The Shrub *Cratylia argentea* as a Dry Season Feeding Alternative in Costa Rica

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CRATYLIA is a neotropical genus that occurs naturally south of the Amazon river through the area east of the Andes in Brazil, Perú, Bolivia and Argentina. *C. argentea* (syn. *C. floribunda, Dioclea floribunda*) is one of five species presently identified in the genus and the most widespread in South America (Queiroz and Coradin 1995).

It is a shrub that branches from the base of the stem and reaches 1.5 to 3.0 m in height. It is well adapted to subhumid climates with a 5–6 month dry season and infertile acid soils with high aluminum content in tropical areas below 1200 masl. However, this shrub responds to better conditions and yields of edible tissues (leaves and young stems) can reach over 20 t/ha/yr dry matter in humid environments on soils of medium to high fertility. It is currently used as a protein complement to sugar cane or king grass for supplementing lactating dairy cows during the dry season (Argel and Lascano 1998).

Response to Cutting

C. argentea regrows well after cutting even during the dry season. It can first be cut four months after planting, without affecting subsequent persistence. Yield is increased to a plant density of at least 20 000 plants/ha, which is a plant spacing of 1 m × 0.5 m (Table 1). From 30%–40% of the total growth occurred during the dry season, which lasted from 5–6 months during the experimental period of 2.5 years.

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Table 1. Effect of plant density and age at first cut on DM yields of *C. argentea* (CIAT 18516) cut every 60 days at 70 cm height, Costa Rica (P. Argel, unpublished data).

Density	Plant age at first cut (months)			Mean	Yield estimate
	4	6	8		
(plants/ha)	(kg/plant)				(kg/ha)
20 000	0.16	0.15	0.24	0.19 a*	3700 a
10 000	0.28	0.25	0.23	0.25 b	2500 b
6667	0.34	0.36	0.36	0.35 c	2300 c
Means	0.26 a	0.25 a	0.27 a		

*$P < 0.05$.

A cutting trial in progress shows that a 30% higher yield can be obtained by cutting at a height of 90 cm than by cutting at 60 cm height. Further, regrowth (leaves + fine stem) at 60 days has a crude protein content of 20% vs 16% for regrowth at 90 days (M. Lobo, unpublished data).

Cratylia as a Protein Supplement for Lactating Cows

Experimental feeding trials at CIAT in Colombia demonstrated that *C. argentea* could be used as a protein supplement for low quality grasses in the dry season (Wilson and Lascano 1997). However, the best response was obtained when the *C. argentea* was fed with a high energy supplement such as sugarcane to cows of medium to high genetic potential for milk production grazing low quality grasses (Argel and Lascano 1998).

In sites with a 5–6 month dry season in Costa Rica, there is a need to supplement cows with concentrates to maintain acceptable levels of milk production. Concentrates are becoming a very expensive input as real prices received for milk are decreasing. It has now been demonstrated on experiment stations and on-farm that *C. argentea* fed fresh or as silage

with sugar cane or king grass can replace concentrates at a much reduced cost for the farmer.

The initial experimentation was carried at the Livestock College for Central America, (ECAG), Atenas, Costa Rica. This is located at 460 masl, has annual mean temperature of 23.7°C, and mean precipitation of 1600 mm. Six mature Jersey cows within 50 days postpartum were randomly assigned to three treatments and then rotated through the other treatments using a cross-over Latin square design. Each treatment period comprised 12 days, 7 for adaptation and 5 for measurement. A low amount of concentrate was fed with the *Cratylia* treatments as cows were accustomed to receiving some concentrate and this kept them quiet during feeding and milking.

The treatments were:

T1 = sugarcane (1% BW) + rice polishings (0.5% BW) + concentrate (1.48% BW) + urea (0.02% BW).

T2 = sugarcane (1.3% BW) + concentrate (0.5% BW) + freshly cut *Cratylia argentea* (1.2% BW).

T3 = sugarcane (1.1% BW) + concentrate (0.5% BW) + silage of *Cratylia argentea* (2.4% BW).

Nutritional characteristics of supplement:

Sugar cane: % CP, 3.0 Mcal ME.

Concentrate: 14% CP, 2.3 Mcal ME (mixture of corn and soybean).

Rice polishings: 12% CP, 3.0 Mcal ME.

Fresh *Cratylia*: 20% CP, 1.8 Mcal ME (from 90 day regrowth cut at 30 cm).

Cratylia silage: 16.4%CP, 1.9 Mcal ME (from 180 day regrowth cut at 30 cm).

There was no significant differences ($P < 0.05$) in DM intake, milk yield or total solids between the Jersey cows fed with silage and fresh *C. argentea* and those fed on a full concentrate diet during a dry period. The full concentrate diet had a higher amount of milk protein ($P < 0.01$) while the silage increased the milk fat ($P < 0.06$). The lowest cost supplement was the one based on freshly cut *Cratylia*. The high cost of the diet containing silage made from *Cratylia* was due to the high labour cost on the station of harvesting and separating edible portions of 6-month old *Cratylia* regrowth.

Similar trials have been repeated on small farms in the Central Pacific coast area of Costa Rica. We report one trial on a farm where *Cratylia* was fed fresh or as silage conserved during the rainy season and where the main concentrate fed is dried chicken manure.

The trial was conducted in a small farm located in Barrancas at an altitude of 280 masl, annual mean temperature of 28°C, mean precipitation of 2500 mm, and with a 5 months dry season. Six crossbred Swiss Brown × Brahman cows in the third month of lactation were randomly assigned to the three treatments and then rotated through the other treatments using a a cross-over Latin square design. Each treatment period comprised 10 days, 7 for adaptation and 3 for measurement. A low amount of rice polishing was fed to all cows to ensure that they were quiet during milking.

Treatments:

T1 = 12 kg sugarcane + 6 kg *C. argentea* silage + 0.6 kg rice polishings.

T2 = 12 kg sugarcane + 6 kg *C. argentea* fed fresh + 0.6 kg rice polishings.

T3 = 12 kg sugarcane + 3 kg chicken manure + 0.6 kg rice polishings.

Nutritional characteristics of feed:

Sugarcane: 2.1% CP, 3.0 Mcal ME

Chicken manure: 19.5% CP (ME not measured).

Rice polishings: 12% CP, 2.9 Mcal ME.

C. argentea fresh: 20% CP, 1.8 Mcal ME.

C. argentea silage: 16.5% CP 1.9 Mcal ME (pH 4.5, 36% DM.).

Milk yields in all treatments were similar though slightly higher in the treatment where *Cratylia* was fed fresh (Table 3). Milk fat and total solids were higher in the treatments with *Cratylia*. The cost of supplementation was lower with *Cratylia* with the result of a higher cost to benefit ratio for the farmer. Also the costs of using *Cratylia* were much cheaper than those estimated for the research station. Farmers cut all material from 3–4 month regrowth when making silage and do not separate them into leaves and stems.

Our results show that there is a beneficial effect of using *Cratylia* as an on-farm protein supplement. Furthermore farmers have contributed to the development of the technology in initiating the conservation of *Cratylia* as silage and using it fresh to feed other farm animals like pigs and horses. Three years after introduction of *Cratylia* to pilot farms, there is an increasing interest by other farmers in the area. This is shown by the distribution in 1999 of 79 kg of experimental seed by the Seed Unit of CIAT in Costa Rica, plus seed sold by pioneer farmers to their neighbours.

Management

C. argentea produces abundant seed with no evidence of either physical (hard seed coat) or physiological dormancy. Viability is high but can diminish rapidly when stored under humid conditions due to seed deterioration and fungal attack. It is best propagated using non-scarified seed and must be sown at less than 2 cm depth. It responds to

rhizobia inoculum with CIAT strains 3561 and 3564 (Argel and Lascano 1998).

It is a robust shrub and coppices freely when cut. It recovers well from accidental fires. The youngest leaves are less palatable than older leaves. Intake is increased when *Cratylia* is cut the day prior to feeding and allowed to wilt before feeding. It is acceptable to cattle, horses, pigs, sheep and goats.

In the dry pacific coast of Central America, natural or improved pastures provide sufficient feed of reasonable quality during the rainy season. Feeding trials show no response to *Cratylia* unless it is fed as 100% in the supplement. Farmers themselves do not see the need to use *Cratylia* as a supplement during the rainy season and the idea and first experiments with making and feeding silage were carried out by them. It is obvious after the first few trials that *Cratylia* fed as silage does not have the same value as freshly cut material.

One of the reasons is that it is generally cut at a later stage of regrowth than when fed fresh and so the material ensiled is of lower quality than material cut earlier and fed fresh. Also there is probably some loss in feeding value during the ensiling process. Nevertheless, there is an advantage in farmers producing silage as it decreases the area of *Cratylia* that needs to be managed as a protein bank. Research is underway to study the effect of adding different proportions of molasses, and different sources of energy such as sugar cane and maize, on quality *Cratylia* silage.

It has been observed that dense strips or banks of *Cratylia* can be grazed continuously by cattle without harming the plant. The growing tips tend to be avoided and the good coppicing ability ensures rapid recovery from trampling or grazing pressure. Direct animal intake of immature *Cratylia* forage is low (Raaflaub and Lascano 1995), and for this reason it would seem to be an ideal plant for strip grazing, given that the plant would be preferentially grazed when mature and when the companion grass is of low quality, as is the case in the dry season.

The current research emphasis is to evaluate the contribution of direct grazing of *Cratylia* on milk production when sown in strips in association with a grass. It could also be sown in contour strips in permanent pastures to provide supplementary feed when needed.

Limitations

- Lines of *C. argentea* studied so far (CIAT 18516 and CIAT 18668) do not adapt well to cool environments (over 1200 masl in the tropics).
- *C. argentea* establishes slowly, although faster than other shrub legumes like *Leucaena leucocephala*. Thus, production is low during the first year.

Table 2. Dry matter intake and milk production of Jersey cows fed different diets during the dry season in Costa Rica (F. Romero and J. Gonzalez, unpublished data).

Treatments	DM intake	Milk yield	Fat	Protein	Solids	*Cost of supplement	Benefit cost ratio
	(kg/cow)	(kg/cow/d)	%	%	%	($/kg DM)	
T1. Concentrate	10.8	11.1	3.5	3.4	12.4	0.20	1.33
T2. Fresh *C. argentea*	10.7	10.9	3.7	3.2	12.5	0.16	1.68
T3. Silage of *C. argentea*	10.4	10.7	3.8	3.2	12.5	0.43	0.62
Sig. difference	ns	ns	P < 0.06	P < 0.01	ns		

*Supplement includes the cost of all ingredients in the supplement except sugarcane.

Table 3. Average milk yield of dual-purpose cows supplemented with *Cratylia argentea* either fresh or as silage and with chicken manure (M. Lobo and V. Acuna, unpublished data).

Treatments	Milk yield	Total solids	Fat	Cost of supplement	Benefit cost ratio
	(kg/cow/d)	(%)	(%)	($/kg DM)	
T1. *Cratylia* as silage	5.1 b	12.3	3.6	0.17	1.58
T2. Fresh *Cratylia*	5.5 a	12.2	3.4	0.11	2.37
T3. Chicken manure	5.3 a b	11.7	3.0	0.22	1.14

Summary and Conclusions

Cratylia argentea provides an interesting example in time path for identification and evaluation of a new species. Seed was collected in Brazil in 1980 and again in 1984, then evaluated in the RIEPT network during the late 1980s. It showed promise not only in several sites in Latin America (Isla in Mexico, La Ceiba in Honduras, and several sites in Costa Rica, Colombia and Brazil) but also in West Africa (CIAT 1995).

However, it was not until scientists realized a need for shrub legumes tolerant to acid infertile soils for small farm use in hillside agriculture that there was a major effort to evaluate the shrub more intensively, starting in 1996. It has been shown since that it is indeed widely adapted and at this stage appears to have most promise as a commercial species in Central America, rather than in the Cerrados where it originated.

Management does not appear to be a problem for small farmers. It establishes readily from seed, though production is low during the first year. Regrowth is vigorous after cutting. Yield increases as the plant matures (up to 0.5 kg of DM/plant every 3 months up to a plant age of 5 years, plants at 1.0 × 1.0 m spacing).

The shrub produces high yields of good quality forage (19%–26% CP and 40%–55% IVDMD, depending of plant maturity); a high proportion of this yield is produced during the dry season. For this reason, *C. argentea* is a shrub with high potential as a protein supplement for high energy forages like sugar cane or king grass in cut and carry systems.

Dual-purpose or dairy cows grazing protein-deficient grasses during the dry season and supplemented with sugar cane and *C. argentea*, have produced similar milk yields to animals fed with more expensive concentrates, giving greater economic returns to farmers.

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