

**PROGRESS REPORT**

**Improved Legume-based Feeding Systems for Smallholder  
Dual-purpose Cattle Production in Tropical Latin America**

**An output of the Tropileche Consortium**

**Federico Holmann  
Peter Kerridge  
Carlos Lascano**

**International Center for Tropical Agriculture**

**September 1999**

## Table of Contents

	<b>Page</b>
<b>Executive Summary</b>	1
<b>Introduction</b>	4
<b>Component 1. Optimization of forage utilization</b>	6
Activity 1.1 Feeding and grazing trials to determine relationships between milk production and forage resources	6
Activity 1.2 Feeding and grazing trials to determine the most effective dry season supplementation using different forage resources	10
<b>Component 2. Development of new on-farm feeding systems for dual-purpose cattle</b>	14
Activity 2.1 Evaluation of different forage systems with dual-purpose cattle	14
Activity 2.2 Evaluation of improved forage-based feeding systems to allow early weaning	22
Activity 2.4 Workshops to discuss and analyze current and future research programs	25
<b>Component 3. Utility of the new forage systems</b>	27
Activity 3.2 Dissemination of research results	27
<b>List of publications</b>	29
<b>List of proposals developed</b>	32
<b>Trips and meetings of the Consortium Coordinator</b>	33
<b>List of Consortium Collaborators</b>	34

## EXECUTIVE SUMMARY

The project “Improved Legume-based Feeding Systems for Smallholder Dual-Purpose Cattle Production in Tropical Latin America” is a CIAT-led consortium that operates under the Systemwide Livestock Programme (SLP) convened by ILRI. The consortium consists of scientists from CIAT, ILRI and national agricultural research organizations in Peru (IVITA, CODESU, INIA, FUNDAAM), Costa Rica (MAG, ECAG, CATIE, UCR), Nicaragua (IDR), and Honduras (DICTA). The strategy to improve feeding systems is through:

- an evaluation of new feed resources to match nutritional requirements of animals
- on-farm evaluation of new legume-based forage components, and
- economic analysis, and acceptability/adoption studies.

The results generated in this second year of the project further confirm that improved grasses and legumes can have a significant impact in animal production.

Applied research has demonstrated the value of the shrub legume *Cratylia argentea* fed as silage in addition to its value when fed fresh. Milk yields are maintained at similar levels as with protein sources from commercial concentrates but at lower cost. There is a need for more information on the best manner to manage *Cratylia* for silage production. New information has been obtained on producing a high protein supplement from *Cratylia*. A cutting interval of 60 days at a height of 90 cm produces feed with higher crude protein, 19%, than cutting at 90 days, with only a small reduction in dry matter yield.

Applied research also provided information on frequency of feeding on N utilization. Results indicated that feeding twice a day with legumes only results in higher N uptake when a high level of supplement is fed (eg., 1% BW).

On-farm research with *Cratylia argentea* only began last year. It has now been confirmed through on-farm trials that it can be effectively used as a supplement to replace protein concentrates fed either fresh or as silage. The most economical option for a producer in the dry season is to supplement cows with freshly-cut *Cratylia* though feeding as silage is also more economical than feeding purchased commercial concentrates or chicken manure. Producing silage from *Cratylia* during the rainy season when it is not needed as a supplement will reduce the size of the protein bank that farmers need to plant and maintain.

Grass-legume associations are a viable option for improving feed quality and increasing milk yields. *Arachis pintoii* - *Brachiaria* associations increase the milk yield by 8% over that of straight grass when legume content in the diet is near 30%, even where cows are supplemented with commercial concentrates. This is provided that cows have a moderate to high genetic potential for milk production.

The results obtained on the use of *Stylosanthes guianensis* in the forest margins of Colombia for pre-weaned calves are similar with those obtained last year in small dairy farms in Pucallpa, Peru. When *stylo* was fed to calves, the amount of milk for sale was 21% higher than recorded with cows whose calves were managed in the traditional system. Liveweight gain of calves with access to *stylo* was 30% higher than in the control group. In addition, *stylo* was shown to increase the yield of a subsequent rice crop and thus could be included in a rotational system with agricultural crops.

The database available in the Tropileche web page containing research results on dual-purpose cattle systems in LAC since 1960 continues to be expanded and consulted. During the last year an average of 3.1 entries were recorded per day. This web page also contains information about other research centers in LAC working with dual-purpose cattle. We also use it to share research results generated by the project.

Steps to disseminate these technologies has commenced. This year a 11-min video was produced, with our national partner Ministry of Agriculture (MAG) in Costa Rica, about the adaptation of *Cratylia* and *Arachis*-based technologies by a small farmer, Antonio Lopez. Antonio is currently producing more milk on less area, has doubled his family income, and has released areas from the livestock enterprise to serve as protected areas for timber production and protection of water sources. This videotape will be used for disseminating information to other farmers in Latin America.

In addition to this video, farmers collaborating with the project are sharing their experiences with other farmers through field days organized by MAG. Next year it is planned to produce and distribute pamphlets on management of new feeding systems to producers through extension services.

The impact generated by the project is shown by:

- (a) other countries evaluating the new technologies. In Nicaragua and Honduras, our partners IDR and DICTA have established more than 65 ha of improved forages in 20 farms located in 5 sites;
- (b) Spontaneous adoption of *Cratylia argentea* is occurring in Costa Rica. During the last 12 months 84 kg of experimental seed has been sold to 28 farmers located in four different sites.
- (c) Ecuador and Bolivia have expressed their interest in joining the project. Proposals are being prepared with our partners INIAP and CIAT-Santa Cruz to commence research activities in small dual-purpose farms.

The challenge ahead is to facilitate wider evaluation of herbaceous and shrub legumes by small farmers and the production of seed of selected legumes. We are identifying new research needs from problems that are being experienced by farmers evaluating the new technologies. To effectively accomplish these objectives we need to continue building strong linkages between the project and other ILRI and CIAT Projects, NARS partners and the private livestock and seed sectors.

## INTRODUCTION

The objective of the project “Improved Legume-based Feeding Systems for Smallholder Dual-Purpose Cattle Production in Tropical Latin America” is to increase milk and beef production of dual-purpose livestock in smallholder farms through the development of improved forage-based feeding systems.

The value of livestock production in Latin America and the Caribbean (LAC) represents nearly 13% of the world production and nearly 47% of the production in developing countries. Milk and meat provide 20% of the protein consumed by the population of LAC. However, LAC has a 12% deficit in milk production which is currently supplied by imports.

The livestock population in LAC is about 330 million head and nearly 78% of this population is in the hands of small farmers with dual-purpose cattle systems (ie., producing milk and beef from the same system). The dual-purpose cattle system accounts for 41% of the milk produced in the region. In addition, there are 590 million hectares of pasture land, half of these now considered to be in an advanced stage of degradation.

The project "Improved legume-based feeding systems for smallholder dual-purpose cattle production in Tropical Latin America" is a CIAT-led consortium that operates under the Systemwide Livestock Programme (SLP) convened by ILRI.

Study sites include the dry hillsides of Central America (Costa Rica, Nicaragua, and Honduras) and the forest margins of the Amazon (Colombia and Peru). These sites were selected because livestock production is an important form of land use and economic activity by smallholders. They are agroecosystems subject to severe environmental degradation, and are areas dominated by resource-poor farmers.

In the forest margins, low quality feed from degraded pastures limits milk production. In the seasonally dry hillsides, the major feed constraint to increasing milk production is the lack of high quality forage from the naturalized pastures during the dry season. Other factors also limit milk production such as the genetic potential of cows for milk production and, in the forest margins, low market demand.

The strategy to solve the feed constraint is through (a) an evaluation of new feed resources to match nutritional requirements of animals, (b) on-farm participatory evaluation of new legume-based forage components to intensify livestock production and enhance sustainable land use, and (c) characterization of benchmark sites, economic analysis, and acceptability/adoption studies.

The project teams build on the existing capability of CIAT in forage development and land use characterization, of ILRI in livestock production, and national agricultural research organizations active at the benchmark sites in Perú (IVITA, CODESU,

INIA), Costa Rica (MAG, ECAG, CATIE, UCR), Nicaragua (MAG), and Honduras (DICTA).

The project is financed jointly from the Inter-american Development Bank (IDB) and the German Development Agency (GTZ) through the Systemwide Livestock Program. The objective of this report is to inform about the activities carried out in each research component executed during July 1998 to June 1999.

## PROGRESS REPORT

### RESEARCH RESULTS

#### COMPONENT 1

#### OPTIMIZATION OF FORAGE UTILIZATION

##### Scientist-led research on-station and on-farm

##### Activity 1.1

##### Feeding and grazing trials to determine relations between milk production and forage resources.

##### Highlight

- Response in milk yield during the dry season to legume supplementation, either fresh or as silage, of sugarcane, is similar to yields obtained using commercial concentrates

##### Effect on milk yield and its components from feeding *Cratylia argentea* either fresh or as silage during the dry season

**Rationale.** In agroecosystems with prolonged droughts, supplementation to dairy cows with legumes such as *Cratylia argentea* cut fresh during the dry season has been successfully used to replace concentrates and maintain milk production. However, the use of this legume during the rainy season did not seem justified to farmers because of the abundant biomass available for grazing. Some of them began conserving *C. argentea* as silage. The next step was to evaluate the use of *Cratylia argentea* cut fresh or conserved as silage to replace protein concentrates during the dry season.

**Methods.** This study was carried out from 25 February to 20 April, 1999 in the Escuela Centroamericana de Ganaderia (ECAG) Atenas, Costa Rica. Atenas is at an altitude of 460 m.a.s.l. with an annual mean temperature of 28°C.

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); and

T3= sugarcane (0.1% BW) + concentrate (0.5% BW) + silage of *Cratylia argentea* (2.4% BW).

Six mature Jersey cows within 50 days of postpartum were randomly assigned to the three treatments in a cross-over Latin square design in which each pair of cows were fed the three treatments simultaneously and then rotated through the other treatments.

The *Cratylia* silage was made from a 6-month old regrowth of a protein bank cut at a height of 30 cm. The chemical composition of the silage was 16.4% crude protein (CP) and 1.9 Mcal of metabolizable energy (ME). The fresh *Cratylia argentea* was from 3-month old regrowth cut daily at a height of 30 cm. The chemical composition was 20% CP and 1.8 Mcal ME. Both sources of *Cratylia* were mixed with the sugarcane.

The nutritional content of the sugarcane was 2% CP and 3.0 Mcal ME. The commercial concentrate was mixed at ECAG and made primarily from corn and soybeans with a composition of 14% CP and 2.3 Mcal ME. The rice polishing had a composition of 12% CP and 3 Mcal ME.

Each treatment period comprised twelve days, seven for adaptation and five for sampling for total milk production, and during days 1, 3 and 5, for the following variables:

- (i) Milk quality: Samples were taken from both milkings (100 ml/cow/milking), and analyzed for fat, protein, lactose, total solids and non-fat solids.
- (ii) Dry matter intake and quality (IVDMD) of offered and rejected material;

**Results.** There was no significant differences among the three rations offered with regards to dry matter intake between *C. argentea* fed fresh (10.7 kg/cow/day) or as silage (10.4 kg/cow/day; Table 1). Also there was no difference with respect to milk yield and its components except for the milk protein ( $P < 0.01$ ), which was greater in the treatment where concentrate was utilized and a trend ( $P < 0.06$ ) for higher fat concentration where *C. argentea* was fed as silage.

Most importantly, the level of milk production achieved with rations of *C. argentea* fed fresh or as silage (10.9 and 10.7 kg/ cow/ day, respectively) were similar to those obtained with a typical concentrate for dairy cows where the protein source comes from corn and soybeans (11.1 kg/cow/day).

There were large differences ( $P < 0.0001$ ) in the production costs for the different treatments, that with freshly cut *C. argentea* being the lowest and *C. argentea* fed as silage the highest. The cost of *C. argentea* silage was very high due to the amount of labor required to separate the edible leaf and fine stem from the six-month old regrowth.

Table 1. Feeding cost, dry matter intake, and milk production and its components by treatments.

Treatment	FeedCost	DM Intake	Milk Yield	Fat	Protein	Lactose	TS	NFS
	(\$/kg milk)	kg/cow	kg/cow			(%)		
Concentrate	0.20	10.8	11.1	3.53	3.36	4.80	12.39	8.86
Fresh <i>Cratylia</i>	0.16	10.7	10.9	3.69	3.24	4.84	12.47	8.78
<i>Cratylia</i> silage	0.43	10.4	10.7	3.81	3.22	4.76	12.49	8.68
Significance level		P<0.59	P<0.27	P<0.06	P<0.01	P<0.35	P<0.74	P<0.09

**Impact.** The results from this experiment demonstrate that complementing a high energy feed, such as sugarcane, with *Cratylia argentea* during the dry season maintains milk yield at a similar level as do protein sources from a commercial concentrate. Using fresh-cut *Cratylia* was cheaper than feeding it as silage. It will be useful to investigate if silage made from 3-4 month old regrowth reduces labor requirement and hence cost of the silage. It is important that an economic use be found using *Cratylia* leaf produced during the rainy season. Possible alternative uses to making silage are feeding as a fresh supplement during the rainy season (see below) or as a green manure to improve soil fertility for high value crops.

**Contributors:** F. Romero and J. Gonzalez, ECAG, Costa Rica.

### Effect on milk yield due to the inclusion of forage legumes in the diet of dual-purpose cows in Pucallpa, Peru.

**Rationale.** Despite the existence of forage legumes adapted to tropical conditions, the response in milk yield to legume supplementation has generally been modest or inconsistent in the Peruvian Amazon region of Pucallpa. Therefore, it was considered useful to evaluate legume supplementation under controlled conditions with the objective of estimating the effect on milk yield.

**Methods.** The experiment was carried out in the Experimental Station of IVITA in Pucallpa which is situated 270 m.a.s.l. and with annual mean precipitation of 2000 mm and mean temperature of 26°C.

Treatments were:

T1=Legumes - *Pueraria phaseoloides*, *Stylosanthes guianensis*, and *Centrosema macrocarpum*

T2=Proportion of legume feed in the diet - 0, 15, 30, and 45% with king grass (*Pennisetum purpureum* x *P. typhoides*)

Crossbred Zebu x Holstein milking cows from 20 to 90 days into the lactation were used as test animals. Feeding was arranged in a Latin square design with 2 cows per treatment at each cycle of the cross-over design.

The different diets were offered at 3% DM/100 kg liveweight and fed twice a day to confined cows over four consecutive feeding periods. Each period lasted 14 days, the first 7 days for adjustment and the remaining 7 days for data collection. Individual milk yields were recorded every milking during days 1, 2, and 5 of the data collection period. Samples were taken from both forage offered and refused for chemical analysis. Milk samples were analyzed for urea, fat, and non-fat solid contents.

**Results.** The trials using *P. phaseoloides* and *S. guianensis* have been concluded. Table 2 summarizes the results for milk yield, contents for milk urea nitrogen, fat, and non-fat solids, and liveweight gain.

Table 2. Values of different variables by proportion of legume in the diet of milking cows.

Legume	Milk Yield (kg/cow/d)	Urea content in milk (%)	Fat content in milk (%)	Non-fat solid content in milk (%)	Liveweight gain (g/cow/d)
<i>Pueraria phaseoloides</i> (% of diet)					
0	5.7	8.6	2.8		606
15	6.2	13.7	3.1		500
30	5.8	18.0	3.1		125
45	6.0	23.8	3.1		340
Significance level	>0.05	<0.05	>0.05		<0.05
<i>Stylosanthes guianensis</i> (% of diet)					
0	5.1	10.6	3.0	8.8	482
15	5.5	12.5	3.2	8.9	196
30	5.1	15.5	3.1	8.8	321
45	5.1	16.4	3.1	8.9	517
Significance level	>0.05	<0.05	>0.05	>0.05	<0.05

These results show that the only variables that were affected by increasing legume content in the diet were urea in the milk and liveweight gain. The increase of urea in milk had a linear and consistent pattern for both legumes. The higher rate of increase with *P. phaseoloides* than *S. guianensis* reflects the higher N concentration in the former. The response in liveweight gain was erratic with both legumes. Chemical analysis of the refused forage indicated that there was a slight reduction in total dry matter intake as the legume content of the diet was increased.

The reason why an increase in the protein content of the diet, which is reflected in the

increasing urea in the milk, did not increase milk production is not clear. Crossbred animals were used and should have been able to respond to increased protein in the diet. Data from the chemical analysis of forage consumed may assist in the interpretation of the results.

**Impact.** Under the conditions of energy/protein balance of the animals in this trial, legume intake increased the level of milk urea nitrogen but not milk yield. Thus, urea level in milk has potential as a metabolic indicator to protein intake and where the only variable source is legume, then the amount of legume in the diet.

**Contributors:** M. Ara, M. de la Torre and C. Reyes (IVITA), and I. Unchupaico (Universidad Nacional del Centro), Peru.

## Activity 1.2

**Feeding, and cutting trials to refine methods of supplementation during the dry season using different forage resources.**

### Highlights

- Nitrogen intake was higher with more frequent feeding at high levels of legume supplementation
- Frequent cutting of *Cratylia* is more important than cutting height for producing a high quality feed supplement

### In vivo studies on the complementarity between forage basal diet and legume supplement

**Rationale:** Previous results from confined feeding trials suggested that in supplementing available forage sources to overcome nutrient deficiencies in ruminants, it is important to synchronize feeding of the higher quality forage supplement with the basal forage so that energy and protein are available concurrently. On the other hand, synergism among forages may vary not only with the types of forages fed but also with how they are fed (level and frequency).

**Methods:** Eight African type weathers (24 kg LW) fed a low quality grass basal diet were randomly allocated to 4 treatments of supplementation with sugar cane (60%) mixed with *Cratylia argentea* (40%). Treatments arranged in 4x4 Latin Square design were:

T1- Low level of supplementation (0.5% of BW) fed once a day (AM),  
T2- High level of supplementation (1.0% of BW) fed once a day (AM),  
T3- Low level of supplementation (0.5% of BW) fed twice a day (AM+PM) and  
T4- High level of supplementation (1% of BW) fed twice a day (AM+PM).

Measurements included quality of the basal diet and supplements offered intake, digestibility and N balance.

**Results:** The low quality grass basal diet was low in CP (4.8%) and high in cell wall content (NDF 79% and ADF 44%). On the other hand, chopped sugar cane fed as an energy supplement was low in CP (3.1%) but had low cell wall content (39% NDF and 24% ADF). The legume (leaves of *Cratylia*) fed had high CP (21%) and high levels of cell wall (67% NDF and 37% ADF). Thus the supplement fed was high in energy and medium in protein (10% of DM). Intake of the basal diet did not differ among treatments, but there were differences in supplement intake due to treatments. As expected, intake of sugar cane and *Cratylia* tended to be higher when fed at the highest level. However, it is interesting to note that when supplements were offered at the high level, intake of sugar cane and *Cratylia* increased with twice-a-day feeding relative to once-a-day feeding (Table 4).

These differences in intake of supplements were not reflected in significant changes in DM or cell wall digestibility. Nevertheless, there was a tendency for higher digestibility with a twice a day feeding at both levels of supplementation.

As expected, N intake was highest with increased level of supplementation (Table 5); however at the high level of supplementation N intake was higher with twice a day feeding. Since fecal and urinary N did not change with treatment, N retention was greater when sheep were given the forage-based supplements at the high level and twice a day (Table 5).

**Impact:** With the forage-based supplement fed it was evident that level and frequency of feeding had an effect on nitrogen utilization by growing sheep. However, the results indicate that feeding twice a day would only be justified when high levels of forage-based supplements are offered. When the high level (1% of BW) of sugarcane/*Cratylia* was fed twice a day there was a 33% increase in N retention relative to feeding the same amount of supplement once a day. This was not the case when the low level (0.5% of BW) was offered.

Table 4. Effect of level and frequency of forage-based supplementation on intake and digestion by sheep fed a low quality grass.

Item	Frequency and level of supplementation*				SE
	AM** 0.5% BW	AM 1% BW	AM + PM*** 0.5% BW	AM + PM 1% BW	
<b>Intake (gDM/kgBW/d)</b>					
Basal diet	25.7	25.2	25.2	25.7	0.8
Sugar cane	2.5 b	3.3 b	2.8 b	4.0 a	0.4
Cratylia	2.0 c	3.1 b	2.0 c	3.6 a	0.1
<b>Digestibility (%)</b>					
DM	53.0	53.0	55.4	56.6	1.7
NDF	54.1	54.3	57.7	57.1	1.8
ADF	51.6	50.7	54.3	53.1	1.9

\*60% sugar cane + 40% *Cratylia argentea* (leaves)

\*\*Supplement fed once a day at 0.5 or 1% of BW

\*\*\*Supplement fed twice a day at 0.5 or 1% of BW

a,b,c Means different (P<0.05)

Table 5. Effect of frequency and level of forage-based supplementation on nitrogen utilization by sheep fed a low quality grass.

Item	Frequency and level of supplementation*				SE
	AM** 0.5% BW	AM 1% BW	AM + PM*** 0.5% BW	AM + PM 1% BW	
N Intake (g/d)	5.6 a	6.2 b	5.6 a	6.7 c	0.01
Fecal N (g/d)	3.5	3.5	3.3	3.5	0.1
Fecal N, % N intake	62.5 a	57.1 b	59.9 a	52.0 c	2.0
Urine N (g/d)	1.4	1.5	1.5	1.6	0.2
Urine N, % N intake	25.4	25.8	28.6	24.7	3.7
Retained N (g/d)	0.8 e	1.2 d	0.8 e	1.6 a	0.2

\*60% sugar cane + 40% *Cratylia argentea* (leaves)

\*\*Supplement fed once a day at 0.5 or 1% of BW

\*\*\*Supplement fed twice a day at 0.5 or 1% of BW

a,b,c,d,e Means different (P<0.05)

**Contributors:** W. Quiñonez, P. Avila, and C. Lascano, CIAT, Colombia.

## **Productivity of *Cratylia argentea* cut at different frequency and height in the Central Pacific region of Costa Rica.**

**Rationale.** The legume *Cratylia argentea* has proven to be an alternative to farmers because it provides forage biomass with a high protein content during the dry season. It is necessary to have more details of a management strategy to maximize the quality and quantity of biomass of *Cratylia* that guarantees the sustainability of the bank in the long-term. Earlier cutting studies had shown that yield increased with high density of planting (10,000 to 20,000 plants/ha) and that it could be cut as early as 4 months after planting without a long term effect on yield. In feeding trials, it has been observed the crude protein concentration of leaves is higher at a cutting frequency of 90 days (20%) cf. 180 days (16%). As the reason for supplementing with *Cratylia* is to provide a high protein feed, it was thought useful to investigate the effect of cutting more frequently and also learn if cutting height affected productivity in the longer term. We present the first years results of a cutting trial investigating these factors. The experiment was conducted on-farm under researcher control.

**Methods.** 210 plants from a protein bank of *Cratylia argentea* established in 1996 were divided into 3 groups of 70 plants each managed at three height levels: 30, 60, and 90 cm. Each group was then divided into two sub-groups of 35 plants each for two harvesting frequencies to give re-growth of 60 and 90 days. Plant spacing was 0.5 m between plants and 1 m between rows (20,000 plants/ha). Chemical analysis for crude protein, non-detergent fiber, acid detergent fiber, and lignin was performed on the edible portions (leaves and thin stems of approximately less than 6 mm thick).

**Results.** Results indicate that there was no significant difference in forage quality between cutting heights (30, 60 and 90 cm above ground level) for plants cut at either 60 or 90 days though the nutritional quality (higher CP and lower NDF) for material from plants cut at 60 than 90 days. Yield increased with a higher cutting height and at the lower cutting frequency (Table 3).

**Impact.** The slight reduction in biomass (8%) at the shorter cutting interval of 60 than 90 days is well compensated by a higher nutritive value (19% vs 16% CP). These results need to be made known to farmers growing *Cratylia* as a protein bank. It is planned to continue this trial over 2-3 years to determine if more frequent cutting is sustainable in the long term.

Table 3. Evaluation of *Cratylia argentea* at two ages of re-growth and three cutting heights.

Re-growth (days)	Cutting height (cm)	Height of re-growth (cm)	Re-growth Shoots (#)	DM %	CP %	NDF %	ADF %	Lignin %
	30	0.61	8.58	28.8	18.7	52.7	44.9	14.6
<b>60</b>	60	0.51	9.64	24.5	18.0	55.4	43.9	15.4
	90	0.70	13.44	22.5	19.1	57.9	43.9	15.3
	<b>Mean *</b>	<b>0.60</b>	<b>10.55</b>	<b>25.3</b>	<b>18.6</b>	<b>55.3</b>	<b>44.1</b>	<b>15.1</b>
	30	1.10	9.88	32.3	16.2	57.0	44.1	15.8
<b>90</b>	60	1.15	12.69	34.4	15.2	59.5	46.1	16.5
	90	1.24	14.53	33.9	15.9	61.8	44.2	16.0
	<b>Mean **</b>	<b>1.16</b>	<b>12.37</b>	<b>35.5</b>	<b>15.8</b>	<b>59.4</b>	<b>44.8</b>	<b>16.1</b>

\* Average of 5 cuts

\*\* Average of 3 cuts

**Contributors:** M. Lobo and V. Acuña, MAG, Costa Rica

## COMPONENT 2

### DEVELOPMENT OF NEW FEEDING SYSTEMS FOR DUAL-PURPOSE CATTLE

#### On-farm participatory research

##### Activity 2.1

#### Evaluation of different forage systems for dual-purpose cattle

##### Highlights

- Forage feeding systems for strategic supplementation during the dry season reduce the need for purchasing animal feed concentrates and increases income in dual-purpose farms
- The use of legumes with an energy source during the dry season maintains milk production

**Milk production with dual-purpose cows grazing *Brachiaria brizantha* associated with *Arachis pintoii* and *Centrosema brasilianum* during the rainy season in the Central Pacific region of Costa Rica.**

**Rationale.** The overall constraint limiting animal productivity in the Central Pacific region of Costa Rica is the low quality of naturalized grasses. There is a need to develop new feeding alternatives to overcome this limitation. In our on-farm work, some farmers have chosen to develop fodder banks (eg., of sugarcane and shrub legumes). For others this did not seem feasible because of high labor demand. Another alternative is to develop more productive grass-legume pastures to improve forage quality. This reports on-farm research with a farmer who did not wish to plant fodder banks and had relatively level land on which to establish improved pastures associated with legumes. Previously this farmer had had experience only with pure grass pastures.

**Methods.** Areas were selected for pure grass pasture and grass-legume associations. At the beginning of the 1996 rainy season, pure grass pastures and associations of 4 ha of *B. brizantha* with *A. pintoii* and *C. brasilianum* were established. There were two paddocks per treatment. The *B. brizantha* and *C. brasilianum* were established by seed at a rate of 4 kg/ha for each species and the *A. pintoii* with vegetative material at a rate of 1 t/ha. Both legumes were planted in furrows set at a distance 70 cm apart after the grass was established. Pastures were grazed for 5 days grazing by the dairy herd every month. Measurements were made only during the rainy seasons over the two years, 1997 and 1998 when milk yield was measured on days 1, 3, and 5.

**Results.** Tables 6 and 7 show forage biomass availability, botanical composition, and milk yield of cows grazing pure grass and the grass-legume associations. Biomass production was higher during both years in the pasture containing the greatest proportion of legume, which suggests that nitrogen fixation promoted greater grass growth. Likewise, milk yield was 8% higher than pure grass where there was 30% legume and only 3 to 5% higher where there was 20% legume.

Table 6. Forage availability and botanical composition of *B. brizantha* associated with different proportions of legumes during the 1997 and 1998 rainy seasons.

	Pasture with 20% legumes		Pasture with 30% legumes	
	1997	1998	1997	1998
Biomass (kg DM/ha)	4113	4483	5105	5408
Grass (%)	62	67	57	58
Legumes (%) *	22	18	31	27
Weeds (%) **	16	15	12	14

\* *Calopogonium muconoides*, *Zornia* spp *Aeschynomene* spp, *C. brasilianum* and *Arachis pintoii*.

\*\* *Mimosa modest*, *Amaranthus* spp, *Borreria* spp and others.

Table 7. Average milk yield (kg/cow/day) of dual-purpose cows grazing pastures with different proportions of legumes during the rainy season in 1997 and 1998.

Type of pasture	Milk production (kg/cow/d)		Increase (%)	
	1997	1998	1997	1998
Only grass	8.6	7.6		
Grass with 20% legumes	9.0	7.8	4.7	2.6
Grass with 30% legumes	9.3	8.2	8.1	7.9

**Impact.** The increase in milk production on the grass-legume associations occurred despite the fact that cows were receiving a daily supplementation of 5 kg of chicken manure and 1.5 kg of soybean hulls. Thus, the use of legumes in association with grasses increase milk yields, especially when the proportion is around 30% of total edible biomass. This could be due to a combination of higher biomass availability during the rainy season and higher N content in the diet.

**Contributors:** M. Lobo and V. Acuña, MAG, Costa Rica

### **Milk production of dual-purpose cows supplemented with *Cratylia argentea*, chicken manure, and sugarcane during the dry season in the sub-humid tropics.**

**Rationale.** In ecosystems with prolonged droughts such as the Central Pacific region of Costa Rica, the production and quality of forage biomass from grasses is reduced drastically. Producers solve this limitation by supplementing with agricultural by-products such as chicken manure. This by-product was inexpensive several years ago. However, its demand has been growing and therefore, its price in real terms has increased. As a result, producers are interested in the evaluation of alternatives to replace the use of chicken manure. We report three on-farm trials, two evaluating the replacement of chicken manure with *Cratylia argentea* and the other trial evaluating *Cratylia* fed fresh or as silage.

#### **Methods.**

Experiment 1. This trial was conducted during the dry season (April 1999) in a farm from a small producer located in Miramar in the Central Pacific region of Costa Rica. Miramar is at an altitude of 250 m.a.s.l. with an annual mean temperature of 28°C and mean precipitation of 2400 mm. Treatments evaluated were:

- T1= Control group, grazing only (naturalized and jaragua grasses),
- T2= Sugarcane + *C. argentea* + rice polishing + grazing,
- T3= Sugarcane + chicken manure + rice polishing + grazing.

Nutritional characteristics of feeds were:

Sugar cane: 2% CP, 3.0 Mcal ME.

Chicken manure: 19.5% CP, 1.8 Mcal ME

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)

A latin square design was used with the three treatments with two cows in each of them and with selected cows in the second month of lactation. Animals in treatment 2 received 12 kg of sugarcane, 8 kg of *C. argentea*, 0.6 kg of semolina, and 0.5 kg of molasses per cow in addition to grazing, while animals in treatment 3 received 3 kg of chicken manure instead of *C. argentea*. The experiment lasted for 30 days, where animals were rotated through each treatment for 10 days each (7 days of adjustment and 3 for data collection).

Experiment 2: This trial was conducted in a small farm located in Barranca in the Central Pacific region of Costa Rica. Barranca is at an altitude of 280 m.a.s.l. with an annual mean temperature of 28°C and mean precipitation of 2500 mm. Treatments evaluated were:

T1= Sugarcane + silage of *C. argentea* + rice polishing

T2= Sugarcane + fresh *C. argentea* + rice polishing; and

T3= Sugarcane + chicken manure + rice polishing.

A latin square design was used with three treatments with two cows in each one as in the above experiment. Animals were handled in individual groups and received for treatment 1 an averaged of 12 kg of sugarcane, 6 kg of *Cratylia silage* and 0.6 kg of rice polishing as fed; treatment 2 received 12 kg of sugarcane, 6 kg of *C. argentea*, and 0.6 kg of rice polishing; and cows in Treatment 3 received 12 kg of sugarcane, 3 kg of chicken manure and 0.6 kg of rice polishing. The experiment lasted for 30 days where the animals rotated on each treatment for 10 days each (7 days for adjustment and 3 days of data collection).

Experiment 3: This experiment was conducted on-farm as part of student thesis program. This trial was conducted in the middle of the dry season (February to May, 1998) in a small farm located in Barranca in the Central Pacific region of Costa Rica. Barranca is at an altitude of 280 m.a.s.l. with an annual mean temperature of 28°C and mean precipitation of 2500 mm. Treatments evaluated were:

T1= Chicken litter and molasses,

T2= Chicken litter, sugarcane, molasses and wheat bran,

T3= Chicken litter, molasses, *C. argentea*, and wheat bran

Details of the diet are presented in Table 10. The diets were balanced to be isonitrogenous and isocaloric with different quantities of supplements used. In D<sub>3</sub>, *C. argentea* contributed more than 75% of the CP requirements of animals but a small amount of chicken litter was included in the diet since observed intake of *C.*

*argentea* was not sufficient to balance N requirements. Animals had access to *H. rufa* pastures. The crude protein (CP) content and in vitro dry matter digestibility (IVDMD) for *Cratylia* was 19.2% and 58.4%, respectively, and for *H. rufa* was 3.9% and 33.9%, respectively.

A 3x3 Latin square change over design with three replications was used with a total of 9 crossbred cows between 60 to 80 days into lactation. Each of the three experimental periods consisted of 10 days of adaptation to treatments and 5 days experimental data collection..

### Results.

Experiment 1: Table 8 shows milk yield and composition, feeding costs, income from milk, and the benefit : cost ratio for the different treatments evaluated. As can be observed, milk yields between treatments 2 and 3 were not significantly different ( $p=0,076$ ), which suggests that *C. argentea* can be used to substitute for chicken manure without a decrease in milk production. In addition, these results indicate that when milk is produced with *Cratylia argentea*, the feeding costs are lower and the benefit : cost ratio greater, thus making this alternative more attractive economically to producers.

Table 8. Average milk production and composition, supplement feeding cost, milk income, and benefit : cost ratio of diets supplemented to dual-purpose cows with *Cratylia argentea* and chicken manure.

Treatments	Milk yield kg/cow/d	Total solids (%)	Fat (%)	Supplement Feeding Cost (\$/kg milk)	Income (\$/kg milk)	B:C Ratio
Grazing only	5.45 b	11.2	3.1	-	0.24	
Grazing + <i>Cratylia</i>	5.85 a b	11.5	3.2	0.11	0.25	2.22
Grazing + Chicken manure	6.29 a	11.2	2.9	0.22	0.24	1.08

Experiment 2: Table 9 show that the feeding alternatives based on *Cratylia argentea*, both as silage and as fresh leaf, were more economical than the alternative to supplement with chicken manure. In addition to *Cratylia* rations being more economical, the milk yields of cows consuming *Cratylia* either as fresh or as silage were similar to those with chicken manure. However, milk yields from cows consuming *Cratylia* silage were lower than those from cows consuming fresh *Cratylia*. Nevertheless, *Cratylia* silage might be used as a substitute for chicken manure because of lower feed costs.

Table 9. Average milk yield of dual-purpose cows supplemented with *Cratylia argentea* either fresh or as silage and with chicken manure.

Treatments	Milk yield (kg/cow/d)	Total solids (%)	Fat (%)	Supplement Feeding cost (\$/kg)	Milk Income (\$/kg)	B:C Ratio
Cratylia as silage	5,09 b	12,33	3,65	0.17	0.27	1.58
Fresh Cratylia	5.47 a	12,22	3,45	0.11	0.27	2.37
Chicken manure	5.26 a b	11,71	3,00	0.22	0.26	1.14

Experiment 3: Table 10 shows the effect on milk yield by treatment. Milk yield averaged 6.0 kg milk/cow/day and there were no significant differences between treatments. Milk fat was lower (2.7%) for the treatment which had a higher amount of sugarcane in the diet, but differences were not significant. The results clearly show that *Cratylia* can be used as a substitute for chicken manure, at least up to 82% of the diet.

Table 10. Diets offered to animals and milk yields for all treatments.

Diets	Consumption (kg/animal/day)	Milk yield (kg/cow/day)
<b>Diet #1</b>		5.9
Chicken manure	6.0	
Molasses	2.5	
<b>Diet #2</b>		6.0
Chicken manure	5.0	
Sugar cane	5.0	
Wheat bran	0.7	
Molasses	0.12	
<b>Diet #3</b>		6.1
Chicken manure	1.0	
Molasses	4.12	
Wheat bran	0.7	
<i>Cratylia argentea</i>	6.0	

**Impact.** Most farmers with dual-purpose cattle in recent years have been producing milk during the dry season using chicken manure. Results from this work clearly show that *Cratylia* can largely replace chicken litter as a protein supplement, without a significant reduction in milk yield. This is a very important finding given that the demand for chicken litter to supplement dairy cows has increased its price in many tropical regions and farmers can no longer afford to buy it. With the introduction of *Cratylia argentea* to cattle production systems in the Pacific region, the utilization of

chicken manure has declined in farms participating in the Tropileche Consortium to such degree that this year practically none was purchased. Therefore, the legume technology being promoted for dual purpose cattle farms has the possibility of allowing small producers to have access to a farm- grown protein supplement and to increase cash flow and profits. In addition, spontaneous adoption of *Cratylia argentea* is occurring in other locations in Costa Rica. During the last 12 months 84 kg of experimental seed has been sold to 28 farmers located in three different sites in Guanacaste, Nicoya, and around Esparza.

On the other hand, the most economical option for a producer in the dry season is to supplement cows with fresh *Cratylia*. The next best option is to supplement with *Cratylia* as silage. The least economical option is to supplement cows with chicken manure. As a result, the use of legume silage such as *Cratylia argentea* is recommended over the use of chicken manure. In addition, the use of legume silage allows producers to utilize smaller areas because more edible biomass is produced for dry season supplementation, especially in situations where the opportunity cost for labor during the rainy season is low.

**Contributors:** M. Lobo, V. Acuña, and J. Araya (MAG), M. Ibrahim, M. Franco, D. Pezo, and A. Camero (CATIE), Costa Rica

### **On- farm evaluation of new forage alternatives in dual-purpose farms in Honduras and Nicaragua.**

**Rationale.** The adoption of improved pasture technology is more expedite if farmers participate in the evaluation of selected and advanced pasture germplasm from research. Forage components based on adapted grasses and legumes have been identified during the last years by CIAT research projects, which have demonstrated significant increases in animal productivity and the improvement of soil organic matter and soil macrofauna. However, the adoption of new technologies, particularly the utilization of forage legumes, has been slow. Forage research projects, such as Tropileche, have on-farm components that allow farmers to participate in the development of new pasture technologies and thus increase dissemination and adoption.

**Methods.** Tropileche objectives and results have been shared with regional institutions, and the on-farm components included in their development and research programs. Experimental seed, assessment on pasture establishment and methodologies for on-farm pasture evaluation has been provided by CIAT; however, seed cost, the establishment of forage alternatives, and follow-up activities have been covered by the collaborating institutions in Honduras and Nicaragua with the technical assistance of Tropileche.

**Results.** During the planting period of 1998 and 1999 around 63 ha of new pasture components were successfully established in Honduras and Nicaragua by two collaborating institutions (Table 1). *B. brizantha* cv. La Libertad and the promising new line, *B. brizantha* CIAT 26110, either in monoculture or associated with *Arachis pinto* (cvs. Porvenir and Maní Forrajero), are the two grasses being promoted. Plots have been also established of the shrub legumes *Cratylia argentea* (CIAT 18668) and *Leucaena leucocephala* (CIAT 17263).

Twenty dual-purpose farmers are participating in this activity and it is evident the improvement in forage production of new components compared to traditional grasses such as Jaragua and *Paspalum* spp. However, monitoring the impact on animal productivity - particularly the increase in milk yield per cow – has not been done yet due to two reasons: (a) lack of resources, especially transportation and per diem, and (b) the Hurricane Mitch, which damaged a significant proportion of established alternatives and in addition, Mitch damaged most rural roads which has made the follow-up process more difficult.

**Table 1.** Areas planted with new forage options during the period July 1998-August 1999 by collaborators of the Tropileche Project in Nicaragua and Honduras.

Country (collaborator)	Site	Species planted	Area Planted (ha)	Farmers Involved (#)
Nicaragua (Proyecto de Desarrollo Lechero)	Esquipulas	<i>B. brizantha</i> cv. La Libertad +	2.8	1
		<i>A. pinto</i> cv. Porvenir cv. La Libertad	6.6	2
	Rivas	Cv. La Libertad	21.8	4
		<b>C. argentea</b>	0.7	1
		<b>L. leucocephala</b>	0.7	1
	El Rama	Cv. La Libertad	7.0 (39.6)	1 (10)
Honduras (DICTA)	Yoro- Yorito	Cv. La Libertad + <b>A. pinto</b>	7.5	3
		<i>B. brizantha</i> 26110 + <i>A. pinto</i>	3.5	2
		Cv. Llanero + <i>A. pinto</i>	2.0	1
	Comayagua	<b>C. argentea</b>	1.0	1
		Cv. La Libertad + <i>A. pinto</i>	7.5	2
		Cv. Llanero + <i>A. pinto</i>	2.0 (23.5)	1 (10)

**Impact.** Progress has been made during the last year in relation to the establishment of new forage components in collaboration with national institutions and farmers in Honduras and Nicaragua. The Tropileche project has been used as a platform to test and promote new forage alternatives at the farm level. The collaboration and acceptance by farmers has been good, but the documentation of the impact on animals and soils by the collaborating institutions has not been implemented yet.

On-farm work is costly and demands not only time and effort, but also resources like transportation facilities and operating capital for gas and per diem, which are frequently scarce at the national institution level, especially in poor countries such as Nicaragua and Honduras, both considered with Haiti the poorest countries in Latin America. Given this reality, it is suggested to consider giving these institutions additional resources in the form of operating capital to complement on-farm data collection and monitoring.

**Contributors:** Tito Fariñas (IDR, Nicaragua), Conrado Burgos (DICTA, Honduras), P. J. Argel and F. Holmann (CIAT).

## **Activity 2.2**

### **Evaluation of new feeding alternatives to allow an early weaning.**

#### **Highlights**

- Supplementing pre-weaned calves with legumes during the dry season results in more milk for sale and higher liveweight gain than with current management practice of feeding only grass
- The legumes grown for feeding calves contribute to soil N and might be incorporated in a rotational crop-legume fallow system

### **Use of *Stylosanthes guianensis* with pre-weaned calves in dual-purpose cattle systems in the forest margins of Colombia**

**Rationale:** The two main outputs in dual-purpose cattle farms are (a) milk and (b) weaned calves for fattening. Under traditional management, farmers usually favor selling as much milk as possible to increase their cash flow, but as a result calves suffer from under nutrition and mortality rates are high. Therefore, development of feeding systems that allow farmers to obtain more milk for sale and the same time result in good performance of pre-weaned calves is of high priority in dual-purpose cattle systems.

The idea of using *Stylosanthes guianensis* for grazing pre-weaned calves has been tested in Pucallpa, Peru. Results indicate that with this alternative farmers can sell

almost one more liter of milk/cow/day and still maintain adequate growth of their calves, which has important economical benefits. To further test the use of *Stylosanthes* for pre-weaned calves, we initiated a collaborative study this year with COPROICA partners in Macagual, Caqueta, Colombia.

**Methods:** A small paddock (2 ha) of *Stylosanthes guianensis* was established in the CORPOICA research station in Macagual, Caquetá to allow 1 to 3 months calves to freely graze after milking. Calves with access to *Stylosanthes* also received residual milk (milk remaining in the udder after hand milking) after each milking. Calves in the control treatment received milk from one quarter of the udder at milking and had access to a grass pasture after milking. In all cases calves remained with their dam for 3 to 4 hours after milking, before going to the grass or *Stylosanthes* pastures.

**Results:** The amount of milk for sale resulting from the use of *Stylosanthes* by pre-weaned calves was 21% higher than recorded with cows that had calves managed in the traditional systems (Table 12). In addition, liveweight gain of calves with access to *Stylosanthes* was 30% higher than in the control group during a 90-day period.

**Impact:** The results obtained in forest margins of Colombia on the use of *Stylosanthes guianensis* for pre-weaned calves are in agreement with those obtained in small dairy farms of Pucallpa, Perú. This technology could be very attractive to small dairy producers given that the cost of establishment of this legume is less than the establishment of legume-based pastures for the milking herd and it results in increased cash flow due to the extra milk for sale, without affecting calf performance. In addition, the *Stylosanthes* technology could form part of a crop-pasture rotation system eliminating the need to fallow land for secondary forest regeneration and subsequent slash and burn for annual crop production. This is because well managed *Stylosanthes* pastures can persist for 3 or 4 years and during this time produce a beneficial effect on the soil through N fixation and nutrient cycling.

Table 12. Milk for sale and growth of pre-weaned calves with and without access to a *Stylosanthes guianensis* pastura in Caquetá, Colombia.

Item	Control <sup>1</sup>	<i>Stylosanthes</i> pasture <sup>2</sup>
Milk for sale (l/cow/day)	3.3	4.0
Liveweight gain of pre-weaned calves (g/A/d)	297	389

<sup>1</sup>Six cows with calves

<sup>2</sup>Six cows with calves

**Contributors:** J. Velasquez, G. Ruiz, and C. Lascano, CORPOICA and CIAT, Colombia.

## **Rice yield (*Oriza sativa* L.) as an indicator of soil fertility with the incorporation of *Stylosanthes guianensis* stubbles in Pucallpa, Peru.**

**Rationale.** It has been demonstrated that pure fodder banks of *Stylosanthes guianensis* can be used for calf feeding (Tropileche Annual Report 1998). However, *Stylosanthes* only persists for 2-3 years under grazing and then needs to be replanted. As it is a legume that can also add N to the soil for a following crop, it was thought that its adoption by farmers might be enhanced if it could be demonstrated that it had a dual role, feed for calves and green manure in a rotation system. This study reports the evaluation of *Stylosanthes* as a legume for a potential crop-legume fallow system.

**Methods:** The experiment was conducted on a farmer's field with low fertility soils, acid pH, and highly saturated with aluminum (ultisoils). Farm is located near Pucallpa which is situated 270 m.a.s.l. and with annual mean precipitation of 2000 mm and mean temperature of 26°C. The experiment started in October of 1998 and concluded in February of 1999. Treatments were:

- T<sub>1</sub> = rice without N fertilization,
- T<sub>2</sub> = rice after *S. guianensis* without N fertilization,
- T<sub>3</sub> = rice after *S. guianensis* with 50 kg N/ha,
- T<sub>4</sub> = rice after *S. guianensis* with 100 kg N/ha,
- T<sub>5</sub> = rice after *S. guianensis* with 150 kg N/ha, and
- T<sub>6</sub> = rice after *S. guianensis* with 200 kg N/ha.

The variables evaluated were: Rice yield, number of tillers/m<sup>2</sup>, number of spiklets/m<sup>2</sup>, number of grains per spiklet, and weight per 1000 grains. The rice variety planted was "Chancabanco" with a 90-day vegetative period. All treatments received a basal application of 50 kg/ha of potassium chloride and 50 kg/ha as rock phosphate. The design was a completely randomized block with 6 treatments and 5 replications.

**Results:** Table 11 shows rice yield, number of tillers, and number of spiklets. Rice yield after the incorporation of *Stylo* stubble was significantly higher than the control. There were no significant differences to N fertilization above 100 kg/ha N. These results demonstrate that the incorporation of *Stylo* stubble can make a significant contribution of N to the soil for a following crop and there may be economical benefits from a rotation system incorporating *Stylo*.

**Impact.** *Stylosanthes guianensis* is a legume with the potential to benefit small farmers when used in a rotational system with agricultural crops because it can be used both as animal feed and increases crop yields through increasing available soil N.

Table 11. Effect of incorporation of *S. guianensis* and N fertilization on rice yield, and number of tillers and spiklets in Pucallpa, Peru.

Treatments	Rice yield (kg/ha)	Tillers (#/m <sup>2</sup> )	Spiklets (#/m <sup>2</sup> )
Control	380 c	102 a	136 b
<i>Stylo</i>	520 b	111 a	154 ab
<i>Stylo</i> + 50 kg/ha N	600 b	119 a	154 ab
<i>Stylo</i> + 100 kg/ha N	830 a	125 a	174 ab
<i>Stylo</i> + 150 kg/ha N	870 a	130 a	187 a
<i>Stylo</i> + 200 kg/ha N	890 a	136 a	185 a

\* Values in a single column followed by equal letters do not differ significantly ( $P < 0.05$ ), according to the test of Duncan.

**Contributors:** Jorge Vela, IIAP, Peru

## Activity 2.4

### Workshops and meetings to analyze and plan research activities

#### Highlights

- The workshop held in Peru in July 1999 established the research agenda in the forest margins for the next two years and set the principles for expanding the collaboration with other partners in Ecuador and Bolivia.

#### Annual Workshops 1999

**Rationale:** Annual meetings to discuss workplans, current research and future challenges as well as constraints are important in order to increase the efficiency of research and interchange ideas. This year separate workshops have been organized for South America (July 1999 in Peru) and Central America and the Caribbean (Costa Rica in October 1999).

**Results:** Tropileche held a workshop to plan and discuss present and future activities in South America during June 27 to July 2, 1999, in Moyobamba, Peru. The objectives of the workshop were to: (a) present the research achievements obtained by the Consortium and pose future challenges; (b) present research results achieved in Peru and to discuss new activities for 1999 and 2000; (c) participate in a field visit to understand and identify opportunities in current animal production systems in the Moyobamba region of the Peruvian Amazon; (d) review strategic and participatory research based on needs and constraints; and (e) analyze and discuss new forms of

collaboration with other institutions and in other countries of South America, especially Ecuador, Bolivia and Brazil.

Invited participants in the workshop included 22 researchers from Peru, Colombia, Ecuador, Bolivia, and Brazil. The workshop proceedings will be distributed during the month of October. Major outcomes of the workshop were:

- (1) Tropileche will continue to reduce research activities in Pucallpa in 1999 and 2000 and increase activities in Moyobamba. Potential for adoption of new forages activities in Pucallpas is low due to an oversupply of forage from a reduced herd inventory. In addition, the dual-purpose herd has a low genetic potential for milk yield which reduces economic benefits from investing in new forage technologies and the market potential for milk in Pucallpa is severely limited as there is no milk plant. The situation in Moyobamba is the reverse. A cooperative milk processing plant has been opened, farmers are improving the genetic potential of their herds for milk production and there is a demand by farmers for improved feeding systems.
- (2) The Consejo Transitorio Agrícola Regional (CTAR), through the Fundación para el Desarrollo Agrícola del Alto Mayo (FUNDAAM) will be our partner in Moyobamba and the institution responsible to carry out all of the research activities agreed during the workshop. The CTAR also agreed to invest as matching funds 35% of the resources that Tropileche delivers to Moyobamba.
- (3) There are good possibilities to expand research activities in Ecuador with our partner INIAP by accessing World Bank funds bilaterally and in Bolivia with CIAT-Santa Cruz through a collaborative project with DFID. Tropileche agreed with both INIAP and CIAT-Santa Cruz to follow up and develop project proposals for submission to both WB and DFID to access bilateral funds.

**Collaborators:** F. Holmann, C. Lascano, P. Kerridge and A. Ramirez, CIAT, Colombia.

## **COMPONENT 3 UTILITY OF THE NEW FORAGE SYSTEMS**

### **Activity 3.2**

#### **Dissemination of research results**

#### **Highlights**

- The database developed on the web with research results on dual-purpose cattle offers researchers a new tool to access information
- The production of a videotape about a small producer who adopted new feeding strategies is a practical way to show producers and extension agents how small farmers can succeed in intensifying production

#### **Tropileche Newsletter**

The Consortium has published six newsletters and the seventh is in print. Publication dates are March and October. The objective of this newsletter is to inform about the activities of the Consortium, on-going research trials, research results being produced at the different benchmark sites, and any other news our partners consider useful to inform. These newsletters can be obtained free of charge through the Tropileche HomePage on the Internet (<http://www.ciat.cgiar.org/tropileche/start.htm>).

**Contributors:** F. Holmann, CIAT-ILRI, Colombia, and national institutions in Peru, Costa Rica, Nicaragua, and Honduras

#### **Data base on research results from dual-purpose cattle**

In 1996 Tropileche developed a database of research results on dual-purpose cattle systems in tropical Latin America from the year 1960. Themes include nutrition and feeding, forages (grasses and legumes), genetic improvement and reproduction, animal health, economics, and extension, transfer, and adoption of technology. This is maintained.

At present there are more than 2,200 references and approximately 100 items are added each month. All references include basic descriptors and 70% of them also include an abstract. This database was developed in micro CD/ISIS and follows the normative of the information system AGRIS-CARIS from FAO. This database is available through the Tropileche HomePage on the Internet (<http://www.ciat.cgiar.org/tropileche/start.htm>). The average number of users consulting the database during the last year was 4.3 per day.

**Contributors:** A. Medina and F. Holmann, CIAT-ILRI, Colombia

### **Tropileche on Internet**

The Tropileche Consortium has developed its own HomePage on the Web, which contains the newsletters that have been produced as well as the data base containing research results generated in tropical Latin America. This HomePage can be accessed through the CIAT HomePage (<http://www.ciat.cgiar.org/tropileche/start.htm>).

In addition, this HomePage has a list of researchers with affinities in research on dual purpose cattle in LAC, with contact addresses. Researchers can access the database from anywhere in the world, request information, and communicate and interact with other colleagues.

**Contributors:** F. Holmann and A. Medina, CIAT-ILRI, Colombia

### **Videotape Production**

Tropileche in collaboration with the Department of Communications of the Ministry of Agriculture of Costa Rica developed and produced a 11-min videotape. This is a case study of evolution of the feeding system on a dual-purpose farm located in the dry tropics of the Central Pacific region of Costa Rica. This will be made available to extension workers and loaned to farmers and others on request.

Antonio Lopez is a small producer who has adopted many of the technologies that the Tropileche consortium has developed in association with the Ministry of Agriculture. Antonio is currently producing more milk on less area, has doubled his family income, and has released areas from the livestock enterprise to serve as protected areas for timber production and protection of water sources.

This videotape will be used to show other producers in Costa Rica and Latin America how one small farmer succeeded in intensifying production with new forage-based technologies that were developed by him with the technical assistance of MAG and Tropileche and a donation of seed for evaluation.

**Contributors:** F. Holmann, C.E. Lascano, P.J. Argel, and R. Goyenaga, CIAT, and MAG, Colombia, Costa Rica.

## LIST OF PUBLICATIONS

### Book chapters

Argel, P.J. and Paton, C.J. 1999. Overcoming Legume Hardseededness. In: Loch, D.S. and Ferguson, J.E. (eds). Forage Seed Production, Volume 2:Tropical and Subtropical Species. Commonwealth Agricultural Bureau (CAB) p. 247-265.

Argel, P.J. 1999. Maní Forrajero: Una Leguminosa de Uso Múltiple para el Sector Agropecuario de Costa Rica. Montecillos (Costa Rica). Año XV, No. 102. p. 12-13.

Holmann, F. and C. Lascano. 1998. A new strategy to improve the dual purpose cattle production systems in the tropics: The Tropileche Consortium. In G. Gonzalez-Stagnaro, N. Madrid-Bury, and E. Soto Belloso, eds., Improvement of crossbred cattle in dual purpose systems. University of Zulia. Maracaibo, Venezuela.

White, D., F. Holmann, S. Fujisaka, K. Reategui, and Carlos Lascano. 1999. Does intensification of pasture technologies affect forest cover in tropical Latin America?: Inverting the question. In D. Kaimowitz and A. Angilsen, eds., Agricultural Technology Intensification and Deforestation. Commonwealth Agricultural Bureau (CAB). Forthcoming.

### Technical Bulletins

Argel, P.J. y Villarreal C., M. 1998. Nuevo Maní Forrajero Perenne (*Arachis pintoi* Krapovickas y Gregory). Cultiva Porvenir (CIAT 18744): Leguminosa herbácea para alimentación animal, el mejoramiento y conservación del suelo y el embellecimiento del paisaje. Ministerio de Agricultura y Ganadería de Costa Rica (MAG), Centro Internacional de Agricultura Tropical (CIAT). Boletín Técnico. 32 p.

### Scientific articles

Argel, P.J. y Lascano, C. E. 1998. *Cratylia argentea* (Desvaux) O. Kuntze: Una nueva leguminosa arbustiva para suelos ácidos en zonas húmedas tropicales. *Pasturas Tropicales* 20(1): 37-43.

Holmann, F. 1999. Ex-ante analysis of new forage alternatives in Peru, Costa Rica, and Nicaragua. *Journal of Livestock Research for Rural Development* (in press).

Holmann, F. 1999. Evaluación ex-ante de nuevas alternativas forrajeras en Perú, Costa Rica, y Nicaragua. *Pasturas Tropicales* (en imprenta).

Ibrahim, M.A., F. Holmann, M. Hernandez, and A. Camero. 1999. The contribution of *Erythrina* as a protein bank with banana waste for the improvement of animal production systems in the humid tropics. *Agroforestry Systems* (in press).

Rivas, L. and F. Holmann. 1999. Early Adoption of *Arachis pintoi* in the humid tropics: The case of the dual-purpose systems in Caquetá, Colombia. Tropical Grasslands (submitted).

Rivas, L. and F. Holmann. 1999. Adopción temprana de *Arachis pintoi* en el trópico húmedo: El caso de los sistemas de doble propósito en Caquetá, Colombia. Pasturas Tropicales 21 (1): 2-17.

### **Poster Paper**

Argel, P. J., M. Lobo, J. Gonzalez, F. Romero, F. Holmann, C. E. Lascano, and P. C. Kerridge. The shrub *Cratylia argentea* as a feeding alternative for the dry season in Costa Rica. Presented at the Workshop "Working with farmers: The key to adoption of forage technologies", October 12-15, Philippines.

### **Workshop Proceedings**

Holmann, F., C. Lascano, and A. Ramirez. Workshop on Research Progress achieved by the Tropileche Consortium. Moyobamba, Peru. June 28-30. 1999.

### **Seminars**

Argel, P.J. and Pérez, G. 1998. Adaptation of new species of *Leucaena* in Costa Rica, Central America- Preliminary results. In: Shelton, H. M., Gutteridge, R. C., Mullen, B. F. and Bray, R. A. (eds). *Leucaena - Adaptation, Quality and Farming Systems*. ACIAR Proceedings No. 86, Canberra, Australia. p. 146-149.

Argel, P.J., Lascano, C. E. and Ramírez, L. 1998. *Leucaena* in Latin American Farming Systems: Challenges for Development. In: Shelton, H. M., Gutteridge, R. C., Mullen, B. F. and Bray, R. A. (eds). *Leucaena - Adaptation, Quality and Farming Systems*. ACIAR Proceedings No. 86, Canberra, Australia. p. 319-323.

Argel, P.J. 1999. Tecnologías Forrajeras para el Desarrollo de una Ganadería más Productiva en el Trópico bajo de Centroamérica. Contribución del CIAT. In: Pomareda, C. (ed). Intensificación de la Ganadería en Centroamérica: Beneficios Económicos y Ambientales (Memorias). FAO/CATIE, mayo, 1999. (In press).

Holmann, F. Study of options for the development and intensification of milk production systems in tropical Latin America. Presented at the Workshop "Development of milk production in tropical Latin America", November 18-21, 1998, Maracay, Venezuela.

White, D., F. Holmann, S. Fujisaka, K. Reategui, and Carlos Lascano. Does intensification of pasture technologies affect forest cover in tropical Latin America?: Inverting the question. Presented at the International Workshop “ Agricultural Technology Intensification and Deforestation”. March 11-13, 1999. CATIE, Turrialba, Costa Rica.

Peters, M., P. Horne, A. Schmidt, F. Holmann, P. Kerridge, S.A. Tarawali, R. Schultze-Kraft, C.E. Lascano, P. Argel, W. Stür, S. Fujisaka, K. Müller-Sämann and C. Wortmann The role of forages in reducing poverty and degradation of natural resources in tropical production systems. Presented in the “ Poverty Workshop”, September 10-14, 1999. IICA, San Jose, Costa Rica.

**Tropoleche Newsletters**

No. 5 (October 1998); No. 6 (March 1999).

**Videotape**

Production of a videotape: The farm of Antonio Lopez (11 minutes). CIAT and MAG, Costa Rica. August 1999.

## LIST OF PROPOSALS DEVELOPED

<b>Title</b>	<b>Requested Amount (Millions US\$)</b>	<b>Duration (years)</b>	<b>Donor</b>
Evaluation of options for the development of the dairy industry in tropical Latin America	0.48	2000-2003	Fontagro (Submitted)
Integrating biodiversity conservation and smallholder livestock production in subhumid tropical landscapes	0.54	2001-2004	CRUSA & SLP (In preparation)

## TRIPS AND MEETINGS

### Coordinator of the Consortium

Month	Activity	Place	Days (#)	Documentation
Sep '98	Participation at annual meeting of ILRI	Ethiopia	10	Trip report 1998-6
Sep '98	Participation in 25 <sup>th</sup> World Dairy Congress	Denmark	5	Trip report 1998-6
Nov '98	Meeting to develop project proposal for FONTAGRO	Venezuela	5	Trip report 1998-7
Nov '98	Participation in 1 <sup>st</sup> International Congress on Dual Purpose Livestock	Venezuela	3	Trip report 1998-8
Jan '99	Finalizing Nicaragua project proposal for Norway	Nicaragua	4	Trip report 1999-1
Jan '99	Tropileche research planning	Peru	14	Trip report 1999-1
Mar '99	Tropileche research planning	Costa Rica	10	Trip report 1999-2
May '99	Finalizing biodiversity project proposal with InBio for CRUSA and SLP	Costa Rica	6	Trip report 1999-3
Jun '99	Participate in 3 <sup>rd</sup> Annual Meeting of Tropileche	Peru	5	Trip report 1999-4

## LIST OF CONSORTIUM COLLABORATORS

NAME	POSITION	INSTITUTION
<b>Colombia</b>		
Federico Holmann	Consortium Coordinator	CIAT/ILRI
Carlos Lascano	Animal Nutritionist	CIAT
Peter Kerridge	Agronomist	CIAT
Pedro Argel	Agronomist	CIAT
Samuel Fujisaka	Anthropologist	CIAT
Anderson Medina	Administrative assistant	CIAT
Patricia Avila	Research assistant	CIAT
Alberto Ramírez	Editor	CIAT
Jaime Velasquez	Agronomist	CORPOICA
<b>Costa Rica</b>		
Carlos Hidalgo	National coordinator	MAG
Marco Lobo	Agronomist	MAG
Vidal Acuña	Agronomist	MAG
Francisco Romero	Animal nutritionist	ECAG
Jesus González	Animal Scientist	ECAG
<b>Peru</b>		
Miguel Ara	National coordinator	IVITA
Jorge Vela	Agronomist	IIAP
Keneth Reategui	Agronomist	DEPAAM
Geiner Romero	Research assistant	CIAT
<b>Nicaragua</b>		
Tito Fariñas	Agronomist	IDR
<b>Honduras</b>		
Conrado Burgos	Agronomist	DICTA