ON-FARM INTRODUCTION OF SOME DRY SEASON FEEDING STRATEGIES TO CATTLE FARMERS ON THE ACCRA PLAINS OF GHANA AND THE RESPONSE OF CATTLE TO THESE STRATEGIES.

BY

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DEDICATION

To my children; David Adrian Nii Odoi and George Frederick Nii Sowah. I hope you can emulate Daddy or go even further if that is your wish.

DECLARATION

I hereby certify that, except for references to other people's work which have been duly acknowledged, this work is the result of my own original research.

I further certify that this thesis, either in whole or in part, has neither been presented for another degree nor is currently being submitted for any degree elsewhere by me or any other person.

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ABSTRACT

A baseline survey and three (3) experiments (one (1) on-farm and two (2) on-station) were conducted in a study to introduce some dry season feeding strategies to cattle farmers in the Accra Plains.

The baseline survey was carried out in the Dangbe East and West Districts of the Accra Plains for two main reasons: (i) to ascertain the reasons why cattle farmers had not adopted dry season feeding strategies which had been known in Ghana for some time and, (ii) to find out the types of crop residues that were available in the areas and could be used for dry season feeding. A questionnaire, designed to elicit the desired information, was randomly administered to thirty (30) farmers in each District with the help of the District Veterinary Technical Officer. All cattle farmers in both areas were found to be also crop farmers producing both cash and subsistence crops. Respondents in the Dangbe East District tended to have larger farms than their counterparts in Dangbe West (6.9 ± 0.69 ha vs 4.0 ± 0.93 ha). All Cattle owners were involved in the management of their herds in the Dangbe East District. In the Dangbe West District there were a lot of absentee owners (53.3%) who left their herds in the care of hired Fulani herdsmen, and only occasionally visited the farm. In the Dangbe East District the hired herdsman was usually an indigene. Most kraals visited (Dangbe East – 83.3%; Dangbe West – 63.3%) had multiple cattle owners numbering at least three (3). All cattle, in the survey area, relied exclusively on natural communal grazing lands. Cattle farmers were aware of seasonal production differences and had also realized that the differences were due to a lack of feed and water during the dry season. There were a few instances where calves had been supplemented with dried cassava peels and wheatbran but generally no supplementation was carried out.

Herdsmen grazed cattle for longer periods during the dry season and in cases of very severe drought moved the animals and their settlement, temporarily, to a new area with better grazing resource; returning to their old settlement when conditions improved. Farmers had heard about some dry season feeding strategies such as the feeding of crop residues and the use of multi-purpose trees. Most farmers were, however, not using these technologies because of inadequate contact with extension staff. Maize stover was identified as the crop residue abundant in both Districts. Based on an average maize yield of 0.5 tonnes/ha it is estimated that at least 1.5 tonnes of stover will be produced by each farmer. Cassava leaves and peels, as well as leguminous browse plants such as *Griffonia simpicifolia* and *Jasminum dichotomum* were also identified as possible feed resources.

The first experiment, a feeding trial, was carried out on-farm to demonstrate to farmers the effect of supplementation on parturient cows grazing natural unimproved grasslands. The experiment was in two (2) parts, which run concurrently. The first part involved supplementation of cows only, with measurements made on both cows and calves. A supplement of urea-ammoniated rice straw was available on four (4) farms with four (4) other farms serving as controls during four (4) months of the dry season (December 1998 to March 1999). Supplemented cows lost significantly ($P < 0.05$) less weight (-0.23 ± 0.009 vs -0.34 ± 0.010 kg day^{-1}) than their un-supplemented counterparts. Calves of supplemented cows showed a slightly better mean daily weight gain (though not significantly different ($P < 0.05$)) than calves of un-supplemented cows (0.19 ± 0.300 vs 0.16 ± 0.320 kg day^{-1}). Mean body condition scores of cows (supplemented - 4.7, un-supplemented – 4.3) were not significantly ($P > 0.05$) affected by supplementation. There was, however, a significant time X treatment interaction. In the month of February, supplemented cows (5.0) had a significantly ($P < 0.05$) higher body condition score compared to un-supplemented cows (4.3). In the second part of the experiment, only calves were fed the supplement. Calves on three (3) farms were fed a supplement of urea-ammoniated rice straw with calves on three (3) other farms serving as controls. Supplemented calves showed a significantly ($P < 0.05$) higher weight gain than the controls (0.20 ± 0.015 vs 0.13 ± 0.011 kg day^{-1}). By the end of the project farmers had learnt to prepare urea-ammoniated rice straw by themselves without supervision.

The next experiment involved an on-station feeding trial, which was carried out at the Katamanso Research Station of the Animal Research Institute during the dry season from December 1999 to March 2000. The treatments used were: grazing on natural pasture only (control) (diet 1), urea-ammoniated rice straw (diet 2), untreated rice straw supplemented with *Griffonia simplicifolia* (diet 3) and untreated rice straw supplemented with wheatbran (diet 4). Supplements were fed to individual animals in the test groups, with the control (diet 1) receiving no supplement. There was no significant difference ($P > 0.05$) between diets in terms of cow and calf growth rate (kg day^{-1}). Cows on diet 4 showed the least mean weight loss (-0.19 ± 0.058 kg day^{-1}) followed by cows on diet 2 (-0.30 ± 0.052 kg day^{-1}), diet 3 (-0.31 ± 0.052 kg day^{-1}) and the control (-0.31 ± 0.056 kg day^{-1}) in that order. Growth rate of calves (kg day^{-1}) of cows on diet 4 proved superior to the others (0.23 ± 0.041 kg day^{-1}), followed closely by diet 2 (0.20 ± 0.050 kg day^{-1}), the control (0.15 ± 0.094 kg day^{-1}) and diet 3 (0.14 ± 0.041 kg day^{-1}). Parirt did not significantly ($P > 0.05$) affect cow or calf growth rate. However, cows with high parity had the lowest cow and calf growth rate (0.32 ± 0.050 kg day^{-1} and 0.15 ± 0.043 kg day^{-1}) with cows of low parity having the highest cow and calf growth rates (0.22 ± 0.061 kg day^{-1} and 0.19 ± 0.053

kg day^{-1}). Cow body condition score was not significantly affected by treatment. Mean cow body condition scores were 4.3, 4.7, 4.6 and 4.5 for the control diet, diets 2, 3 and 4, respectively. There was a significant effect of month of observation ($P < 0.05$) but no significant month X treatment interaction ($P > 0.05$). By the end of the experiment in March, body condition score of control cows was significantly lower ($P < 0.05$) than that of cows on diets 3 and 4 but not significantly different ($P > 0.05$) from cows on diet 2. All the supplemented diets were also not significantly different ($P > 0.05$) from each other. Cow body condition score was not affected significantly ($P > 0.05$) by parity. Cows on diet 4 had the highest daily dry matter intake (DDMI) (775.4 g day^{-1}) and this was significantly higher ($P < 0.05$) than that of cows on diet 2 (460.3 g day^{-1}) and diet 3 (319.4 g day^{-1}). There was a significant effect of month of observation ($P < 0.01$) and also a significant treatment X month of observation interaction ($P < 0.001$). In January DDMI of diet 3 was not significantly different ($P > 0.05$) from DDMI of diet 2 but was significantly lower ($P < 0.05$) than the DDMI of diet 4). Daily dry matter intakes of diet 2 and 4 were not significantly different ($P > 0.05$) from each other. In Feburary, DDMI of diet 4 was significantly ($P < 0.05$) different from DDMI of the other two. The situation in March was similar to that in January. There was a general increase in daily dry matter intake from January to March for all treatments. Dry matter intake of untreated rice straw was significantly ($P < 0.001$) higher in diet 4 (361.8 g day^{-1}) as compared to diet 3 (132.4 g day^{-1}) in all the months. Daily dry matter intake of untreated rice straw increased in all diets from January to March. Milk yield from the various treatments were not significantly ($P > 0.05$) different (control – 0.64 ± 0.029 kg, diet 2 – 0.74 ± 0.027 kg, diet 3 – 0.70 ± 0.027 kg, diet 4 – 0.69 ± 0.029 kg). Parity also had no effect on milk yield ($P > 0.05$).

The final experiment was a metabolic trial which aimed at examining changes in rumen ecology when sheep were fed either urea-ammoniated rice atraw (diet 1) or untreated rice straw supplemented with *Griffonia simplicifolia* (diet 2), *Jasminum dichotomum* (diet 3) or wheatbran (diet4). Urea-ammoniated rice straw was the diet that had been fed on-farm and the idea was to compare this with feeding untreated rice straw supplemented with a leguminous browse common in Dangbe East (*Jasminum dichotomum*) or West (*Griffonia simplicifolia*) District, as well as a common agro-industrial by-product (wheatbran). Diet significantly affected ($P < 0.01$) rumen pH with diets 3 and 4 being significantly lower than those for diets 1 and 2. Mean ph were 7.25, 7.21, 6.81 and 6.81 for diets 1 to 4, respectively. There was also a time X diet interaction ($P < 0.01$). The pH values in all diets were, however, above the cellulolysis threshold. Rumen ammonia nitrogen was neither significantly ($P > 0.05$) affected by diet nor was there a significant diet X time interaction ($P > 0.05$). The corresponding mean rumen ammonia concentrations (mg N l^{-1}) were 178.91, 119.84, 131.64 and 223.07 for diets 1 to 4, respectively. In terms of dry matter degradability, the potentially degradable fraction (b) and the potential degradability ($a+b$) were significantly affected by diet ($P < 0.05$). Degradation of nitrogen was not significantly affected by diet ($P > 0.05$). The intercept (a), potentially degradable fraction (b) and time lag (*TL*) for neutral detergent fibre degradation, were all affected by diet ($P < 0.05$). Nitrogen utilisation was, however, not significantly ($P > 0.05$) affected by diet. Nitrogen balance (g day^{-1}) were 3.21, 3.76, 5.09 and 4.23 for diets 1, 2, 3 and 4, respectively. It was concluded that supplementation of untreated rice straw with appropriate supplements gave results comparable to the feeding of urea-ammoniated rice straw in terms of rumen ecology.

The following conclusions can be drawn from the study:

1. The major crop residue in the survey area was maize stover. In addition cassava leaves and peels (a by-product of processing) are also available for feeding. Leguminous shrubs (Dangbe East - *Jasminum dichotomum*, Dangbe West - *Griffonia simplicifolia*) were also present.

2. The major reason for the non-adoption of known dry season feeding technology by farmers was the lack of sufficient information and in the particular case of agro-industrial by-products, the high cost.

3. Supplementation of parturient cows grazing natural unimproved pastures with urea-ammoniated rice straw significantly reduced their weight loss during the dry season. In a similar experiment it was shown that supplementation of calves with urea-ammoniated rice straw during the dry season significantly improved their body weight gain.

4. It was concluded from experiments two (2) and three (3) that the feeding of untreated rice straw with *Griffonia simplicifolia*, *Jasminum dichotomum* or wheatbran was comparable to the feeding of urea-ammoniated rice straw.

5. The feeding of urea-ammoniated rice straw, as a dry season feed supplement, is therefore recommended. Where appropriate supplements (AIBP or leguminous browse) are available and/or affordable they can also be fed with untreated rice straw as a dry season feed supplement. A similar approach can be applied to maize stover.

CHAPTER 1

INTRODUCTION

1.1. Introduction

Ghana is a net importer of meat and other livestock products. Table 1.1 shows the growth in the livestock sector over a ten-year period (1986 - 1996). Growth in the cattle sub-sector was very low (1.1%).

Traditionally, agriculture in Ghana is predominantly arable farming. For example, in 1997 livestock formed 7.0% of agricultural GDP and 3.0% of total GDP (ISSER, 1997).

Most ethnic Ghanaian tribes do not herd cattle. Cattle rearing is therefore often associated with migrant Fulani herdsmen. These herdsmen rely extensively on the natural grasslands for grazing cattle, practising an agro-pastoralist or semi-nomadic type of management. This system has low returns per man-equivalent, per animal and per unit of land. The low productivity often arises from the desire to accumulate large herds using communal grazing lands, and from overgrazing of these lands, rather than unfavourable natural land conditions.

The natural grasslands are able to sustain growth and milk production of cattle in the wet season but rapidly lose quality in

Table 1.1. Livestock Census for Ghana: 1986 - 1996

Species	Cattle	Sheep	Goats	Pigs	Poultry
1986	1,134,870	1,814,242	1,632,576	486,653	6,409,709
1987	1,169,837	1,988,522	1,900,876	533,845	8,214,086
1988	1,143,812	2,045,964	1,991,217	478,344	8,039,795
1989	1,136,421	2,211,922	2,363,624	558,604	8,787,127
1990	1,144,787	2,223,599	2,018,027	473,946	9,989,889
1991	1,194,633	2,162,340	2,194,372	453,877	10,572,472
1992	1,159,431	2,125,522	2,157,278	413,243	11,231,574
1993	1,168,640	2,224,974	2,124,529	408,134	12,169,523
1994	1,216,677	2,215,964	2,204,150	351,169	12,289,376
1995	1,122,730	2,010,147	2,155,938	365,339	13,082,552
1996	1,247,861	2,418,738	2,532,710	354,678	14,589,303
Growth (%)*	1.1	3.2	5.0	2.2	8.8

*Growth refers to cummulative average yearly increase in livestock numbers over the period.

SOURCE: Livestock Planning and Information Unit (LPIU, 1996)

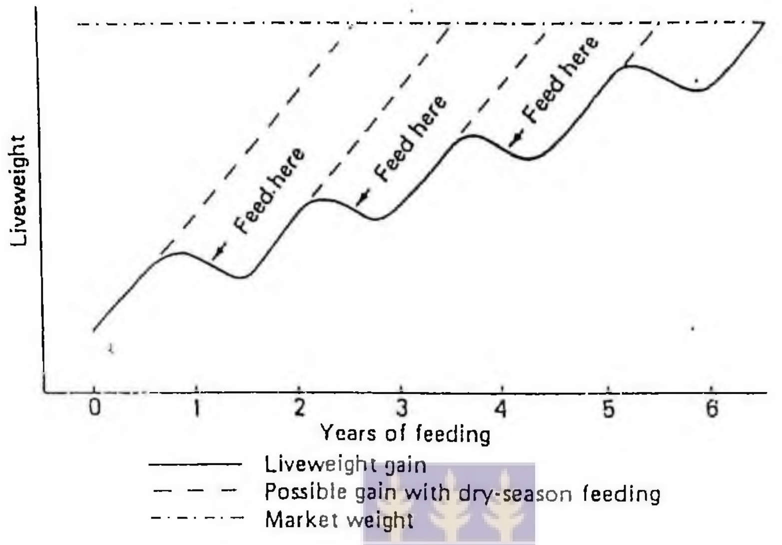
the dry season. Nitrogen and mineral content fall and there is a concomitant increase in fibre and lignification. When fed as the sole feed the low nitrogen level results in low rumen ammonia nitrogen and negative nitrogen balance leading to reduced microbial protein synthesis, depressed digestion and voluntary intake.

Animal growth rates are therefore seasonal and follow a stop-fall-start growth pattern (see Fig. 1.1) in a cycle corresponding with the available herbage as influenced by rainfall. Thus cattle usually do not reach marketable size (250 kg) until they are six (6) years old or more (Rose Innes, 1977). Milk production in the dry season is low or non-existent and herdsmen may sometimes not milk their cows at all. Cows may not calve more than once in three (3) years and calf mortality is extremely high. Twenty percent of calves may not survive the first six (6) months and another 20% may fail to reach maturity (Webster and Wilson, 1980).

On the Accra Plains increased pressure on land and changing trends in land use have decreased the size of grazing lands. In addition uncontrolled bush fires destroy large areas of natural grassland annually thus reducing the total forage available for grazing.

The successful development of a prosperous cattle industry depends mainly on the provision of cheap, adequate and high quality feed

FIG. 1.1. Liveweight gain of cattle in the coastal savanna of Ghana.



SOURCE : Rose Innes (1977)

throughout the year.

Several attempts have been made to provide year round quality feed in Ghana. The use of improved pasture has been suggested by Montsma (1960), Rose-Innes (1960) and Sunkwa-Mills (1974). However, the overall cost involved in the development and establishment of pasture has made the realisation of this suggestion difficult. The conservation of forage as either hay (Lansbury, 1958; Grieve, 1976) or silage (Lansbury, 1959; Tuah, 1971; Abban, 1970; Owusu-Sarfo, 1972; Larsen, 1975;) has been tried. Though successful, these efforts have remained "on-station" and are yet to be utilised by cattle farmers. Difficulties posed by uneven and unstumped grassland, lack of mowing implements, impossibility of cutting and transporting heavy bulky material by human labour alone combine to place this approach beyond the grasp of the village farmer at this present time.

The feeding of supplements to cattle during the dry season has been of interest to animal scientists for many years. Supplementation can be done in several ways but any method chosen must be cheap and must fit into the current husbandry practices and farming systems. Crop residues (Alhassan and Aliyu, 1992; Egyir, 1994; Oddoye *et al.*, 1996), leaves of multipurpose trees and browse plants (Rose Innes and Mabey, 1964; Mabey and Rose Innes, 1964a; Mabey and Rose

Innes, 1964b; Sottie, 1994; Bonsi *et al.*, 1994) and agro-industrial by-products, have been fed alone (Karikari *et al.*, 1995, Okantah *et al.*, 1999) or in combination (Larsen and Amaning-Kwarteng, 1976; Otchere *et al.*, 1977; Adams, 1994; Sottie, 1994; Yankey, 1996) with varying success. Again these results have remained largely "on-station".

Hinderances to development are sometimes technical but more often lie in the socioeconomic sphere. The gravest problems are those that appear when attempting to apply research results to farming practice, for it is at this point that the complex difficulties surrounding the farmer in his social and economic environment are encountered.

The village farmer is often thought to be obstinate in his opposition to change. It would be more reasonable to admire his shrewdness and practicality. He may well be opposed, and rightly so, to new agricultural methods which have not been proven to him, the fact of his existence being in itself proof of the effectiveness of agricultural practices which have been successfully used in a hostile environment over the course of many centuries. He will not relinquish these practices unless better methods are clearly demonstrated on his own ground (Rose Innes, 1977).

1.2. Project Justification

Any attempt to provide some answers to the above problems especially where the end users, cattle farmers, are involved is in the right direction. This project therefore seeks to:

1. Revisit and document the problem of dry season feeding with the farmers on the Accra Plains.
2. Teach farmers the use of simple dry season feeding technologies to alleviate the problem(s).

1.3. Hypotheses:

1. There is no shortage of feed resources (both basal and supplementary) to feed the ruminant livestock population in Ghana.
2. The inefficient use of the feed resources available to livestock farmers is the major reason for the low output (production of meat and milk) in the livestock sector.
3. Farmers have not taken up the many dry season feeding strategies that are available because they are either not aware of them or they have not been convinced of the efficacy of the strategies.

1.4. Specific Objectives

The objectives of this project therefore are:

1) To carry out a diagnostic survey to find out why there is a non-adoption of these studied strategies.

2) To find out what opportunities exist for livestock farmers to adopt such strategies.

3) To teach farmers to treat crop residues with urea to improve their feeding value and to feed the treated crop residues to their cattle during the dry season.

4) To investigate the use of leguminous browse and agro-industrial by-products as supplements to un-treated rice straw.

1.5. Expected benefits

It is hoped that at the end of the programme:

i) An understanding of the farmer's perception of the problem would have been obtained.

ii) Farmers would have learnt how to improve the feeding value of crop residues through urea treatment.

iii) Farmers would have learnt how to feed a supplement of urea-ammoniated crop residue to their cattle during the dry season.

iv) The feeding value of un-treated rice straw with suitable supplements (agro-industrial by-products or leguminous browse) as an alternative to urea-ammoniation of rice straw would have been established.

CHAPTER 2

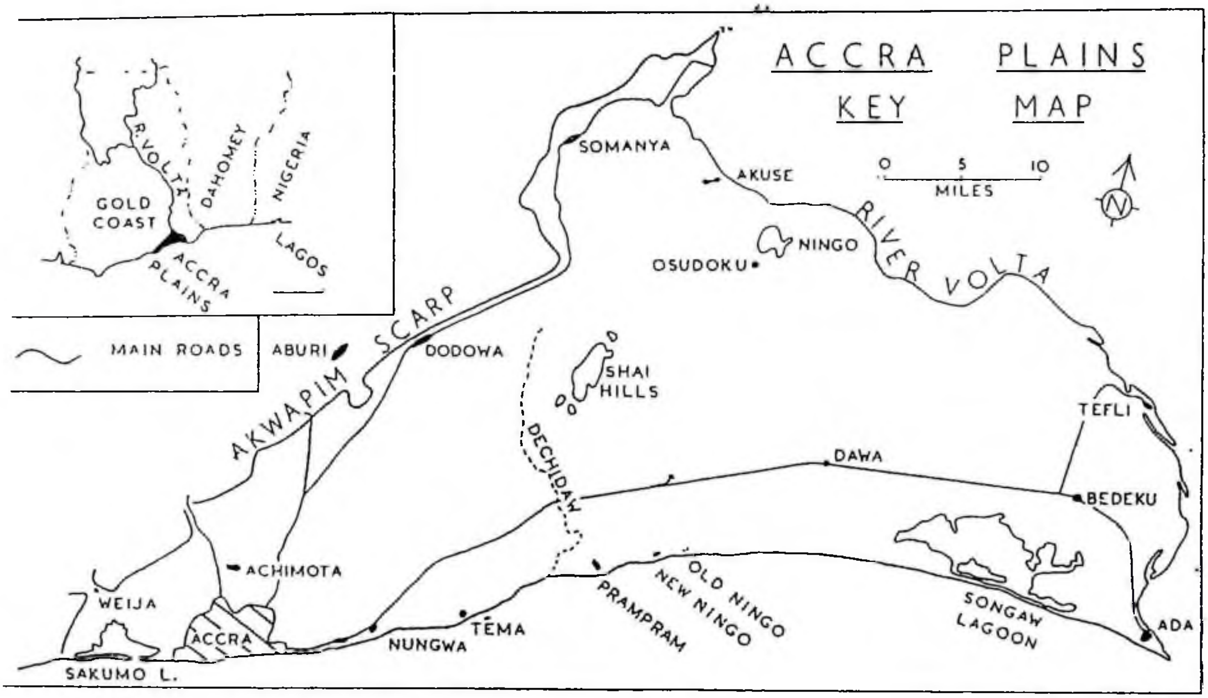
LITERATURE REVIEW.

2.1. The Accra Plains.

The Accra Plains lie between latitudes 5° and 6° north of the equator, and is in the form of an isoceles triangle, its base the Gulf of Guinea and its western angle enclosing the town of Accra (see Fig 2.1). North-Westwards the Akwapim ridge rises as a steep and continuous scarp, extending from the sea about 13 kilometres west of Accra to the water gap of the Volta, 96 kilometres to the North-East. The Volta river is the remaining boundary and all three exert a significant influence on those parts of the plains adjacent to them without at the same time destroying the essential unity of the region (White, 1954)

The rainfall pattern on the Accra Plains is bimodal. Mean annual rainfall is about 800 mm and occurs during the two rainy seasons of March to June (peak-June) and September to October (peak-October). The dry season starts from November and ends in February. Mean daily temperature is 26°C with a range of 18°C - 34°C. Relative humidity can be as high as 97% in the morning during the wet season and as low as 20% in the afternoon during the dry season (Rose-Innes, 1977). The vegetation consists of trees and shrubs, often in thickets known as coastal scrub, and also supports a wide

FIG. 2.1. Map of study area.



SOURCE: White (1954)

variety of grasses, both tall and short. The gently rolling plains to the east of Accra are covered mainly with a very open 'peppercorn' tree savanna, the woody element consisting of clumps of trees and shrubs occuring on widely scattered termite mounds (Rose-Innes, 1977). More trees and shrubs can be found towards Akuse in the north-east, where rainfall is higher (Rose Innes, 1977). The vegetation is classified as sub-humid coastal savanna grassland (Rose-Innes, 1977).

2.2. Characteristics of natural/native pasture on the Accra plains.

2.2.1. C_3 and C_4 type grasses

2.2.1.1. Comparison between C_3 and C_4 type grasses.

Tropical grasses have evolved a different biochemical pathway of photosynthesis better adapted to the higher radiation and temperature conditions of the tropics, and giving the potential for higher growth rates. This biochemical pathway has 4-carbon acids (malic and aspartic) as its first photosynthetic products and is termed the C_4 pathway (Hatch and Slack, 1966). The C_3 pathway found in temperate plants has a 3-carbon acid (phosphoglyceric acid) as its first photosynthetic product (Calvin and Benson, 1948).

Tropical grasses (C_4) have been found to be richer in cell wall content (higher proportion of thick walled tissues such as vascular bundles) as compared to their temperate counterparts (C_3) (Akin, 1986, 1989; Susmel and Filacorda, 1996). The levels of water-soluble carbohydrates such as glucose, fructose and sucrose in C_4 grasses are generally low compared to those in C_3 grasses (3 to 5% and 6 to 10% DM respectively). The polysaccharide reserve in C_4 grasses is starch, which is mainly stored in the leaves (2 to 5% DM), whereas C_3 grasses store fructosans in stems and sheaths (2 to 10% DM) (Aufrere and Guerin, 1996).

During early growth, C_4 grasses contain slightly less nitrogen than C_3 grases (2.5 to 4% DM), but in C_4 grasses, nitrogen content decreases more rapidly with age of plant. At the end of the growth cycle, the nitrogen content may be very low (0.5% DM). This difference relative to C_3 grasses partly derives from the faster growth of C_4 grasses, with an increase in the proportion of stems and the senescence of leaves, together with generally low levels of soil nitrogen (Aufrere and Guerin, 1996).

2.2.1.2. Digestibility of C_3 and C_4 grasses.

On average, wild or cultivated C_4 grasses have lower dry matter digestibilities (DMD) than temperate grasses. During active plant growth the differences can reach 10 to 15 points (55 to 65% versus 60 to 80%) (INRA, 1989). During the dry periods of the year when tropical forage grasses are not growing, annual and perennial grasses may have digestibilities comparable to those of rice and sorghum straws (DMD close to 50%) and those of wheat and barley straws (DMD close to 40%), respectively (Richard *et al.*, 1989). The total digestible nutrients (TDN) of C_4 grasses averages 15 units lower than that of C_3 grasses (McDowel, 1972). Lower digestibility at higher temperatures is the result of a combination of two main effects: Lignin systhesis and elevated metabolism. Higher temperatures increase the rate of the enzymatic processes associated with lignin biosynthesis and therefore lignification of the plant cell wall and promote more rapid metabolic activity, which decreases the pool of metabolites in the cell. Photosynthetates are more rapidly converted to structural components. This reduces nitrate, protein and soluble carbohydrate components and increases cell wall content (Deinum *et al.*, 1968, Van Soest *et al.*, 1978). Mesophyll cells are comparatively unlignified and highly digestible. The higher proportion of mesophyll cells in C_3 plants therefore increases digestibility (Akin, 1980).

2.2.2. Types of grasses found on the Accra Plains.

Typical bunchgrass of the kind so abundant in tropical savannah country occur on the Accra Plains. Grasses are usually of varying heights dependent on rainfall regime, soil type and soil nutrient levels (Rose Innes, 1977).

Biomass production and carrying capacity of the Accra plains have been studied by Fleischer *et. al.*, (1996). They estimated that the Accra Plains were capable of producing 4.5 metric tonnes of herbage dry matter per hectare per annum, of which only 20% is produced in the dry season. They also observed that there were two peaks of biomass production which coincided with the bimodal (two peaks) pattern of rainfall.

Important pasture species on the Accra Plains include *Andropogon sp.*, *Brachiaria sp.*, *Veteveria sp.* and *Panicum maximum.* These species have generally been overgrazed leading to their replacement by less palatable species such as *Sporobolus sp.*, *Dactyloctenium sp.*, *Heteropogon contortus*, *Sporobolus pyramidalis* and *Vetiveria fulvibarbis* (Fianu, 1980). Thickets on the Accra Plains, usually growing on termitaria, contain browse and shrub plants. These include *Griffonia sp.*, *Baphia nitida*, *Milletia thoningii*, *Antiaris sp*, *Grewia simplicifolia and Leucaena sp* (Agyare, 1977; Rose-Innes, 1977).

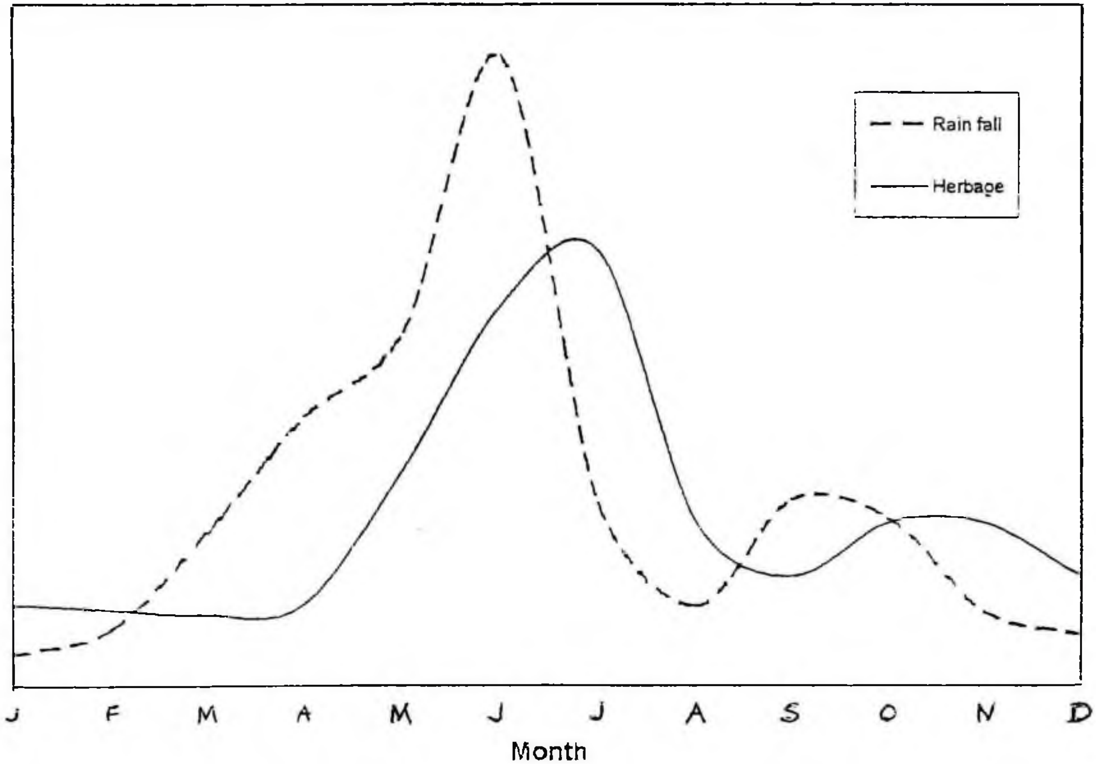
2.2.3. Effect of season on growth of grasses on the Accra Plains.

The growth of herbage, on the Accra Plains follows the characteristic bimodal rainfall pattern (Fianu, Atta-Krah and Koram, 1972). Although grasses are endowed with unlimited growth potential, actual growth is regulated by the rythmic variations of the seasons, modified by the supply of plant nutrients or food available to the plant. The period of growth begins with the first rains and continues, often with fluctuations due to erratic rainfall, to the end of the rainy season. The plant then enters a resting period similar to dormancy, which lasts until the beginning of the next cycle (Rose Innes, 1977). The growth curve for grasses on the Accra Plains, with the corresponding rainfall pattern, is shown in Fig 2.2.

2.2.4. Effect of season on nutritional value of grasses found on the Accra Plains.

As the rainy season begins nutrients in the soil and organic food reserves stored away in the root and stem bases, together provide the essentials for renewed growth and they become concentrated in the emerging leaves and culms. Once these leaves have formed, they manufacture their food supplies by photosynthesis and the plant grows rapidly to maturity. In the young growing leaves, large quantities of nutrients are packed into a small volume of tissue, which consequently forms a rich source of animal feed. But, as the volume of tissue expands far more rapidly than the supply of nutrients, and as a proportion of those nutrients are used up in the development of seeds and structural materials such as cellulose and semi-woody material which have little value as animal feed, the nutritive value per unit volume of plant tissue declines as the

FIG. 2.2. **Growth curve of herbage and rainfall distribution in the coastal savanna.**



SOURCES:
Herbage data from Rose Innes (1977).
Rainfall data from 30-year average supplied by Meteorological Services Department.

season advances. On the approach of the dry season, food materials manufactured in the leaves are translocated to and stored in the and culm bases, the aerial parts of the plant wither and die, and the grass enters its dry-season resting period. Drained of their nutrients, the dry leaves and culms fall to the lowest level of nutritive value in their seasonal life cycle (Rose Innes, 1977).

The highest crude protein values are obtained during the first two to four weeks of growth. Thereafter crude protein content of grasses decline until the short rainy season (September-October) when they recover for a short period. The decline then continues with the lowest values being recorded during the dry season. Phosphorous levels follow a similar pattern (Rose Innes, 1977).

2.3. Cattle production on the Accra Plains.

2.3.1. System of management.

The cattle industry on the Accra Plains is basically agropastoralist or semi-nomadic in nature. Cattle herds may number from 30 - 40 heads up to 300 - 400 (Okantah, 1988). The owners of cattle herds are usually business men, who live in the capital, Accra, and have little time for their animals. They therefore hire Fulani herdsmen who take full control of the animals. The major type of cattle is the Sanga, which is a cross between the humped Zebu type animal and the local West African Shorthorn (WASH) or in some cases the N'dama. A few WASH and N'dama may still be found in some herds (Rege *et al.*, 1994).

In the wet season, cattle leave for grazing at about 6.00am. They return to the kraal at about 10.00am for milking and leave again at noon returning at about 6.00pm. In the dry season cattle are milked early in the morning and leave for grazing at about 8.00am. They return to the kraal at about 6.00pm. Calves are penned separately and as they grow older may be let out to graze around the kraal while the main herd is away (Otchere, 1966; Okantah, 1974; Okantah *et al.*, 1995). There is the need for kraaling at night because of theft and predators and this imposes day time grazing. There are often long treks, especially in the dry season, between the kraals, grazing lands and watering points. Major sources of water are dams, dug-outs, streams and rivers (Okantah *et al.*, 1995).

There is no systematic breeding, and hence herd bulls run with the females in the herd all year round. Fulani herdsmen, however, have excellent memories and a knowledge of parental relationships of the individual cattle under their control. To avoid competition and fighting between the bulls, young bulls not intended for breeding are sold before they become sexually active. In a few cases such young bulls may be castrated and fattened for sale. Replacement heifers are usually generated from within the herd. New breeding bulls are often brought in from outside the herd about every 5 years (Okantah *et al.*, 1995).

The Veterinary Services Department (VSD) of the Ministry of Food and Agriculture (MOFA) undertakes a yearly rinderpest vaccination of all cattle. Herdsmen usually have access to District Veterinary Officers. Most herdsmen can, however, readily recognise sickness and will usually take some elementary remedial measures, calling in the Veterinary officer, only if all else fails. A recent development has been the introduction of community livestock workers. With this scheme, communities are required to select one person who is trained by the VSD in simple first aid procedures for livestock. These trained personnel are allowed to collect a small fee for cost recovery of drugs and medications used. They are, however, not authorized to give injections and are also banned from carrying out surgery. When in doubt they are to consult the VSD. Some form of tick control is practised by herdsmen. Usually after mixing acaricide a rag is used to apply it to spots which are heavily infested with ticks (Okantah *et al.*, 1995; Okantah *et al.*, 1996). Deworming is limited to calves and adults which show signs of heavy worm infestation (Okantah *et al.*, 1995; Okantah *et al.*, 1996).

Fulani herdsmen are generally confident in their handling and control of cattle. Their wages are generally paid in kind and the milk from the herd usually forms the major wage reward. Milk let-down is induced by brief suckling by the calf. The calf is tied to one of the forelegs of the cow during milking and the milker sits or squats beside the cow, near the hind legs, and milks into a calabash. Milking is partial in that the calf is allowed to have the dam's residual milk (Otchere, 1966; Okantah, 1974). Some herdsmen, however, milk half the udder with the other half being left for the calf. A herdsman with good judgement will leave enough milk for the calf. Some of the herdsmen on the contrary take too much milk and the calf suffers slow growth and in extreme cases even death. Calves are weaned at about 6 to 8 months at which time the dam is usually pregnant. Difficult calves, which want to continue suckling their dams have a stick put through their nostrils to prevent them from doing so (Okantah *et al.*, 1995).

The herdsman usually lives just by the kraal and farms an area of about an acre just near his homestead. Farming is subsistence in nature and the major crop grown is maize. When the maize crop is poor, owing to poor rainfall, cattle owners usually give the herdsman some maize to keep him going. Most herdsmen also keep a few poultry and a few sheep and/or goats to supply meat (Okantah *et al.*, 1995; Okantah *et al.*, 1996).

2.3.2. Production coefficients of cattle on the Accra Plains.

Some coefficients of cattle production in Ghana are shown in Tables 2.1 (liveweight, reproductive performance, growth rate) and 2.2 (milk yield).

The production coefficients suggest that productivity in cattle on the Accra plains is relatively low and could be improved. Earlier work by Okantah *et al.*, (1995) indicated that herd offtake is low (8.9%) and that cattle are usually considered a store of wealth.

2.3.3. Influence of season on cattle production

The poor quality of forages in the dry season is generally known (see 2.2.4.). During the dry season therefore, cattle are unable to meet their requirements for maintenance and production. Animals are often in negative energy and nitrogen balance and as a result mobilise body reserves in a bid to survive. This is reflected in low growth rates/weight loss and reduced milk yield during the dry season, which ultimately affect the total output by the animals. Cattle may lose up to 30% of their body weight in a very severe dry season (Rose Innes, 1960; Sada, 1968). Average daily partial milk yield may fall to 0.3 kg in the dry season and rise to 1.5 Kg in the wet season (Okantah, 1992; Okantah *et al.*, 1996).

Table 2.1. Production coefficients of some breeds of cattle in Ghana.

	BREED			
	WASH	N'DAMA	SANGA	GUDALI
1. LIVEWEIGHT[1] (Kg)				
Birthweight	19	19	24	27
Weaning weight	154	138	122	214
Mature weight				
Male	256	311	328	-
Female	229	260	306	-
2. GROWTH RATE (Kg)				
*Pre weaning ADG**	0.27[2] 0.16[3]	-	0.27[2]	-
Post weaning ADG	0.36[2] 0.15[3]	-	0.33[2]	-
3. REPRODUCTIVE PERFORMANCE[1]				
Age 1st calving (mths)	34.8	39.0	36.0[4]	38.6
Calving interval (days)	444.0	457.0	440.0[4]	465.0
Milk yield 182 days (Kg)	383.5	460.0	273.0[4]	604.0
Milk yield 252 days (Kg)	1001.0	943.0	-	1531.0

SOURCE:
1 - ILCA (1979).
2 - Okantah (1974).
3 - Okantah (1980).
4 - Okantah *et al.* (1995).
* - ADG: Average daily gain.

Table 2.2. Average milk yield and composition in cattle herds on the Accra plains.

MEAN DAILY PARTIAL COW MILK YIELD (KG)	0.875
SPECIFIC GRAVITY	1.029
TOTAL SOLIDS (%)	13.0
FAT (%)	4.1
SOLIDS NOT FAT (%)	9.0

SOURCE: Okantah (1992).

A study by Okantah *et al.*, (1995) in which eighty-eight (88) Sanga cow and calf pairs were monitored in areas on the Accra plains, indicated that there were seasonal production differences (Table 2.3) though these differences were not significant ($P > 0.05$). The authors stated that these findings were probably because the dry season was not severe during the time of the study.

2.3.4. Milk collection, processing and marketing.

There are no organised milk collection arrangements in Ghana. The Ministry of Food and Agriculture has, however, started a pilot milk collection scheme aimed at collecting all milk produced in the Accra Plains. At present, however, herdsmen organise their own individual sales. Fulani women, and sometimes men, buy fresh milk from the herdsmen for sale in towns and villages close to the kraals. Where kraals are far from market centres, fresh milk is usually processed into cottage cheese popularly known as "wagashi" to prolong its shelf life (Okantah, 1988, Okantah *et al.*, 1995).

"Wagashi" is manufactured by heating raw milk to about 80^{0}C, care being taken to avoid boiling. The latex from *Calotropis pocera*, an euphorbia species, is added to the milk to facilitate or enhance coagulation. The 80^{0}C temperature is maintained for 3 to 4 hours during coagulation. The mixture is then heated to boiling to expel the whey. The heat is then removed and the curd allowed to cool.

Table 2.3. The effect of season on some production coefficients of Sanga cattle on the Accra plains.

	DRY SEASON	WET SEASON
Calving weight (Kg)	273.5 ± 5.1	281.7 ± 9.1
Calving condition score	5.1 ± 0.2	5.4 ± 0.1
calf birth weight (kg)	30.8 ± 0.7	29.4 ± 0.8
Daily partial milk yield (Kg)	0.57 ± 0.04	0.66 ± 0.05
Daily cow weight gain (Kg)	0.05 ± 0.02	0.10 ± 0.03
Daily calf weight gain (Kg)	0.16 ± 0.01	0.20 ± 0.02

SOURCE: Okantah *et al.* (1995)

The curd is transferred into baskets and the whey allowed to drain overnight. The resulting cheese is ready for consumption (Okantah, 1988).

Butter oil (*mayi-shanu)* may be separated from the milk for use in household cooking. This involves the overnight fermentation of milk. The fermented milk is agitated in a partially filled gourd. Butter oil separates from the butter milk and is decanted. The butter is washed with water and is ready for use (Okantah, 1988).

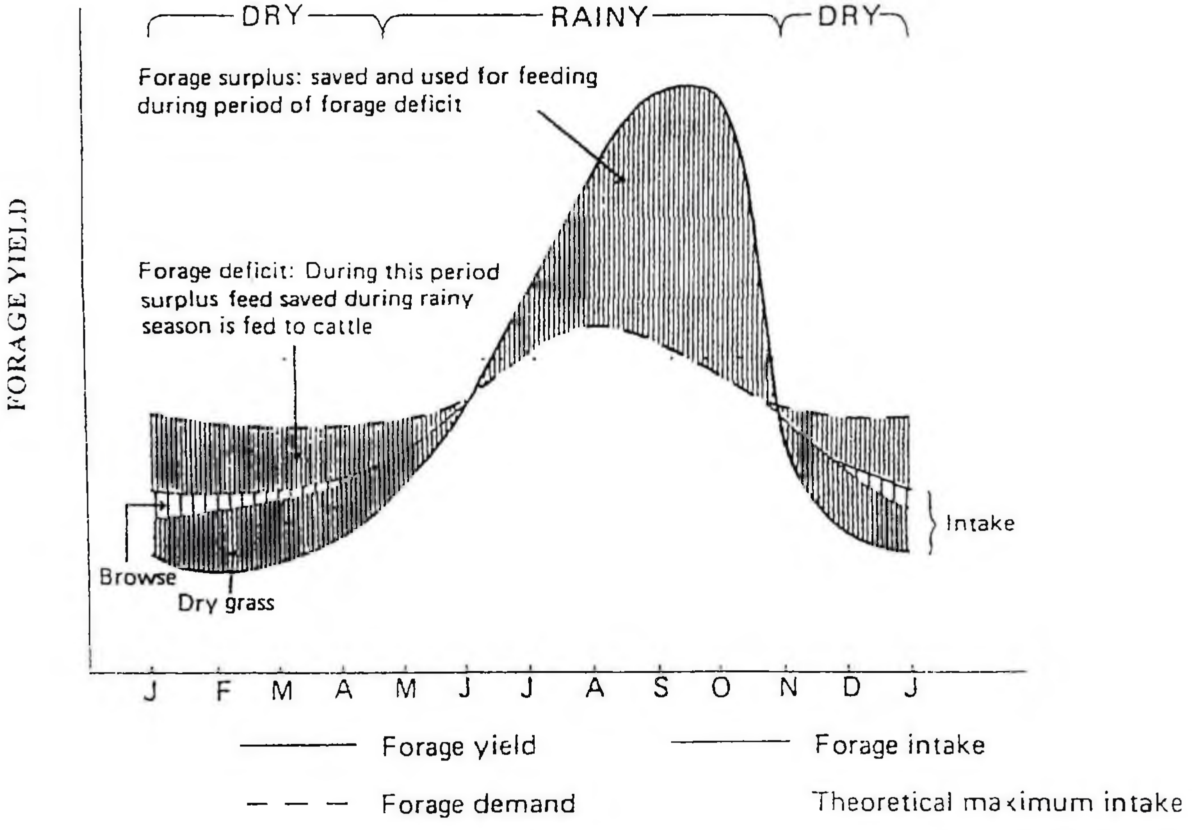
2.4. Dry season feeding: Principles, options and limitations.

The principle behind dry season feeding is to provide basal feeds and/or supplements to livestock in the dry season in such a way that requirements for maintenance and/or production are met. Several methods of achieving this aim have been studied and include the use of conserved forages, crop residues(CRs), agro-industrial by-products (AIBPs) and multi-purpose trees (MPT), either singly or in combination.

2.4.1. Conserved forages.

During the wet season, supply of herbage soon exceeds the requirements of livestock and herbage is produced which is surplus to demand (Fig. 2.3). As it is seldom possible to make short-term

Fig. 2.3. Forage Yield, Animal Intake and Demand in the Coastal Savanna



SOURCE: ROSE INNES (1977).

adjustments to the size of the herd, the surplus forage is wasted, either by allowing it to develop to its coarse fibrous unacceptable late-season condition, or by burning it later in the year. If the forage surplus were to be cut at the right time (best compromise between bulk and nutritive value), conserved (hay or silage) and fed back to the herd during the dry season, the forage deficit experienced at that time of year could be eliminated and live weight gains maintained (Rose Innes, 1977). This is standard practice in the temperate zones.

The conservation of forage would, however, present difficulties to the village farmer of the Accra Plains. Bottlenecks would be encountered in the cutting, raking, gathering and transporting of grass from field to barn without the necessary implements and, above all, without animal or machine power to supplement human labour.

2.4.2. Supplementation.

The aim of supplementation is to increase productivity (milk production, beef production or draught power). This can be achieved when the supplement increases the energy and/or protein supply to the host animal (Osuji, 1994).

Supplements can increase the energy extracted from basal feeds by:

1. alleviating a deficiency in microbial fermentation, eg., nitrogen or sulphur.
2. improving the rumen environments, eg., by increasing the number of cellulolytic organisms to increase invasion and adhesion rate of new substrate.

Both of the effects stated above will generally also increase the intake of basal feeds if they are offered *ad libitum.*

3. Supplements of course are also in themselves a source of energy.

Supplements can increase the protein supply to the host animal by:

1. increasing the supply of undegraded proteins.
2. increasing production of microbial proteins mediated through a more favourable rumen environment and by the fermentation of the energy contained in the supplement itself (Osuji, 1994).

In practice this may be achieved by supplying, in order of priority:

1. a supplement of fermentable nitrogen and minerals.
2. a small amount (10-20% of diet) of good quality forage, preferably a legume or grass cut at an early stage.

3. a small amount of a supplement containing materials that bypass the rumen: These include protein meals (soya cake, groundnut cake, cotton seed cake, fishmeal) or starch-based supplements (maize and sorghum) (Preston and Leng, 1987).

These methods may not always be applicable and their adoption will depend on the aim of the farmer (survival vs production) and the economics involved. In the tropics, the improvement of the rumen ecosystem is the primary consideration. In situations where dry matter intake is limited by a low availability of basal feed, a supplement may replace part of the basal feed (substitution).

2.4.2.1. Supplementation with agro-industrial by-products and urea-molasses multi-nutrient blocks.

By-products resulting from the processing of agricultural products, which are of no direct feeding value to humans, have been termed agro-industrial by-products (AIBPs). These include brans and middlings from the processing of cereals into flour, oil seed cakes from the processing of oil seeds, molasses from the processing of sugarcane into sugar and by-products from the brewing industry. By-products are also produced by small cottage industries and these include cassava peels from gari processing and "pito" mash from "pito" (local beer made from sorghum) brewing. These AIBPs have been in use in monogastric diets for a long time but are now finding increasing use as supplements in ruminants, either alone or in combination, to improve ruminant productivity.

Ogundola (1989) fed 24 calves with concentrates consisting of 20 (diet B), 40 (diet C) and 60% (diet D) of a mixture of dry brewers grain and wheat offals (50:50) which had replaced the maize in a standard ration (diet A). Growth rates of 0.26, 0.27, 0.24 and 0.31 Kg/day were obtained for diets A, B, C and D respectively but the differences were not statistically different ($P > 0.05$). Njwe and Olubajo (1989) reported that maximum live weight gain in goats (62g/day) fed a basal diet of fresh Guatemala grass (*Tripsacum laxum*) was achieved when the goats were given a supplement consisting of 200g of cassava flour with 150g of groundnut cake. When weaned lambs were supplemented with either wheatbran (A), roasted cocoa beanshell (B) or dried brewers spent malt (C) (all supplements were fed with molasses), all supplemented diets proved superior to the control (grazing only) with the wheatbran diet giving the best results (Ameyaw-Gyarko and Larsen, 1975).

Mixtures of liquid molasses and urea, which provide fermentable nitrogen and are a good source of minerals, have been used for many years by ranchers in Australia and Southern Africa (Topps, 1971). However, small scale farmers have rarely benefitted from these supplements usually because of the difficulties of handling and storage. The solidification of the mixture into a block is a way of overcoming these difficulties and also allowing for the incorporation of other ingredients. The production of urea-molasses blocks has been reviewed by Sansoucy (1986) and Aarts *et al.*, (1990).

Variable responses to feed block supplementation have been reported in the literature. Mesenger *et al.*, (1971) reported that feed block supplementation significantly improved wheat stubble (3.2% CP) consumption by grazing sheep. Dry matter intakes (DMI) of stubbles, without and with block supplements were found to be 0.4 and 1.0 Kg/day, respectively. Leng (1984) reported that rice straw intake by swamp buffalo increased from 3.4 to 4.2 Kg/day with a block supplement and that this decreased slightly to 4.0 Kg/day when the animals were offered 1 kg concentrate in addition to the block. In a study by Pearce (1973) dry matter intake (DMI) of hay (9.0% CP) by steers increased from 7.18 Kg to 7.45 Kg with feed block supplementation . He, however, reported that as the level of crude protein in the hay decreased, DMI of hay decreased with block spplementation. Dry matter intake of hay were 7.64 and 8.59 Kg and 7.91 and 8.14 Kg, with and without a block supplement, on hay containing 7.1% and 5.7% crude protein, respectively (Pearce, 1973). In contrast, Schiere *et al.*,(1989) found no significant improvement in rice straw intake with a block supplement. Intakes of untreated rice straw, without and with a block supplement, were 79.2 and 79.8 g/$Kg^{0.75}$/day, respectively.

Egyir (1994), working with sheep, observed a significant increase ($P < 0.05$) in dry matter intake between urea-ammoniated rice straw (768.58 g day^{-1}) and untreated rice straw supplemented with a urea molasses block (707.24 g day^{-1}). Both treatments were, however, superior to untreated rice straw (555.29 g day^{-1}). In terms of daily gain of sheep, urea-ammoniated rice straw (72.0 g day^{-1}) was similar to untreated rice straw supplemented with urea molasses block (68.92 g day^{-1}) and both treatments were significantly ($P<0.05$) higher than those on untreated rice straw (10.70 g day^{-1}).

Rumen ammonia concentration in Jersey bulls, measured before and after feeding a feedblock, increased (Leng, 1984). The bulls were on a basal diet of rice straw and the group with no blocks had 1 Kg concentrate per head per day. Rumen ammonia concentration in bulls with the block supplement were 112 and 195 mg N/litre before and after feeding respectively. Values of 56 and 45 mg N/litre before and after feeding, were recorded for the group with no block supplementation.

Krebs and Leng, (1984) fed sheep on a basal diet of oat chaff (1.4% N) supplemented with urea-molasses blocks containing 10, 15 or 20% urea in the block. Mean ruminal ammonia concentration was 23 mg

N/litre for the control and 131, 210 and 317 mg N/litre for supplemented groups with 10, 15 and 20% urea in the feedblock, respectively. Digestibility of cellulose, assessed by the nylon bag method, was 19% on the basal diet of oat chaff (Krebs and Leng, 1984). This was increased to 76% with 15% urea in the feedblock supplement.

There was no significant difference (P > 0.05) in 24 hour dry matter digestibility (DMD) of wheat straw in lambs offered a basal diet of wheat straw with or without a feedblock supplement (Sudana and Leng, 1986). DMD values were 42.7% and 44.2% for the unsupplemented and supplemented groups, respectively. Schiere *et al.*, (1989) also recorded no significant difference in 24 hour DMD of rice straw by growing cattle with and without a block supplement. DMD values were 45.4% and 47.2% respectively.

There was a dramatic increase in liveweight gain from 220 to 700 g/day by 350 Kg liveweight Jersey bulls on a diet of straw and 1 Kg concentrate when offered a feed block (Leng,1984). Feedblock supplementation turned a liveweight loss of 53 g/day in lambs on a basal diet of wheat straw to a gain of 10 g/day (Sudana and Leng, 1986). Schiere *et al.*, (1989), on the contrary, reported no significant improvement (P > 0.05) of a feedblock supplement on weight gain in cattle fed a basal diet of rice straw. Liveweight changes were -121 and -101 g/day with and without feedblocks, respectively.

Apart from the use of feedblocks as supplementary feeds, they are also used as carriers of medication. Feedblocks containing 0.07% poloxalene (bloat preventive agent) were found to be effective in preventing alfalfa bloat in dairy and beef cattle (Stiles *et al.*, 1967). Elliot (1970) reported that the weight gain of lambs with access to feedblocks containing 0.5% phenothiazine and 0,04% thiabendazole in paddocks was 27 Kg above that of control animals. Prichard *et al.*, (1978) showed that the presence of prolonged low levels of benzimidazole (BZ), as is the case when they are used in feedblocks can efficiently control nematode parasites in livestock. Studies by Barton *et al.*, (1990) and Barger *et al.*, (1993) have demonstrated the effectiveness of this technology even in areas where BZ resistant strains have been identified.

Feedblocks, however, are more expensive than other forms of supplements. Ducker and Kendal (1977) reported that the cost of a unit of energy (10 MJ metabolisable energy) of feedblocks was 14-17 pence compared with 11-12 pence from either a 14% crude protein sheep cob or a 20% crude protein sheep concentrate. Landblom *et al.*, (1990) compared the performance of Angus X Hereford, and Hereford cows when they were fed either a 12% crude protein feedblock or a dry rolled barley supplement. Supplementation of cows with the block gave an animal response nearly equal to that from rolled barley but cost 13% more. In countries with locally available resources for block production, costs will be less. In countries with warmer climates, the elimination of preheating of ingredients would further reduce costs.

2.4.2.2. Multipurpose trees (MPT), fodder legumes, browse trees and shrubs.

Multipurpose trees (MPTs) and forage legumes (FLs) have been identified as potential supplements to low quality tropical forages (Jones, 1979; Reed *et al.*, 1990; Siaw *et al.*, 1993; Richards *et al.*, 1994). These MPTs and FLs contain proteins, minerals and vitamins essential for the growth of rumen microorganisms that degrade feedstuffs prior to gastric and intestinal digestion by the host animal (Osuji and Odenyo, 1997)

Dayton (1931) as cited by Skerman *et al.*, (1988) defined "browse" as the "shoot or sprouts", especially of tender twigs and stems of woody plants with their leaves which are cropped (browsed) to a varying extent by domestic and wild animals. Skerman *et al.*, (1988) however, recommended that the term be extended to include the fruits or pods which are often more valuable than the foliage, especially if the browse, shrub or tree is deciduous. Everist

(1969) as cited by Skerman *et al.*, (1988), reported that with advancing dry season, livestock turn more to browse to satisfy their daily needs for food. In fact, browse is often the only source of green forage in the dry season, serving as a vital source of vitamin A precursors (Atta-Krah and Reynolds, 1989). Browse is also known to maintain its feeding value well into the dry season and is also rich in protein (Gohl, 1993). As part of a feeding strategy for ruminants in the tropics and sub-tropics, Preston and Leng (1987) recommend that a supplement of highly digestible forage, preferably legume, should form 10-20% of the diet.

Rose Innes and Mabey (1964) drew attention to the potential of local Ghanaian browse plants as supplementary feeds to grazing especially in the dry season. They reported a preference by cattle for *Griffonia simplicifolia* and *Baphia nitida.* These two browses showed a yearly average crude protein content of 15.7% and 21.2% respectively. Mabey and Rose Innes (1964a,b) also reported organic matter digestibilities of 69.8% and 54.0% and digestible crude protein contents of 7.3% and 6.0% for *Griffonia simplicifolia* and *Baphia nitida* respectively. They however, concluded that these two browse plants do not probably contribute much to the diet of cattle because they are usually found only on termite hills and may grow out of the reach of most cattle. If they are to make any impact then more work on propagation and establishment, yields of seed and herbage, etc, need to be carried out. More recently investigations have been made on the propagation and suitability of local browse species like *Baphia nitida* and *Milettia thonningii* as dry season supplements (Addo-Kwafo, 1996). These studies have indicated that local browse trees are difficult to propagate. Other introduced species like *Leucaena leucocephala* and *Gliricidia sepium* are not only easier to propagate, but also grow very fast and their use as a feed supplement has been investigated with good results (Budu-Biney, 1993; Karbo *et al.*, 1996; Jones and Barnes, 1996; Barnes, 1997, 1998, 1999).

Studies have shown that supplementation of teff straw with either *Sesbania* or *Leucaena* sp. increases the fractional rate of passage of particulate matter by 23-53% and of liquid phase by 9-43% (Bonsi *et al.*, 1994; Umunna *et al.*, 1995). Supplementation of teff straw with graded levels of cowpea or *Lablab* significantly increased microbial N supply in calves (Abule, 1994). Muinga *et al.*, (1992 a,b) supplemented napier grass fed to lactating crossbred cows with graded levels of *Leucaena*. These workers observed an increase in total dry matter intake and milk yield, and reduced body weight loss of cows in early lactation. Sottie (1994) reported no significant differences in peak rumen ammonia nitrogen levels in sheep fed either urea ammoniated rice straw or sodium hydroxide treated rice straw supplemented with browse. Peak rumen ammonia nitrogen levels were 15.0 mg N/100ml for urea ammoniated rice straw and 15.0, 14.0, 17.0, 19.0, 18.0 and 16.0 mg N/100ml for sodium hydroxide treated rice straw supplemented with *Millettia thonningii, Delonix regia, Securinega virosa, Grewia carpinifolia, Griffonia Simplicifolia* and *Khaya senegalensis*, respectively.

Some MPTs contain secondary plant compounds such as tannins, saponins, alkaloids, etc, that may be toxic to both the microbes and/or the host animal (Akin, 1982; Woodward and Reed, 1989; Reed *et al.*, 1990). Although some of these compounds are known to evoke an immediate violent reaction, much more subtle effects are commonly noticed when eaten for a prolonged period. Such effects might include reduction in feed intake, diminution of digestive process or metabolic utilisation of feed resulting in an inhibition of growth, a goitrogenic response or damage to vital organs (Kumar and D'Mello, 1995). These compounds are therefore termed "anti-nutritional factors'. Both pasture and browse species of tropical legumes are associated with anti-nutritional factors, which affect livestock either via direct toxicity or through reduced palatability of food (Skerman *et al.*, 1998). Some of these species and the anti-nutritional factors they contain are sumarised in Table 2.4.

Table 2.4. Examples of anti-nutritional factors naturally occurring in forage and browse legumes

Anti-nutritional factors	Species
1. Tannins	*Acacia aneura, A. nilotica, A. pendula, Albizia chinensis, Calliandra calothyrsus, Lespedeza cuneata, Leucaena leucocephala, Lotus corniculatus, Onobrychis viciifolia, Prosopis cineraria, Robinia pseudoacacia.*
2. Cyanogens	*Acacia binervia, A. cunninghamii, A. giraffae, A. leucophloea, A. Sieberiana, A. Sparsiflora, Albizia procera, Sesbania grandiflora, Stylosanthes viscosa*
3. Saponins	*Albizia stipulata, Medicago sativa, Sesbania sesban*
4. Non-protein amino acids	
(a) Mimosine	*Leucaena leucocephala*
(b) Indospicine	*Indigofera spicata*
(c) Canavanine	*Canavalia ensiformis*
5. Phytohaemagglutinins	*Robinia pseudoacacia*
6. Alkaloids	
(a) N-methyl-β-phenethylamine	*Acacia berlandieri*
(b) Sesbanine	*Sesbania vesicaria*
7. Oxalate	*Acacia aneura, Bauhinia thoningii, Calopogonium mucunoides, Erythrina variegata*

SOURCE: Kumar and D'Mello (1995)

2.4.2.3. Crop residues (Crs)/urea ammoniation of crop residues.

There are vast amounts of crop residues available in developing countries (Kossila, 1984). Fleischer (1991) estimated that in the West African sub-region a total of some 136 million metric tons of crop residues are produced annually. This ranges from 0.07 to 70.57 million metric tons depending on the country and may constitute 1% to 82% of the available national feed resource. In Ghana, it is estimated that the annual production of crop residues is about 9.38 million metric tons (Ampadu-Agyei *et al.*, 1994) and this may form about 30% of the available feed resource (Fleischer, 1991).

Whereas crop residues can make a significant contribution to the feed resources for ruminants in the West African sub-region, they are currently not used much but largely left to rot or burned (Fleischer, 1986).

As the human population in the developing countries increases, there is increased pressure on the land for food production and consequently less land becomes available for the production of pasture and fodder for animals. There is therefore a greater need for the integration of crop and animal production (Gartner, 1984).

The problem with crop residues is that they are of low feeding value to livestock. They contain low amounts of crude protein, are very fibrous and have low digestibility, leading to a reduced intake by livestock. Considerable attention has therefore been focused on ways to improve the quality and use (intake and digestibility) of crop residues for livestock by combining these materials in diets with supplements or by various physical, chemical or enzyme treatments (Sundstol and Owen, 1984; ARNAB, 1986; Doyle *et al.*, 1986). Treatment of straws with alkaline reagents, in particular sodium hydroxide and ammonia, has been of particular interest to researchers and has been extensively studied. The effects of alkali treatment have been found to be more pronounced for plant materials with an initially low digestibility (Waiss *et al.*, 1972; Mwakatundu and Owen, 1974). In general alkali treatment of crop residues has several advantages. The palatability of the treated material is greatly improved. There is also an increased digestibility of crude fibre as well as an increase in rate of gain and efficiency of feed utilisation. Since straw and other fibrous materials are normally low in protein, the added nitrogen is considered as one of the main advantages of ammonia treatment. The value of this added nitrogen however, depends on the composition of the whole diet (Sundstol and Owen, 1984). Demarquilly *et al.*, (1989) also pointed out that this added nitrogen is poorly utilised by the animal as is reflected by the high faecal nitrogen excretion in animals fed urea-ammoniated crop residues. The digestibility of ammonia-treated straw seems to be slightly inferior when compared to that of sodium hydroxide treated straw but a review of performance trials (Sundstol *et al.*, 1978) suggests that rates of gain are frequently more similar than digestibility trial differences would lead one to expect. Ammonia is also known to have a preservative effect especially with materials of high moisture content (Oddoye, 1987). The generation of ammonia through urea ensiling involves relatively simple and inexpensive methods and has been tried, at farm level, in many countries throughout the world.

Urea treatment of crop residues results in two processes that occur simultaneously within the mass of material to be treated:
a) Ureolysis: This is the process which converts urea into ammonia and, b) The effect of the generated ammonia on the cell walls of the material to be treated.

Ureolysis is an enzymatic reaction that requires the presence of the urease enzyme in the treatment medium. Urease is however practically absent in straw. Research work has shown that sufficient urease is produced by the telluric ureolytic bacteria during the treatment of residues such as straw or maize stover, at least under conditions where moisture imposes no limits (Williams *et al.*, 1984 a,b).

Results of both experimental and practical work show that moisture content of crop residues should be between 30 and 60%. Below 30%, ureolysis can be severly reduced or may even not take place (Wanapat *et al.*, 1996). Below 30%, compression of the forage and expulsion of air would be difficult. Above a moisture level of 60% there is leaching of the urea solution towards the bottom layers and insufficient diffusion of the generated ammonia within the forage mass as ammonia tends to bind to water instead of the plant cell walls because of its hygroscopic nature. High moisture also promotes mould growth. Within the recommended range there are no fixed rules and moisture content of materials to be treated is left to the farmers judgement and prevailing local conditions eg: availability and cost of water, air humidity, etc (Wanapat *et al.*, 1996). Optimal temperature for ureolysis is between 30-60° C. Within the range of temperatures 20-45° C, ureolysis is completed in a week. The activity of urease decreases below 5-10° C (Wanapat *et al.*, 1996).

The recommended dose of urea is 50 g/kg of crop residue (5%). Many authors (Williams *et al.*, 1984a,b; Ibrahim and Schiere, 1986; Alhassan and Aliyu, 1992) have not observed the increase in digestibility of the treated matter that could have been expected with an increased dosage of applied urea.

Studies by Bui Van Chinh and associates (1994) have shown that the amount of urea needed to treat a given amount of crop residue can be reduced without losing alkali treatment efficiency by adding lime to the urea. These authors reported that treating rice straw with 2.5% urea plus 0.5% lime gave the same increase in straw feeding value compared with 5% urea treatment.

During the ensiling process an atmosphere as anaerobic and as ammonical as possible should be maintained to achieve the best results (Wanapat *et al.*, 1996). Ammonia is released more slowly from the ureolysis process than from anhydrous ammonia injection. However only a third of the ammonia released can bind the plant material, the remaining 2/3 being in a labile form is lost.

Quarshie (1992) determined the optimum urea concentration, moisture level and treatment time for urea ammoniation of rice straw in Ghana. The optimum conditions were found to be 40% moisture, 6.5% urea and 21 days of ensiling. These conditions may be the absolute biological optimum but may not necessarily be the best conditions. For example, an increase in urea level from 3.5 % to 5.0% gave an increase of 0.03% in terms of nitrogen content of the finished material. This increased by a further 0.04% when the level was further increased to 6.5%. Similarly increasing the period of ensiling from 7 to 14 days gave an increase of 0.05% in nitrogen content which increased by a further 0.07% when the ensiling period was increased to 21 days. The results of the *in vitro* digestibility trial followed a similar pattern. Increasing the duration of ensiling from 1 week to three weeks increased the *in vitro* organic matter digestibility (IVOMD) from 47% to 50% at 5% urea concentration and from 50% to 54% at 6.5% urea concentration. In terms of costs to the farmer, the increase in nitrogen content and IVOMD as against the cost of the extra urea and the extra time needed for ensiling may not be economical in terms of expected improvement in animal performance as a result of the increase in nitrogen content and IVOMD. It would therefore appear that the best conditions for Ghana are 40% moisture, 5% urea and 7 days of ensiling.

Animal responses to feeding of urea-treated straw in South East Asia have been reviewed by Wanapat et al., (1996) and are shown in Tables 2.5. and 2.6. In general urea treated rice straw proved superior to untreated rice straw in terms of dry matter intake, average daily gain and milk yield.

2.4.2.4. Supplementation of cattle grazing natural pasture.

Seasonal decline in natural pasture quality is a well known

Table 2.5. Effect of urea treatment (4 to 6 kg/100 Kg straw) of rice straw on straw intake and average daily gains with young cattle and buffaloe (same level of supplementation untreated/treated) (South East Asia).

Animals (Live weight Kg)	Urea (Kg/100 Kg straw)	Straw intake (Kg DM/d) Un-treated	Treated	Increase	Average daily gain (g/d) Un-treated	Treated	Increase	REFERENCES
Buffaloe (200)	5	4.21	4.75	0.54	-182	79	261	Wanapat *et al.*, 1984
Buffaloe (290)	3	5.87	6.42	0.55	-130	-50	180	Wongsrikeao and
	6	5.87	7.32	1.45	-130	210	340	Wanapat *et al.*, 1985
Cattle (60)	5	1.70	1.90	0.20	35	110	75	Saadullah *et al.*, 1982
Cattle (130)	5	2.93	3.68	0.75	125	310	185	Khan *et al.*, 1982
Cattle (170)	4	2.09	2.84	0.75	73	346	273	Perdok *et al.*, 1982
Catle (120)		3.40	3.30	-0.10	224	306	82	Saadullah *et al., 1982*
		3.30	3.40	0.10	193	295	102	
Cattle (285)	5	4.97	6.82	1.85	-134	430	564	Wanapat *et al.*, 1982
	5	2.69	4.82	2.13	-312	75	387	
Cattle (65)	5	2.00	2.20	0.20	107	295	188	Hamid *et al.*, 1983
Cattle (125)	5	2.40	4.80	2.40	114	227	113	Haque and Saadullah, 1983
	5	2.40	4.60	2.20	132	227	95	
Cattle (165)	4	3.39	4.19	0.80	141	308	167	Kumarasuntharam *et al.*, 1984
	4	3.39	4.75	1.36	141	207	66	
	4	3.39	3.94	0.55	141	336	195	
Cattle (-)	4	2.00	3.00	0.90	103	282	179	Perdok *et al.*, 1984
average		3.29	4.28	0.98	38	235	203	11 references, 17 trials
SE			0.76		127			

SOURCE: Wanapat *et al.*, (1996)

Table 2.6. Effect of treating rice straw on cow/calf performance (Bangladesh)

Rice straw (*ad libitum*)	Untreated	Treated
No. of animals	17	17
Dry matter intake (Kg/d)		
Straw	5.20	8.60
Concentrate	1.50	1.50
Milk produced (Kg/day, over calf)	2.42	3.41
Average daily gain (g/d)		
Cow	-266	93
Calf	181	257

SOURCE: Wanapat *et al.*,(1996)

phenomenom all over the world (Duval, 1969; Ford, 1976; Rose Innes, 1977). Limiting nutrients are mainly nitrogen and phosphorous, but energy may also become limiting during the late dry season/winter. These pastures must therefore be supplemented with the missing nutrients to enhance animal survival and productivity.

Cows grazing Pine-Bluestem range, in Louisiana (USA), were supplemented with cottonseed cake either daily or every other day in winter. Cows fed on alternate days weighed more and had higher calving percentages than cows fed daily. The cost of distributing the cake every other day was 40% less than for the daily schedules (Duval, 1969).

Ford (1976) fed Biuret over four dry seasons to breeding cows grazing native pastures or Townsville stylo. There was no appreciable effect of supplement on the liveweight change of cows grazing Townsville stylo. Biuret reduced liveweight and condition loss of cows grazing native pasture to some extent but it was not sufficiently effective to prevent mortalities during the late dry season.

In a grazing experiment with Brahman crossbred and Shorthorn cattle, three levels of urea: 26, 49 and 69 g/head/day, fed with 0.21 Kg molasses/head/day, were compared with no supplement. The control group lost 0.01 Kg/day over the 83 day feeding period, while supplemented groups gained 0.14, 0.19 and 0.23 Kg/day for the low, medium and high urea levels, respectively. No significant differences in post feeding growth rates were observed between treatment groups, and all treated groups were significantly heavier than controls 7 months after cessation of supplementation (Winks *et al.*, 1972).

Hereford heifers grazing native and fertilised phalaris pastures were supplemented with urea-molasses mixtures for 2 years. Live weight gain of heifers grazing fertilized pastures was not influenced by supplementation, but the liveweight gain of heifers grazing native pasture increased significantly by 6g/day/g nitrogen consumed as urea during July, August and September and by 0.16g/day/g digestible organic matter consumed as molasses at other times of the year (Langlands and Donald, 1978).

Several studies in Ghana have shown that supplementation of cattle grazing native pasture is beneficial. For example, studies by Okantah and associates (1999) demonstrated that wheatbran supplementation of cows (1.5 kg/cow/day) grazing natural pasture in the Katamanso area significantly improved daily partial milk yield (0.80 kg vs 0.51 kg). Results of some other studies are summarised in Table 2.7.

Table 2.7. Summary of some experiments conducted in Ghana with cattle grazing on native pasture and receiving various supplements.

AGE OF CATTLE	SUPPLEMENT	PERFORMANCE	REMARKS	AUTHOR
Cows	Rice straw with molasses and urea, Diet A	0.14kg/head/day	No significant difference between diets and control	
	Sorghum tops with molasses and urea, Diet B	0.18kg/head/day		
	Control, grazing only	0.12kg/head/day		Dzator (1974)
Cows	Sundried cassava peels with urea and molasses, Diet T1	0.36kg/head/day	No significant difference between diets and control	
	Ensiled cassava peels with urea and molasses, Diet T2	0.28kg/head/day		Larsen and Amaning-Kwarteng (1976)
	Control, grazing only	0.30kg/head/day		
Calves	Wheatbran and cassava peels, Diet T1	0.25kg/head/day	T1 and T2 significantly better than control	
	Wheatbran and maize, Diet T2	0.27kg/head/day		
	Control, grazing only	0.16kg/head/day		Okantah (1974)
	Rice straw with sorghum tops and molasses, Diet B	0.07kg/head/day	Diet C significantly better than B or control.	
	Concentrate mix, Diet C	0.15kg/head/day		
	Control, grazing only	0.07kg/head/day		Agbodaze (1975)
Calves	Panicum maximum straw only, Diet A	0.10kg/head/day	No significant difference between diets and control	
	Panicum maximum straw with poultry manure, Diet B	0.14kg/head/day		Oddoye *et al.*, (1996)
	Control, grazing only	0.15kg/head/day		

The benefits of supplementation have also been shown in studies with sheep. For instance, Attah-krah (1972) and Rhule (1973) fed rice straw supplemented with urea as a dry season supplement and observed that at the end of the experiment test animals were healthier and had gained more weight, on average, as compared to the control. Similarly, Dadzie *et. al.* (1977) fed either rice straw or cassava peels fortified with molasses as a dry season feed supplement to sheep and observed that sheep fed the supplement lost less weight than the control.

Table 2.8. shows a summary of some field studies in Southern Africa, in which cattle grazing native pasture (veld) were given non-protein nitrogen (NPN) supplements with or without additional energy supplements. Supplementation with NPN decreased weight loss. In two of the experiments it was shown that the additional energy supplement gave an increased response in terms of weight gain.

2.5. Milk production on the Accra Plains.

2.5.1. Amount produced in relation to national demand.

Domestic milk production is not adequately quantified (no milk recording, etc). Nevertheless about 15% of all cattle are milked annually (Okantah, 1988). Consumption of meat and milk is low due to scarcity and high cost.

Table 2.8. Summary of some results of field studies in Southern Africa with cattle grazing native veld and receiving non-protein nitrogen supplement.

AGE OF CATTLE	GRAZING	SOURCE & AMOUNT OF NPN G/ANIMAL/DAY	ENERGY SUPPL.	LEVEL OF RESPONSE TO NPN	EFFECT OF ADDITIONAL ENERGY ON RESPONSE TO NPN	REFERENCE
Mature steer	Winter veld	Urea 85	Molasses	Weight loss reduced by 57 kg	Not shown	Bishop (1957)
2.5 years	Winter veld	Urea 42-57	Molasses or maize	Weight loss reduced by 34 Kg	Small, positive response	Pieterse(1961)
Yearlings	Winter veld	Urea 57	-	Weight loss reduced by 20 Kg	-	Pieterse(1961)
Weaned calves	Winter veld	Urea 57	Molasses or molasses & corn cobs	Improved weight gain by 10 Kg	No effect	Heydenrych(1962)
15 months	Winter veld	Urea, ad lib as a lick	Maize	Weight loss reduced by 14 Kg	Positive, further reduced weight loss by 7 Kg	Pieterse & De kock (1962)
Steers 250-300 Kg	Winter veld	Urea or Biuret	Molasses	Weight loss reduced by 18 Kg (urea) or by 10 Kg (biuret)	Not shown	Schoeman & Lishman (1965)

SOURCE: Topps, 1971.

Tables 2.9 and 2.10 show estimates of milk and meat production and demand in Ghana from 1998 to 2000 and projections for 2001 to 2003, respectively. It is evident from the tables that demand far outstrips national production. The FAO estimated that in 1994 Ghana imported a total of 3,700,000 mt of milk (fresh-600,000; dry powdered-2,000,000; condensed and evaporated-1,100,000) worth $5,480,000.

2.5.2. Current trends in milk production on the Accra Plains.

There has been renewed interest in the production of milk, in the Accra Plains, in recent times. One of the outgrower schemes of the Animal Production Department (APD) of the Ministry of Food and Agriculture (MOFA) is geared towards producing *Bos indicus* X *Bos taurus* crosses for improved milk production (MTADP, 1990). The APD has started a milk collection scheme in an attempt to collect whatever milk is available on the Accra Plains. The scheme has taken root in some areas but has run into problems in other areas. One major problem is that herdsmen are reluctant to sell their milk to the Ministry when they are being offered a better price by private buyers.

2.6. Effect of supplementation on reproductive performance.

A prolonged anoestrous period is recognized as a major constraint for maintaining a 12 month calving interval. Calving interval is

Table 2.9 Estimates of domestic cattle milk and meat production and demand in Ghana from 1998-2000

YEAR	1998	1999	2000
Milk (mt)			
Production	81,000	85,000	92,000
Demand	1,460,000	1,504,000	1,549,000
Beef (mt)			
Production	49,000	54,000	59,000
Demand	292,000	301,000	310,000

SOURCE: Livestock Economics and Extension Division, Animal Research Institute

Table 2.10 Projections of cattle milk and meat production and demand in Ghana from 2001 to 2003.

YEAR	2001	2002	2003
Milk (mt)			
Production	99,400	108,400	119,200
Demand	1,595,500	1,646,600	1,702,700
Beef (mt)			
Production	65,000	73,000	82,000
Demand	300,800	310,425	319,900

SOURCE: Livestock Economics and Extension Division, Animal Research Institute dependent upon the re-establishment of ovarian cyclicity after parturition. Delayed re-establishment is influenced by body condition (Van Niekerk, 1982), suckling (Wells *et al.*, 1986; Galinan and Arthur, 1989), milk yield (Spalding *et al.*, 1975; Fonseca *et al.*, 1983) and diseases (Watson, 1984). Feed supplementation can cover or at least reduce post-partum anoestrus and enhance the onset of ovarian cyclicity after calving (Mongomery *et al.*, 1985; Sasser *et al.*, 1988).

Multiparous Zebu cows were supplemented with a Urea-molasses block during the 3 month period after calving (Ghosh *et al.*, 1993). The body weight of supplemented cows showed a 4.8% increase while unsupplemented cows lost weight. Supplemented cows initiated ovarian cyclicity between days 14 and 44 postpartum with behavioural oestrus occurring within 35-84 days postpartum. Control cows began cycling between days 60 and 125 postpartum and showed behavioural oestrus between 145 to 196 days post partum.

Tegegne *et al.*, (1992) supplemented grazing small East African Zebu cows with a molasses block containing 10% urea for 8 months. Over the 8 month period 65% of supplemented and 53% of control cows exhibited oestrus. The postpartum oestrus interval was shorter by 54 days in supplemented cows as compared to control cows. Pregnancy rate was also higher in supplemented than in control cows

(37% vrs 33%).

Zebu cows that received supplementary concentrate postpartum had their first follicle 2 days before and also ovulated 18 days earlier than those that only grazed (Eduvie, 1985).

Reports on the effect of supplementation on the onset of puberty indicate that increased protein in the diet accelerates age and weight at puberty of zebu heifers (Oyedipe, *et al.*, 1982). Young Bunaji and Fresian-Bunaji crossbred bulls on a high protein diet had larger scrotal circumference than those on a low protein diet. Semen volume, percentage sperm motility, sperm concentration and total spermatozoa were significantly higher for bulls on the high protein diet (Rekwot *et al.*, 1988). Similar results were obtained when N'Dama bulls were supplemented with 4 Kg/day of a mixture of milled Andropogon, rice bran and groundnut cake (Sayang and Presicoe, 1989).

2.7. Farming systems research.

To improve technology that is pertinent to crop and animal production on small farms requires a systematic analysis of all the factors involved. Farming systems are normally described in pluridisciplinary studies which cover not only the cropping or farming system but also the whole environment in which production takes place. This environment includes political, economic and social factors as well as ecological ones (Amir and Knipscheer, 1989).

A system may be described as a conceptual artifice that includes a collection of interdependent and interactive elements that act together to accomplish a given task. The interactions with, and the influence upon, elements outside the system may be either weakly or strongly connected to an intrinsic feedback mechanism of the system (Amir and Knipscheer, 1989). A farming system may therefore be described as a unique and reasonably stable arrangement of farming enterprises that a household manages according to well-defined practices in response to physical, biological, and socioeconomic factors and in accordance with household goals, preferences, and resources (Van Der Veen, 1986).

Farming systems research (FSR) is an approach to agricultural research and development that:

1) views the whole farm as a system
2) focuses on the interdependencies of the components under the control of the members of the farm household and on the interaction of these components with physical, biological and socioeconomic factors not under the household's control and
3) aims at enhancing the efficiency of farming systems by improving

the focus of agricultural research in order to generate and test better technology (Shaner *et al.*, 1982; Van Der Veen, 1986).

2.7.1. On-farm research

The testing of new technologies or already well-established practices at the farm level may be described as on-farm adaptive trials (OFAT) or on-farm research (OFR). The general goal of such tests is to improve the productivity of the farming system. Improvement in productivity may be accomplished by demonstrating new technologies or by refining existing practices. Better economic analysis of the production system will help to determine which technologies will increase productivity the most. On-farm research (OFR) is an important component of farming systems research (FSR). It is gainfully employed in testing crop and animal improvement technologies. In FSR, OFR is therefore carried out only after careful identification of farmers' problems, constraints and screening of potentially useful technologies. The basic objectives of OFR are to (i) verify and evaluate the performance of a new technology; (ii) determine the farming systems under which new technology is suitable, (iii) provide feedback to researchers on the performance of technology under existing resource conditions, (iv) analyse interactions between technology and social factors including gender-specific considerations; and (v) assess the farmers' perception about the technology (Jain *et* *al*., 1995).

Types of trials

Knipscheer (1986) categorised livestock on-farm trials into three broad categories based on the management of the trial: (i) Researcher-managed/Researcher-executed, (ii) Researcher-managed/Farmer-executed and (iii) Farmer-managed/Farmer-executed.

Researcher-managed/researcher-executed trials

These are limited to measuring technical parameters. Here researcher provides the experimental animals and all associated inputs like feeds, veterinary medicines, etc. along with necessary technical guidance while the farmers control non-experimental variables like grazing time, watering frequency and other management inputs.

Researcher-managed/Farmer-executed trials

Here, the farmers administer the experimental inputs as prescribed by the researcher and controls all other factors relating to livestock.

Farmer-managed/Farmer-executed trials

In these trials, the farmers manage all experimental inputs as they like and the researcher observes the manner in which they apply the inputs. These trials are conducted under the management of farmers so as to enable them to evaluate one or two most promising treatments. Large plots without any replication are used. It is desirable to have at least 30 farmers in these trials in a recommendation domain.

On-farm trials may also be classified based on the purpose for which the trial is intended (Hildebrand and Poey, 1985; Collinson, 1987; Mettrick, 1993):

Exploratory trials

These trials are limited to measuring the possible effects of a specific technology and are conducted in an area about which little is known. These trials provide more qualitative than quantitative information about several factors with limited participation of farmers.

Adaptation trials

These trials are conducted with emphasis on technical aspects but farmers' reactions to the technology are also measured.

Validation trials

In these trials, farmer management is included as a variable and emphasis is laid on socio-economic aspects.

Promotion trials

These trials, also called demonstration trials, are designed to carry out demonstrations of a new technology.

2.7.1.1. Farmer participation in on-farm research.

On-farm work can be successfully carried out only with the full participation of farmers because they alone know most about their actual livestock situation. The OFR test or trial can be implemented only when individual farmers are convinced of the benefits of the on-farm study. The farmers should have a clear understanding of any consequential side effects of the new technology on his animals. The farmer should have full confidence in the technology (Horne and Stur, 1998).

CHAPTER 3

A SURVEY OF FARMING SYSTEMS IN THE ACCRA PLAINS OF GHANA.

3.1. INTRODUCTION

Feeding of ruminant livestock in the dry season has long been identified as one of the major constraints to the development of the livestock industry (Rose-Innes, 1960; Montsma, 1960; Wharton *et al.*, 1967; Sunkwa-Mills, 1974). Attempts have been made to come up with suitable dry season feeding strategies, eg: supplementation with agro-industrial by-products like wheatbran and brewers spent grain (Karikari *et al.*, 1995), the use of rice straw fortified with cassava peels and molasses (Larsen and Amaning-Kwarteng, 1976, Otchere *et al.*, 1977) and the use of *Panicum maximum* straw fortified with poultry litter (Oddoye *et al.*, 1996).

Despite all these known dry season feeding strategies, cattle farmers in Ghana, have not taken them up. As far as nutrition of their livestock is concerned, little investment is made in supplementary feeding. It is not clear why this state of affairs exists.

3.2. OBJECTIVES

The objectives of this survey therefore were:

1) to find out whether farmers perceive dry season feeding as a major problem

2) to find out why there was a non-adoption of studied dry season feeding strategies.

3) to find out what opportunities existed for livestock farmers to adopt such strategies.

The survey was intended to elicit information on the following:

i) demographic characteristics of the household.

ii) crops grown if any.

iii) number, size and types of farm plots and their distances from the homestead or kraals.

iv) number of cattle, breed, age and sex.

v) cattle feed availability and nature.

vi) cattle disposal outlets and difficulties.

vii) degree of integration of crops and cattle production.

viii) period of extreme difficulty in obtaining feed.

ix) access to (new) knowledge/information on livestock feeding.

x) why farmers have not adopted new knowledge/information on livestock.

3.3. MATERIALS AND METHODS

A questionnaire (see appendix 1) was designed to sample two (2) Districts, namely Dangbe East and Dangbe West, on the Accra Plains. With the help of the District Veterinary Technical Officers, known cattle farming communities were visited and cattle farmers were selected, as randomly as possible, for the interview. In all thirty (30) farmers in each of the two Districts were sampled, making a total of sixty (60) farmers.

The survey was carried out between July and September 1997. Data from the field administration of the questionnaires were coded. The coded data were entered into the computer using DBASE4 (Ashton-Tate, Inc) and imported into SAS (SAS, 1987) for subsequent analyses. The frequency procedure of SAS was used to generate crosstabulations (using percentages) between the two (2) Districts and the other variables.

Mortality rate was calculated as the total number of animals which had died within the last year divided by the total number of animals in the herd expressed as a percentage. Offtake rate was calculated as the total number of animals removed from the herd for sale, gifts, etc expressed as a percentage of the total number of animals in the herd.

3.4. RESULTS.

3.4.1. Demographic characteristics of the household

The demographic characteristics of the households surveyed are summarised in Table 3.1.

The majority of farms were 2 km or less from the main road (83.7%). Most respondents did not belong to a cattle farmers association (36.2%). Farm facilities and infrastructure were poor. Few farms had electricity and pipe borne water. Although most farmers had no vehicles they had access to the public transport system.

In the Dangbe East District all owners of cattle were involved in the management of their herds. Kraals which housed the animals at night were built near the owner's homestead. A young man, usually a native (Ada/Krobo) is hired to herd the animals. The herdsman is paid a heifer after 3 years. In the Dangbe West District only about 47% of owners were involved in the management of their herds. The remainder of the herds were managed by Fulani herdsmen (33.3%), sons/relatives of owners (25.0%) and native herdsmen (41.7%) whose conditions of service were similar to those in the Dangbe East District. Households were larger in the Dangbe East District as compared to the Dangbe West District (see Table 3.1) with household heads being predominantly male. Most household heads were middle aged (about 50 years) and had farming as their major occupation. More than half of the household heads had no formal education (Table 3.1). All households employed some wage labour for livestock (Table 3.1). Casual labour was used for cropping, as it is seasonal.

Table 3.1 Summary of demographic characteristics of households in the study area.

ITEM	DISTRICT	
	DANGBE EAST	DANGBE WEST
Distance of farm from main road (≤ 2km)	77.3%	90.0%
Membership of cattle farmers association	33.3%	40.0%
Owner's involvement in farm management	100%	46.7%
Household size	13.2 ± 1.73	8.7 ± 1.05
Sex of household head	29 males (1 female)	All male
Age of household head (Yrs)	49.6 ± 3.25	50.4 ± 3.65
Farming as major occupation	70.0%	83.3%
Educational level (no education)	56.7%	60.0%
Use of wage labour	100.0%	66.7%
Use of casual labour	76.7%	60.0%

3.4.2. Land tenure and land use.

3.4.2.1. Land tenure systems.

According to respondents, lands were either family lands, having been handed down from generation to generation, or leaseholds (See Table 3.2) which involved the payment of yearly rents ranging from ¢20,000.00 to ¢50,000.00 per acre (0.4 ha).

3.4.2.2. Food crops grown.

The major food crops grown in the Dangbe area (both East and West) were maize and cassava. The two crops were sometimes grown separately or as an intercrop. Table 3.2 shows that it was more common for the two crops to be grown separately. Table 3.2 also shows that some farmers in the Dangbe East District grew cassava only (30.0%) and a few in the Dangbe West District grew maize only (23.3%). The hectarage of food crops grown ranged from a hectare or less to more than 3 hectares with farms in the Dangbe East District being, on average, larger than farms in the Dangbe West District (Table 3.2).

3.4.2.3. Cash crops grown.

The major cash crops grown were Pepper, Okro and Tomatoes. A few farmers grew beans and groundnuts as well. The hectarage of cash crops grown also ranged from a hectare or less to more than 3 hectares with farms in the Dangbe East District being, on average, larger than farms in the Dangbe West District (Table 3.2).

Table 3.2. Summary of Land tenure and land use variables.

ITEM	DISTRICT	
	DANGBE EAST	DANGBE WEST
Family land	66.7%	23.3%
Leasehold	33.3%	76.7%
Food crop hectarage (cassava, maize)	3.0 ± 0.35	2.7 ± 0.74
Single crop cassava	30.0%	0.0%
Single crop maize	0.0%	23.3%
Both crops (intercrop)	20.0%	20.0%
Both crops (seperate)	50.0%	56.7%
Cash crop hecterage (pepper, okro, tomatoes, beans, groundnuts)	3.9 ± 0.41	1.3 ± 0.31
Land preparation (tractor)	40.0%	20.0%
Land preparation (hoe & cutlass)	60.0%	80.0%
Use of cattle manure	64.0%	40.0%
Use of fertiliser	96.7%	46.7
Crop yields (t/ha)		
Maize	0.2 -1.0	0.2 - 1.0
Cassava	≤2.0 - >10.0	5.0 - 10.0

3.4.2.4. Land preparation for cropping

Land preparation for cropping was by either tractor or hoe and cutlass. Tractor use was more common in the Dangbe East District (40.0%) than in the Dangbe West District (20.0%) and may be a reflection on the larger size of crop farms in that district (Table 3.2). Land preparation with the hoe and cutlass was more predominant in the Dangbe West District.

3.4.2.5. Use of cattle manure

Generally the application of cattle manure, collected from kraals, on crop farms (Table 3.2) was more popular in the Dangbe East District (64.0%) than in the Dangbe West District (40.0%).

3.4.2.6. Use of fertiliser

All the farmers in the Dangbe East District, with the exception of one farmer, used fertiliser (96.7%) as compared to 46.7% in the Dangbe West District (Table 3.2).

3.4.3. Source of water for cattle during the dry season

Sources of water included dams, dugouts and streams. There were 4 farms in Dangbe West and one in Dangbe East where the farmers had constructed a drinking trough from cement blocks. This trough was filled with pipe-borne water for cattle (Fig. 3.1a). The most common source of water during the dry season were dams. There were no dugouts in Dangbe East.

Fig. 3.1a. Source of water for cattle during the dry season by district

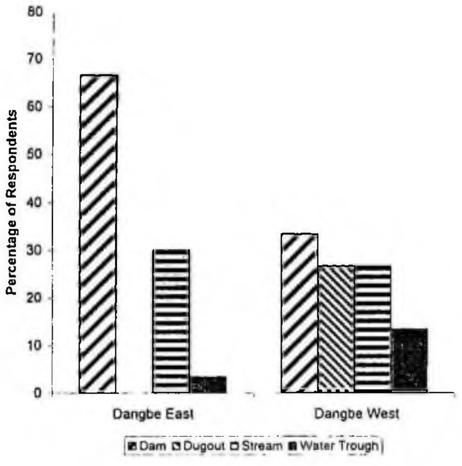


Fig 3.1b. Frequency of watering cattle during the dry season by district.

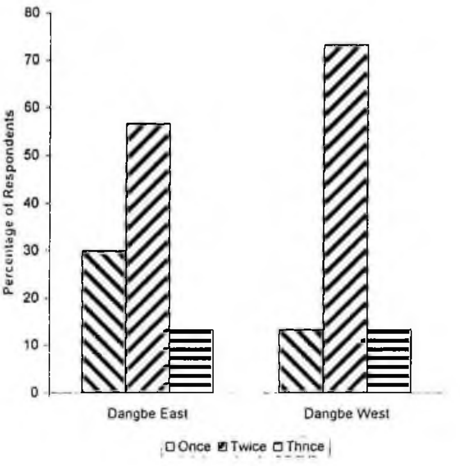
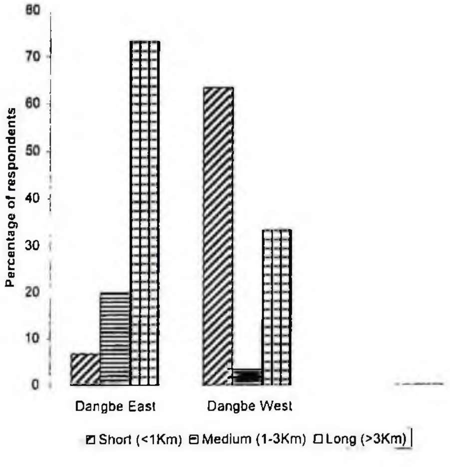


Fig. 3.1c. Distance to nearest watering point



3.4.4. Frequency of watering cattle during the dry season

Fig. 3.1b shows the frequency of watering cattle during the dry season. On average, most stock men watered their animals twice a day, that is once on their way to graze and again when they returned from grazing. There were a few cases where herdsmen watered their animals only once and this was more common in the Dangbe East District.

3.4.5. Distance to nearest watering point

Watering points were quite far from the homesteads as is shown in Fig. 3.1c. In about half of the cases they were more than 3Km away. In general, farmers in the Dangbe West District were closer to watering points than their counterparts in the Dangbe East District.

3.4.6. Livestock inventory

3.4.6.1. Percentage distribution of various classes of cattle

Majority of farmers did not keep a lot of bullocks/oxen (Table 3.3). Most farmers explained that these had been sold off by the time of the survey. Breeding bulls were also few in number(Table 3.3). This is because usually a cattle farmer would only keep a few breeding bulls to avoid competition between the bulls. Breeding bulls are changed from time to time.

On average, cows formed between 26-50% of the herd (61.7%). The figures for the two districts for this class were similar (60.0% vrs 63.3%). In 28.3% of the farms cows even formed more than 50%

Table 3.3. Percentage distribution of various classes of cattle by district

	BULLOCKS/OXEN		BULLS		COWS				YOUNG BULLS				HEIFERS			BULL CALVES		HEIFER CALVES	
% OF HERD	≤ 10	11 - 25	≤ 10	11 - 25	≤ 10	11 - 25	26 - 50	> 50	≤ 10	11 - 25	26 - 50	> 50	≤ 10	11 - 25	26 -50	≤ 10	11 - 25	≤ 10	11 - 25
DANGBE EAST	93.34	6.66	96.66	3.34	3.34	6.66	60.00	30.00	33.34	60.00	3.32	3.34	16.66	60.00	23.34	73.34	16.66	70.00	30.00
DANGBE WEST	96.66	3.34	96.66	3.34	0.00	10.00	63.34	26.66	63.34	33.34	3.32	0.00	33.34	50.00	16.66	33.34	66.66	13.34	86.66
TOTALS	95.00	5.00	96.66	3.34	1.67	8.33	61.67	28.33	48.34	46.67	3.32	1.67	25.00	55.00	20.00	53.34	46.66	41.67	58.33

of the herd.

Young bulls formed up to 25% of the herd in most cases. This is an indication that farmers did not castrate their animals, preferring to sell them off as entire males or use some of them for replacement breeding bulls. The situation was different in the two Districts in that in the Dangbe East District there were more farmers who had between 11-25% of their herd as young bulls while in the Dangbe West district there were more farmers with young bulls forming 10% or less of the herd. The situation with heifers was similar to that of young bulls although there were some differences. The dominant class was 11-25% (55.0%). A sizeable proportion (20.0%) were found in the 26-50% class and this goes to show that heifers are not sold but go to replace cows or add to the number of cows.

Calves formed 25% or less of the herd. This means that about half of the cows were calving every year.

3.4.6.2. Total herd size

Cattle herds were classified as small (≤ 20 cattle), medium (21-50 cattle), large (51-100 cattle) and very large (> 100 cattle). Table 3.4 shows that most herds fell within the medium and large class. There was not much difference between the two Districts.

Dangbe East had an average herd size of 48.8 ± 4.51 whilst Dangbe West had an average herd size of 65.1 ± 9.51.

Table 3.4. Total herd size, ownership of cattle in a kraal and measures to make up feed deficit in the dry season by District.

ITEM	DISTRICT	
	DANGBE EAST	DANGBE WEST
Total herd size		
≤ 20	13.3%	10.0%
21-50	36.7%	40.0%
51-100	43.3%	36.3%
> 100	6.7%	13.3%
Ownership of cattle in a kraal		
1 owner	16.7%	36.7%
2-5 owners	53.3%	50.0%
> 5 owners	30.0%	13.3%
Meaures to make up feed deficit in dry season		
Longer grazing hours	90.2%	100.0%
Move to better grazing	9.8%	0.0%

3.4.6.3. Ownership of cattle in a kraal

Cattle found in a single kraal often had multiple owners. Only 26.66% of respondents owned all the cattle in their kraals. The Dangbe East District had 16.7% of single owners with the Dangbe West District having 36.7% (Table 3.4). Kraals with between one to five owners, were the most common (51.7%).

3.4.7. Feeding

All farmers interviewed grazed their cattle on natural communal grazing lands all the year round. There was only one farmer, in the Dangbe West District who cut grass for calves and sick animals during the dry season. About 70% of farmers in the Dangbe East District and 30% in the Dangbe West District allowed their cattle into their crop farms after harvest to graze the crop residues. However, none of the farmers stored any of their crop residues from harvest for use in the dry season. Uneaten crop residues were either burnt or left on the fields to rot.

Most farmers interviewed (68.6%) were of the opinion that there were about five months of the year when there was insufficient grazing for their cattle. The months were from November to March and this coincides with the dry season on the Accra Plains.

There were a few who included October as a dry month (15.7%) and others also thought the dry period started from December (9.8%). During the dry months of the year, farmers grazed their animals for longer hours as a means of making up the feed deficit. In a few cases in the Dangbe East District, the animals were moved to a new location where there was better grazing (Table 3.4).

3.4.8. Milk production

3.4.8.1. Age at first calving

The age at which the first calf was born varied from 24 months to 72 months according to the respondents (Fig. 3.2a). Most animals calved for the first time at 36 months of age (66.7%).

3.4.8.2. Calving interval

The interval between one calf and the next ranged between 12 months and 36 months (Fig 3.2b). About 43.0% had an interval of 12 months followed closely by those who had an interval of 24 months (38.3%).

There were more farmers in the Dangbe West District with calving intervals of 12 months (60.0%) as compared to the Dangbe East District (26.7%).

3.4.8.3. Calving pattern

There were more births in the dry season as compared to the wet season (55.0% vrs 45.0%) (Fig. 3.2c). This may be the natural calving season of the herds since the bulls are always with the cows. There were differences between districts in that whilst the Dangbe East district followed the general trend (wet-36.7% vrs dry-63.3%), in the Dangbe West district it was the other way round (wet-53.3% vrs dry-46.7%).

Fig. 3.2a. Age at first calving (months) by district

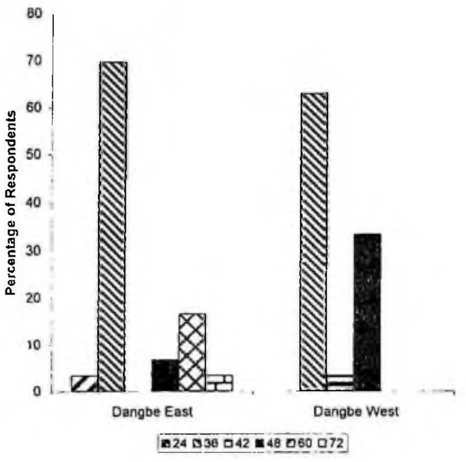


Fig 3.2b. Calving interval (months) by district

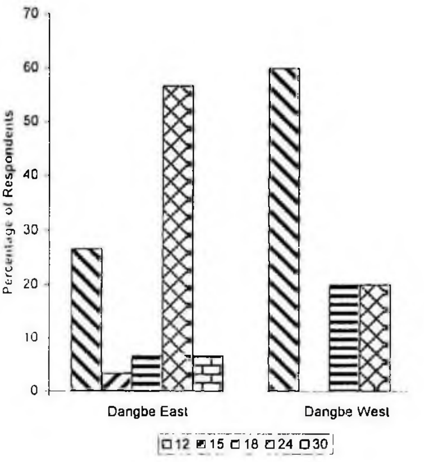
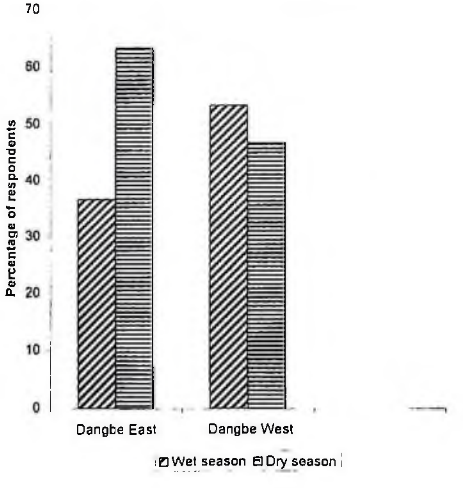


Fig. 3.2c. Calving pattern by district



3.4.8.4. Milk production

Figures 3.3a, b and c show dry season milk production, wet season milk production and total yearly milk production, respectively. About 52.0% of farmers did not milk their animals at all in the dry season (Fig 3.3a) and 10.0% of them did not milk their animals even in the wet season (Fig 3.3b). Total annual milk production was estimated as:

(DAILY DRY SEASON MILK PROD/COW X 60) + (DAILY WET SEASON MILK PROD/COW X 180)

The above formula is based on the following:

a. a 240-day lactation (Okantah, 1992; Okantah *et al.*, 1995, 1996).

b. milk production drops so low during the height of the dry season that the little milk available is left for the calf. It is therefore assumed that milk is produced for about only 2 months.

c. milk is produced constantly during the wet season which is about 6 months long.

A Total production of more than 2,000 litres per herd per annum (Fig. 3.3c) was found in 53.3% of the herds surveyed. This works out to an average of 5.5 litres (1.25 gallon) per day per year.

3.4.8.5. Reasons for seasonal production differences

The reasons given by farmers for the seasonal variation in milk yield are shown in Fig. 3.3d. The major reason for the difference in milk production was a lack of feed (70.0%). About 17.0% thought that availability of both feed and water was the problem and 13.3% thought that a lack of water in the dry season was the

Fig. 3.3a. Dry season milk production (litres) per cow by district

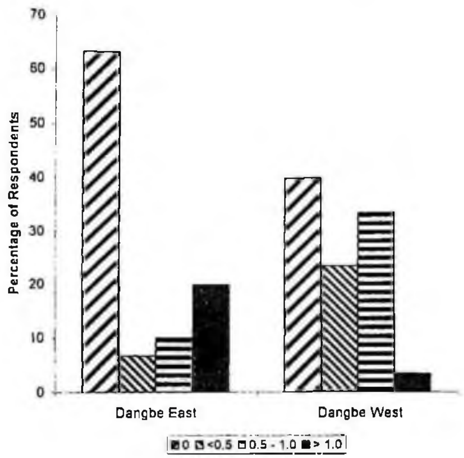


Fig 3.3b. Wet season milk production (litres) per cow by district

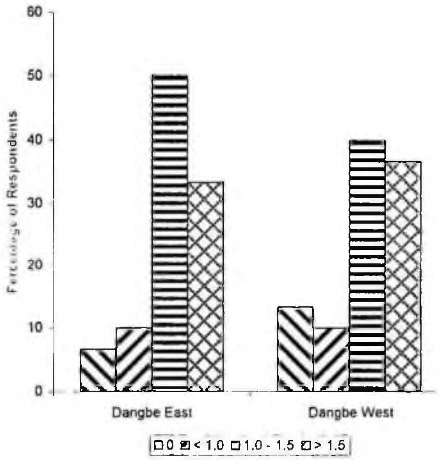


Fig. 3.3c. Total milk production (litres) per herd per annum by district

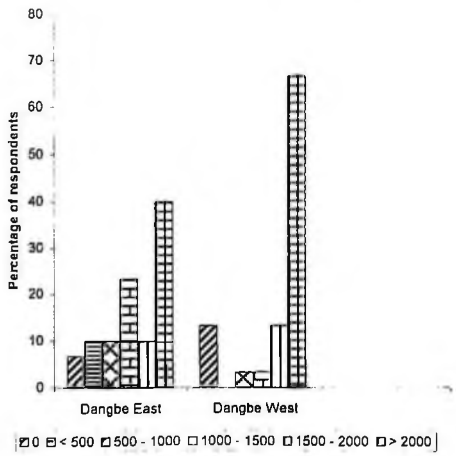
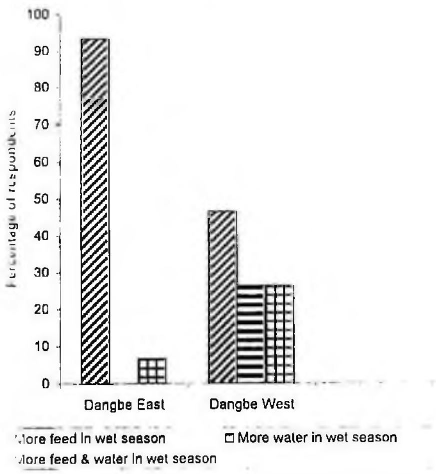


Fig. 3.3d. Reasons for seasonal production differences by district



problem.

3.4.8.6. Solutions to seasonal production differences

Farmers suggested that supplementary feeding in the dry season, the provision of water or a combination of both could help solve the problem of seasonal production differences. The responses of farmers are shown in Table 3.5. The 'Others' group were farmers who thought that the best thing to do was to move cattle to an area where there was adequate feed and water during the dry season.

3.4.8.7. Actions taken to solve seasonal production differences

Asked whether any thing at all to improve conditions for their animals during the dry season had been done majority of farmers said they had done nothing at all to help their animals during the dry season (Table 3.5). A few (8.3%) were practising some form of supplementation. Common supplements included cassava peels and wheatbran. These were often fed to only calves.

3.4.8.8. Milk disposal

Methods of milk disposal are summarised in Table 3.6. It was common to have a combination of methods (42.6%). Milk was either used by the family (20.4), sold fresh (29.6%) or sold as a form of cottage cheese locally known as "Wagashi" (7.4%). The major buyer of milk was the general public (69.4%). In some cases there were wholesalers who bought milk from several farmers for resale in town (22.2%). There were a few cases where the milk was sold to

Table 3.5. Solution to seasonal production differences and actions taken to solve seasonal production differences by District.

ITEM	DISTRICT	
	DANGBE EAST	DANGBE WEST
Solution to seasonal production differences		
Supplementary feeding	63.3%	33.3%
Provision of water	33.3%	33.3%
Supplementary feeding and provision of water	0.0%	23.3%
Others	6.7%	13.3%
Action taken to solve seasonal production differences		
Supplementary feeding	6.7%	10.0%
No action	86.7%	86.7%
Others	6.7%	3.3%

Table 3.6. Milk disposal by District.

ITEM	DISTRICT	
	DANGBE EAST	DANGBE WEST
Family use only	29.6%	11.1%
Sold fresh only	44.4%	14.8%
Sold as "wagashi" only	3.7%	11.1%
Combination of methods	25.9%	59.3%

buyers who turned it into "Wagashi" (8.3%). Of those who used milk at home, 58.8% used 25.0% or less of what was produced. 21.6% used between 25.0% and 50.0% of the milk produced and 19.6% used more than half (50.0%).

3.4.9. Knowledge of dry season feeding strategies.

3.4.9.1. Visits by extension agents.

There were generally no visits by extension agents. When they visited at all, it was in connection with crop production and not animal production. The local veterinary technician was a more regular visitor and was also the one consulted when there was a problem with cattle.

3.4.9.2. Knowledge of crop residue feeding.

Quite a few farmers (45.0%) had heard about crop residue feeding (Table 3.7). The proportion was higher in the Dangbe West District (53.3%) as compared to the Dangbe East District (36.7%).

Of those who knew about crop residue feeding, about half (48.1%) got their information from farmer's fora and meetings. The other half (51.9%) gave other sources. These included: hearing from other farmers, from the Katamanso Agricultural Project and the Aveyime Cattle Ranch. There was one farmer in the Dangbe East District who had worked with the Agricultural Research Station (ARS), Legon and had his information from there. Even though the use of crop residues was known, none of the farmers was using it. The most important reason assigned for non-use of crop residue

Table 3.7. Knowledge of crop residue feeding by district.

ITEM	DISTRICT	
	DANGBE EAST	DANGBE WEST
Knowledge of crop residue feeding		
Yes	36.7%	53.3%
No	63.3%	46.7%
Reasons for non-use of crop residues		
Crop residues not available in sufficient quantity	11.1%	54.5%
Did not know enough about the use of crop residues	22.2%	36.4%
Crop residues were too expensive	11.1%	0.0%
Inability to transport crop residues from farm to kraal	11.1%	9.1%
Other reasons	44.4%	0.0%

(32.8%) was that it was not available in sufficient quantity (Table 3.7). Others said they did not have enough knowledge about crop residue feeding (29.4%). The "others" group (22.2%) comprised people who were not prepared to use crop residue at all (60.0%) (they would continue to use their old traditional methods, i.e. extended grazing times during the dry season and moving cattle to areas where there is better grazing) and those who had not thought about the use of crop residues even though they knew about it (40.0%). All the members of this group were from the Dangbe East District and comprised 44.4% of the respondents there.

3.4.9.3. Urea ammoniation of crop residues.

Only four (4) farmers, two (2) from each District, had heard about urea treatment of crop residues. The 2 farmers in the Dangbe West District got their information from farmers fora/meetings. One of the 2 farmers in the Dangbe East District had his informaion from the Aveyime Cattle Ranch and the other one got his information from ARS, Legon. None of these farmers was applying the urea treatment method and all the 4 farmers said this was because they did not know enough about its use.

3.4.9.4. Use of multi-purpose trees.

Quite a sizeable number (55.0%; Dangbe East-70.0%, Dangbe West-40.0%) had heard about the use of multi-purpose trees. Of these 75.8% had heard it from extension officers. These trees were introduced with the idea of alley cropping or farming (*Leucaena leucocephala, Gliricidia sepium*) but extension officers had informed farmers that they could also be cut and fed to cattle. The remaining 24.3% had their information from other sources such as farmers meeting/fora, Aveyime Cattle Ranch, Katamanso Agric. Project and ARS, Legon.

Farmers were, however, not using multi-purpose trees and the main reason assigned for this was that farmers did not know where to obtain seedlings of these trees (40.9%). Other farmers said they had not grown any trees as yet (28.2%) and some farmers had just not thought about it (23.8%) (see Table 3.8).

3.4.9.5. Use of local browse trees.

Apart from three farmers (2 in the Dangbe East District and 1 in the Dangbe West District) all farmers were aware that their cattle fed on certain browse trees (*Griffonia simplicifolia, Jasminum dichotomum*) during the dry season. During the dry season, farmers in Nakonkope village of the Dangbe East District actually send their animals to a place where these shrubs are known to be in abundance before they go out to graze. Three farmers (1 in Dangbe East and 2 in Dangbe West) cut local browse trees to feed to their calves, but generally the cutting of local browse trees for feeding was not practised. Most people had just not thought of feeding local browse trees to their animals (60.9%). Others thought there were not enough browse trees availble in the wild to allow for cutting and feeding (25.9%). The rest (13.2%) thought that harvesting and feeding of browse would be time consuming and would require extra labour (Table 3.8).

Table 3.8. Reasons for non-use of multi-purpose trees, local browse trees and Agro-industrial by-products (AIBPs) by district.

ITEM	DISTRICT	
	DANGBE EAST	DANGBE WEST
Reasons for non-use of multi-purpose trees		
Had not grown any trees yet	27.8%	28.6%
Establishment of trees was time consuming	0.0%	14.3%
Did not know where to find tree seedlings	38.9%	42.9%
Hade not thought about it	33.3%	14.3%
Reasons for non-use of local browse trees		
Had not thought about cutting and feeding local browse	69.2%	52.7%
Harvesting and feeding would be time consuming and would require extra labour	0.0%	26.3%
There were not enough browse trees available for cutting	30.8%	21.1%
Reasons for non-use of AIBPs		
AIBPs were too expensive	88.9%	57.9%
AIBPs not easily available	0.0%	26.3%
Did not know enough about the use of AIBPs in cattle feeding	11.1%	10.5%
Other reasons	0.0%	5.3%

3.4.9.6. Use of agro-industrial by-products.

Quite a high percentage (80.0%, 60.0%-Dangbe East, 100.0%-Dangbe West) knew about the use of agro-industrial by-products (AIBP's).

In the Dangbe West District all farmers knew about the use of AIBP's, the most common one being wheatbran which could be easily obtained. Of those who knew about the use of AIBP's 39.6% said they had heard from Veterinary technical officers. Half of the farmers (50.0%) had heard from other sources, and these included other farmers, particularly in Ashaiman, where the use of wheatbran was quite popular, The Presbyterian Agric Station (SANKAT), Katamanso and the Aveyime Cattle Ranch.

Despite all these encouraging observations the majority of farmers (89.6%) were not using any AIBP of any sort. Just 10.4% of farmers, all of whom were in the Dangbe West District (20.8%), were feeding some form of AIBP. The major reason given for this was that AIBP's were too expensive (73.4%) (Table 3.8) or were not easily available (13.2%). For example, currently a 25 Kg bag of wheatbran sells for about ¢18,000.00 but this often increases around December (dry season) which is when cattle farmers really need wheatbran. Christmas holiday breaks by the flour milling companies creates an artificial shortage.

3.4.9.7. Use of urea-molasses blocks.

Farmers were not familiar with the use of urea-molasses blocks.

3.4.9.8. Knowledge of other dry season feeding strategies.

Two farmers, one in each District had heard about the making of both silage and hay. In addition one other farmer in the Dangbe west District had heard about silage making. This information was gathered from the Agricultural Research Station, Nungua (Dangbe East) and from the Amrahia Dairy farm (Dangbe West).

3.4.9. Cattle sale/disposal.

Figures 3.4a-3.4d show the number of deaths in the various classes of cattle in each district. Deaths were higher in females (Dangbe East - 47.4 ± 10.02%, Dangbe West - 19.5 ± 6.44%) and calves (Dangbe East - 36.0 ± 8.96%, Dangbe West - 60.8 ± 8.66%).

Table 3.9 show that the problem of mortality was greatest in the Dangbe West District. Offtake was higher in the Dangbe East District as compared to the Dangbe West District but was generally low (Table 3.9).

3.5. DISCUSSION

According to Okantah *et. al.,* (1995), the distance of the farm from the main road determines whether milk is sold fresh or processed. Since most farms were 2 km or less from the main road most milk would be sold fresh. Membership of cattle farmers associations was low and there may be the need to popularise such associations so that they may be used as the vehicles for the development of the cattle industry.

Basic infrastructure (water, electricity) needs to be extended to

Fig. 3.4a. Mortality in adult male cattle by district

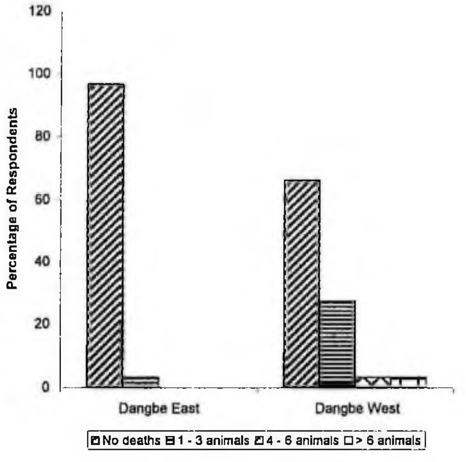


Fig 3.4b. Mortality in adult female cattle by district

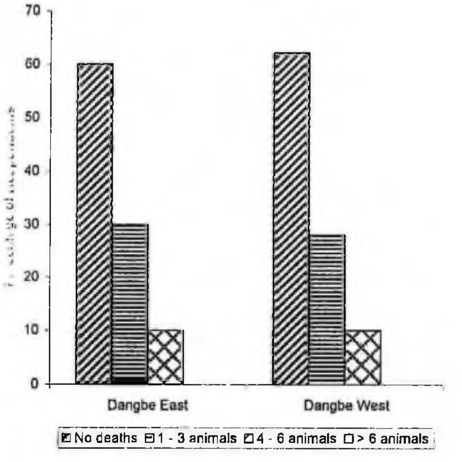


Fig. 3.4c. Mortality in weaner cattle by district

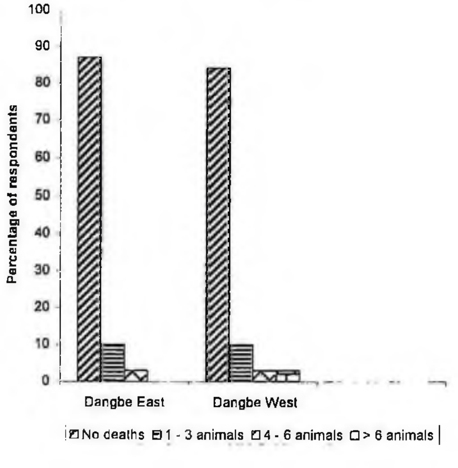


Fig. 3.4d. Mortality in calves by district

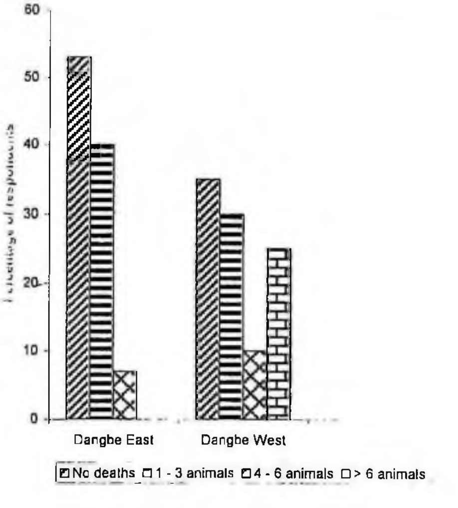


Table 3.9. Mortality rate and offtake rate by district.

ITEM	DISTRICT	
	DANGBE EAST	DANGBE WEST
Mortality rate (%)		
0-5	14	8
6-10	4	8
> 10	12	14
Mean	5.18 ± 0.91	22.06 ± 9.95
Offtake rate (%)		
0-5	17	14
6-10	4	4
> 10	0	0
Mean	9.23 ± 2.46	5.75 ± 1.58

cattle farming communities. The provision of clean (pipe-borne) water (for cleaning and in milk processing), for example, is necessary for the dairy industry. Even though ownership of vehicles was low the easy access to public transport would more or less make up for it.

The involvement of the farm owner in the management of the cattle herd has an influence on the welfare of the animals. In an earlier survey, carried out in five districts on the Accra Plains by Okantah *et al.*, (1995), about 44% of the farms surveyed had the farm owner as the farm manager. In all other cases the farm owner had hired a herd manager to look after the herd. The herd manager gets the milk from the herd as his remuneration and sometimes a small salary in cash or kind (Maize, Rice, etc). In most cases the herd manager is not able to take major decisions affecting the welfare of the herd unless he has consulted the owner. This is a major constraint as the owners sometimes stay away for long periods and only show up when they want animals to sell.

The experience of the Animal Research Institute (ARI), with supplementation of cattle on the Accra Plains (Okantah *et. al.*, 1999), is that unless herd owners are involved, uptake of improved technologies will not take place. In this particular instance the key issue involved was that herdsmen were not willing to buy the supplement even though it had been proven that the extra milk would more than offset the cost of the supplement. They were satisfied with the low input/low output system they were operating. There was the added benefit of a reduced calving interval (18 months vs 12 months with supplementation) but here again the herdsmen argued that the calves born were profit for the owners and not for them. Most of the herdsmen receive nothing from the owners apart from the milk from the animals they herd. A reduced calving interval would, however, ultimately lead to more milk for the herdsmen. Based on these findings it would appear that it would be easier to introduce new technologies in the Dangbe East District where all herd owners were involved in the management of their cattle.

The rural household is relatively large compared to urban households. This is due, in part, to a lot of men having more than one wife. There is also the fact that in farming communities, especially, the larger the family the more hands that are available to work on the farm. The larger families in the Dangbe East District could therefore be a reflection on the larger crop farms in that District. It appeared that cattle farming was traditionally a male affair. Women usually kept the smaller ruminants (sheep and goats) and poultry. Okantah *et al.*, (1995) reported a similar finding, in their survey of the Accra Plains. They also reported that most cattle farmers had farming as their sole occupation with 85% of respondents having no other activity than farming.

Lack of formal education was common with most household heads. However, most of them indicated that it was because of the unfortunate impressions about schooling when they were growing up and in some cases the poverty of their parents. They were, however, making sure that their children had some basic education. The survey carried out by Okantah *et al.*, (1995) recorded a similar finding with 49 percent of respondents being illiterate.

The differences in the use of hired labour between the two Districts is related to the involvement of the herd owners. In the Dangbe East where all herd owners are involved in the management of their herds the herd owner and household head are the same person. In the Dangbe West District, where the herd owner was not involved in the management of the herd, the person interviewed was the herd manager. The herd manager himself can be considered as a wage labourer but the distinction has been made to bring out these differences. In the case where the herd manager was the household head he would usually use some of his older sons to assist in herding. They would also get some of the milk as salary, especially if they were married and had a household of their own to cater for. In some cases the household head may split the herd up into smaller units and give to each of the sons for easier management of the herd. Okantah *et al.*, (1995) reported that with the exception of a few households most households hired at least 2 people to help with herding of cattle. The use of hired labour for cropping was negligible. The use of casual labour for crop farming was probably because crop farming was seasonal and therefore did not require permanent labour.

Food crops refer to crops that are grown for subsistence or home use and not for sale. Farmers found it easier to grow maize and cassava separately as they mature at different times. Growing them separately also allows for the growing of a minor season maize crop. Maize stover could be used as a dry season feed for ruminant animals if harvested and stored. Based on an average maize yield of 0.5 tonnes/ha it is estimated that 1.5 tonnes of stover per hectare will be produced (Kossila, 1988). Cassava leaves, which have a high crude protein content, would complement the stover very well. Cassava peels, a by-product of the cassava dough and gari-processing industries is also available and would serve as a source of readily soluble carbohydrates. The major cash crops (pepper, okroes and tomatoes) produce residues which are of no importance in livestock feeding. The minor ones (beans and groundnuts), however, are known to produce residues which have a high crude protein content and would therefore complement maize stover or any other low protein crop residue.

The use of cattle manure was not too widespread. One would have expected farmers to have made more use of manure which was virtually free of charge coming from their own animals. Most of them used fertiliser. The rate of fertiliser application was low with about 70% of farmers applying less than 1 bag per hectare. This low rate of application is associated with the high cost of fertiliser. Farmers also complained that cattle manure grows a lot of weeds very quickly. This is probably due to the fact that cattle ingest a lot of grass seeds which pass through their digestive system undigested. These seeds then germinate when cattle manure is spread on the farm. Such seeds may be destroyed by composting which would also provide a material which is more friable and easy to spread (I. K. Ofori, Personal Communication, 2000).

The use of the hoe and cutlass as the major tools for land preparation is worthy of note. The cost of hiring a tractor for land preparation appeared to be the problem. Some respondents thought that once the land had been prepared by initial burning, weeding with hoe and cutlass became fairly easy and there was no need to go in for a tractor. Since all these farmers keep cattle, the introduction of bullock ploughing is an idea worth investigating.

Water is a very important nutrient for all living organisms, perhaps even more so for milking animals as milk itself is more than 80% (82-87%) water. It was therefore worthy of note that some farmers had actually constructed watering troughs for their animals which they filled with pipe-borne water. This is indicative of the fact that farmers appreciate the importance of water to their animals. Other sources of water were dams, dugouts and streams. Okantah *et al.,* (1995) also observed that streams, dugouts and dams were the principal sources of water for cattle on the Accra Plains. Ideally cattle should have *ad libitum* access to water. Most herdsmen, however, water their animals on their way to and from grazing. Okantah *et al.,* (1995) also observed that cattle on the Accra Plains were watered twice daily, on average. In the few cases where animals were watered once daily the location of the watering point made it impracticable to return to it after grazing. The degree of water dependence is influenced by the ability of an animal to absorb water from faecal material during its passage through the large intestine, and by mechanisms of thermoregulation. Obligatory water loss through the skin, respiratory tract, urine and faeces also varies among different animal species. It has, for example, been reported to amount to 4% of body mass per day in sheep, compared to 12% for cattle (MacFarlane and Howard, 1970, 1972 as reported by Tainton, 1999). Zebu cattle can get by with half the water intake of Hereford cattle (Taylor, 1968, as reported by Tainton, 1999). Desert-adapted species like gemsbok and eland have been reported to have the ability to conserve water by allowing their body temperatures to rise during the day (Taylor, 1969 as reported by Tainton, 1999). There is a possibility, therefore, that after a while local cattle adjust to these conditions and learn to take in enough water for their needs whenever they go to drink. Much as the distance to the watering point from the homestead was long (> 3km in 50% of respondents) it may not be much of a problem because of the management system in practice. When animals are released from the kraal for grazing, the herdsman follows a route which ensures that the animals pass by the watering point on their way out and also on their way back from grazing. As mentioned earlier, the problem arises when the herdsman has to send the animals to graze in an entirely different area after watering the animals. It then becomes impracticable to walk the animals so far just to drink some water before kraaling them for the night.

A high premium is placed on cows in the herd and the high percentage of cows in the herd (26-50%) is indicative of this. This compares favourably with the national average of about 39% (LPIU, 1996). The idea of keeping the herd as a store of wealth means that greater numbers would mean more wealth and therefore the role of the cow becomes even more important. Total herd size will therefore usually continue to grow over the years as the additions to the herd usually outnumber the removals from the herd. This may not be too good for the development of the cattle industry as the herds become too large to handle effectively. Farmers often complain of lack of money to purchase basic inputs like drugs when they have very large herds and could sell off a few animals to purchase these inputs. The education of farmers is very necessary in this regard. The organisation of the industry such that there are two types of operations, i.e. Cow and calf, and fattening, may help as farmers will then stick to one specialised operation. The issue of multiple owners of the cattle in the kraal is another area of concern and is also another cause of the large size of herds. Over 70% of respondents stated that some owners do not provide basic needs for their animals. Such owners only show up when they need an animal to sell for money. Since herdsmen cannot, for example, spray some animals against ticks and leave the others, they have to stretch whatever they have to cover the whole herd which is not fair to the other owners.

The total reliance on natural communal grazing is a serious problem of the cattle industry in Ghana. Okantah *et al*., (1995) also reported a similar finding in their survey. It is well known that the available quantity and quality of the communal grazing lands falls sharply during the dry season, which according to this survey, is about 5 months long. This means that for almost half of the year cattle are malnourished. According to Okantah *et al*., (1995) farmers allowed their cattle into their crop farms after harvest to graze crop residues. This practice was also observed in this survey. However, whatever the cattle could not eat during the time they were allowed into the crop fields was allowed to rot in the field or was burnt. Longer grazing hours hardly make up the feed deficit as the animals often have to walk longer distances in search of whatever grazing is available.

The results of this survey are in agreement with the studies of Okantah *et al*., (1995, 1996) which reported that cows calved for the first time at 36 months and also showed that the majority of calvings occurred between January and March (dry season). The major difference is in the high percentage (43.3%) of respondents claiming that their cows calved every year. It has been suggested (Otchere, 1966) that even though farmers do not keep written records they have their own way of keeping records which are fairly accurate. These figures, however, may not be used without care. Calving intervals of 12 months are only possible with dry season supplementation. Without supplementation calving intervals fall between 18 and 24 months (Gyawu, 1988; Okantah *et. al.*, 1999).

Cattle were milked once a day, usually in the morning. Milk production was generally low in the dry season. It, however, tended to increase dramatically in the wet season, where production of 1.5 Kg milk per cow was not uncommon. Similar reports have been made by Okantah, 1992; Okantah *et al.*, 1995 and Okantah *et al.*, 1996. Production may fall so low in the dry season that it is often advisable not to milk the cows at all, leaving what little milk is available for the calf. In a herd where the herdsman gets nothing else but milk as a salary this is often impracticable as the herdsman needs to survive as well. Milking therefore goes on in the dry season often to the detriment of the calf. The yearly production of more than 2,000 litres may seem low compared to the figure of 10,040 reported by Okantah *et al.*, (1995). This figure was however accompanied by a coefficient of variation of 96% and their survey was also over a wider area (Juapong to Winneba), with differing management conditions for cattle.

Cattle farmers seemed to have diagnosed their problems. Most of them had realised that the non-availability of feed and water during the dry season was the major cause of low milk yield and poor condition of their animals. They even suggested that the way out was to provide supplemental feed and/or water. Most farmers had, however, not taken the pains to actualise their thoughts. Supplementation of calves with cassava peels and wheatbran was, however, recorded on a few farms (8.3%).

It was fairly common to have a combination of methods of milk disposal. According to Okantah *et al.*, (1995), the processing of milk into cottage cheese ("wagashi") was dependent on the distance of the farm from the main road. If this distance was long farmers would not risk their milk going bad, while they waited for customers to buy it fresh, and would convert it to "wagashi" as a way of extending its shelf life.

The farmers claim that they had no visits from extension staff may need further clarification. According to an extension staff in Dangbe West District, who I discussed the matter with, extension staff had been visiting farmers and advising them on all matters concerning the husbandry of their livestock (Mrs G. Fleischer, Personal communication, 1998). At the time of the survey, however, the veterinary technical officers were in more contact with the farmers. Infact, they were the people who took us around to interview farmers during the course of the survey. In a survey of agricultural extension services to smallholder farmers in the Dangbe West district (Aboe, 1998) it was reported that extension technology/information transferred to the farmers was biased towards crops as compared to livestock. Constraints to the adoption of technology included financial, expensive and unavailable inputs, late arrival, difficulty in understanding and irrelevance of technology/information transferred, unavailable and expensive equipment/tools, among others. The survey also reported that despite these constraints, most of the farmers who were in contact with the extension agent had observed some improvement in their farming activities, with the areas which had more contact with the extension agent recording higher improvement (82%) than those who had less contact (18%).

About half of the farmers had heard about crop residue feeding. Since all farmers grew some crops, residues from maize, groundnuts, cassava, etc. were available free of charge. It would appear that farmers had not been educated enough on the advantages to be gained from the use of these materials as dry season supplements for their animals and also how to combine them for the best results. The excuse by some farmers that sufficient quantities were not available was misleading. Apart from the at least 1.5 tonnes of maize stover which they would generate from their own farms, there are also likely to be a few big crop farmers who do not keep animals but will be willing to allow livestock farmers to purchase their crop residues at minimum cost. By careful feed budgeting it should be possible to spread whatever is available over the dry season to, at least, keep animals at maintenance.

In Ghana, urea-ammoniation of straw is a relatively new technology even though some studies have been carried out at the University of Ghana, Legon. Similarly the urea-molasses block was also unknown. This was suprising as I have seen it displayed at a farmers forum held at the Aveyime Cattle Ranch in 1996.

The use of multi-purpose trees and agro-industrial by-products, to feed livestock, was known by farmers but was not being practised. The fact that farmers were aware that cattle fed on certain browse trees goes to support the assertion by Rose-Innes (1977) that browse plants play a very important role in dry season feeding and that but for their presence dry season weight loss would be even more marked.

The high calf mortality may be a reflection on poor calf pen construction. Calf pens were often not roofed. During the rainy season, for example, poor conditions (wet soggy floors owing to build up of dung in pen) may predispose calves to sickness. The much higher mortality rate in the Dangbe West district is difficult to explain. Offtake rate was low. Okantah *et al.*, (1995) also recorded an offtake rate of 8.9% in their survey. Ths goes to buttress the fact that in this country, cattle are mainly a store of wealth.

3.6. Conclusion

The survey has established that:

1. farmers were aware that there is a problem with dry season feeding which affects the productivity of their herds and that
2. farmers knew about some of the dry season technologies

developed for use in the dry season but were not using them.

3.7. Recommendations

The answers given by farmers as to why they were not using these dry season feeding strategies point to the fact that dissemination of information may have been a problem. Where farmers knew about a technology the uptake of the technology was often wrought with problems such as lack of enough information about the technology to apply it properly. In the special case of Agro-industrial by-products, price was also an important consideration.

The problem with dissemination of information may be traced to the low contact between the extension agent and the farmer. The impact of extension services on the activities of the farmers and consequently food production depends on the level of contact between the frontline staff and the farmer. In this regard the extension agents need to have more contact with farmers and also need to balance their information between crops and livestock, particularly in livestock producing areas. The link between scientists and the extension agents also needs to be improved to ensure a steady flow of information from the scientist to the farmer, through the extension agent and vice-versa.

The issue of herd management, ownership of cattle in a herd and the size of herds are areas that need to be adressed if the cattle industry is to move from its present extensive system of management through a semi-intensive system to a more intensive system as practised in the developed countries. Crop-livestock integration, where animals are used for traction and manure, and crop residues are fed back to the animals needs to be encouraged. Addressing these issues will, however, be far from simple. The priorities of the local cattle farmer, in respect of livestock, are very different from the priorities as seen by the politician, scientist or commercial farmer. It is probable that the priorities of the local farmer are as follows:

1. Reducing and spreading risk
2. Generating and accumulating capital
3. Fulfilling social, cultural and religious requirements and obligations
4. Providing status or prestige within the immediate community
5. Providing food and other direct products
6. Generating income

This difference in prioritisation is one of the principal reasons why it has seldom been easy to transfer supposedly improved technology or livestock breeds directly to tropical agricultural systems.

CHAPTER 4

ON-FARM STUDIES ON THE USE OF UREA-AMMONIATED RICE STRAW AS A DRY SEASON FEED SUPPLEMENT.

4.1. INTRODUCTION.

The loss in body weight of ruminant animals, during the dry season in Ghana, is a well known phenomenon. Rose-Innes (1960) estimated that in a very severe dry season cattle may lose up to 15% of their body weight. The supplementary feeding of crop residues, in a bid to reduce the dry season weight loss may be the answer. Crop residues are cheap and may often be a by-product of the farmer's own cropping activities. The major drawback with the feeding of crop residues is their high fibre and low crude protein content, leading to low digestibility. These shortcomings may be overcome, to some extent, by urea-ammoniation which increases nitrogen (crude protein) content of the straws and also improves the digestibility of fibre. This study was therefore conducted:

i. to teach farmers how to prepare and feed urea-ammoniated rice straw to their cattle.

ii. to investigate the effect of dry season supplementation with urea-ammoniated rice straw on cow and calf growth rates and cow body condition score.

4.2. MATERIALS AND METHODS

4.2.1. Location of cattle farms

The study which began in November, 1998 and ended in March 1999 was located in the Sege area, in the Dangbe-East district of the Accra Plains.

4.2.2. Selection of farmers

Farmers for the project were selected from those who had been interviewed during the survey. With the help of the District Veterinary Technical Officer, and based on previous experience, farmers who were most likely to accept the project were identified. Farmers were grouped into two, that is, those with their kraals towards the sea and those with their kraals towards Battor town. Farmers were then chosen, at random, from the two groups making sure as much as poosible that there were equal numbers from each group. This was done because even though farmers relied on the same communal grazing lands and watering points those of them towards the sea could be identified as a distinct group with those towards Battor forming another group. It was therefore important to have equal representation from the two groups to ensure the success of the project.

4.2.3. preparation of farmers for feeding trials

A rapid rural appraisal (RRA) was organised in both Dangbe East and West districts prior to the start of the feeding trials. The idea was to sensistise farmers as to what they could expect from the dry season feeding trial and also to find out the farmer's own perceptions of the feeding trial. A demonstration of the ensiling process was carried out (see 4.2.5.). The criteria for selection of farmers for the project was then explained to the farmers after which selected farmers were introduced to the gathering. Farmers who had not been selected were encouraged to visit the selected farms to see for themselves how the project would go.

4.2.4. Cattle herd management

The average size of herds was 100 with a range of 50 - 200 head. The Sanga (Zebu X Shorthorn) was the predominant breed although a few Shorthorns were found in some herds. Management systems were principally agropastoralist in nature with herdsmen in charge. Grazing was generally on natural grasslands. Owing to a shortage of forage the herdsmen left home with the cattle between 6.00am and 7.00am and returned at about 6.00pm. Grasses identified were those found commonly on the Accra Plains (see 2.2.2.). A few thickets were found and herdsmen identified two species (*Jasminum dichotomum and Parkinsonia aculeata*) as being eaten by cattle. Cattle were watered from dams with the animals drinking once on their way to graze and once on their return. All farms practised natural mating with service bulls running freely with females. Older calves(9 months plus) followed their dams to pasture while younger ones were isolated and penned up until their dams had gone for grazing. They were then released to graze around the homestead. Herdsmen controlled ectoparasites fortnightly by applying a mixture of acaricide and water to affected areas on the animal. Deworming was limited to calves and other animals who showed signs of heavy worm infestation. Owing to the severity of the dry season no cows were milked.

4.2.5. Preparation of urea-ammoniated rice straw.

A small portable silo was used in the ensiling process. The silo was a sheet of polysack material about 2.2m X 2.2m and could contain 25 kg of chopped rice straw. This was made by sewing together 4 empty sacks used for bagging wheatbran after they had been cut open (see Plate 1). The polysack sheet was lined with a polythene sheet (1m x 1m) to prevent seepage of the urea solution (Plate 2). Rice straw was chopped with a cutlass into lengths of 3 - 5cm long (Plate 3). Twenty five kilograms of straw were ensiled with 1.65 kg of fertilizer grade urea dissolved in 22 litres of water (6.5% urea, 40% moisture; Quarshie, 1992) . The chopped rice straw was spread on the polysack sheet in layers. Successive layers of chopped rice straw were sprayed with urea solution, using a watering can, and thoroughly mixed (Plate 4). This process continued until all straw and urea solution were used up. The ends of the sheet were then tied together, diagonally. During the tying process pressure was applied to the mass of chopped rice straw with the feet to expel as much air as possible (Plate 5). After one week the silo was opened and the contents aired for a day after which it was ready for use (Plate 6).

4.2.6. Experiment 1

Eight farms (herds) were used in the study. Target animals were parturient cows and their calves.

4.2.6.1. Feeding

On four of the farms all parturient cows were fed a supplement of urea-ammoniated rice straw on their return from grazing. Feeding was done in a group with an allowance of 1 kg of urea-ammoniated straw per cow. The supplement was offered in a feed trough which also contained a salt lick. Initially cows had to be enticed to

Plate 1: Poly-Sack Sheet Spread out for ensiling

Plate 2: Plastic Sheet about to be Spread on Poly-sack Sheet

Plate 3: Chopping of rice straw with Cutlass.

Plate 4: Spraying of urea solution with watering Can and mixing rice straw with urea solution.

Plate 5: Tying of Silo.

Plate 6: Airing of urea-ammoniated rice straw after 7 days of ensiling.

eat urea-ammoniated rice straw by mixing it with sun-dried cassava peels and salt. By the end of the adjustment period (November-December). cows had become used to the urea-ammoniated rice straw and the use of these materials (Cassava peels and salt) was, therefore, discontinued. The supplement was available throughout the night until grazing time the next morning. On the other four farms, which served as controls, no supplement was offered. The animals on the control farms were, however, also supplied with salt lick. Feeding was from November 1998 to March 1999.

4.2.6.2. Parameters studied

Four cow and calf pairs were monitored on each farm. Measurements made included: initial weights of cow and calf, monthly weights of cow and calf for 3 months (January, February and March), initial body condition score of cow and monthly body condition score of cow also for 3 months. All weights were estimated using the Dalton weighband (Dalton Supplies Ltd, England). Although not calibrated for tropical animals, it is known that a relationship exists between heart girth and body weight. In the absence of a weighband designed for tropical animals, and in an on-farm situation, it was, therefore, decided to use the Dalton weighband to estimate weight gain. Body condition score of cows was estimated using the 9-point scale developed at the International Livestock Centre for Africa (Nicolson and Butterworth, 1986).

4.2.7. Experiment 2

A second experiment using six other farms was carried out simultaneously. On these farms even though parturient cows and their calves were the target group, the cows refused to eat the supplement. Their calves (older than 4 months), which were left to graze around the homestead while their dams went further to graze, started to eat the supplement, and therefore measurements were made on only the calves.

4.2.7.1. Feeding

On three of the farms the supplement was available to all calves all day long until they were penned up at night while on the other three farms, which served as controls, no supplement was available. Calves on all farms had access to salt licks. Feeding was done in a group with an allowance of 0.3kg of urea-ammoniated rice straw per calf per day. Six calves were monitored on each farm. Cassava peels and salt were fed during the adjustment phase (November-December) as in experiment 1.

4.2.7.2. Parameters studied

Measurements made were: initial weight of calves and monthly weights of calves for 3 months (January, February and March). Weighing was done with a spring balance until the calf was 40 kg or more when the Dalton weighband (Dalton Supplies Ltd, England) was used.

4.2.8. Chemical analysis

Samples of untreated rice straw and urea-ammoniated rice straw were analysed for nitrogen (AOAC, 1984) and detergent fibre (NDF, ADF, ADL; Goering and Van Soest, 1970). Organic matter was determined as the weight loss after ignition in a furnace at 550° C for 3 hours. Hemicellulose was calculated as the difference between NDF and ADF. Samples of urea-ammoniated rice straw prepared by farmers was also analysed and compared with that made by the researcher.

4.2.9. Statistical procedures

Data were analysed using the GLM procedure of the Statistical Analysis Systems Institute (SAS, 1987). The regression of monthly cow and calf weights on time (month) was used to estimate growth rate of cow and calf respectively in both experiments. The effects of treatment on cow and calf growth rate were examined for experiment 1 and for calf growth only in experiment 2. Analysis of variance for repeated measures was used to assess the change in cow body condition score with time (month) for experiment 1.

The statistical model used was as follows:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where Y_{ij} = cow or calf growth rate or body condition score of cow, T_i = effect of ith treatment and e_{ij} = a random error associated with each observation.

4.3. RESULTS.

Chemical analysis of untreated rice straw and urea-ammoniated rice straw are shown in table 4.1. The table compared the chemical composition of urea-ammoniated rice straw prepared by the researcher and the various farmers. The results, though not statistically tested, indicated that what farmers made themselves was comparable to what the researcher had made. The results also showed that generally urea-ammoniation increased the crude protein content in all treated rice straws by over 100%.

Table 4.2 shows the cow and calf growth rates for the first experiment as well as calf growth rate for the second experiment. In the first experiment, there was a significant difference ($P < 0.05$) between supplemented and unsupplemented cows in terms of weight loss. This was, however, not reflected in calf growth rates which were not significantly different ($P > 0.05$) even though calves from supplemented cows showed a better growth rate. In the second experiment, supplemented calves showed a significantly superior ($P < 0.05$) weight gain as compared to their unsupplemented counterparts.

Cow body condition scores for the experimental period are shown in Table 4.3. There was a significant interaction ($P < 0.05$) between month of observation and treatment. In the second month (February, 2000), supplemented cows showed a significantly superior ($P < 0.05$) body condition score as compared to their unsupplemented counterparts.

Table 4.1. Chemical composition of untreated rice straw and urea-ammoniated rice straw.

Parameter	Untreated Rice straw	UTS1	UTS2	UTS3	UTS4	UTS5
Dry matter (g Kg^{-1})	891	875	847	853	864	860
g Kg^{-1} DM						
Organic matter	818	797	830	835	816	820
NDF	775	727	705	730	729	725
ADF	584	626	570	618	622	612
ADL	67	57	79	67	62	66
Hemicellulose	191	101	135	112	107	113
Cellulose	517	469	491	551	560	546
Nitrogen x 6.25	44.9	92.9	99.3	90.0	91.4	93.4

UTS1 - Urea-ammoniated rice straw prepared by researcher

UTS2 - Urea-ammoniated rice straw prepared by farmer 1

UTS3 - Urea-ammoniated rice straw prepared by farmer 2

UTS4 - Urea-ammoniated rice straw prepared by farmer 3

UTS5 - Urea-ammoniated rice straw prepared by farmer 4

Table 4.2. LSMeans and standard errors for effect of treatment on cow and calf growth rate.

	GROWTH RATE (Kg day^{-1})		
	COW	CALF[1]	CALF[2]
TREATMENT			
Supplemented	-0.23 ± 0.009**a**	0.19 ± 0.300	0.20 ± 0.015**a**
Not supplemented	-0.34 ± 0.010**b**	0.16 ± 0.320	0.13 ± 0.011**b**

1 - Experiment 1
2 - Experiment 2
Means within an effect with common postscripts are not significantly different (P > 0.05).

Table 4.3 LSmeans of cow body condition score as affected by treatment and month.

	SUPPLEMENTED	NOT SUPPLEMENTED	SED	P VALUE
Min.	4.0	3.0		
Max.	5.0	6.0		
Mean	4.7	4.3	0.47	**NS**
Month				
January	5.0	5.3	0.50	**NS**
February	5.0	4.3	0.50	*
March	4.0	3.5	0.58	**NS**

SED - Standard error of the difference between two means.

4.4. DISCUSSION.

Increase in nitrogen/crude protein content is one of the advantages of urea-ammoniation of straw. The values obtained in this study were higher than the 84 g kg^{-1} obtained by Quarshie (1992) for rice straw treated with 6.5% urea, at 40% moisture, incubated for 14 days and aired for 24 hours. On the contrary, the values reported by Sottie (1994), for both untreated rice straw (5.74%) and urea-ammoniated rice straw, treated at 6.5% urea and 40% moisture (10.45%), were higher than those reported in this study. This study also used a rate of 6.5% urea and 40% moisture but had a 106.9% increase, relative to the crude protein level of the untreated material, as compared to 82.05% in the work of Sottie (1994). These differences may be accounted for by the different types of silos used and the length of the ensiling period as well as the initial quality of the straw which is affected by cultural practices used in growing rice. Sottie (1994) ensiled his material in a concrete silo for 21 days as compared to the poly sack silo used in this study with an ensiling period of 7 days.

In this study, the effect of the urea-ammoniated rice straw supplement on weight gain in cattle was a reduced weight loss in cows and increased weight gain in calves. Wharton *et al.*, (1967) reported similar results in an experiment where urea was fed as a supplement to cattle at Pong-Tamale, in Northern Ghana. They reported that animals receiving the urea supplement did not lose as much weight as control animals during the dry season.

In their studies with sheep, in which they fed rice straw supplemented with urea as a dry season supplement, Attah-Krah (1972) and Rhule (1973) also observed that at the end of the experimental period, test animals were healthier and had gained more weight on average, as compared to the control. A similar observation was made by Larsen and Amaning-Kwarteng (1976) when they fed urea-supplemented diets to cattle during the dry season. On the contrary, Oddoye *et al.*, (1996) reported no apparent advantage when calves, grazing natural pasture, were supplemented with chopped *Panicum maximum* straw and poultry manure. The authors concluded that the calves did not eat enough of the supplement for it to make a difference. Daily dry matter intake of *Panicum maximum* straw was 0.25 ± 0.03 kg. Dagbui (1993) also reported a 6.8% increase in milk yield for animals being supplemented with urea-ammoniated *Panicum maximum* straw as compared to those on natural grazing only. This difference was, however, not significant ($P > 0.05$). Daily dry matter intake of urea-ammoniated *Panicum maximum* per cow was 0.75 kg .

That the advantage in weight gain by supplemented cows was not passed onto their calves may be explained by the fact that the partitioning of nutrients in lactating animals is a very complex issue, controlled by other factors, and it is possible that under the severe dry season conditions maintenance of body weight, to ensure survival, was more important than increased milk production. It is also possible that under the prevailing conditions, increasing protein intake, as a result of supplementation with urea-ammoniated rice straw, increased the overall digestibility of the cow's feed and the cow's total dry matter intake. The increased energy intake would counterbalance energy release from tissue, thus reducing net tissue mobilisation or liveweight loss.

The increased weight gain in calves, fed the urea-ammoniated rice straw supplement may be partly due to the fact as compared to the cows in experiment one, these calves did not walk long distances in search of forage, neither were they producing milk; two factors which are known to have high energy demand. The urea-ammoniated rice straw would also form a relatively higher proportion of the calves diet as compared to that of the cows. In fact forage around the homestead during the dry season was virtually standing hay. As a result, on the farms where calves were fed the supplement, the calves took to it completely. There was usually a rush for it at feeding time.

Feed intake for the group of animals on urea-ammoniated rice straw supplement was not measured because farmers fed the supplement to all their paturient cows (experiment 1) and to all calves (experiment 2) as the dry season was very severe. This made the calculation of feed intake very difficult. This behaviour or attitude of farmers will have to be taken into account in future on-farm work. It was intended to provide about 1.5 kg of urea-ammoniated rice straw per animal per day. This figure was based on providing about a quarter of the potential dry matter intake of a 250kg weight cow (6.25 kg). It is likely that this figure was not attained for the reasons stated above. The low intake could therefore be one of the factors that led to a less than expected performance from supplemented animals.

Cameron (1970) reported that cattle did not readily accept supplemental feed. He attributed this to the fact that cattle were not used to supplementation and restricting them in pens to allow them to consume the supplement may also contribute. Oddoye *et al.*, (1996) also reported similar problems. In this study, however, apart from initial problems during the first four weeks, cows and calves ate the supplement readily. This may be partly attributed to the salt and cassava peels used to entice the animals, the severity of the dry season and also farmer interest in the project.

There was active farmer participation during the project and this is very important to ensure the success of any on-farm project. The experiment had aimed at teaching farmers to prepare urea-ammoniated rice straw by themselves. Farmers did participate and by the end of February could carry out the process unaided. During the process of teahing farmers it was realised that 4 wheatbran sacks, very well packed with chopped straw, gave a weight of about 25 kg (Plate 7). The farmers also provided an empty margaraine container which could contain approximately 0.55 kg of urea (Plate 8). Three measures of this container would

Plate 7: Empty wheatbran sacks being packed with chopped rice straw. Four of such sacks contain approximately 25 kg of chopped rice straw.

Plate 8: Margarine container used for weighing urea. Contains approximately 0.55 kg of urea.

therefore provide enough urea (1.65 kg) for ensiling 25 kg of straw. Farmers also had an aluminium container which they used to fetch water for domestic chores. It was also realised that this container, when filled to the brim with water, was about 22 litres.

At the end of the whole project, there was a wrap-up farmers forum at which farmers who had participated in the project shared their experiences with their colleagues. This was also a way of finding out if the farmers had learnt anything at all from the project. The farmers demonstrated how to chop rice straw and then prepare urea-ammoniated rice straw. It was evident during the forum that farmers viewed the success of the project in other terms. For example, the fact that calves on the farms where the supplement was being fed looked healthier and stronger, and were therefore more likely to survive the dry season was considered highly important. A premium is placed on calves, especially heifer calves, and calf survival means continued growth of the herd. During the study, cows which were not given the supplement, would often go down and would have to be sold. Animals would then be so thin that farmers got very little from the sale. This did not happen on farms were cows were fed the supplement.

4.5. CONCLUSION.

In conclusion this work has shown that:

1. A supplement of urea-ammoniated rice straw can help reduce dry season weight losses in cattle. Feeding of about 1.5

kg per animal per day is recommended.

2. The technology needed for urea-ammoniation of rice straw has been transferred to a few farmers in the Sege Area of the Dangbe East district of the Accra Plains.

3. Farmers participated actively in the project. Their ability to demonstrate the technique used in urea-ammoniation of rice straw to their colleagues during the final farmers forum was evidence of this.

4. Together with the farmers, alternative methods of weighing rice straw (the use of empty poly sacks) and urea (empty plastic margarine tin) for ensiling, have been developed.

The use of simple dry season feeding strategies, with emphasis on the use of locally available materials, and with the active participation of farmers may be a step in the right direction.

CHAPTER 5

RESPONSE OF CATTLE TO DRY SEASON SUPPLEMENTATION OF UREA-AMMONIATED RICE STRAW OR UNTREATED RICE STRAW FED WITH *GRIFFONIA SIMPLICIFOLIA* OR WHEATBRAN.

5.1. INTRODUCTION.

Supplementation of poor quality tropical forages with foliage from multi-purpose trees or leguminous browse has been shown to improve growth rates in animals (Jones, 1979; Van Eys *et al.*, 1986; Reed *et al.*, 1990; Siaw *et al.*, 1993; Richards *et al.*, 1994). The foliage of these trees maintain their feeding value well into the dry season and are a rich source of nitrogen, minerals and vitamin A precursors. Rose Innes and Mabey (1964) drew attention to the potential of local Ghanaian browse plants as supplementary feeds to grazing especially in the dry season. Sottie (1994) compared the feeding of various local browse plants with sodium hydroxide treated rice straw to the feeding of urea-ammoniated rice straw. He concluded that the feeding of browse was beneficial to the animals. Studies carried out in Ethiopia (Abule, 1994; Bonsi *et al.*, 1994, 1995; Umunna *et al.*, 1995), in which untreated teff straw was fed with various multi-purpose tree leaves, also gave good results. The survey (see chapter 3) had identified *Griffonia simplicifolia* and *Jasminum dichotomum* as common leguminous browse available in the Dangbe West and East districts, respectively. Wheatbran had also been identified as a common agro-industrial by-product.

This study was therefore to compare the feeding of urea-ammoniated rice straw with untreated rice straw supplemented with either *Griffonia simplicifolia* or wheatbran. The leguminous browse, *Jasminum dichotomum*, was left out of this study because it was difficult to obtain enough to supplement the animals.

5.2. SPECIFIC OBJECTIVE

To assess the effects of feeding urea-ammoniated rice straw or untreated rice straw fed with wheatbran or *Griffonia simplicifolia* on cow and calf growth rates, cow body condition score and milk yield.

5.3. MATERIALS AND METHODS

5.3.1. Location of cattle farms

The study was carried out between December, 1999 and March 2000 at the Animal Research Institute, Frafraha.

5.3.2. Cattle herd management

The Animal Research Institute's Sanga Herd is basically managed under a pastoral system. Herdsmen take the cattle out to graze. The herd leaves the station at about 9.00am and returns at 4.00pm. These grazing times are adhered to regardless of season. During the dry season, however, animals are usually fed a supplement of hay (*Bracchiaria spp*) on their return from grazing. Animals are milked once, in the morning, before they are taken out to graze. Dominant grass species in the grazing areas are *Panicum maximum*, *Sporobolus pyramidalis* and *Vertiveria fulvibarbis*. Thickets with

Griffonia simplicifolia are also present. Cattle are watered from The Animal Research Institute dam with the animals drinking once on their way to graze and once on their return. Natural mating is practiced with service bulls running freely with females. Control of ectoparasites is by use of pour-on (Bayticol, Bayer, Germany) and this is done once every two months.

5.3.3. Preparation of urea-ammoniated rice straw.

The method described in section 4.2.5. was used.

5.3.4. Chemical analysis

Samples of untreated rice straw, urea-ammoniated rice straw, *Griffonia simplicifolia* and wheatbran were analysed using the methods stated in section 4.2.8..

5.3.5. Parameters studied

A total of 16 cow (274.2 ± 6.49 kg) and calf (58.6 ± 3.57 kg) pairs were randomly allocated to four treatments as follows:

1. Natural grazing only (control) (Diet 1).
2. Natural grazing plus urea-ammoniated rice straw (Diet 2).
3. Natural grazing plus *Griffonia simplicifolia* and untreated rice straw (Diet 3).
4. Natural grazing plus wheatbran and untreated rice straw (Diet 4).

There were 4 cow and calf pairs per treatment. Cows on supplementary feeding treatments (Diets 2, 3 and 4) were fed individually in pens constructed for that purpose. Water and mineral lick were provided in each pen. Mineral lick was also provided for control cows. Wheatbran and *Griffonia simplicifolia* were first fed to cows on diets 3 and 4 respectively for 30 minutes, in the morning, after which they were removed and replaced with chopped untreated rice straw. The quantity of wheatbran and *Griffonia simplicifolia* consumed was noted. Untreated rice straw was available to the cows until grazing time and was also available on their return from grazing until feeding time the next morning. The amount of untreated rice straw that had been eaten was noted. Urea-ammoniated rice straw was fed at the same time as wheabran and *Griffonia simplicifolia* and was also available to cows until grazing time, and then on their return from grazing until feeding time the next morning. The amount of urea-ammoniated rice straw that had been eaten was also noted. There was an adjustment period of two weeks before measurements started. During this period the amounts of wheatbran and *Griffonia simplicifolia* eaten were averaged and fed to the animals during the measurement phase. Measurements made were: initial weights of cow and calf, monthly weights of cow and calf, initial body condition score of cow and monthly body condition score of cow, intake of supplements and milk yield. All liveweights were estimated using the Dalton weighband (Dalton Supplies Ltd, England). Body condition score of cows was estimated using the 9-point scale developed at the International Livestock Centre for Africa (Nicolson and Butterworth, 1986). Partial milk yield was measured once a week and averaged for the whole period. Mean daily dry matter intake of all supplements was averaged for the month. Parity was classified as low (Parity 1 and 2), medium (parity 3 and 4) or high (Parity 5 and above).

5.3.6. Statistical procedures

Data were analysed using the GLM procedure of the Statistical Analysis Systems Institute (SAS, 1987). The regression of monthly cow and calf weights on time (month) was used to estimate growth rate of cow and calf respectively. The effects of treatment and parity of cow, on cow and calf growth rate, intake of supplements and milk yield were examined. Analysis of variance for repeated measures was used to assess the change in body condition score and intake of supplements with time (month).

The statistical models used were as follows:

1. $Y_{ijk} = \mu + T_i + P_j + e_{ijk}$

Where Y_{ijk} = cow or calf growth rate, body condition score of cow, or milk yield; T_i = effect of *i*th treatment; P_j = effect of *j*th parity of cow and e_{ijk} = a random error associated with each observation.

2. $Y_{ijk} = \mu + T_i + e_{ijk}$

Where Y_{ijk} = intake of supplements or total dry matter intake; T_i = effect of *i*th treatment and e_{ijk} = a random error associated with each observation.

5.4. RESULTS.

Mean intakes (as fed) of wheatbran and *Griffonia simplicifolia*, during the adjustment phase were 452.0 ± 25.67 grams and 527.3 ±

5.78 grams, respectively.

5.4.1. Chemical composition of experimental feeds.

Proximate chemical composition of experimental feeds are shown in Table 5.1. Dry matter values ranged from 891 g kg^{-1} for untreated rice straw to 389 g kg^{-1} for *Griffonia simplicifolia*. Organic matter values ranged from 944 g kg^{-1} for wheatbran to 801 g kg^{-1} for urea-ammoniated rice straw. Neutral detergent fibre (NDF) was highest in rice straw (775 g kg^{-1}) and lowest in wheatbran (441 g kg^{-1}). Crude protein values (N x 6.25) were highest in *Griffonia simplicifolia* (178.2 g kg^{-1}) and lowest in rice straw (44.9 g kg^{-1}).

5.4.2. Total dry matter intake

Table 5.2 shows the LSmeans of daily total dry matter intake. The diet 4 had the highest daily dry matter intake and this was significantly different ($P < 0.05$) from the other diets. There was a significant effect of month of observation ($P < 0.01$) and also a significant diet X month of observation interaction ($P < 0.01$). In January, diet 3 was not significantly different ($P > 0.05$) from diet 2 but was significantly different ($P < 0.05$) from diet 4. Diets 2 and 4 were not significantly different ($P > 0.05$) from each other. In February, the diet 4 was significantly ($P < 0.05$) different from the other two. The situation in March was similar to that in January. There was a general increase in dry matter intake from January to March for all diets.

Table 5.1. Chemical composition of experimental feeds

Parameter	Untreated Rice straw	Urea-ammoniated rice straw	*Griffonia simplicifolia*	Wheat bran
Dry matter (g Kg^{-1})	891	873	389	843
g Kg^{-1} DM				
Organic matter	818	801	888	944
NDF	775	721	534	441
ADF	584	624	330	125
ADL	67	58	149	37
Hemicellulose	191	97	204	316
Cellulose	403	445	195	89
Nitrogen x 6.25	44.9	92.5	178.2	150.3

Table 5.2 LSmeans of daily total dry matter intake (TDMI) (grams) as affected by diet and month.

	DIETS					
	DIET 1	DIET 2	DIET 3	DIET 4	SED	P-VALUE
MIN.	-	61.1	161.2	408.3		
MAX.	-	871.1	467.7	871.5		
MEAN	-	460.3**a**	319.4**a**	775.4**b**	312.03	*
Monthly effect						
JAN.	-	405.4**ab**	247.1**a**	646.2**b**	314.59	*
FEB.	-	474.1**a**	326.3**a**	857.8**b**	284.97	*
MAR.	-	542.3**ab**	450.1**a**	869.2**b**	290.30	*

Means within a row with common postscripts are not significantly different (P > 0.05).

SED - Standard error of the difference between two means.

Nb: Animals on diet 1 did not receive any supplement (control) and so there are no values.

5.4.3. Dry matter intake of untreated rice straw

Dry matter intakes of untreated rice straw as affected by diet are shown in Table 5.3. Dry matter intake of untreated rice straw was significantly ($P < 0.001$) higher in diet 4 as compared to diet 3 in all the months. There was a general increase in dry matter intake of untreated rice straw from January to March irrespective of diet.

5.4.4. Cow and calf growth rates

Table 5.4 shows cow and calf growth rates. There were no significant differences ($P > 0.05$) between treatments for either cow or calf growth rate. Generally all cows lost weight during the period. Cows on diet 4 (-0.19)showed the least weight loss compared to diets 3 (-0.31), 2 (-0.30), and 1 (-0.31). With the calves, again those on diet 4 proved superior (0.23), followed closely by diet 2 (0.20), diet 1 (0.15) and diet 3 (0.14) following in that order. The effects of parity were also not significant ($P > 0.05$). For both cow and calf growth rates, however, cows with high parity had the worst performance (-0.32 and 0.15, respectively) with cows of low parity having the best performance (-0.22 and 0.19, respectively).

5.4.5. Cow body condition score

Cow body condition scores as affected by treatment are shown in Table 5.5. There was a significant effect of month of observation ($P < 0.05$) but no significant month X diet interaction ($P > 0.05$). By the end of the experiment in March, cows on diet 1 had a

Table 5.3 LSmeans of daily dry matter intake of untreated rice straw (grams) as affected by feeding wheatbran of Griffonia.

	DIETS					
	DIET 1	DIET 2	DIET 3	DIET 4	SED	P-VALUE
MIN.	-	-	0.0	77.1		
MAX.	-	-	273.2	450.0		
MEAN	-	-	132.4a	361.8b	16.28	***
Monthly effect						
JAN.	-	-	75.5a	244.3b	47.71	*
FEB.	-	-	131.8a	436.3b	35.19	***
MAR.	-	-	255.5a	447.6b	17.57	***

Means within a row with common postscripts are not significantly different (P > 0.05).

SED - Standard error of the difference between two means.

NB: Diets 1 and 2 did not receive the supplement of untreated rice straw and so there are no values for them.

Table 5.4. LSMeans and standard errors for effect of treatment on cow and calf growth rate.

	GROWTH RATE (Kg day^{-1})	
	COW	CALF
DIETS		
DIET 1	(4) -0.31 ± 0.056	0.15 ± 0.094
DIET 2	(4) -0.30 ± 0.052	0.20 ± 0.050
DIET 3	(4) -0.31 ± 0.052	0.14 ± 0.041
DIET 4	(4) -0.19 ± 0.058	0.23 ± 0.041
PARITY		
LOW	(3) -0.22 ± 0.061	0.19 ± 0.053
MEDIUM	(8) -0.29 ± 0.038	0.20 ± 0.029
HIGH	(5) -0.32 ± 0.050	0.15 ± 0.043

Number of animals in parentheses

significantly lower ($p < 0.05$) body condition score than those on diets 3 and 4 but was not significantly different ($P > 0.05$) from the cows on diet 2. All the supplemented diets were also not significantly different ($P > 0.05$) from each other. Cow body condition score was not affected significantly ($P > 0.05$) by parity (Table 5.6).

5.4.6. Partial milk yield

Partial milk yields from the various diets were not significantly ($P > 0.05$) different (Table 5.7). Parity also had no effect on partial milk yield ($P > 0.05$).

5.5. Discussion.

Increase in nitrogen/crude protein content as a result of urea-ammoniation was similar to that reported in the on-farm study (See 4.4). Generally it was not as dry on the Research Station as it was the previous year when the on-farm study was conducted and this may in part account for the fact that there were no significant differences between treatments in terms of cow and calf growth rates. The loss of condition of cows as the dry season progressed is similar to that observed during the on-farm experiment. Okantah *et al.* (1996, 1999) had earlier observed a similar phenomenon. Cows often had to draw on their body reserves to be able to producce enough milk to feed the calf and as a result lost condition. The feeding of supplements appeared to help maintain the body condition of the cows.

Table 5.5 LSmeans of cow body condition score as affected by diet and month.

	DIETS					
	DIET 1	DIET 2	DIET 3	DIET 4	SED	P-VALUE
MIN.	3.0	3.0	3.0	3.0		
MAX.	6.0	6.0	6.0	6.0		
MEAN	4.3	4.7	4.6	4.5	0.46	**NS**
Condition score						
JAN.	4.9	5.3	5.3	4.5	0.71	**NS**
FEB.	4.3	4.6	4.1	4.0	0.51	**NS**
MAR.	3.0**a**	3.7**ab**	3.9**b**	3.9**b**	0.48	*

Means within a row with common postscripts are not significantly different (P > 0.05).

SED - Standard error of the difference between two means.

Table 5.6 LSmeans of Cow body condition score as affected by Parity and month.

	PARITY				
	LOW	MEDIUM	HIGH	SED	P-VALUE
MIN.	3.0	3.0	3.0		
MAX.	6.0	6.0	5.0		
MEAN	4.3	4.6	4.4	0.51	**NS**
Monthly effect					
JAN.	4.6	5.3	4.9	0.76	**NS**
FEB.	4.2	4.3	4.0	0.561	**NS**
MAR.	3.5	3.9	3.1	0.53	**NS**

SED - Standard error of the difference between two means

Table 5.7 LSmeans (± standard error) of daily partial milk yield as affected by diet and parity.

	Milk yield (kg)
DIETS	
DIET 1	0.64 ± 0.029
DIET 2	0.74 ± 0.027
DIET 3	0.70 ± 0.027
DIET 4	0.69 ± 0.029
Parity	
LOW	0.67 ± 0.026
MEDIUM	0.70 ± 0.029
HIGH	0.71 ± 0.021

The lack of significant difference in growth rates and milk yield between the various treatments may also be explained by the results for total dry matter intake and intake of untreated rice straw. Animals were not used to the supplements and even though an adjustment period of two weeks was allowed before measurements were started, intakes of supplements were generally low in the first month. As the dry season progressed, however, and natural grazing became more limiting, cows ate more of the supplements. Cameron (1970) reported that cattle did not readily accept supplemental feed, in Ghana, and attributed this to the fact that cattle were not used to supplementation and restricting them in pens to allow them to consume the supplement may also contribute. In a dry season feeding trial, Oddoye *et al.* (1996) also reported that calves which had previous exposure to supplementation consumed almost twice as much supplement as those which had no previous exposure. During the on-farm experiment it did not take animals so long to adapt to their feed and this may be attributed to the severe nature of the dry season in that area. There was very little grazing available and animals therefore took to the supplement readily.

Based on a tropical livestock unit of 250Kg, it was estimated that a cow would eat at least 2.5% of its body weight which is equivalent to 6.25 kg of dry matter. The experiment aimed to provide about 25% of this (1.56 kg DM) in the form of supplements. In reality, daily total dry matter intake formed 5.1% for the griffonia supplemented diet, 7.4% for the urea-ammoniated rice straw diet and 12.4% in the wheatbran supplemented diet. Supplement intakes were therefore not high enough to cause the expected increase in performance.

There is often a negative relationship between water content of roughage and voluntary intake of the roughage. With sheep the addition of 8 litres of water into the rumen had no effect on roughage intake, while the inclusion of only 2 litres in a balloon depressed intake by 0.27 (Davies, 1962); water in stems and leaves acts more like water in balloons than free water. The high moisture content of *Griffonia simplicifolia* may therefore have contributed to its low dry matter intake. It may be advisable to wilt leguminous forages for a day before feeding to increase dry matter intake. It has been stated, however, that chemical composition and degradation of foliages are normally altered due to drying. Bamualin *et al.* (1984) for example, observed that fresh leucaena was highly degraded in the rumen and resulted in less substitution and less by-pass protein when compared to the dry material. On the contrary, Bonsi *et al.* (1995) observed a high substitution rate for fresh leaucaena, when fed as a supplement to teff straw, and suggested that bulkiness compared to degradability may be the first limiting factor in the control of intake of low quality roughages supplemented with tree leaves. There may therefore be the need to study the wilting of foliages before feeding further. The less bulky wheatbran may have caused minimal substitution of untreated rice straw as compared to *Griffonia simplicifolia* and may explain the higher untreated rice straw intake in the wheatbran supplemented diet.

6.6. Conclusion.

This study established the following:

1. The feeding of untreated rice straw with either *Griffonia simplicifolia* or wheatbran is comparable to urea-ammoniated rice straw as a dry season feed supplement for cattle.
2. Intake of supplements was generally low and may be the cause of a less than expected improvement in performance.
3. Cattle took a long time to adjust to the supplements and there is the need to train cattle, probably after weaning, so that they get used to being fed a supplement.

To ensure a dry matter intake, high enough to cause an appreciable change in production, the way forward may be the use of both leguminous browse and agro-industrial byproduct as they would appear to complement each other.

CHAPTER 6

In sacco degradability of grass hay and rumen characteristics in sheep fed urea ammoniated rice straw or untreated (but supplemented) rice straw.

6.1. Introduction/Justification

The use of the nylon bag in the characterisation of feeds is now a well known technology. It is relatively simple and easy to use in that all it requires are fistulated animals, nylon bags , a scale and an oven for drying the bags. The nylon bag can be used in different ways to asses quality of forages and their effects on the rumen environment. A mixture or combination of feeds may have a nutritional value different from the sum of the values of its components. Such associative effects are difficult to quantify in most feed evaluation systems. Incubation in the nylon bag thus provides a powerful tool for studying these effects (Orskov and Ryle, 1990). Incubation in the nylon bag can be employed to study optimum combinations of feeding, feeding regimes and degree of processing concentrates to give maximum utilisation of mixed feeds (Orskov and Ryle, 1990). This study was therefore designed to compare rumen characteristics when sheep were fed urea ammoniated rice straw or untreated rice straw supplemented with wheat bran, *Griffonia simplicifolia* or *Jasminum dichotomum*. This study was also to provide extra information to help explain the observations in the experiments reported in chapters 4 and 5. The browse plant, *Jasminum dichotomum*, has been incluced to represent browse plant common in the Dangne East district.

6.2. Specific objective

1. To determine the effects of feeding urea ammoniated rice straw or untreated rice straw supplemented with either wheat bran, *Griffonia simplicifolia* or *Jasminum dichotomum* on degradability of dry matter (DM), nitrogen (N) and neutral detergent fibre (NDF) of grass hay incubated in the rumen of sheep.

2. To determine the effects of the various diets on rumen ammonia nitrogen, rumen pH and nitrogen retention in sheep.

3. To help adduce reasons for some of the findings of the first two feeding trials (Chapter 4 and 5).

6.3. Materials and methods

6.3.1. Location

The study was carried out at the Agricultural Research Station (ARS), Legon.

6.3.2. Animals

Three (3) rumen-cannulated wethers (Mean liveweight 23.5 ± 1.78 Kg) were used.

6.3.3. Experimental design

The experiment was designed as a balanced complete block with diets as treatments.

6.3.4. Diets

Diets fed were:

1. Urea ammoniated rice straw (*ad lib.*) (see 4.2.5.) (Diet 1)
2. Chopped untreated rice straw (*ad lib.*) supplemented *Griffonia simplicifolia* (Diet 2).
3. Chopped untreated rice straw (*ad lib.*) supplemented with *Jasminum dichotomum* (Diet 3).
4. Chopped untreated rice straw (*ad lib.*) supplemented with wheatbran (Diet 4).

6.3.5. Methodology

Management of animals

All sheep were initially dewormed with Albendazole(Dapharma, Raamsdonskever, Holland). A period of 14 days was allowed for sheep to adjust to their diets before measurements were made. Sheep were fed at 7.00am every morning. Feeding was done based on the methods described in chapter 5 (see 5.3.4.) but this time supplements were on offer for 1 hour before untreated rice straw was fed. The very large woody twigs were removed from the foliage but soft green twigs (about 2-3 mm thick) were included. The experiment ran for 4 months and diets were randomly allocated so that by the end of the fourth month each animal had been fed each diet once. During the adjustment period the amount of supplement being eaten were averaged and fed to each animal during the measurement phase.

Collection of rumen fluid

After the 14 day adjustment period rumen fluid collection was made on day 15. Rumen fluid was collected at 3, 6, 9, 12 and 24 hours after feeding. Rumen fluid was collected using a stomach tube with the aid of a vacuum pump. The fluid was quickly filtered through 3 layers of cheese cloth, stirred and the pH immediately read with a pH meter (Corning 250). The rumen fluid was then acidified with a few drops of concentrated sulphuric acid and stored in a freezer (-5 °C) for subsequent analysis of rumen ammonia.

Degradability studies

Degradability studies started on day 16. Bracchiara hay was ground (2mm screen) and degradabilities of DM, N and NDF were studied. About 2.5 g of sample was weighed into nylon bags(8cm x 12cm; pore size= 25μ). Two bags per animal per each incubation time were used. A maximum of six bags at a time were tied to a drop line consisting of nylon cord and weighted with a 20 g steel bolt at one end. One drop line was incubated at a time in the rumen of each sheep. Samples were incubated for 0, 3, 6, 12, 24, 48, 72, 96 and 120 hours. Zero hour bags were not incubated but were soaked for an hour in water and then washed. On removal of bags from the rumen they were washed repeatedly, until the water in the washing bowl was clear. Bags were then dried in a forced draught oven at 50°C for 48 hours, cooled in a dessicator and weighed to determine DM disappearance. Contents of the bags were also analysed for nitrogen (AOAC, 1984) and NDF (Goering and Van

Soest, 1970).

Collection of faeces and urine

Total collection of faeces and urine for the determination of nitrogen retention started on day 23. Measurements were made for a 5 day period. Sheep were fitted with a harness to facilitate the collection of faeces. Urine was collected into a receptacle containing 40 ml of 25% sulphuric acid. Total weight of faeces and total weight of urine were noted. A 10% aliquot of the daily collection of faeces and urine were stored in the freezer (-5°C) pending further analysis.

Chemical analysis

Nylon bag residues and feeds were analysed using the methods stated in section 4.2.8.. Rumen fluid was analysed for ammonia-N by a modified Kjeldahl method (AOAC, 1984) Faecal and Urine samples were also analysed for nitrogen by the standard method (AOAC, 1984). Feeds were analysed for tannins using the method described by Hagerman and Butler (1978). All analysis were done in duplicate.

6.3.6. Statistical analysis

Treatment effects on degradability of Dry matter (DM), Neutral detergent fibre (NDF) and Nitrogen (N) and nitrogen retention were assessed using the General Linear Model (GLM) in SAS (SAS, 1987). Degradation constants of DM, OM and NDF were estimated by fitting the exponential model of Orskov and McDonald (1979) to data using the non-linear (NLIN) procedure in SAS (SAS, 1987):

$P = a + b\ (1 - e^{-ct})$; where P is disappearance of DM, N or NDF at time t, a is the zero time intercept, b is the potentially slowly degradable fraction degraded at a rate constant c. The Lag time (TL) was calculated as: $TL = \{(-1/c)\ln[1 - ((w - a)/b)]\}$; where w is the washing loss. The resulting constants were used to estimate the potential degradability, PD following the equation of Orskov and McDonald (1979):

$PD = a + b$

The differences between treatments with respect to rumen ammonia concentration and pH were analysed using repeated measures analyses (Winer, 1971; Statistical Analysis Systems Institute Inc., 1987).

The statistical model used was as follows:

1. $Y_{ijk} = \mu + D_i + B_j + e_{ijk}$

Where Y_{ijk} = Degradability constants of DM, NDF or N, rumen pH or ammonia nitrogen or nitrogen retention; D_i = effect of ith Diet; A_j = effect of jth block and e_{ijk} = a random error associated with each observation.

6.4. RESULTS.

Mean intakes (as fed) of *Griffonia simplicifolia*, *Jasminum dichotomum* and wheatbran during the adjustment phase were 265.0 ± 20.48 grams, 257.5 ± 15.87 grams and 241.8 ± 11.57, respectively What each individual sheep consumed, on average, during the adjustment phase was fed to it during the measurement phase

6.4.1. Chemical composition of experimental feeds.

Chemical composition of experimental feeds are shown in Table 6.1. Dry matter values ranged from 891 g kg^{-1} for rice straw to 386 g kg^{-1} for *Jasminum dichotomum*. Organic matter values ranged from 944 g kg^{-1} for wheatbran to 799 g kg^{-1} for urea-ammoniated rice straw. Neutral detergent fibre (NDF) was highest in rice straw (775 g kg^{-1}) and lowest in wheatbran (441 g kg^{-1}). Acid detergent fibre (ADF) was highest in urea-ammoniated rice straw (626 g kg^{-1}) and lowest in wheatbran (125 g kg^{-1}). Hemicellulose ranged from 100 g kg^{-1} in urea-ammoniated rice straw to 316 g kg^{-1} in wheatbran. Cellulose ranged from 89 g kg^{-1} in wheatbran to 444 g kg^{-1} in urea-ammoniated rice straw. Acid detergent lignin (ADL) ranged from 37 g kg^{-1} in wheatbran to 149 g kg^{-1} in *Griffonia simplicifolia*. Crude protein values were highest in *Griffonia simplicifolia* (178.2 g kg^{-1}) and lowest in rice straw (44.9 g kg^{-1}). Some tannin was detected in *Jasminum dichotomum* (2.6 g kg^{-1}).

6.4.2. Rumen characteristics

6.4.2.1. Rumen pH

All mean pH values were 6.81 or higher (Table 6.2). Diet had a significant effect ($P < 0.01$) on rumen pH. Time X diet interaction was significant for rumen pH ($P < 0.001$). There was no significant effect ($P > 0.05$) of diet 3 hours after feeding. By 6 hours after feeding and up to 24 hours after feeding, however, differences began to appear as shown in Table 6.2. With

Table 6.1. Chemical composition of experimental feeds

Parameter	Untreated Rice straw	Urea-ammoniated rice straw	*Griffonia simplicifolia*	*Jasminum dichotomum*	Wheat bran
Dry matter (g Kg^{-1})	891	872	387	386	843
g Kg^{-1} DM					
Organic matter	818	799	885	895	944
NDF	775	726	560	464	441
ADF	584	626	332	344	125
ADL	67	53	143	133	37
Hemicellulose	191	100	228	120	316
Cellulose	403	444	190	159	89
Tannins	-	-	-	2.6	-
Crude Protein	44.9	92.9	176.8	139.7	150.3

Table 6.2
Rumen characteristics in sheep fed urea-ammoniated rice straw (USTR) or untreated rice straw supplemented with either wheatbran (WBRAN), *Griffonia simplicifolia* (GRIFF) or *Jasminum dichotomum* (JAS).

	USTR	GRIFF	JAS	WBRAN	SED (*n=3*)	p-value
Rumen characteristics						
pH						
Minimum	7.02	6.90	6.27	6.23		
Maximum	7.59	7.63	7.30	7.60		
Mean	7.25a	7.21a	6.81b	6.81b	0.147	**
Time (hrs)						
3	7.09	7.31	7.03	7.10	0.336	NS
6	7.25a	7.24a	7.13a	6.62b	0.213	*
9	7.47c	7.08a	6.79b	6.46d	0.170	**
12	7.08a	6.93a	6.67b	6.41c	0.117	**
24	7.21a	7.48a	6.43b	7.45a	0.269	**
Ammonia (mg N l^{-1})						
Minimum	69.70	33.90	101.65	33.90		
Maximum	313.90	289.20	206.69	435.90		
Mean	178.91	119.84	131.64	223.07	107.040	NS
Time (hrs)						
3	278.15	254.80	173.78	294.60	137.938	NS
6	246.73	119.20	145.04	255.37	125.640	NS
9	221.26	93.83	115.78	221.53	125.865	NS
12	147.62	79.10	111.23	199.77	122.878	NS
24	105.95	52.27	112.36	144.07	75.363	NS

SED, standard error of difference;
NS, not significantly different, $P > 0.05$;
$P < 0.05$ *, $P < 0.01$ **, $P < 0.001$ ***;
Means in the same row with common postscripts are not significantly different

the exception of the diet 3, all diets recorded the lowest pH 12 hours after feeding (Diet 1 - 7.08, Diet 2 - 6.93, Diet 4 - 6.41). The pH subsequently rose to the highest value 24 hours after feeding. In diet 3 the pH continued to drop with the lowest value being recorded 24 hours after feeding (6.43). At 6 hours after feeding the pH of diet 4 was significantly different ($P < 0.05$) from the other diets. At 9 hours after feeding all the diets were significantly different from each other ($P < 0.01$). Diets 1 and 2 were not significantly different from each other ($P > 0.05$) at 12 hours post feeding, but were significantly different from the other two diets ($P < 0.01$). Diets 3 and 4 were also significantly different from each other ($P < 0.01$). Twenty-four hours after feeding diet 3 was significantly different ($P < 0.01$) from the other diets.

6.4.2.2. Rumen ammonia nitrogen

Mean rumen ammonia nitrogen (mg l^{-1}) ranged from 119.84 (diet 2) to 223.07 (diet 4). Diet had no effect ($P > 0.05$) on rumen ammonia nitrogen concentration. Time X diet interaction was also not significant ($P > 0.05$). Rumen ammonia nitrogen concentration peaked 3 hours after feeding in all diets (diet 1 - 278.15, diet 2 - 254.80, diet 3 - 173.78, diet 4 - 294.60). With the exception of the diet 3, the values then dropped steadily reaching a minimum value 24 hours after feeding (diet 1 - 105.95, diet 2 - 52.27, diet 4 - 144.07) In diet 3, the lowest value occured at 12 hours after feeding (111.23) with the value rising slightly to 112.36 at 24 hours post feeding. The drop in rumen ammonia concentration was more rapid in diet 2 as compared with the others.

6.4.3. Degradability studies

6.4.3.1. Degradability of dry matter (DDM)

Degradability of dry matter (Table 6.3) was not significantly different ($P > 0.05$) among diets from 3 to 12 hrs. At 24 hours DDM of diet 1 was significantly lower ($P < 0.05$) than the other diets. This trend disappeared at the 48 hour stage ($P > 0.05$) but was again noticed from the 72 hr stage till 120 hrs of incubation ($P < 0.001$). The potentially degradable fraction (*b*) as well as potential degrdability (*PD*) were affected by diet ($P < 0.05$). All other constants were not significantly different ($P > 0.05$). The estimated time lag (*TL*) shows that no degradation took place until about 4 hours after feeding. Although not significantly different ($P > 0.05$) from the other diets, the time lag in diet 1 was at least an hour longer as compared to the other diets.

6.4.3.2. Degradability of nitrogen (DN)

The degradability of nitrogen (Table 6.4) followed a slightly different trend as compared to the degradability of dry matter. No differences between diets were apparent ($P > 0.05$) up to 6 hours. At 12 and 24 hours after incubation the DN of diets 1 and 3 were significantly lower ($P < 0.05$) than the DN of diets 2 and 4. At 48 and 72 hours after incubation the DN of diets 2 and 4 were similar but significantly lower than diet 3 ($P < 0.001$) and significantly higher than diet 1 ($P < 0.001$) At 96 hours after incubation ($P < 0.01$) and at 120 hours after incubation (P <

Table 6.3.
Rumen degradation of dry matter of Brachiara hay observed in sheep fed urea-ammoniated rice straw (USTR) or untreated rice straw supplemented with either *Griffonia simplicifolia* (GRIFF), *Jasminum dichotomum* (JAS) or wheatbran (WBRAN).

Parameter[a]	USTR	GRIFF	JAS	WBRAN	SED (*n=3*)	P-value
Dry matter disappearance $(g\ kg^{-1})$						
Incubtion time (h)						
Wash value = 115						
3	113	121	114	120	10.5	NS
6	105	131	142	129	26.8	NS
12	214	148	261	231	96.5	NS
24	242b	308a	334a	303a	74.7	*
48	448	499	521	490	75.4	NS
72	451c	557a	613b	569a	45.6	***
96	505b	622a	633a	606a	32.7	***
120	512b	643a	634a	639a	40.2	***
Degradation constants $(g\ kg^{-1})$						
a	53	56	48	57	26.6	NS
b	488b	669a	628a	603ab	75.9	*
PD $(a + b)$	541b	725a	676ab	660ab	92.8	*
c (h^{-1})	0.0256	0.0224	0.0313	0.0266	0.01295	NS
TL (h)	5.4	4.2	3.8	3.9	1.78	NS

[a] *a*, intercept; *b*, potentially degradable component; *c*, rate of degradation of potentially degradable component; *PD*, potential degradability; *TL*, time lag;
SED, standard error of the difference.
NS, not significantly different, $P > 0.05$;
$P < 0.05$ *, $P < 0.01$ **, $P < 0.001$ ***;
Means in the same row with common postscripts are not significantly different.

Table 6.4.
Rumen degradation of nitrogen of Brachiara hay observed in sheep fed urea-ammoniated rice straw (USTR) or untreated rice straw supplemented with either *Griffonia simplicifolia* (GRIFF), *Jasminum dichotomum* (JAS) or wheatbran (WBRAN).

Parameter[a]	USTR	GRIFF	JAS	WBRAN	SED (*n*=3)	P-value
Nitrogen disappearance ($g\ kg^{-1}$)						
Incubtion time (h)						
Wash value = 231						
3	227	254	230	231	26.1	**NS**
6	224	257	231	231	41.9	**NS**
12	221**b**	260**a**	231**b**	317**a**	57.7	*
24	249**b**	383**a**	266**b**	333**a**	88.3	*
48	380**c**	491**a**	592**b**	441**a**	45.6	***
72	419**c**	516**a**	651**b**	573**a**	69.1	***
96	502**b**	648**a**	677**a**	667**a**	75.7	**
120	508**b**	648**a**	695**a**	683**a**	40.2	***
Degradation constants ($g\ kg^{-1}$)						
a	195	201	150	205	22.8	**NS**
b	572	607	671	718	176.7	**NS**
PD (*a* + *b*)	767	808	821	923	179.5	**NS**
c (h^{-1})	0.0062	0.0154	0.0168	0.0099	0.00646	**NS**
TL (h)	9.2	3.6	7.8	4.1	2.76	**NS**

[a] *a*, intercept; *b*, potentially degradable component; *c*, rate of degradation of potentially degradable component; *PD*, potential degradability; *TL*, time lag;
SED, standard error of the difference.
NS, not significantly different, $P > 0.05$;
$P < 0.05$ *, $P < 0.01$ **, $P < 0.001$ ***;
Means in the same row with common postscripts are not significantly different.

0.001), the DN of diet 1 was significantly lower than the other diets. Degradability of nitrogen did not begin until nearly 4 hours after incubation. Although there were no significant differences (P > 0.05) the lag time (*TL*) was almost twice as long in Diets 1 and 3 as compared to diets 2 and 4. All constants (Table 6.4) were not significantly different (P > 0.05).

6.4.3.3. Degradability of neutral detergent fibre (DNDF)

Values for time lag indicate that NDF degradation started almost immediately in diets 3 and 4 (Table 6.5). It took about 3 hours for NDF degradation to begin in the other diets. This is reflected in the significant differences (P < 0.01) between diets 3 and 4 and the others at 3 and 6 hours after the start of incubation. By 12 hours after incubation there was a slight change in the rankings as the DNDF for diet 1 was then not significantly different (P > 0.05) from diets 3 and 4. No significant differences (P > 0.05) were observed at 24 and 48 hours after incubation. At 72, 96 and 120 hours after incubation DNDF for diet 1 was significantly lower (P < 0.05) than the other diets. Neutral detergent fibre has no soluble component (wash value=0) and coupled with lag time this caused a negative value for the rapidly soluble fraction (*a*) in diets 1 and 2 (Table 6.5). Values for the rapidly soluble fraction (*a*) in diets 1 and 2 were therefore significantly different (P < 0.001) from the other diets. There was also a significant difference (P < 0.05) in the potentially degradable fraction (*b*) among the diets. Diet 2 was significantly higher (P < 0.05) than diets 1 and 4 but not

Table 6.5.
Rumen degradation of neutral detergent fibre (NDF) of Brachiara hay observed in sheep fed urea-ammoniated rice straw (USTR) or untreated rice straw supplemented with either *Griffonia simplicifolia* (GRIFF), *Jasminum dichotomum* (JAS) or wheatbran (WBRAN).

Parameter[a]	USTR	GRIFF	JAS	WBRAN	SED (*n*=3)	P-value
NDF disappearance (g kg⁻¹)						
Incubtion time (h)						
3	0a	11a	63b	63b	16.0	**
6	57a	41a	127b	141b	23.0	**
12	156ab	114a	221b	229b	58.9	*
24	192	301	323	309	77 5	NS
48	400	464	520	472	93.3	NS
72	433b	546a	602a	561a	54.3	*
96	479b	595a	623a	602a	55.6	*
120	500b	643a	632a	635a	61.6	*
Degradation constants (g kg^{-1})						
a	-41a	-61a	6b	40c	13.9	***
b	572b	731a	656ab	622b	55.0	*
PD (a + b)	531	670	662	662	60.9	NS
c (h^{-1})	0.0283	0.0275	0.0318	0.0254	0.01106	NS
TL (h)	2.5a	3.2a	-0.4b	-2.5c	0.65	***

[a] *a*, intercept; *b*, potentially degradable component; *c*, rate of degradation of potentially degradable component; *PD*, potential degradability; *TL*, time lag;
SED, standard error of the difference.
NS, not significantly different, $P > 0.05$;
$P < 0.05$ *, $P < 0.01$ **, $P < 0.001$ ***;
Means in the same row with common postscripts are not significantly different.

significantly different ($P > 0.05$) from diet 3.

6.4.4. Nitrogen utilization

Nitrogen intake was highest in wheatbran (Table 6.6). Differences in nitrogen intake between diets were not significantly different ($P > 0.05$). Faecal and urinary nitrogen outputs were not significantly different ($P > 0.05$). Urinary nitrogen was lowest in diet 3 and highest in diet 2, while faecal nitrogen was lowest in diet 2 and highest in diet 1. There were no significant differences ($P > 0.05$) among diets in nitrogen balance or nitrogen balance per kilogram nitrogen intake. Nitrogen balance was highest in diet 3 followed by diets 2, 4 and 1 in that order. Nitrogen balance per kilogram nitrogen intake followed a similar pattern.

6.5. DISCUSSION

6.5.1. Chemical composition.

Wheatbran, rice straw and urea-ammoniated rice straw were air-dry materials and therefore had high DM values (843 - 891 g kg^{-1}). In contrast, the browses were fed fresh and had a dry matter range of 386 - 389 g kg^{-1}. Rose-Innes and Mabey (1964) reported a range of 308 -471 g kg^{-1} DM for a number of browse species in Ghana. Sottie (1997) also reported a range of 338 g kg^{-1} - 403 g kg^{-1} DM for eight browse species in Ghana. The DM values obtained for the browse species in this experiment fell within the range reported in both studies.

Table 6.6.
Nitrogen utilisation in sheep fed urea-ammoniated rice straw (USTR) or untreated rice straw supplemented with either *Griffonia simplicifolia* (GRIFF), *Jasminum dichotomum* (JAS) or wheatbran (WBRAN).

Parameter	USTR	GRIFF	JAS	WBRAN	SED	P-value
				(*n=3*)		
Nitrogen utilisation						
N intake (g day^{-1})	8.31	8.53	8.49	10.01	1.800	**NS**
Faecal N (g day^{-1})	3.87	2.18	2.96	3.40	0.938	**NS**
Urinary N (g day^{-1})	1.22	2.59	0.43	2.38	2.049	**NS**
N balance (g day^{-1})	3.21	3.76	5.09	4.23	1.915	**NS**
N balance (g Kg^{-1} N intake)	386	441	599	422	203.7	**NS**

SED, standard error of the difference.
NS, not significantly different, $P > 0.05$;

Organic matter values were fairly constant although lower for rice straw and urea-ammoniated rice straw. This is a reflection of the high ash content (mostly silica) of rice straw.

Browses (*Griffonia simplicifolia*, *Jasminum dichotomum*) and wheatbran had fairly high crude protein content. The value obtained for *Griffonia simplicifolia* (178.2 g kg^{-1}) in this study was a little higher than the mean value of 149.9 g kg^{-1} (dry season - 168.5 g kg^{-1}, wet season - 131.3 g kg^{-1}) reported by Sottie (1994). This difference could be attributed to the different stages of growth of the plant as at the time of cutting, and also to the different areas from where the material was harvested. The crude protein content of urea-ammoniated rice straw was more than twice the value for untreated rice straw. Increase in nitrogen/crude protein content is one of the advantages of urea-ammoniation of straw. The values obtained in this study were higher than the 84 g kg^{-1} obtained by Quarshie (1993) for rice straw treated with 6.5% urea, at 40% moisture, incubated for 14 days and aired for 24 hours. On the contrary, the values reported by Sottie (1994), for both rice straw (5.74%) and urea-ammoniated rice straw (10.45%) were higher than those reported in this study.

Although browse species contain more lignin, it is distributed in such a manner that it does not interfere with the breakdown of plant cell walls by microbes. ADL content of Urea-ammoniated rice straw was also lower than that of untreated rice straw and is a reflection of the effects of ammonia in breaking down the bonds between lignin and cellulose or hemicellulose and also the solubilisation of some of the lignin.

6.5.2. Rumen ammonia concentration and rumen pH

The generally high rumen ammonia nitrogen levels at 3 hours post feeding were indicative of rapid degradation of the supplements and also urea-ammoniated rice straw. Rumen ammonia nitrogen release is an index of rumen proteolitic acitivity (Woodward and Reed, 1989), and according to Hungate (1966) ammonia is the preferred nitrogen source for fibre-digesting bacteria. According to Orskov and Ryle (1990), two factors jointly determine which micro-organisms predominate in the rumen ecosystem; type of substrate and rumen pH. Bicarbonate secreted in the saliva is the most important buffering agent in the system. Differences in pH are caused by differences in the secretion of saliva, which arise from differences in the time required for chewing the feed and for rumination. Mould *et al.* (1983) showed that when rumen pH was less than 6.0 - 6.1, fibre digestion was depressed and called this the 'cellulolysis threshold'. The time and extent to which pH remains below this threshold is an important determinant of bacterial growth rate (Mackie and Gilchrist, 1979)

In the present study supplements (Diets 2, 3, and 4) were fed as a pulse dose, that is, once a day at morning feeding, and hence the initial response seen shortly after feeding and then a return to normal until the next feeding time 24 hours later. Urea-ammoniated rice straw (diet 1) was, however, fed as the only diet and with ammonia constantly present its mode of action was slightly different. Rumen pH in urea-ammoniated rice straw (diet 1) fed animals did not fluctuate much relative to the others and remained fairly high over the 24 hour period.

The high initial rumen ammonia level in diet 4 (294.60) and the fairly high level even after 24 hours (144.07) may be explained by the fact that wheatbran contains a lot of soluble carbohydrates and nitrogen which aided rapid microbial growth initially thus providing high levels of rumen ammonia nitrogen and volatile fatty acids. The rumen pH therefore also fell to 6.41 after 12 hours. After exhausting the readily soluble nitrogen the microbes would then turn their attention to materials with a slower release thereby maintaining a reasonably high rumen ammonia level. This slow down in activity is also evidenced by the increase in pH to 7.45, twenty-four hours after feeding.

Griffonia simplicifolia (diet 2) was degraded fairly rapidly, with most of the nitrogen being readily soluble such that by 9 hours post- feeding the rumen ammonia nitrogen concentration had already dropped below 100 (93.83).

The Pattern of pH and ammonia release of *Jasminum dichotomum* (diet 3) is more difficult to interpret. The low pH (6.43) even 24 hours post feeding is indicative of a continued high production of volatile fatty acids (VFA) or a decrease in absorption rate of VFA. Normally saliva serves to provide a buffered medium for microbes rather than to neutralise all the VFA produced. In fact the quantity of saliva secreted is enough to neutralise only about one-third of the VFA produced (Orskov and Ryle, 1990). Most VFA is absorbed in its undissociated acid form through the rumen epithelium and is neutralised by the blood buffering system until metabolised (Orskov and Ryle, 1990). Saliva thus maintains rumen pH above 6.0 unless VFA is produced at an overwhelming rate or unless there is a decrease in aborption rate of VFA. The high levels of rumen ammonia nitrogen, for the *Jasminum dichotomum* supplemented diet, over the 24 hour period (173.78 - 112.36 mg N l^{-1}) also suggest a good pattern of rumen ammonia release probably due to some amount of resistance to rapid microbial breakdown due to the presence of tannins (2.6 g kg^{-1}). Woodward and Reed (1989) have stated that tannins form complexes with protein which lower their fermentation rate in the rumen. This lower fermentation rate may help improve the fermentation of fibrous crop residues, which also ferment slowly (Woodward and Reed, 1989).

There are conflicting reports in the literature as to the relationship between ammonia concentration and ruminal microbial growth. *In vitro* studies (Satter and Slyter, 1974; Schaefer *et al.*, 1980) have shown that no more than 50 mg l^{-1} of ammonia is required for maximal microbial growth. In contrast, Wallace (1979) observed that increased *in situ* DM and CP degradation rates of barley grain were accompanied by increased bacterial growth when ammonia concentration was increased from 97 to 214 mg l^{-1} ruminal fluid. Similarly, Mehrez *et al.* (1977) and Erdman *et al.*

(1986) reported that *in situ* degradation rates plateaued at ammonia concentrations in excess of 200 mg l^{-1} ruminal fluid. Alvarez *et al.* (1983) pointed out that with forages containing considerable amounts of crude protein it is highly likely that organisms adhering to the fibre depend on the nitrogen within the plant cell wall. The efficiency of growth of these organisms may be less affected by the level of ammonia in the rumen fluid. With fibrous diets low in nitrogen, the critical ammonia concentration must be higher than for protein rich feeds. The rate of dry matter loss from alkali-treated maize cobs in nylon bags in the rumen in the rumen increased linearly as rumen ammonia concentration was raised from 30 to 120 mg N l^{-1} of rumen fluid (Alvarez *et al.*, 1983) Generally, however, it would appear that all the experimental diets provided enough ammonia nitrogen, at least to optimise microbial growth, over a 24 hour period.

6.5.3. Degradability of dry matter, nitrogen and neutral detergent fibre.

A ranking of diets in terms of dry matter, nitrogen or neutral detergent fibre degradability would put diet 1 last. There was a delay in its degradation but once degradation started it took place fairly rapidly, quickly reaching the limits of its degradation. The extent of degradation (*b*, *a+b*) was therefore low relative to the other diets. This is a reflection on the fact that even though in terms of rumen ammonia diet 1 was not significantly different from the other diets, it lacked readily soluble carbohydrates which are also a prerequisite for rapid microbial growth and colonisation. In fact there must be a synchronisation in the release of nitrogen and soluble carbohydrates for the microbes to operate at an optimum. Silva *et al.*, (1989) carried out experiments to determine which supplements, when added to untreated rice straw, would elicit a response in the degradation rate. They reported that generally, supplements containing a source of easily fermentable fibre, such as sugar beet pulp, gave the best response. The leaves of leguminous trees and shrubs may also provide a highly fermentable fibre. Pathirana *et al.*, (1992) fed increasing amounts of *Gliricidia sepium* as a supplement to sheep on a basal diet of untreated rice straw and found that the sheep ate considerably more with the addition of *Gliricidia sepium* to their diet.

The long time lag (*TL*) for nitrogen degradation to begin may be due to the fact that all diets had sufficient rumen ammonia nitrogen. The nitrogen in the incubated sample was therefore not attacked until such time that rumen ammonia levels began to fall.

6.5.4. Nitrogen utilisation

That nitrogen intake of diet 4 was about 1.2 times higher than the other diets can be explained by its high dry matter value coupled with the way the supplements were fed.

Powell *et al.* (1994) reported that consumption of tannins caused a shift in the paths of nitrogen excretion from the urine to the faeces with an increase in the insoluble fraction of faecal nitrogen, as a result of the presence of indigestible tannin-protein complexes and this may explain the very low value of urinary nitrogen for diet 3.

6.6. Conclusion.

The results of this study have shown that:

1. the four diets tested are all capable of maintaining a suitable rumen pH and ammonia level for optimum microbial growth. The rumen ammonia level of the *Griffonia simplicifolia*-supplemented diet had, however, fallen rapidly by 12 hours after feeding and this needs to be taken into account. Supplements should form at least 12.5% of the animal's diet on dry matter basis.
2. diets 2, 3 and 4 were superior to diet 1 in terms of rumen degradation.
3. nitrogen balance was similar among the diets.

Supplementation of untreated rice straw with leguminous browse or agro-industrial by-product is therefore an alternative to urea-ammoniation of rice straw.

CHAPTER 7

GENERAL DISCUSSION

The survey of farming systems in the Dangbe East and West districts showed that the problem of dry season feeding exists in both districts and that farmers were aware of this problem. That farmers were not using any of the known dry season technologies was traced to a lack of information which clearly showed that very little information actually trickles down to the farmers who are supposed to be the end-users of research. This brings into focus the role of the extension service in the dissemination of information from the researcher to the farmer. The extension service has gone through many changes in a bid to make it more effective. The latest of such changes is the "Unified Extension System" This system has a District Director of Agriculture who is in charge of all field workers or front-line staff (FLS). Front-line staff, regardless of their discipline or subject speciality, are to work under the supervision of the District Director. The FLS are to work as a team which should be able to solve most of the farmer's problems. The results of the survey, however, indicated that the system was not operating as planned, at least in the areas covered by the survey. Front-line staff were still operating based on disciplines. There may be the need for a re-orientation of staff.

It appears, however, that there is still an information gap, especially where livestock are concerned. Researchers may need to be encouraged to take their research results on-farm, by themselves as a means of solving this problem. On-farm studies should be carried out with the assistance of the District Director of Agriculture to ensure that all front-line staff are involved and also to ensure that it has as wide a coverage as possible.

The survey also indicated that there exists in each district, enough crop residue, in the form of maize stover, and other feedstuffs such as cassava peels, cassava leaves and the foliage of some leguminous browse plants which can be fed together with the maize stover. This should reduce the cost of dry season feeding significantly.

Having established that there was a problem with dry season feeding the next study aimed at teaching farmers in the Dangbe East district how to prepare and feed urea-ammoniated rice straw as a way of solving the dry season feed problem. The study established the fact that supplementation with urea-ammoniated rice straw would significantly reduce dry season weight loss. The study also ensured that farmers had learnt the technology well enough to transfer it to others as shown by the ability of farmers to demostrate the preparation of urea-ammoniated rice straw to their colleagues at a wrap-up farmers forum.

During the wrap-up farmers forum, farmers complained about the problems involved with the chopping of straw by cutlass and wondered whether they could be assisted with a machine of some sort. This could be the only bottleneck that would hamper the uptake of the technology by farmers. An important but often neglected aspect of the introduction of new technologies is how they affect the use and efficiency of labour. Innovations that demand too much additional work are seldom adopted. The provision of some sort of mechanical chopper, possibly designed locally to reduce cost, is therefore indicated. Such a chopper could be shared by farmers in a locality to make it more cost-effective

It has often been considered that modern systems are dynamic, productive and responsive to innovations and change, while traditional systems are static, unproductive and conservative. Both views are stereotypic. There are 'conservative' farmers in modern systems and 'progressive' farmers in traditional ones. Advances in productivity in both types of systems are likely to be achieved only where new technologies are:

1. fitted to the prevailing conditions;
2. do not increase the risk of instability;
3. do not create too much additional work and
4. produce sufficiently attractive biological and economic returns.

More recently, it has been taken into account that innovations should not lead to the degradation of natural resources and that they should be sustainable in the long run (Wilson, 1995). the use of urea-ammoniated crop residues ensures that biomass which would otherwise be burnt, is put to good use. The use of locally-produced crop residues such as maize stover will ensure sustainability as maize is planted every year for human consumption. The provision of extra feed during the dry season, when grazing is limited, will also reduce the pressure on grazing lands thereby reducing land degradation as a result of over-grazing.

The next experiment was an on-station feeding trial which included two more treatments than had been used on-farm. These treatments were untreated rice straw supplemented with either *Griffonia simplicifolia*, a leguminous browse common in the Dangbe West district or wheatbran. The aim of the experiment was to compare urea-ammoniation of rice straw with the feeding of untreated rice straw with supplements. This experiment showed that there were no significant differences between treatments as far as growth rate and milk yield were concerned. Supplementation tended to improve body condition of cows.

The study indicated that low intake of supplementary feeds was one of the major problems associated with the lower than expected biological response when supplements are fed to grazing animals. The minimum amount of supplement to feed is calculated based on what the animal is expected to get from grazing. This was not estimated in this study. In this study the aim was to feed 25% of the dry matter intake of a 250kg cow. Dry matter intakes of supplements in the experiment were not up to even half of this amount. Intake of supplement would also be affected by the availability of natural grazing. The Katamanso Research Station, of the Animal Research Institute, had a better rainfall regime as compared to Dangbe East and there was more grazing during the dry season. Cows, however, began to eat more of the supplement as available grazing diminished with the advance of the dry season. The introduction of supplementary feeding to cattle may therefore need to start at an early age (after weaning) so that cattle are used to it by the time they mature.

Allowing cattle access to Griffonia and wheatbran for half an hour was meant to simulate an on-farm situation where farmers would be instructed to allow their animals to feed on the supplements for about half an hour before offering them the chopped rice straw or other crop residue. This method gave an advantage to wheatbran as it is a material of high dry matter value. This was reflected in a significantly higher total dry matter intake and dry matter intake of untreated rice straw for the wheatbran supplemented diet. Very often agro-industrial by-products cause a substitution effect, replacing some of the basal diet, rather than stimulating its intake. Under such conditions the maximum digestion/utilisation of roughage is affected adversely (Chowdhury, 1998). By feeding wheatbran for such a short time this was prevented.

The problem with the feeding of leguminous browse would be the provision of browse during the dry season. In some areas of Sege, where the on-farm feeding trial was carried out, browse trees were scarce, a lot of them having failed to survive the drought. Where browse is available its use should be encouraged. During the course of the study, the idea of growing small plots of browse, to be cut and fed during the dry season was mooted. The farmers were skeptical about this, however, as they did not seem to see how they could grow enough to feed all their cattle. The use of other high protein forages like cassava leaves was also suggested to farmers. Cassava leaves would be available after the harvesting of cassava, a crop which all the farmers grow. The leaves could be wilted after harvest and stored for dry season feeding. The advantages to be gained from the use of agro-industrial by-products like wheatbran would, however, be largely whittled away by its high price. A 25 kg bag of wheatbran cost ¢5,000.00 in 1997, at the time of the survey. By the time the on-station feeding trial started in late 1999 it was selling for ¢9,000.00. Currently (May 2001) a 25 kg bag of wheatbran sells for ¢18,000.00. The use of other agro-industrial by-products like sundried cassava peels, generated by the farmers themselves as a by-product of the gari and cassava dough industries, is therefore to be encouraged.

Supplementary feeding assumes that the supplement will be extra to what the animal gets from natural grazing. It is also assumed that the supplement is of better quality than natural grazing and should stimulate a higher intake of natural grazing and also improve the overall digestibility of the diet. This appears to have been so with the on-farm study but may not always be true. In feeding supplements like urea-ammoniated rice straw and untreated rice straw (with supplements) the supplements could replace or substitute part of the basal diet. In an area with a good rainfall regime dry season grazing could be of a fairly good quality and if cattle have access to local browse plants as well then the feeding of supplements could actually lower the quality of the basal diet. This could partly explain why the cattle on the control diet of grazing only performed so well.

The final experiment was a metabolic study which aimed at explaining some of the observations made in the earlier experiments. In this experiment, the negative control (grazing only) was replaced with untreated rice straw supplemented with *Jasminum dichotomum*, a leguminous browse common in the Dangbe East district. The study showed that all diets were capable of providing suitable environments, in terms of rumen pH and rumen ammonia nitrogen, for optimum microbial growth. Degradability of dry matter and NDF was significantly inferior in the urea-ammoniated rice straw diet, as compared to the others, especially after 24 hours of incubation. Nitogen utilisation was not different among the diets. That the diets were basically similar could explain the fact that there were no differences in the on-station experiment. Though not significantly different, the urea-ammoniated rice straw diet was ranked last and may be a reflection on its inferior degradation rate as compared to the other diets.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

In conclusion:

1. The problem of dry season feeding has been established with the farmers.
2. The major reason for the non-use of known dry season feeding strategies was that the farmers did not know enough about them.
3. The preparation and use of urea-ammoniated rice straw has been taught to some cattle farmers in the Sege area of the Dangbe East District of the Accra Plains.
4. The dry season feeding problem with cattle can be solved by the feeding of urea-ammoniated rice straw as a supplement.
5. The feeding of untreated rice straw with a suitable leguminous browse or agro-industrial by-product (wheatbran) is a viable alternative to the feeding of urea-ammoniated rice straw.

In most developing countries the basal diet is poor quality native pasture and/or crop residue. Protein meals, derived from the processing of oil seeds, fish, cereal grains, etc can be expensive and are often unavailable. Furthermore farming systems in developing countries are notoriously difficult to change and innovation must be introduced gradually without inducing excessive risk, which may directly affect the well-being of the family of a resource-poor farmer. The cattle of Ghana will continue to depend on native pasture for a long time to come. The way forward for the cattle industry in Ghana, at least in the short term, is therefore to feed supplements to cattle in such a way as to ensure optimum rumen conditions for fibre digestion. These supplements must be locally available and within easy reach of the farmer. In carrying out on-farm research work a participatory approach, which allows the active involvement of both farmers and researchers should be used. Once innovations have been tried out successfully, on-farm, the extension service should be actively involved in spreading the technology to wherever it may be needed.

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Appendix 1.

A SURVEY ON THE REASONS FOR THE NON-ADOPTION OF DRY SEASON FEEDING STRATEGIES.

QUESTIONNAIRE

DISTRICT

VILLAGE

****

FARMER'S NAME

FARMER'S NUMBER

ENUMERATOR'S NAME

DATE

NEAREST TOWN/CITY

DISTANCE FROM THE FARM TO MAIN ROAD ______________ Km

CATTLE FARMERS ASSOCIATION yes No

I FARM FACILITIES

I/1 Does the farm have electric supply Yes No

I/2 Does the farm have telephone connection Yes No

I/3 Does the farm own transportation facilities (tractor, pickup etc.) for farm related activities. Yes No

I/4 Does the farm have access to transportation facilities (not owned) for farm related activities. Yes No

II. FAMILY COMPOSITION

II/1 Is the farm owner managing the farm? Yes No

II/2 If the answer to II/1 is no who manages the farm?

(a) Fulani herdsman
(b) Son of the owner
(c) other (please state)..................................

All the following questions refer to the farm family whether they are the owners of the farm or not.

II/3 List number of household members living permanently on the compound:

Age Categories	Male Number		Female Number	
	Full time work	Part time work	Full time work	Part time work
< 8 years				
8 - 14				
15 - 65				
> 65				

Work refers to work done on the farm.

II/4 Sex of household head? Male
Female

II/5 Age of household head ______________ years

II/6 Is there another main activity of the household head other than farming?

1. Active civil/public servant
2. Retired civil/public servant
3. Private business
4. Other (please state)...................................
5. No other activity

II/7 Ethnic afiliation of the household head

(a) Akan (b) Ewe (c) Ga/Adangbe (d) Northerner (e) Other.........

II/8 What is the education level of the household head?
1 - No scholar education
2 - Primary school
3 - Secondary school and beyond
4 - Arabic School

II/9 Are there wage labourers permanently employed for farming activities ?

1. No
2. Yes: How many for each type of farming activities?

Total number	How many with specialised task allocation for:		Other task ....
	livestock only	Cropping only	

II/10 Have you employed casual wage labourers for farming activities last year?

1. No
2. Yes: How many mandays for each type of farming activities?
3. Which month do you employ them?.........................

Total number of mandays	How many mandays for specific task allocation :		Other task ....
	livestock only	Cropping only	

III LAND TENURE / LAND USE

Fill the following table. The list for the second column is to be tailored for each site/plot.

Landuse/ category	Specific crop/rotation	Land size (local units)	Land size (Ha)	Tenure right [1]	Distance from homestead (Km)
Irrigated land	Vegetables Rice Other	Vegetables: Rice: Other:			
Food crop	Cassava Maize Cassava/maize intercrop Rice Other	Cassava: Maize: Cassava/maize intercrop: Rice: Other:			
Cash crop	Pepper Okro Tomato Beans Other	Pepper: Okro: Tomato: Beans: Other:			
Other use					

[1] T = Traditional; P = Purchased L= leasehold S= share cropping,

III/1 What is the source of water for your Cattle?
(a) Dam (b) Dugout (c) River (d) Stream (e) other..................................

III/2 How frequently are your cattle watered in a day?
(a) Once (b) Twice (c) Thrice (d) Four times (e) Other......................................

III/3 What is the distance (Km) to the nearest watering point? ....

III/4 How do you acquire or get access to the land. (Please give a description of process paying particular attention to drinks, yearly rents in cash or kind, etc).

IV CROPPING PRACTICES/CROP YIELD

IV/1 How do you prepare land for cropping?
(a) Tractor (b) Animal Traction (c) Hoe & cutlass (d) Other

IV/2a Do you spread cattle manure on your crop land? Yes No

IV/2b If the answer to IV/2a is yes how much?
....

IV/2c If the answer to IV/2a is no why are you not doing so?
(a) Difficult to collect (b) large quantities needed
(c) difficulty in transporting manure to farm.
(d) Other...

IV/3a Do you use chemical fertilizers on your crop land?
Yes No

IV/3b If the answer to IV/3a is yes how much?
....

IV/3c If the answer to IV/3a is no why are you not doing so?
(a) Expensive (b) Do not know how to apply it
(c) Other...

IV/4 What quantity of crops did you produce last year?

Crops	Quantity produced	
	Local unit	? Kg = local unit
Cassava		
Maize		
Rice		
Pepper		
Okro		
Tomato		
Bean		
Other		

V LIVESTOCK INVENTORY

V/1 Population of cattle kept on farm

			SANGA	WASH	NDAMA	XBRED	TOTAL
Total heads of cattle kept on farm	Adult	Ox					
		Bull					
		Cow					
	Young	Young male					
		Heifer					
	CALVES	Male					
		Female					

V/2 Do all the cattle on the farm belong to one person? Yes No

V/3 If the answer to V/2 is no, how many people have cattle on the farm and how many does each owner have?

Owner	1	2	3	4	5	6	7	8	9	10
No.										

VI FEEDING

VI/1 Fill in the grazing calendar for the farm

	J	F	M	A	M	J	J	A	S	O	N	D
Grazing communal pasture land												
Grazing crop residues												
Cut and carry												
Month with insufficient feed available from grazing												

VI/2 What measures do you normally take to make up feed deficit?

(a) Longer grazing hours
(b) use of crop residues (state)...........................
(c) Use of agro-industrial by-products (state).............
(d) Use of multi-purpose trees.............................
(e) Other (please state)...................................

VI/3 Do you store any feed from your crop harvest to feed livestock? Yes No

VI/4 If the answer to VI/3 is yes what type of feed do you store?

TYPE OF FEED	QUANTITY STORED AFTER LAST CROP HARVEST.	
	Local unit	= ? Kg
MAIZE STOVER		
RICE STRAW		
COWPEA VINES		
GROUNDNUT HAULMS		
CASSAVA LEAVES		
OTHER (please state)		

VI/5 Where is the feed stored?

1 - Permanent closed store (indoor)

2 - Temporary closed store (indoor)

3 - Outdoor store

VI/6 Is the feed fed to all animals? Yes No

VI/7 If the answer to VI/6 is no to which class(es) of cattle is the feed fed?

(a) Calves
(b) Milking cows
(c) Calves & milking cows
(d) Other (please state)...............................

VII MILK PRODUCTION

VII/1 What is the age at first calving in your herd?...........

VII/2 What is the calving interval?...........................

VII/3 In which season do you have more births? (a) wet (b) dry

VII/4 Please fill in the following table:

No. of milking cows	Av. daily Prod./cow (lts) DRY SEASON	Av. daily Prod./cow (lts) WET SEASON	Total Prod. (lts) DRY SEASON	Total Prod. (lts) WET SEASON	Total Yearly prod. (lts)

VII/5 What do you think accounts for the differences between wet and dry season milk production?
(a) More feed in the wet season (b) Availability of water
(c) Other...

VII/6 What do you think can be done to improve the situation?
(a) Supplementary feeding in the dry season. (b) Provision of water
(c) Other...

VII/7 What have you done so far?
(a) Dry Season supplementary feeding with......... (b) Nothing
(c) Other...

VII/8 How do you dispose of milk?
(a) used by family (b) sold fresh (c) sold as cottage cheese

VII/9 Who buys the milk when it is sold?
(a) General Public (b) Wholesaler for retail in the towns
(c) Other...

VII/10 When the family uses milk what proportion of the milk do they use?..

VIII KNOWLEDGE OF DRY SEASON FEEDING STRATEGIES.

VIII/1 Do you have visits from the Agric extension service?
Yes No

VIII/2 Do you know about the feeding of crop residues like maize stover and rice straw to cattle? Yes No

VIII/3a If the answer to VIII/2 is yes where did you learn about it
(a) Extension officer (b) Farmers meeting (c) Other..............

VIII/3b If the answer to VIII/2 is yes are you feeding crop residues to you cattle during the dry season? Yes No

VIII/4 If the answer to VIII/3b is no why are you not doing so?
(a) Crop residues not available in sufficient quantity
(b) Do not know enough about their use
(c) Too expensive
(d) Inability to transport crop residues from farm to kraal
(e) Other (please state).....................................

VIII/5 Do you know about urea treatment of crop residues for feeding cattle? Yes No

VIII/6a If the answer to VIII/5 is yes where did you learn about it
(a) Extension officer (b) Farmers meeting (c) Other..............

VIII/6b If the answer to VIII/5 is yes are you treating crop residues for feeding your cattle during the dry season?
Yes No

VIII/7 If the answer to VIII/6b is no, why are you not doing so?
(a) Urea is not easily available
(b) Do not know enough about urea treatment
(c) Too expensive
(d) Other (please state). ....

VIII/8 Do you know about the use of multipurpose trees for feeding cattle? Yes No

VIII/9a If the answer to VIII/8 is yes where did you learn about it
(a) Extension officer (b) Farmers meeting (c) Other..............

VIII/9b If the answer to VIII/8 is yes are you feeding multipurpose trees to your cattle during the dry season?
Yes No.

VIII/10 If the answer to VIII/9b is no why are you not doing so?
(a) Have not grown any trees as yet
(b) Establishment of trees too time consuming
(c) Harvesting & feeding of trees to animals is time consuming and requires extra labour
(d) Do not know where to find tree seedlings
(e) Other (please state)....................................

VIII/11 Have you noticed the cattle eating any particular shrub, browse or tree leaves, especially during the dry season?
Yes No
NB: If answer is yes try to obtain a sample of the material.

VIII/12 If the answer to VIII/11 is yes, have you tried cutting some of this shrub for feeding at home? Yes No

VIII/13 If the answer to VIII/12 is no why are you not doing so?
(a) Have not thought about it
(b) Harvesting & feeding is time consuming & requires extra labour
(c) Not enough of such trees to make it worthwhile
(d) Other (please state)......... ....

VIII/14 Do you know about the feeding of agro-industrial by-products like wheatbran, ricebran, brewers spent grain, etc to cattle? Yes No.

VIII/15a If the answer to VIII/14 is yes where did you learn about it?
(a) Extension officer (b) Farmers meeting (c) Other..............

VIII/15b If the answer to VIII/14 is yes are you feeding agro-indutrial by-products to your cattle during the dry season? Yes No

VIII/16 If the answer to VIII/15b is no why are you not doing so?
(a) Too expensive
(b) Not easily available
(c) Do not know enough about their use
(d) Other (please state)................. .. ..

VIII/17 Have you heard about the urea-molasses block? Yes No

VIII/18a If the answer to VIII/17 is yes where did you learn about it?
(a) Extension officer (b) Farmers meeting (c) Other..............

VIII/18b If the answer to VIII/17 is yes do you feed the urea-molasses block to you cattle during the dry season?
Yes No

VIII/19 If the answer to VIII/18b is no why are you not doig so?
(a) Too expensive
(b) Not easily available
(c) Do not know enough about their use
(d) Other (please state)...................................

VIII/20 Do you know of any other dry season feeding strategy that we have not mentioned?
(a) Hay making
(b) Silage making
(c) Standing hay
(d) Other (please state)..........................

VIII/21 What is the source of your information if you gave answers for VIII/20
(a) Extension officer (b) Farmers meeting (c) Other..........

VIII/22 Please fill in the following table for last year.

FEED TYPE			Quan. Purch. (unit)	Price/unit	unit (= ? Kg)	Price/Kg
AGRO-IND. BY-PRODUCTS	Wheatbran					
	Ricebran					
	UMB					
	Oilseed cake					
	Brewery	wet				
		dry				
Crop residues	Rice straw					
	Maize stover					
Salt lick						
Commercial concentrates						
Other						

IV CATTLE SALE/DISPOSAL

IV/1 Number of cattle wich died last year?

Heads of cattle which died last year	Adult	male	
		female	
	weaners		
	Calves		