IMPROVING THE PRODUCTIVITY OF DAIRY CATTLE ON SMALLHOLDER FARMS IN MZUZU MILKSHED AREA IN MALAWI: CONSTRAINTS AND POSSIBLE INTERVENTIONS

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Abstract

IMPROVING THE PRODUCTIVITY OF DAIRY CATTLE ON SMALLHOLDER FARMS IN MZUZU MILKSHED AREA IN MALAWI: CONSTRAINTS AND POSSIBLE INTERVENTIONS.

A study was carried out in the Mzuzu milk shed area in Northern Malawi, to identify major constraints to dairy cattle production systems prevailing in the area (Phase I) and develop a sustainable feed supplementation intervention (Phase II) based on tree legume leaves of Sesbania sesban for increasing milk production. Phase I of the study revealed that the major constraint to increasing productivity was poor nutrition related to the fluctuating supply of quality and quantity of feed. Body weights of cows averaged 301 ± 81.3 kg and ranged from 189 to 550 kg whereas the body condition score (BCS, on 1-9 scale) averaged 5.73 ± 1.35 and ranged from 2.00 to 9.00. Average milk production was 6.1 ± 5 kg/d and ranged from 1.5 to 19.0 kg/d. Post-partum reproductive status varied considerably. Cows consumed 10.6 ± 6.2 kg/day of roughage and 2.96 ± 1.45 kg/day of concentrates. The quality of the feeds was moderate. Roughages contained 1.56 ± 0.12% N while concentrates contained 1.88 ± 0.04% N. Poor reproductive management and prevalence of internal parasites were also identified as constraints.

The intervention (Phase II) based on supplementation with tree legume leaves of Sesbania sesban significantly (P <0.05) improved the performance of dairy cows. Cows supplemented with tree legume leaves showed significantly higher body weights (368 ± 65.5 vs 348.7 ± 59.2 kg) and BCS (6.3 ± 0.9 vs 5.3 ± 1) compared to their counterparts receiving a supplement according to the present management practice. Daily milk yields of cows on the experimental diet averaged 8.6 ± 3.2 kg whereas those on control diet averaged 5.4 ± 1.7 kg. Significant differences in milk yields between the two groups of cows could have been due to higher dry matter intake from the supplementary diet. Cows on experimental diet consumed 3.5 ± 1.2 kg of supplementary feed as compared to 2.2 ± 0.7 kg by cows on the control diet.

1. INTRODUCTION

In Malawi, the productivity of dairy cattle is low due to poor nutrition caused by inadequate supply of good quality feed. The situation is worsened by the fact that smallholder farmers have limited resources available for feeding their ruminant livestock. Unlike in developed countries, smallholder farmers in developing countries are unable to select their basal diet according to the requirement for production. The strategy for improving production has therefore been to maximise the efficiency of utilization of the available feed resources in the rumen by providing optimum conditions for microbial growth, and then supplementing to provide dietary nutrients to complement and balance the products of digestion to requirements of the animal.

In Mzuzu milk shed area, like in the two other milk shed areas of Malawi (Lilongwe and Blantyre), the productivity of crossbred dairy cattle is low because of low individual yield and poor fertility. The reasons for the low productivity are complex but include the imbalanced
nature of the nutrients that arise from the digestion of the forage resources and other low quality feeds, the incidence of diseases and parasitism and poor reproductive management.

On-station nutritional research has demonstrated the possibility of substantial increases in the productivity of crossbred dairy cattle fed low-quality roughages through small alterations to the feed base. In some cases, these improvements have been demonstrated at the farm level in that milk yields have increased and the reproductive efficiency of these animals has improved [1].

Commercially formulated dairy cattle rations are too expensive for use on smallholder farms in Malawi. Soil fertility is declining at a fast rate and inorganic fertilizers, which can improve soil fertility are also expensive for routine use. Therefore, tree legumes play a multi-purpose role. They provide high quality fodder for animals, fertilizer in the form of mulch, fuel wood, poles and timber for the building trade and shade and shelter from wind for humans.

These studies were therefore conducted to collect baseline information on the existing dairy cattle production systems in the Mzuzu milk shed area in Northern Malawi, through monitoring of feeding practices, milk production, reproduction, body weights and body condition scores for identifying constraints to milk production, and then to develop a sustainable feed supplementation intervention based on tree legume leaves from *Sesbania sesban* for improving productivity.

2. MATERIALS AND METHODS

2.1 Geographical location of smallholder farms

The studies were carried out on smallholder farms belonging to five Bulking Groups (Farmers' Associations) in the Mzuzu milk shed area in Northern Malawi. This area is situated on the Viphya Plateau at an altitude of 1200 m above sea level. Climate is characterized by two distinct seasons, a rainy season commencing in December and ending in May/June and a dry season extending from June to November. The average annual rainfall is 1750 mm of which about 70% falls between December and March. The average minimum temperature is 18 °C, July being the coldest month. The average maximum temperature is 21°C, November being the warmest month. The area is characterized by *Brachystegia* woodland savannah vegetation while the soils which are acidic (pH 5.1) are mostly deep red sandy-clay ferrisols.

The farms involved in the study were located within 20-50 km from Lunyangwa Agricultural Research Station situated at an altitude of about 1342 m above sea level.

2.2. Farm characteristics

The average farm size was 14.6 ± 12.8 ha and ranged from 3.0 to 50.0 ha. Of the total farm size 3.1 ± 2.2 ha was under pasture (range, 1.0 - 20.0 ha) and 4.3 ± 3.2 ha was under food crops (range, 1.0 - 12.0 ha).

The Mzuzu milk shed area is basically agricultural. Major crops grown in the area included food crops such as maize, millet and sweet potatoes, fruits and vegetables. There was also a reforestation programme for planting pine trees. Most of the agricultural activities were performed by family labour (4.8 ± 2.3 workers per household) and the rest by hired labour (2.3 ± 1.8 workers per household).

Farmers in the area kept cattle mainly for milk production. Around 90% of the cattle population were dairy type and the rest were dual purpose type. Friesian x Malawi Zebu
Crossbred cattle were mainly kept for milk production and steers and Malawi Zebu cattle were kept for beef production. On an average each farmer had 3.5 ± 2.1 dairy cows. Of the total population of cattle kept by farmers in the area, 45.6% were dairy cows, 32.2% heifers, 8.8% bull calves, 2.5% bulls and 10.9% a mixture of steers and Malawi Zebu cows.

Dairy animals grazed for 7.7 ± 1.9 h/day. Cows were milked twice a day and calves were allowed to suckle at each milking, but for a total period of 63.0 ± 34.7 min/d. (range, 3.0-120 min.). They were weaned at 4-5 months of age.

As a result of having few dairy bulls in the area the majority of the cows (60%) were bred by artificial insemination (AI). Around 27% were served by both AI and natural mating and around 13% were served by natural mating only. For natural mating, farmers usually used their neighbours' bulls and sometimes bulls from the Government farms. Although AI was the major method of breeding, its use was limited because of lack of adequate transport for the AI technician and poor record keeping by farmers.

Apart from cattle, other types of livestock kept by farmers included chicken, sheep, goats, doves and ducks.

Land was not a major constraint to agricultural productivity in the milk shed area. The bulk of the roughage fed was natural pastures; cultivated pastures such as Napier (Pennisetum purpureum), Rhodes (Chloris gayana), Hamil panic (Panicum maximum) and Guatemala (Tripsacum laxum), crop residues (maize stover, bean haulms and banana leaves) and small amounts of silver leaf desmodium (Desmodium uncinatum) formed the rest of the forage. The major concentrates available in the area were maize bran and dairy mash. Salt was usually mixed with maize bran. Since a large proportion of land carried natural pastures, farmers in the area rarely planted improved pastures for the animals. The land tenure system in the area was communal. The natural pastures were communally grazed and therefore, over grazing was a common feature. As a result of this, animals did not have adequate grazing resources during the dry season and the condition of the animals during this period was poor. The majority of the farmers grazed their animals on natural pasture (75%) and the rest (25%) partially stall fed their animals. Animals were housed in loose barns (67.7%), open paddocks (25.8%) or other types of houses (6.5%), e.g. roofed kraals. The open types of housing predisposed the animals to major diseases and parasites, especially during the rainy season when these structures had muddy conditions. Herd health management programmes were practised in the area through a routine de-worming programme for control of internal parasites and spraying with acaricides for control of tick borne diseases. However, since the drugs were extremely expensive only a few farmers carried out routine disease and parasite control programmes.

2.3. Studies undertaken during the project period

The project had two phases. Phase I, the monitoring phase was aimed at identifying constraints to dairy cattle productivity through monitoring of feeding practices, milk production, reproduction, body weights and body condition scores as well as parasitic egg counts in the faecal samples. Phase II of the study, the intervention phase was aimed at developing a sustainable feed supplementation intervention based on tree legume leaves of Sesbania sesban for improving productivity, especially during the dry season.

2.3.1. Collection of baseline data- Phase I

2.3.1.1. Selection of farms and animals

Initially, 32 farms and 115 dairy cows were selected for the study. However, complete data sets were collected using 97 crossbred dairy cows belonging to 27 farms having an
average of $3.5 \pm 2.1$ dairy cows each. These selected farms were assigned numbers and the animals were identified with eartags.

Of the animals that were used in the study, the majority were crosses of Friesian and Malawi Zebu with 75% Friesian blood. The mean parity of the crossbreds was $2.9 \pm 2$ and the mean body condition score (BCS) was $5.2 \pm 1.8$ at calving.

2.3.1.2. Sampling procedure and measurements on feeds and animals

The study was conducted over a period of 18 months from September, 1994 to February, 1996. Farms involved in the were visited weekly, but feeds were sampled monthly. A total of 151 feed samples were collected during the study for dry matter (DM), ash, and nitrogen (N) determination [2]. The amount of feed offered per day for each cow was also recorded for the cows that were stall fed during the monthly visits to the farms.

Monthly, body weights (BW) of cows were determined through heart girth measurement using a weigh band, while the body condition score (BCS) of cows were recorded using the 1-9 scale [3]. Daily milk yields were recorded during monthly visits to the farms and milk samples were collected weekly from the cows two months post-partum until pregnancy was confirmed by rectal palpation, for progesterone determination by radioimmunoassay (RIA) [4]. Rectal palpations (45-60 days post-partum) were carried out once a month to establish ovarian status of the cows until confirmed pregnant.

To assess the health status of the cows, faecal samples were collected (2-3 months post-partum) once every 3 months. The parasitic worm eggs were counted using the Faecal Floatation Test (concentrated salt solution) using a scoring scale of $0 = \text{no worm eggs;} 1-500$ eggs/g of faecal sample = slight infestation; and $>500$ to $5000$ eggs/g of faecal sample = moderate infestation.

2.3.2. Tree legume leaf supplementation - Phase II

2.3.2.1. Experimental farms, animals and feeds

The intervention phase was carried out during the dry seasons of 1996 (June to December) and 1997 (June to October). Cows used were in their second lactation and had calved in June. They were put on the feeding trial 2-3 weeks after calving.

The study involved 32 smallholder farms and 86 crossbred dairy cows. A mixture of tree legume leaves ($Sesbania$ $sesban$) and maize bran was used to prepare a high quality supplement (15% CP) and was fed to the experimental group of cows (47 cows from 16 farms) during the dry season. The control group of cows (39 cows from 16 farms) utilized a mixture of dairy mash (made from soybean, maize, salt and minerals) and maize bran (the present method of supplementation) as the supplement. All cows in both groups received a basal diet of forage ad libitum. At the beginning of the trial cows on both control and experimental diets produced $4.6 \pm 1.2$ kg milk/cow/d. In both cases, the supplements were fed at the rate of 1.0 kg per every 2.5 kg of milk produced per cow/d.

2.3.2.2. Sampling procedure and measurements on feeds and animals

The same protocol and recording procedures that were used for feeds and animals in Phase I were followed. However, in the Phase II of the study, body weights, BCS and milk yields of cows were monitored, as well as post-partum ovarian activity using RIA. Faeces samples were not collected for faecal egg counts.
2.4. Statistical methods

The data collected during Phase I was recorded and stored using data entry forms and files developed by the Animal Production and Health Section, Joint FAO/IAEA Division, using dBase IV application. The descriptive statistics on the data were carried out using the SYSTAT statistical package [5].

Data from Phase II of the study were entered directly into the database in the statistical package SYSTAT and descriptive statistics and t-test for independent groups were carried out to investigate the effects of the supplementary diets on the amounts of supplements fed, body weights, body condition scores and milk yields of the cows.

3. RESULTS AND DISCUSSION

3.1. Phase I Baseline data

Table I shows the amounts of roughages and concentrates consumed and the production characteristics of the cows used in the study.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of roughages consumed (kg)</td>
<td>10.6 ± 6.2</td>
</tr>
<tr>
<td>Amount of concentrates consumed (kg)</td>
<td>2.96 ± 1.45</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>301 ± 81.3</td>
</tr>
<tr>
<td>Body condition score (1 - 9 scale)</td>
<td>5.73 ± 1.35</td>
</tr>
<tr>
<td>Daily milk yields/cow (kg)</td>
<td>6.08 ± 5.02</td>
</tr>
</tbody>
</table>

Napier and Rhodes grasses as well as natural pastures were the major roughages available for consumption by the cows. Maize bran fed alone or mixed with dairy mash was the major concentrate offered.

The performance of the cows depended on the availability and the quality of the feeds in the area. The level of milk production was less than expected for crossbred dairy cows with 75% Friesian blood. Presumably, the level of feeding was not adequate for the cows to produce milk to their genetic potential. During the dry season, forages became scarce and were of low quality. The situation became worse during the drier months of the year (e.g. October and November and December to some extent) and the condition of animals deteriorated considerably during this period.

Table II shows the nutritive values of roughage and concentrate samples obtained from the study area during the monitoring period. The feeds were of moderate quality and the quality varied considerably during the year. The roughages tended to have a higher content of nitrogen during the wet months (January to May) compared to the dry months of the year.
TABLE II. DRY MATTER (DM) NITROGEN (N) AND ASH CONTENTS OF ROUGHAGES AND CONCENTRATES SAMPLED DURING PHASE I

<table>
<thead>
<tr>
<th>Month</th>
<th>Roughages</th>
<th></th>
<th></th>
<th></th>
<th>Concentrates</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DM</td>
<td>N</td>
<td>Ash</td>
<td></td>
<td>DM</td>
<td>N</td>
<td>Ash</td>
</tr>
<tr>
<td>January</td>
<td></td>
<td>91.3 ±1.6</td>
<td>1.6 ±1.2</td>
<td>17.6 ±1.5</td>
<td>90.6 ± 0.9</td>
<td>1.7 ± 0.2</td>
<td>5.6 ± 3.7</td>
<td></td>
</tr>
<tr>
<td>February</td>
<td></td>
<td>92.3 ±1.0</td>
<td>2.5 ±0.9</td>
<td>12.4 ±5.3</td>
<td>91.3 ± 0.3</td>
<td>1.9 ± 0.5</td>
<td>5.6 ± 2.6</td>
<td></td>
</tr>
<tr>
<td>March</td>
<td></td>
<td>93.3 ±1.1</td>
<td>1.3 ±0.1</td>
<td>12.9 ±2.6</td>
<td>92.7 ± 1.2</td>
<td>1.8 ± 0.6</td>
<td>14.7 ± 1.4</td>
<td></td>
</tr>
<tr>
<td>May</td>
<td></td>
<td>94.9 ±0.4</td>
<td>1.8 ±0.4</td>
<td>6.8 ±1.5</td>
<td>92.7 ± 0.6</td>
<td>2.0 ± 0.4</td>
<td>6.3 ± 4.5</td>
<td></td>
</tr>
<tr>
<td>June</td>
<td></td>
<td>94.6 ±0.2</td>
<td>1.3 ±0.4</td>
<td>9.6 ±4.2</td>
<td>93.1 ± 0.7</td>
<td>2.0 ± 0.6</td>
<td>6.4 ± 4.9</td>
<td></td>
</tr>
<tr>
<td>November</td>
<td></td>
<td>91.1 ±1.7</td>
<td>1.8 ±0.8</td>
<td>16.4 ±4.5</td>
<td>90.6 ± 0.7</td>
<td>1.8 ± 0.3</td>
<td>10.8 ± 7.9</td>
<td></td>
</tr>
<tr>
<td>December</td>
<td></td>
<td>90.8 ±1.0</td>
<td>1.4 ±0.6</td>
<td>13.1 ±5.4</td>
<td>90.9 ± 1.9</td>
<td>1.8 ± 0.4</td>
<td>6.4 ± 4.4</td>
<td></td>
</tr>
</tbody>
</table>

Mean     |           | 92.3 ±0.3 | 1.6 ±0.1 | 13.2 ±0.8 | 91.9 ± 0.1 | 1.9 ±0.04 | 7.4 ± 0.6 |

Standard error within parenthesis

Apart from diseases such as those transmitted by ticks, internal parasites were a threat to the animals. The animals were severely infested after calving. Eight major internal parasites were identified from faecal samples collected from the cows during the monitoring period (Table III). Of the eight species of parasites identified, three caused a moderate degree of infestation. Most of these species were roundworms except for *Moniezia* species (tapeworms) and *Coccidia* species which were protozoa. During the monitoring period, a few farmers had access to deworming drugs and they routinely dewormed their animals. However, the majority of the farmers could not afford these drugs due to their high cost.

TABLE III. MAJOR SPECIES OF INTERNAL PARASITES AND THEIR DEGREE OF INFESTATION IN DAIRY COWS DURING PHASE I OF THE STUDY

<table>
<thead>
<tr>
<th>Species</th>
<th>Degree of infestation in dairy cows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastrointestinal <em>Strongyloides</em></td>
<td>++</td>
</tr>
<tr>
<td><em>Haemonchus contortus</em></td>
<td>++</td>
</tr>
<tr>
<td><em>Moniezia</em></td>
<td>++</td>
</tr>
<tr>
<td><em>Trichostrongylus</em></td>
<td>+</td>
</tr>
<tr>
<td><em>Bunostomum</em></td>
<td>+</td>
</tr>
<tr>
<td><em>Coccidia</em></td>
<td>+</td>
</tr>
<tr>
<td><em>Cooperia</em></td>
<td>+</td>
</tr>
<tr>
<td><em>Strongyloides</em></td>
<td>+</td>
</tr>
</tbody>
</table>

++, moderate (> 500 to 5000 eggs/g of faecal sample)
+, slight (1-500 eggs/g of faecal sample)
3.1.1 Post-partum reproductive status of the cows

Although milk samples were collected weekly from 66 cows post-partum during the monitoring studies of Phase I, the progesterone data appeared to be inconclusive and therefore they are not included here.

In Mzuzu milk shed area, poor reproductive performance of the cows was also identified as a constraint. Cows had long calving intervals (more than 12 months). This was presumably due to limitation of transport for the AI technician, poor record keeping by farmers, and more importantly seasonal fluctuations in feed availability and quality. The success of a dairy cattle production system depends greatly on the reproductive performance of the herd, since sustained levels of milk production could be obtained only if reproduction is satisfactory. Nutrition is considered to be an important factor affecting cattle performance in the tropics [6].

3.2. Phase II Supplementary feeding

The effects of tree legume leaf supplementation on body weight, body condition score, and milk yields of cows during the intervention phase are presented in Table IV.

Tree legume leaf supplementation significantly improved (P <0.05) the performance of dairy cows. Cows that were offered the experimental diet of tree legume leaves produced higher milk yields (8.6 ± 3.2 vs 5.4 ± 1.7 kg) and consumed more of the diet (3.5 ± 1.2 vs 2.2 ± 0.7 kg) compared to cows that were offered the control diet which is the present method of supplementation in the milk shed area.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Diets of cows</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control group¹</td>
</tr>
<tr>
<td>Amounts of supplements consumed (kg)</td>
<td>2.2 ± 0.7</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>349 ± 59.3</td>
</tr>
<tr>
<td>Body condition score (1-9 scale)</td>
<td>5.3 ± 1.0</td>
</tr>
<tr>
<td>Milk yields (kg)/cow</td>
<td>5.4 ± 1.7</td>
</tr>
</tbody>
</table>

¹, Farmers’ present practice of supplementation
², Tree legume leaf supplementation
Standard error within parenthesis

Cows on experimental diet had higher body weights (368 ± 65.5 kg) and body condition scores (6.3 ± 0.9) than cows on control diet whose body weights and body condition scores were 349 ± 59.3 kg and 5.3 ± 1.0, respectively.

The nutritive values of the control and the experimental diets are shown in Table V. The experimental diet was of higher quality with 2.39 ± 0.66% N compared to the control diet which contained only 1.4 ± 0.5% N.

The control supplementary diet, the present method of supplementation, consisted of
maize bran and dairy mash made from soybean meal, maize bran, salt and minerals. The experimental supplementary diet consisted of maize bran and tree legume leaves. Dairy mash is a commercially formulated, well balanced concentrate containing 15% CP. However because of its high cost farmers tend to add more maize bran reducing its quality. Although only one part of tree legume leaves was mixed with four parts of maize bran, the mixture was of higher quality, containing approximately 15% CP.

The main tree legume leaf used in this study was that of Sesbania sesban. Studies carried out at ILCA in Addis Ababa, Ethiopia showed that several Sesbania species were excellent livestock feed, both as fresh fodder as well as dried hay [7]. It appeared that dairy mash (CP = 15%) could easily be substituted with dried Sesbania as a source of protein (CP = 26%) for lactating dairy cows in Malawi.

**TABLE V. NUTRITIVE VALUES OF CONTROL AND EXPERIMENTAL DIETS FED TO COWS DURING THE INTERVENTION PHASE**

<table>
<thead>
<tr>
<th>Feed component</th>
<th>Control diet</th>
<th>Experimental diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter (%)</td>
<td>92.9 ± 1.0</td>
<td>91.6 ± 3.7</td>
</tr>
<tr>
<td>Nitrogen (%)</td>
<td>1.35 ± 0.5</td>
<td>2.39 ± 0.7</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>7.6 ± 3.6</td>
<td>9.8 ± 4.6</td>
</tr>
</tbody>
</table>

1. Farmers' present practice of supplementation
2. Tree legume leaf supplementation
   Standard error within parenthesis

The tree legume hay supplementation had little influence on first progesterone (P4) rise post partum. Although the sample size of cows on both control and experimental diets was small the P4 results were reliable. Nine cows on the control diet had first P4 rise (>4.0 nmol/L) in 40.8 ± 21.4 days (range, 20-86 days) after calving. On the other hand eleven cows on the experimental diet had first P4 rise in 36.8 ± 9.4 days (range, 21-57 days) after calving. However, the difference between the two groups was not significant.

4. CONCLUSIONS

The results of these studies clearly indicate that nutritional deficiencies were the major constraints to improving productivity of crossbred dairy cattle kept on smallholder farms in the Mzuzu milk shed area in Northern Malawi. Apart from nutritional deficiencies internal parasites and poor reproductive management were also identified as constraints. The farmers' present method of supplementation based on a mixture of dairy mash and maize bran could be substituted with a diet consisting of tree legume leaf hay and maize bran. The use of tree legumes as protein supplements for dairy cattle on smallholder farms in would be a possible nutritional intervention for improving the productivity of these crossbred dairy cattle. Although, the economic impact of this intervention on dairy cattle production and reproduction was not evaluated, tree legumes have obvious advantages. They play a multi-purpose role. A farmer would need to grow 0.1 ha of Sesbania sesban trees to supply adequate amount of dry leaf for one animal/year.
ACKNOWLEDGEMENTS

I wish to express my gratitude to the Joint FAO/IAEA Division for funding these studies reported herein under Research Contract No. 7647/RB. Additional funding for these studies was provided by the Ministry of Agriculture and Irrigation of the Government of the Republic of Malawi. The technical inputs provided by Dr. Noble Jayasuriya of Animal Production and Health Section of Joint FAO/IAEA Division and Dr. Dennis Poppi, of the Department of Agriculture, University of Queensland, Australia, are greatly appreciated. I acknowledge the valuable inputs provided by collaborators, Messrs F. Nyondo and H. D. C. Msiska. The services provided by Messrs H. H. Nyasulu, I. L. Chatuwa, A. M. Nyirongo, O. Y. Kanyika, A. Z. K. Soko and J. A. Kumwenda and the co-operation of the farmers involved in the studies are gratefully acknowledged. I am very grateful to Prof. L. A. Kamwanja and his laboratory personnel, especially Mr. A. V. Gondwe of Animal Science Department, Bunda College of Agriculture for carrying out progesterone measurements and the technicians at the Central Veterinary Laboratory of the Department of Animal Health and Industry for analytical work. Special thanks are also due to Mr. O. L. Chirwa for his secretarial services.

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