CARDI

Review

A compilation of CARDI research papers

Issue 5

June 2005

TABLE OF CONTENTS

FOREWORD

The year 2005 sees CARDI celebrating its 30th anniversary and CARDI Review entering its fourth year. When we started CARDI Review in 2002 the objective was to publish issues two or three times per annum with papers from CARDI scientists which had not been published elsewhere. At the same time it was decided that the quality of the papers should be high with a peer review system and also strict rules for layout and structure.

All these conditions have placed some restraint on the type of material we publish. An author certainly cannot throw together a quick report on work and expect it to automatically appear in CARDI Review. The result has been that apart from the inaugural year, 2002, we have only published one issue per year.

The CARDI Publication and Seminars Committee (PSC) does not intend to let the standards drop. Scientists are usually judged on their written material and CARDI scientists who are not accepted for publication elsewhere (or who do not have the time and energy to write articles for other journals) should not find an easy outlet in CARDI Review. We will be stepping up efforts to get work that has not been published elsewhere in CARDI Review, but not at the expense of quality and rigour.

This issue contains the first for CARDI Review from CARDI, Belize. This is very appropriate as the institute is now lead by a Belizean, Dr. Wendel Parham. The other article in this issue is from Jamaica. CARDI, Jamaica continues to submit the most articles for inclusion in CARDI Review. This is an indication of the continuing output of that country's unit; I look forward to the other units, especially the smaller representation, looking up to CARDI, Jamaica for scientific inspiration.

Bruce Lauckner
Editor

Germination and Seedling Emergence (1) in Hot Pepper var. *West Indies Red*

Neville C. McAndrew[1] *and Martin Lindo*[2]

[1] Agronomist/Seed Technologist, [2] Technician,
Caribbean Agricultural Research and Development Institute, PO Box 2, Forest Drive, Belmopan, Belize

ABSTRACT

Some hot pepper producers in Belize reported slow and uneven germination and seedling emergence with seed of variety ***West Indies Red***, lot no. 18/2002, due to the presence of a high percentage of 'hard seeds' which did not germinate and produce seedlings within a reasonable period of time in the nursery. Samples of seeds from the seed lot were subjected to seven treatments before the seeds were planted out, 1.27 cm deep, in moist germination mix in 70-cell black plastic germination trays. Eighty percent or more of the seedlings had emerged in all treatments by 14 days after the seeds were planted out, and the results showed no significant difference (P=0.05) among treatment means for the number of emerged seedlings, hard seeds or dead seeds. The highest percentage of emerged seedlings, 91.33%, was recorded for seeds that were moistened for one or two days before planting with a solution of NewGibb® (Gibberellic Acid 10% SP) at 1.0 g in 10.0 L water. Seeds that were moistened with water for one day or with the solution of NewGibb® for one or two days before planting had emerged seedlings at seven days after planting, which was at least one day ahead of the other treatments.

BACKGROUND

The CARDI (Belize) Unit usually acquired supplies of seed of hot pepper variety ***West Indies Red*** (WI Red) from the CARDI (Antigua) Unit and repackaged the seed for sale to hot pepper producers in Belize. Some producers have reported that the seeds at times exhibited slow and uneven germination in the nursery, which was confirmed in subsequent observations on one seed lot, 18/2002 acquired from CARDI Antigua, in which a high percentage of the seeds appeared not to have imbibed water, over what was considered a reasonable period of time after the seeds had been planted out in the nursery. These apparent 'fresh ungerminated seeds' or 'hard seeds', while still viable, were a problem to hot pepper producers who expected the seeds to exhibit rapid and even germination and seedling emergence in the nursery or seedbed. Faced with the problem the affected farmers understandably complained that the germination of the seeds was poor. Problems consequently arose with the marketing of ***WI Red*** seed as the reports of poor germination circulated among farmers.

Keywords: Hot Pepper, West Indies Red, Gibberellic Acid, Germination, Seedling Emergence.

The causative factor in the development of the hard seeded condition in WI Red hot pepper was not known, but it was clear that the fresh ungerminated seeds did not imbibe enough water to allow the germination process to proceed. It was also not known whether this was the result of the seed coat restricting the passage of water or an inadequacy of water in the germinating medium. Regardless of the cause, to avoid recurrent farmer complaints and preserve the market for ***WI Red*** seeds, it was considered crucial to investigate simple, easy to apply techniques that will effectively allow the seeds to imbibe water and proceed with the germination process so that the farmers experience a more even germination and seedling emergence.

METHODOLOGY

Samples of hot pepper seed, variety ***West Indies Red*** lot no. 18/2002, were subjected to seven treatments before the seeds were planted out in germination trays filled with germination mix to observe germination and seedling emergence. The seeds were either soaked in water for 2, 4, or 6 hours; kept for 24 or 48 hours in paper towels that were moistened with a solution of NewGibb® (Gibberellic Acid 10% SP) at 1.0 g NewGibb in 10.0 L water; kept for 24 hours in paper towels that were moistened with water; or planted without being pre-soaked or moistened.

At planting the cells of black plastic germination trays were filled with thoroughly moistened commercial germination mix (Farfard® Growing Mix 1-P) comprised of Canadian Sphagnum Peat (80%) and Perlite. One seed was planted in each cell at a depth of about 1.27 cm.

The trial was established in shaded ambient conditions in a Complete Random Design with three replications. Each experimental unit was one 70-cell germination tray filled with moistened germination mix and planted with 50 seeds. The trial was watered as required.

A daily count of emerged seedlings was conducted where a seedling was considered to be emerged when it had grown to a height of at least 1.0 mm above the germination mix in the cell.

The trial was terminated at 14 days after the seeds were planted at which time the germinating mix was removed from the cells that did not have seedlings and attempts were made to retrieve the seeds. If a fresh ungerminated seed was found in a cell it was recorded as a hard seed. If no seed was found in a cell then that seed was recorded as a dead seed.

Percentages of emerged seedlings, hard seeds and dead seeds were calculated and an analysis of variance conducted on the data.

RESULTS AND DISCUSSION

Table 1 shows the average percentage (over three replications) of emerged seedlings, hard seeds and dead seeds for the seven treatments at 14 days after the seeds were planted. The Analysis of Variance showed no significant difference (P=0.05) among the treatment means.

Table 1: Average Percentage of Emerged Seedlings, Hard Seeds and Dead Seeds

Treatment		Percent		
No.	Type	Emerged Seedlings	Hard Seeds	Dead Seeds
1	Seeds soaked for 2 hours	85.33	10.00	4.67
2	Seeds soaked for 4 hours	86.67	11.33	2.00
3	Seeds soaked for 6 hours	80.00	16.67	3.33
4	Seeds moistened with NewGibb® solution for 1 day	91.33	7.33	1.33
5	Seeds moistened with NewGibb® solution for 2 days	91.33	7.33	1.33
6	Seeds moistened with water for 1 day	88.67	7.33	4.00
7	No treatment applied to the seed	85.33	6.00	8.67
	Mean	**86.95**	**9.43**	**3.33**
	CV%	**7.72**	**54.44**	**74.35**
	P=0.05	**ns**	**ns**	**ns**
	SEM	**2.54**	**1.94**	**1.52**

The data however show that at 14 days after planting the seeds that were moistened with the NewGibb® solution for one or two days before they were planted averaged the highest percentage, 91.33%, of emerged seedlings. The second highest percentage, 88.67%, of emerged seedlings was recorded for seeds that were moistened with water for one day before they were planted. The lowest percentage of emerged seedlings, 80.00%, was recorded for seeds that were soaked for six hours before they were planted. The data suggest that moistening the seeds, either with water or with a solution of NewGibb® (Gibberellic Acid 10% SP) at 1.0 g in 10.0 L water for one or two days before they are planted in the nursery may be more effective in promoting germination and seedling emergence compared to seeds that were soaked for up to six hours, or with seeds that were not soaked or moistened before planting.

Observations showed that 80% or more of the seedlings had emerged in all treatments by 14 days after the seeds were planted. Figure 1 shows that the seeds that were moistened either with the NewGibb® solution for one or two days or with water for one day had seedlings beginning to emerge at seven days after planting, which was at least one day ahead of the other treatments.

The results suggest that the slow and uneven germination and seedling emergence experienced by some Belizean hot pepper producers with seed of the variety ***West Indies Red***, seed lot no. 18/2002, may not have been seed related as there was no significant difference (P=0.05) in the average percentage of emerged seedlings or hard seeds among the treatments, implying that the problem may exist with the adequacy of water around the seeds after they were planted in the germination mix.

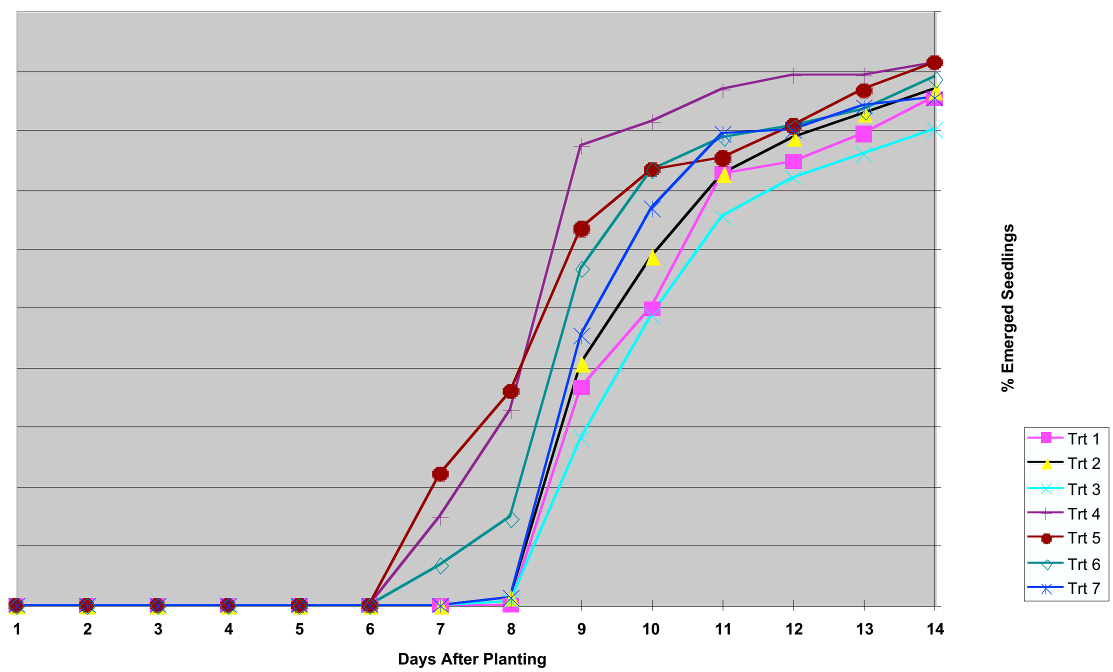

Figure 1 Rate of Seedling Emergence

CARDI marketed hot pepper seed with a minimum of 80% germination, and this level of germination was achieved in all treatments by 14 days after the seeds were planted under nursery conditions. However, some farmers planted seeds in dry germination mix then applied water; a practice which did not always guarantee that the germination mix throughout the depth of each cell in the germination trays became thoroughly moistened, and created a situation where the planted seeds were not in contact with an adequate supply of water at all times. Keeping the seeds moist for 1 or 2 days before planting them at about 1.27 cm deep in moist germination mix appeared to ensure that the seeds imbibed enough water for the germination process and subsequent seedling emergence to proceed.

The results also showed that moistening the seeds before they were planted out in the nursery, either with water for one day or with a solution of NewGibb® (Gibberellic Acid 10% SP) at 1.0 g in 10.0 L water for one or two days, promoted faster germination and seedling emergence which could result in earlier transplanting by reducing the time that the seedlings have to be kept in the nursery.

The Effect of Mulberry Leaf Meal on the Growth Performance of Weaner Goats in Jamaica

David Miller, *Delroy McDonald and °Francis Asiedu

**Ministry of Agriculture, Bodles Research Station, Old Harbour, Jamaica*
°Caribbean Agricultural Research and Development Institute, U.W.I., Mona

ABSTRACT

The ever increasing cost of commercial concentrates, formulated from imported grains, makes supplementation in goat rations very expensive. This has given rise to the need for less dependence on concentrates and for more emphasis to be placed on forages of high nutritive value for use in weaner production systems. Twelve growing male goats (six Boers and six crossbred Nubians), three to four months old with mean body weight of 19.68 ± 2.08 kg were used to evaluate the effect of mulberry leaf meal as a substitute for commercial concentrates on the growth of young stall-fed goats in Jamaica. The animals were randomly assigned to three treatment diets (T1, T2, and T3) and fed in individual stalls for 100 days. They were each given a basal diet of pangola grass hay. The treatments were, mulberry : concentrate ratio, (on dry matter basis as a percentage of body weight) 0 : 2, 1 : 1 and 2 : 0 for T1, T2 and T3, respectively. The parameters measured were average daily gain (ADG), dry matter intake (DMI), crude protein intake (CPI) and feed conversion. There was no significant difference ($P>0.05$) between the three treatment groups for ADG (123.0, 125.0 and 121.0 g/d for T1, T2 and T3, respectively). DMI increased with increasing levels of mulberry from 1.01 kg/d to 1.21 kg/d for goats on T1 and T3 diets, respectively. The DMI for T3 was significantly ($P=0.037$) higher than for T1. This could be attributed to the bulkiness of the mulberry leaf meal compared to the commercial concentrate. There was no significant ($P>0.05$) difference between the treatments for CPI or feed conversion rate. It was concluded that dried mulberry leaves can be used to substitute commercial concentrate as a supplement in the feeding of weaner goats fed pangola grass hay. Further research, however, is needed to determine the economics of such a feeding regime.

INTRODUCTION

Goat production in Jamaica is carried out under systems ranging from small-scale fully intensive management to large-scale extensive range type systems. In most of these systems various types of commercial and on-farm concentrate mixes are used with varying degrees of success. Commercial concentrates are formulated essentially from imported raw materials and as a result come at a high and ever increasing cost. In some systems forages represent the sole source of sustenance for the animals. In the systems where forage alone is utilized there is a tendency toward low levels of productivity. There exists, therefore, a need to reduce the dependence on concentrates and also to increase output levels in all forage production systems. The introduction and utilisation of superior forage species such as the mulberry could assist in achieving these goals.

Mulberry is a shrub or tree traditionally used in sericulture in various countries. It belongs to the order Urticales, the family Moraceae and the genus *Morus*. There are estimated 68 species of the genus *Morus* with the majority of them occurring in Asia (Datta 2001), and in China there are over 1,000 varieties under cultivation (Sanchez 2001a).The most common species are *M. alba,* the White Mulberry, *M. nigra*, the Black Mulberry, *M. rubra*, the Red Mulberry and *M. indica.* The plant is not native to Jamaica but was introduced in 1997.

The nutritive value of mulberry is one of the highest found in products of vegetable origin and is far superior to traditional forages and is comparable to concentrates (Benavides 2001). The foliage of the mulberry is highly digestible and of excellent crude protein (CP) content reaching levels of 20–24% (Gonzalez and Milera, undated). After evaluating the nutritive value of this plant Boschini (2002) concluded that leaf and cell wall contents, together with structural carbohydrates and ash indicate that mulberry is an excellent feed for high yielding animals and can be offered fresh or dried in compound feeds. Sanchez (2001b) also came to this conclusion and proffered that mulberry foliage can be used as a supplement to poor quality forage-based diets or as the main component of a ration in livestock production systems.

Animal production studies have shown the great potential of mulberry as a supplement in the diet of ruminants. Benavides (2001) reported liveweight gains of 60, 75, 85 and 101 g/animal/day when mulberry was fed to Blackbelly sheep at 0, 0.5, 1.0 and 1.5% of body weight on a dry matter basis with King grass as the basal ration. In this study, rather than a substitution effect, there was an additive effect of mulberry on total dry matter intake. Mulberry has been used successfully in the feeding of dairy cows. The yield of lactating dairy cows did not decrease significantly when 75% of grain concentrates was replaced by mulberry (Esquivel et al. 1996 cited by Sanchez 2001b).

Schmidek et al. (2001) using goats fitted with rumen cannula evaluated the degradation rate of mulberry leaves. They concluded that the high values of the soluble and potentially degradable fractions, as well as the potential and effective degradation of leaves of the mulberry clones studied, confirmed the high nutritive value of the plant and its great potential as a feed for goats.

In the humid northern highlands of Tanzania mulberry leaves are used in cut and carry feeding systems for sheep and goats (Shayo 1997). The usefulness and potential of the mulberry plant in animal production systems have been demonstrated in many other countries around the world. The increased need for efficiency and improved productivity in the local livestock sector warranted the investigation of this species in Jamaica.

The objective of the present study was to evaluate the effect of mulberry leaf meal as a substitute for commercial concentrates on the growth of young stall-fed goats in Jamaica.

MATERIALS AND METHODS

Management of materials and animals

The present study was conducted at the Goat Research Unit of the Bodles Agricultural Research Station, Old Harbour, Jamaica. The animals for the trial consisted of 12 male weaner goatlings (six Boers and six crossbred Nubians), three to four months old with mean body weight of 19.68

± 2.08 kg. The feeds used included pangola grass (*Digitaria decumbens*) hay, dried mulberry leaves and a commercial grain concentrate formulated for goats. The pangola grass was produced on farm, mechanically harvested and baled. Mulberry leaves were harvested manually, sun dried on a concrete barbeque, then bagged and stored for feeding. The commercial concentrate was purchased from a local feed mill. Samples of offered feeds were taken fortnightly at time of feed adjustment and stored for bulk sampling and chemical analysis at the end of the trial.
The experimental animals were individually housed in partitioned pens with wooden sides, concrete floors and zinc roof. The pens had wooden sleeping palettes and were well ventilated. The animals were randomly assigned to three treatment diets; T1, T2, T3. These treatments comprised pangola grass hay *ad libitum* as a basal diet and three levels of dried mulberry leaves in combination with a commercial goat ration offered as a percentage of the body weight on dry matter basis as shown in Table 1.

The goats were dewormed with Benvet 10% (Albendazole) at the beginning of the adjustment period (1 week prior to starting the experiment). They were also sprayed with Triatix at that time to control external parasites and again 14 days afterwards. The trial started on March 15 2004 and continued through to June 23 2004.

Table 1 Experimental treatments

	Percentage of body weight	
Treatment	Mulberry	Commercial concentrate
T1	0	2
T2	1	1
T3	2	0

Each animal was provided with a trace mineralized block, and fresh water was made available daily. The animals were fed once per day at 8:30 a.m. and the refusals collected the next day and weighed prior to providing fresh feed. Feeding continued for 107 days including the 7 day adjustment period. The goats were weighed fortnightly to determine average daily gain (ADG) and the amount of feed offered adjusted to reflect body weight changes. Voluntary feed intake was determined daily for each goat (offerings minus refusals). Feed conversion was calculated from dry matter intakes and daily gains.

Chemical analysis

Proximate analysis was done on the feed samples to determine crude protein (CP), ether extract (EE) and ash content. Neutral detergent fibre (NDF) was analysed using the procedure outlined by Goering and Van Soest (1970).

Experimental Design and Data Analysis

The study took the form of a completely randomized block design. Each treatment had four goats/replicates (two Boers and two crossbred Nubians). The data were analysed using Genstat 5 Release 3.2 statistical software (Lawes Agricultural Trust 1996). One goat in T3 died from overeating just prior to the second weighing and was treated as a missing value. The diagnosis by the veterinarian was based on the presence of rumen fluid in the oesophageal tract at the time of death.

RESULTS AND DISSCUSSION

Nutritive value of experimental diets

The nutritive values of the treatment diets are shown in Table 2. The mulberry leaf meal had a higher CP (16.01%) value than the pangola grass hay (6.98%) but was slightly lower than the commercial concentrate (17.69%). The three feed ingredients had similar dry matter content. The CP value of 16.01% falls within the range of 15.0 – 28.0% as stated by Sanchez (2001b). Leaf crude protein content varies according to variety, age of plant and growing conditions (Sanchez 2001b). Yao et al. (2000) found mulberry leaf CP values to be slightly higher in spring than in the fall (21.1% vs. 20.9%). The NDF value of 24.0% in the current study is similar to the 24.6% determined by Shayo (1997) but lower than the 32.8% and 38.8–41.1% found by Malamsha et al. (1997) and Yao et al. (2000), respectively. These differences, however, could be due to maturity of the plant, as it is known that cell wall constituents of forages increase with age. The higher NDF value (69.1%) of the pangola grass hay suggests a lower digestibility than the mulberry leaf meal. High protein and relatively low fibre content of the mulberry is indicative of its suitability as a supplement for goats fed a basal diet of pangola grass hay. The ash content of 14.0% is consistent with that reported by Malamsha et al. (1997), Shayo (1997), and Sanchez (2001b).

Table 2 Chemical composition of the treatment diets

Parameter	Pangola grass hay	Commercial concentrate	Dried mulberry leaves
(% Dry matter)			
Dry matter	91.86	91.08	92.04
Crude Protein	6.98	17.69	16.01
Ash	7.10	8.12	14.00
Neutral Detergent Fibre	69.13	20.00	24.00

Voluntary feed intake and growth rate of goats on the trial

Feed intake, growth rates, mean initial and final liveweights and liveweight gains with standard errors for goats in the various treatments are shown in Table 3. There were no significant ($P>0.05$) differences in liveweights and liveweight gains between goats in T1, T2 and T3. There was also no significant difference ($P>0.05$) between the three treatment groups for average daily gain (ADG). The ADG of 121.0 g for T3 (100% mulberry at 2% liveweight, DM basis) was higher than the 86.2 g realized by Gonzalez and Milera (undated) for goats fed mulberry at 2.5% liveweight, on DM basis. The lower ADG could, however, have been due to the shorter feeding period (29 days) by Gonzalez. The 121.0 g/d is also higher than the 76 g/d and 43 g/d reported by Yates and Pangabean (1988), cited by Malamsha et al (1997), for Katjang goats supplemented with concentrates and *Leucaena leucocephala*, respectively on Napier grass-based rations in a 15-week trial.

In the present study voluntary dry matter intake (DMI) increased with increasing levels of mulberry from 1.01 kg/d to 1.21kg/d for goats on T1 and T3 diets, respectively. Gonzalez and Milera (undated) observed a similar trend with goats fed Guinea grass supplemented with mulberry. Malamsha et al. (1997) fed goats Napier grass supplemented with mulberry leaves and obtained similar results. The DMI for T3 was significantly higher (P=0.037) than for T1. This could be due to the mulberry leaves being more bulky than the commercial concentrate and the animals needing to satisfy their nutritional requirements. There were no significant (P>0.05) differences in DMI between goats in treatments 1 and 2 and between treatments 2 and 3.

Table 3 Mean liveweight, liveweight gain, average daily gain, feed intake, and feed conversion values of goats on three treatment diets.

	Levels of mulberry/concentrate in dry matter						
	T1	T2	T3	Mean	sed (6 df)	P	LSD
	0/100	50/50	100/0				
Initial liveweight (kg)	19.1	19.6	20.5	19.7	2.08	0.798	5.08
Final liveweight (kg)	31.3	32.0	33.1	32.2	2.93	0.829	7.17
Average daily gain, g	123.0	125.0	121.0	123.0	24.7	0.988	60.5
Dry matter intake/d, kg	1.01	1.12	1.21	1.11	0.057	0.037	0.14
Crude protein intake/d, kg	0.12	0.13	0.13	0.13	0.008	0.516	0.02
Feed conversion, kg DM/kg gain	8.42	9.98	10.32	9.57	2.151	0.662	5.26

sed = standard error of the differences
LSD = least significant difference
DM = Dry matter

Neither crude protein intake (CPI) nor feed conversion rate showed any significant difference (P>0.05) between treatments. The CPI of 130 g/d for goats on the T3 (100% mulberry) diet proved adequate for maintenance and growth at 121.0 g/d ADG. The NRC (1981) protein requirement for maintenance is 4.15 g CP/kg $W^{0.75}$ plus an additional 14 g CP for 50 g/d gain for growth. This means that a growing goat at 32.2 kg liveweight and gaining 121.0 g/d would require 89.98 g CP/d. The above results suggest that these CP requirements were met from the dried mulberry.

CONCLUSION

The findings of the present study suggest that dried mulberry leaves are high in protein, highly digestible and comparable to commercial grain concentrates as a supplement to growing goats fed a basal diet of pangola grass hay. The mulberry leaf meal produced ADG similar to that produced by the commercial grain concentrate. Its high digestibility and nutritive value make it an excellent feed for goats in a stall fed production system. It can be used effectively as a substitute for commercial grain concentrate in the diet of growing goats.

Studies to assess the economics of production and the cost of gain are needed to properly evaluate the place of mulberry in commercial goat production systems. Carcass evaluation studies are also needed.

ACKNOWLEDGEMENTS
The authors wish to thank the officers and livestock attendants at the Goat Research Unit, the Forage Unit and the Animal Nutrition Laboratory of the Bodles Research Station for their invaluable help in carrying out this study.

REFERENCES

Benavides J. 2001. Utilization of mulberry in animal production systems (part 1/3) http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGAP/FRG/MULBERRY/Benavid.tx

Boschini C F. 2002. Nutritional quality of mulberry cultivated for ruminant feeding. In Mulberry for Animal Production 171–182. M.D. Sanchez (ed.). FAO animal Production and Health Paper 147

Datta R K. 2001. Mulberry Cultivation and Utilization in India http://fao.org/waicent/faoinfo/agricult/agap/frg/mulber…/Datta.tx

Esquivel J, Benavides J E, Hernandez I, Vasconcelos J, Gonzalez J and Espinoza E. 1996. Efecto de la sustitucio_n de concentrado con Morera (*Morus alba*) sobre la produccio_n de leche de vacas en pastoreo. En: Resumenes. Taller Internacional "Los arboles en la produccio_n ganedera." EEPF "Indio Hatuey", Matanzas, Cuba. p25. Cited by Sanchez 2001b

Goering H K. and Van Soest P J. 1970. Forage fiber analyses (apparatus, reagents, procedures, and some applications) USDA Agr. Handbk. No. 379.

Gonzalez E and Milagras Milera (undated) Mulberry in livestock feeding systems in Cuba: Forage quality and goat growth www.fao.org/WAICENT/FAOINFO/AGRICULT/AGA/AGAP/FRG/MULBERRY/Papers/HTML/Gonzalez.htm

Lawes Agricultural Trust 1996. GENSTAT 5 Release 3.2 Statistical package. Rothamstead Experimental Station, Harpendon

Malamsha P C, Muhikambele V R M and Mtenga L A. 1997. White mulberry (*Morus alba*) as a potential feed supplement for stall- fed growing goats in highland areas of Tanzania http://www.ihh.kvl.dk/php/Tsap99/17-malamsha.htm

NRC, National Academy Press 1981. Nutrient Requirements of domestic animals, Nutrient requirement of goats

Sanchez M D. 2001a. World distribution and utilization of mulberry and its potential for animal feeding In Mulberry for animal production p 1–9. M.D. Sanchez (ed.) FAO Animal Production and Health Paper 147

Sanchez M D. 2001b. Mulberry: An exceptional forage available almost worldwide www.fao.org/decrep/x3770t05.htm

Schmidek A, Takahshi R, Nunez A and de Resende K T. 2001. Potential and effective degradation of mulberry clones in goats. In Mulberry for animal production p213 –217 M.D. Sanchez (ed.) FAO Animal Production and Health Paper 147

Shayo C M. 1997. Uses, yield and nutritive value of mulberry (*Morus alba*) trees for ruminants in the semi-arid areas of central Tanzania. In Tropical grasslands 31:599–604

Yao J, Yan B, Wang X Q and Liu J X. 2000. Nutritional evaluation of mulberry leaves for ruminants. http://www.cipav.org.co/irrd12/2/yao122.htm

Yates N G and Panggabean T. 1988. The performance of goats offered elephant grass (*Pennisetum purpureum)* with varied amount of leucaena or concentrate. Tropical grasslands 22 (3) 126 – 131. Cited by Malamsha et al. 1997.

EDITORIAL GUIDELINES

The aim of CARDI Review is to highlight quality research by scientists working or collaborating with CARDI. Articles are subject to full scientific scrutiny before they are published. All manuscripts should be submitted to the editor of CARDI Review in electronic form. The e-mail address for the editor is biometrics@cardi.org or ic@cardi.org. The preferred format for submission is Microsoft Word, but most versions of Word Perfect can also be read.

Manuscripts should be sent with double spacing. Authors are encouraged to examine articles published in CARDI Review and follow the same style and layout. Authors should also follow the rules and procedures outlined in "CARDI Communications Guide 2 – Guide for Technical Writers". This publication is available from CARDI, P.O. Bag 212, University Campus, St. Augustine, Trinidad and Tobago (ic@cardi.org).

It is expected that most articles which are published will be between six and 20 pages in length; abstracts will be between 100 and 300 words; the title will be informative but not lengthy and there will be between five and 10 keywords. Tables are numbered serially and figures are also numbered serially. Table titles appear above the table to which they refer and figure captions appear below the figure.

Prospective authors who require more information or detail may request this from the editor.