at the age of 4 years and the rest calved after 5 years or more.

3.1.3. Live weight and BCS

Monthly changes in live weight and BCS are shown in Figure 1. Both live weight and BCS was high after the rainy season (July-September), because of better feeding and cooler temperature. Animals started to loose weight and body condition from February, the early dry season. The pastures at this time were less satisfactory both in quantity and quality. In the late dry season, between May and July, the pastures were poor and unsatisfactory and animals lost the maximum body weight and body condition during this period.

3.1.4. Distribution of calving and calculated fertile mating

Distribution of calving showed seasonality (Figure 2). Most of the calving (68%) occurred between the months of June and August; 22% of calvings occurred between the months of November and January. Calving percentage during the first season was higher (50%) than the second (30%). 20% of calvings took place between the two seasons.

The majority of cows resumed ovarian activity around October/November, presumably because of better nutrition at this time of the year. Over 20% fertile matings occurred between October and December. However, this lead to calving in June/July, with cows going through their last three months of pregnancy in the dry season, with poor quality pasture as their main source of nutrients. A second smaller peak of mating occurred between March and June. Seasonality of calving has also been reported by previous workers [7] who suggested that adequate feeding could eliminate seasonality of fertile mating in both heifers and cows.

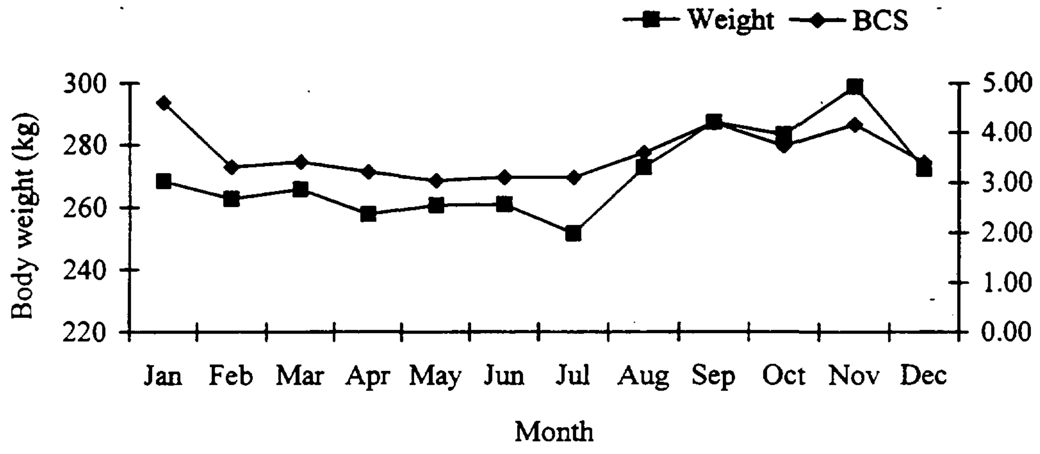

FIG.1. Changes in live weight and body condition score with season.

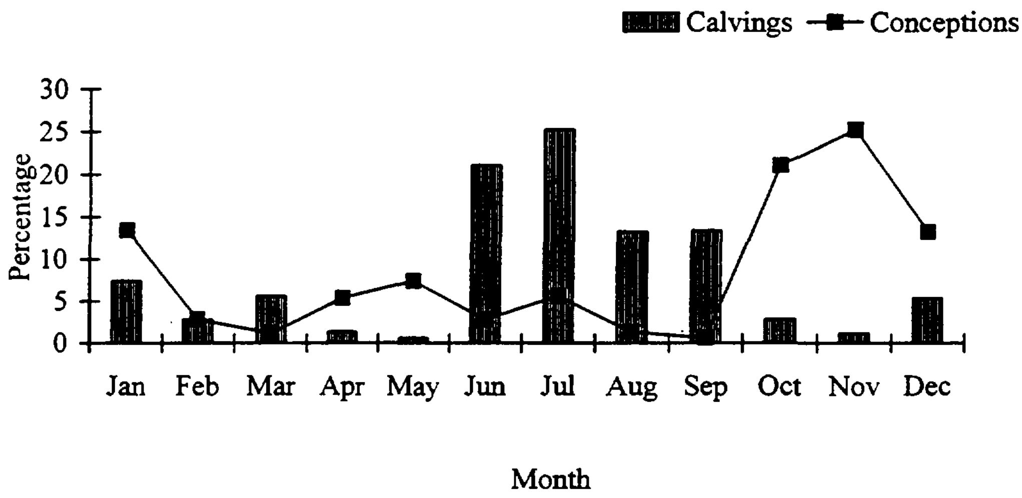

FIG.2. Distribution of calving and fertile mating according to season.

Cows calving before August and September were underfed during the last third of pregnancy and well-fed after parturition. Those that calved in December and January were well-fed before parturition and underfed after calving. Thus, cows that calved between September and November took advantage of satisfactory feeding before and after calving.

The reproductive performance of the postpartum cow is related to nutritional status [12, 13]. Cows fed a high energy diet after calving conceived sooner than those with a lower energy intake [9, 12, 14, 15]. High levels of feeding before calving reduced the postpartum anoestrous period in taurine cows [16]. In addition, more cows exhibited oestrus before the breeding season and subsequent pregnancy rates were increased. King [17] estimated that a 1% change in body weight would result in a 1% change in first service conception rate. Similar results have been achieved in zebu cattle. Seasonality of calving depends on seasonality of mating that is related to the level of feeding.

3.1.5. Resumption of ovarian activity

Although ovarian activity resumed around the 3rd month, only 20% of cows showed ovarian activity at 6 months. 50% ovulated by about the 11th month while over 80% had ovulated in 16 months (Figure 3). This was in contrast to the findings of Galina [2] who reported that usually 50% of cows in tropical pastures show post-partum anoestrus of around 120 days. Eduvie [3] on the other hand observed a post partum anoestrus of 15-20 months in Bunaji cattle under pastoral management. The delayed post partum anoestrus could be ralated to nutrition [14], since zebu cows on-station have shown shorter post-partum anoestrus periods.

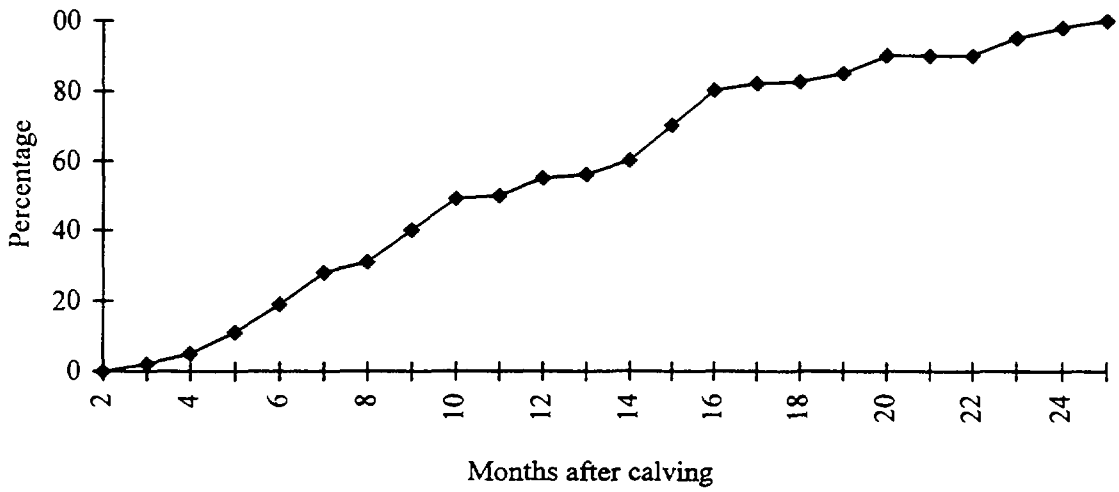

FIG.3. Resumption of ovarian activity.

From the time of calving, body weight and body condition score declined regularly for the first 3 months due to unsatisfactory nature of the pastures. Cows did not resume ovarian activity until its weight and BCS increased. This period for improving weight and BCS, lasted for 11 months after calving.

The relationship between body condition and reproduction has been emphasised by Ward [18] who suggested that every cow has an optimum body weight or BCS for conception, the so-called "target" or "critical" value. Animals weighing less than this 'target' value are less able to reproduce. Wiltbank *et al* [9] added that breeding cows must have an improving body condition during the mating period.

3.1.6. Calving interval

Calving interval was long and averaged 616 ± 150 days. Cows showed a long postpartum anaoestrus period. Average time for the resumption of ovarian activity was 16 months. This would have been responsible for the long calving interval observed in the present study. These results, agree with those of Chicoteau [7] who reported that calving interval ranged from 15.6 to 28.4 months, with an average of 21.4. Denis and Valenza [19] reported a shorter calving interval of 15.5 months for zebu cattle in Senegal. Raised under comparable conditions, *Bos taurus* cows showed early resumption of ovarian activity compared to *Bos indicus* cows [7].

Seasonal effects on calving have been reported by Oliveira [20] and Oyedipe *et al* [1]. They observed in Nellore cattle and in White Fulani heifers a shorter calving interval for cows calved in the dry season compared to those that calved in the wet season. Landais *et al* [21] in

Côte d'Ivoire noted that cows calved in October usualy conceived again in the following January, while those calved in January were unlikely to conceive during the subsequent mating period. Level of feeding after calving appeared to have an important effect on the resumption of ovarian activity.

3.1.7. Milk production

Milk production decreased with advancing dry sason, from around 2-3 kg/d in Decemebr to 1-2 kg/d in May-July (Figure 4). Milk production at calving averaged 2.80 L and decreased to 1.80 L at 10 months. Underfeeding of cows reduced milk production, thus calf growth was also reduced and puberty delayed.

3.1.8. Calf birth weight, growth, weaning and mortality

Birth weight of calves averaged 20 ± 3 kg. Calf growth rate decreased from around 543g/d during the first 4 months to 83.3g/d during 4-8 months. Calves were weaned around 12 months of age. Their mortality was influenced by herd management, age and season: high mortality (90 % of total mortality) was recorded during the dry season.

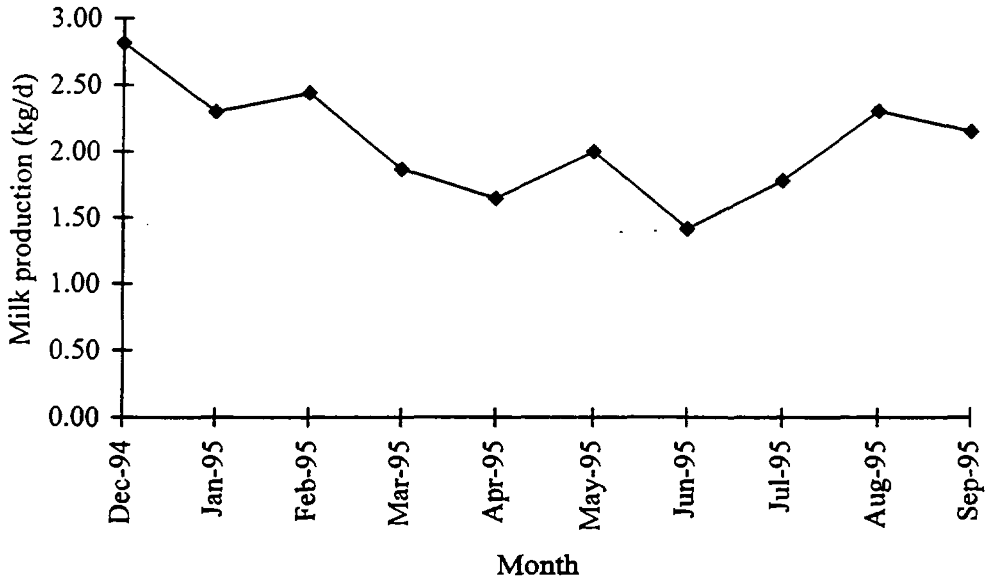

FIG.4. Average daily milk production according to season.

3.2. Feed supplementation on farm

The composition and chemical characteristics of the concentrate supplement used for on-farm supplementation is given in Table II. The supplement was prepared using locally available feed ingredients such as brewer's grain, molasses, groundnut cake, bakery flour waste, oyster shell power and common salt. It had a dry matter content of 73.5% and crude protein content of 19.7%, on DM basis.

TABLE II: CONCENTRATE COMPOSITION, DIET CHARACTERISTICS

Components	Quantity (kg)	DM (%)	Energy (kg DM)	CP	Ca	P
					(g/kg DM)	
Brewer's grain	1.00	87	0.63	162.3	2.9	4.3
Groundnut cake	0.25	25	0.44	113.5	0.25	1.4
Molasses	0.50	42	0.44	3.8	6.3	0.13
Bakery flour waste	1.00	87	0.77	122	1.3	10.79
Oyster shell + salt	0.03	-	-	-	11.7	-

*, Forage Units; DM, dry matter; CP, crude protein; Ca, calcium; P, phosphorus

3.2.1. Production performance

3.2.1.1. Body weight and body condition score

As expected, the supplemented groups lost significantly less body weight compared to the non-supplemented groups between December and August (295 to 274 vs 294.5 to 243 kg) (Figure 5). A similar trend was observed with BCS; supplemented animals lost less body condition compared to non-supplemented animals (from 5.75 to 3 vs 5.75 to 2).

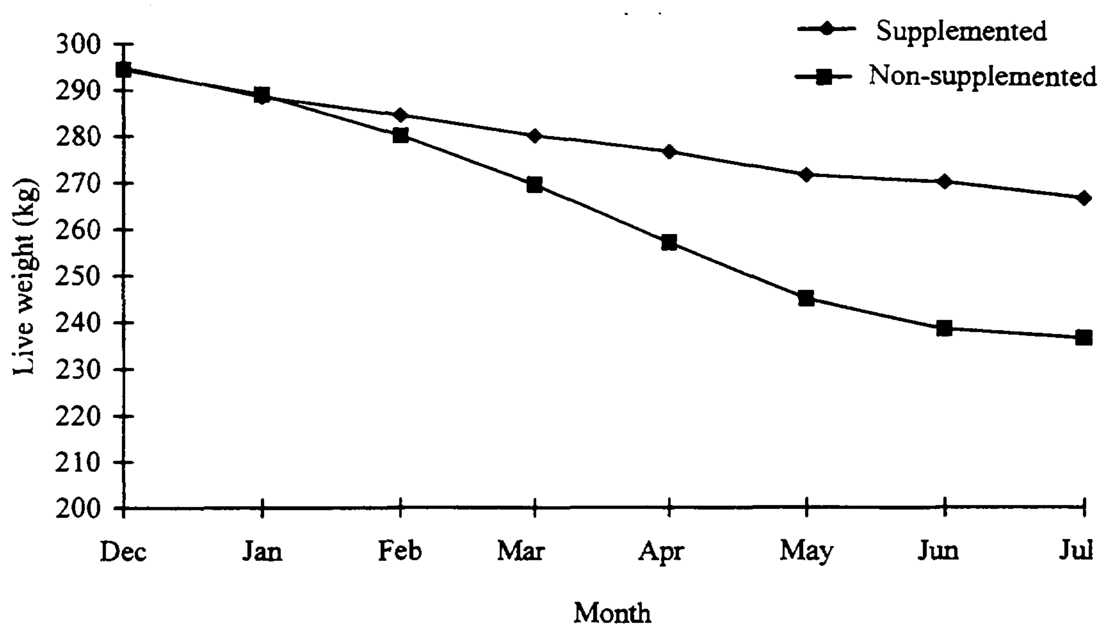

FIG.5. Change in live weight between supplemented and non-supplemented groups.

Forage availability during the dry season is known to affect body weight and body condition of animals maintained under extensive management on native pastures, without additional supplementary feeding. In the Sahel region, quantity and quality of forage decreased from February to July, thus animals lost weight and BCS because of failure to obtain their requirements for maintenance and production.

This study agrees well with those of others [22, 23] who have shown that feed availability is one of the major constraints to improving animal productivity in the Sahel region.

3.2.1.2.Milk production

The effect of supplementation on milk production is shown in Figure 6. Average milk yield was significantly higher in the group receiving supplements compared to the non-supplemented group (2.68 ± 0.36 vs 1.39 ± 0.06). Similar results have also been reported in the tropics and in temperate areas [24, 25].

3.2.1.3.Body weight at birth and growth performance of calves

Body weight at birth of calves from supplemented cows was significantly higher (20.13± 1.1 kg) than from non-supplemented cows (17.3 ± 0.8 kg, $P < 0.05$). Average daily gain was higher in supplemented cows than from non-supplemented animals. This appears to be an effect of supplementation of cows during the late dry season. Calves from cows that received the supplement grew faster than those in the non-supplemented group. Increased milk production in the supplemented group could have affected average daily gain of calves. Both the birth weight and average daily gain in the two groups were similar to those that have been reported by others [19, 26].

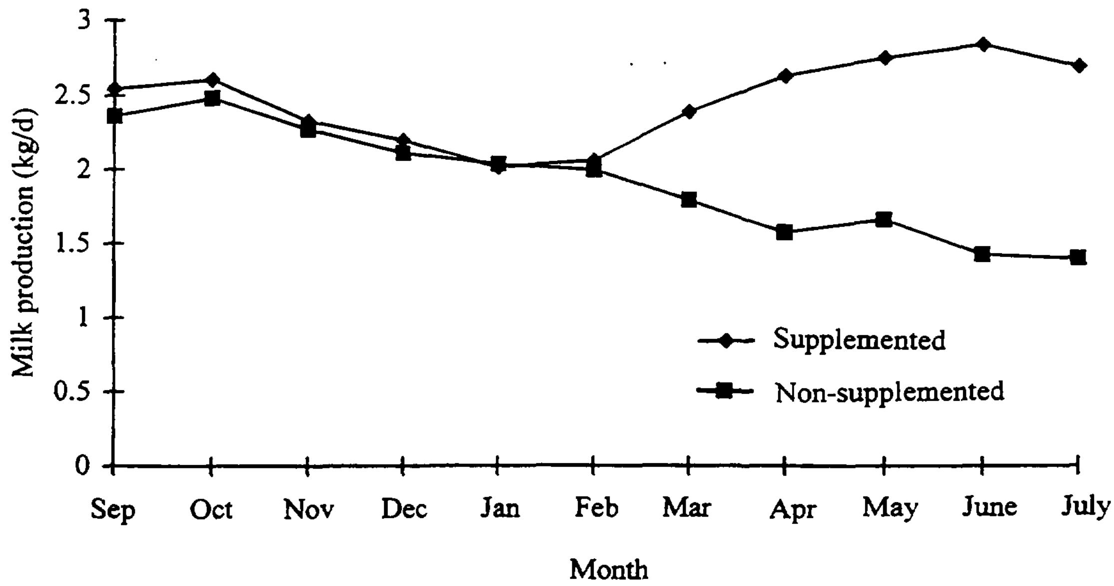

FIG.6. Effect of supplementation on milk production.

3.2.2. Reproductive performance

The resumption of ovarian activity was 52.6 and 100% in supplemented cows compared to 18.5 and 38.8% in the non-supplemented animals at 5 and 9 months post-partum, respectively. Additionally, there was a significantly ($P < 0.05$) shorter calving interval in the supplemented group (14.7 ± 2 months) compared to the non-supplemented animals (21.5 ± 3 months).

The effects of supplementation on body weight and BCS reflected in earlier resumption of ovarian activity. Cows that were able to maintain their body condition, regardless of the nutritional level, had a shorter interval to first post-partum oestrus than cows which had lost body weight.

3.2.3. Profit margin of supplementation

Additional milk production was 0.625 and 1.22 kg/cow/d and 95.6 and 186.6 kg for the supplementation period, for Farm 1 and 2, respectively. Milk price at the local market (Niayes) was 300 FCFA/litre (1USD = 600 FCFA) and in Dakar market was 450 FCFA/litre. The total cost of the supplement per cow during the supplementation period was 22010 FCFA. The profit margin if the milk was sold at the local market or at Dakar market would have been 6680 and 33990 FCFA and 11460 and 43320 FCFA for Farm 1 and 2, respectively.

4. CONCLUSION

It is generally agreed that the reproductive efficiency of *Bos indicus* cattle in tropical areas is poor compared to *Bos taurus* in temperate environments. Feed availability throughout the year is a major constraint to animal productivity in the Sahel region, since the traditional production system is based on native pasture. Therefore, during the late dry season cattle are underfed due to low quantity and quality of forages, which results in acute and chronic under-nutrition.

Nutritional deficiencies can affect milk production and fertility, and in the long term the productive life of the cow. Adequate nutrition is necessary for body weight maintenance, growth and reproductive functions. Supplementation during the late dry season, because it avoids loss of weight and body condition, can maintain milk yield and the growth rate of calves during the dry season and reduce length of 'days open'. Supplementation with agro-industrial by-products at strategic periods during the dry season, can be a cost-effective means of improving productivity on traditionally managed smallholder farms.

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