Output 4: Superior and diverse grasses and legumes delivered to NARS partners are evaluated and released to farmers

4.1 Partnerships in LAC to undertake evaluation and diffusion of new forage alternatives

Highlights

- Results from on-farm trials demonstrated the benefits and limitation of *Brachiaria* hybrid cv Mulato
- Adoption of Cratylia by smallholders in the llanos of Colombia is being promoted by farmers who have experienced the multiple benefits of this legume as a dry season feed
- Forage species to feed livestock in cut/carry systems and for green manure were selected and multiplied for use in hillsides of Haiti
- Scaling of new forage alternatives is an active process in hillsides of Honduras and Nicaragua being promoted by NARS, NGOs and farmers groups
- The first farmer-led forage seed enterprise (PRASEFOR—Productores artesanales de semilla forrajera) was formed in Honduras
- Scaled up the testing of green manures with selected legumes in different production systems in Hillsides of Nicaragua

4.1.1 Evaluation in Central America of *Brachiaria* hybrid cv Mulato

Collaborators: Conrado Burgos (DICTA), Heraldo Cruz (DICTA/CIAT), Dionisio Soto (INTA, Nicaragua), Axel Schmidt (CIAT), Marco Lobo and María Mesén (INTA, Costa Rica), Bolívar Pinzón, Rubén Montenegro and Luis Hartentains (IDIAP)

Rationale

During the last years the availability of new forage options has increased in Central America, particularly new cultivars of the genus *Brachiaria* and *Panicum.* Usually commercial seed companies with limited participation of local research and development institutions carry out promotion of these materials. The involvement of national institutions in on-station and on-farm processes of validation and promotion of the new forage options offers the chance to generate reliable information and expose the new cultivars to different biotic and abiotic stresses and production systems. During the last year this strategy has been utilized to evaluate *Brachiaria* hybrid cv. Mulato.

Material and Methods

As mentioned in the 2002 Annual Report of IP5, a protocol for the validation/promotion of *Brachiaria* hybrid cv. Mulato was developed and proposed to national institutions of Panamá, Nicaragua, Costa Rica and Honduras. As a result dual purpose and beef cattle farms were established with the grass in the region of Yoro, Yorito, Victoria and Olancho (Honduras); León, Chinandega, Posoltega and San Dionisio (Nicaragua); Puriscal, Miramar, San Jerónimo and Orotina (Costa Rica) and Bugaba, Gualaca and Boquerón in Panamá. Commercial plantings have been carried out in these countries and in Guatemala, since the validation exercise has been accompanied by the availability of commercial seed from Semillas Papalotla from Mexico.

Results and Discussion

Successful establishment of cv. Mulato was reported from every site in the different countries were the grass was planted. High seed quality, high seedling vigor, good soil preparation and adequate weather conditions accounted for the excellent establishment of the grass. The absence of major pests and diseases also contributed to the adequate establihsment of cv. Mulato.

On-farm establishment: One of the outstanding characteristics of cv. Mulato is the quickness of the establishment given the high seedling vigor that the plant has. Table 55 shows that in farms in Honduras, plant height and cover had a mean of 0.80 m and 80% respectively, less than two months after the grass was planted. This observation was also made in other countries of the area. As a result of rapid establihsment, farmers could make use of the paddocks much earlier than the time experienced with other grasses.

Table 55. Number of plants, plant height and plant cover of *Brachiaria* hybrid cv. Mulato established in dual-purpose cattle farms of Honduras. (Information supplied by Conrado Burgos and Heraldo Cruz of DICTA and DICTA/CIAT respectively).

Farm/Site	Days after planting	Plants/m^2	Mean plant height (m)	Mean plant cover (%)
La Laguna/Yorito	54	17	0.40	65
Las Brisas/Sulaco	54	23	1.05	95
Las Delicias/Victoria	51	28	1.00	90
Ojo de Agua/Victoria	48	12	0.80	85
Don Pedro/Victoria	49	20	0.75	80
Mean	**51**	**20**	**0.80**	**83**

On-farm monitoring: Milk production has been monitored in dual-purpose cattle farms with cv. Mulato in several countries of the region including Honduras (Table 56). In every site milking cows grazing the grass increased individual daily milk production; for instance in the case of Honduras the increase has ranged from 1.0 to 2.0 liters/day. Additional to this and because of more DM production, the stocking rate has also increased in pastures of cv. Mulato as compared to other *Brachiaria* grasses like *B. decumbens* cv. Basilisk. As a result milk production also increased per unit of land.

Table 56. Area planted, milk production and milk daily increase of dual-purpose cows grazing *Brachiaria* hybrid cv. Mulato in dual-purpose cattle farms of Honduras. (Information supplied by Conrado Burgos and Heraldo Cruz of DICTA and DICTA/CIAT respectively).

Farm/Site	Area planted (ha)	Number of milking cows	Grazing period (days)	Mean daily milk/cow (kg)	Mean daily milk increase/cow (kg)
La Laguna/Yorito	2.0	12	28	5.4	1.7
Las Brisas/Sulaco	3.0	17	37	4.0	1.0
Las Delicias/Victoria	3.0	10	30	9.6	1.6
Ojo de Agua/Victoria	2.0	14	24	11.3	1.7
Don Pedro/Victoria	2.5	6	45	4.0	2.0

Controlled grazing trial: A grazing trial was established by IDIAP (Instituto Panameño de Investigación Agropecuaria) during 2002 at the Experimental Station Gualaca in Panamá. The site is at 100 masl and located in a very humid premontane ecosystem; the soils are clay loam acid inceptisols with pH 4.8, high in Al (1.1 meq/ 100 ml), medium in OM (4.0 %), low in P (1 ppm), medium in K content (59 meq/100 ml) and low in Ca and Mg (1.0 and 0.20 meq/100 ml respectively). Mean temperature is 26 ºC and the site has a record of 4000 mm total rainfall from May to November.

Cultivar Mulato was established by direct seeding after controlling the existing vegetation with herbicides. The 2 ha of the experiment were fertilized with 20 kg/ha of N and 10 kg/ha of P, divided in 8 paddocks and established a rotational grazing scheme of of 3/21 days of grazing/rest. Five young steers with a mean of 205 kg liveweight were used to give an initial stocking rate of 2.5 AU/ha. Animal liveweight gains during the dry period from December 2002 to March 2003 were 363 g/day, while that during current wet period (April to September, 2003) the mean liveweight gain has been 781 g per animal/day. This liveweight gains are relatively high given that usually in this site animal lose weight during the dry period and have liveweights gains around 500 g/day in other *Brachiaria* species during the wet period. The high gains are the result of the good forage quality of cv. Mulato, particularly in terms of digestibility and N content. Forage availability has been 798 kg DM/grazing/cycle during the dry period and 1792 kg DM/grazing/cycle during the wet period. This experiment will continue under evaluation. Observations carried out in Honduras indicate liveweight gains of 900 g/an/day for animals grazing cv. Mulato in contrast with a liveweight gain of 600 g/an/day for animals grazing *B. decumbens* cv. Basilisk. This observation will continue under conditions of a commercial beef cattle farm.

4.1.2 On-farm evaluation of new grasses for livestock systems in Colombia

Contributors: C. Plazas, John W. Miles, P. Argel and C. E. Lascano (CIAT)

4.1.2.1 On–farm evaluation of *Brachiaria* cv Mulato

An important activity in the Forage Project is the on farm evaluation in different regions of Colombia of the *Brachiaria* hybrid cv Mulato. After one year of evaluation the following observations can be made:

1. In the well-drained savannas Llanos of Colombia with soils of low fertility Mulato should be part of a crop –pasture rotation system. One option is to establish Mulato with Maize, as was the case in the Costa Rica farm. In this farm the maize harvested covered 80% of the cost of establishment of Mulato and a very productive pasture was left behind.

2. In the piedmont of the llanos with soils of higher fertility than in the well-drained savannas the use of Mulato requires the application of fertilizer. In the Isla farm Mulato shows very high animal productivity and regrowth after intensive defoliation with the application of chicken manure.

3. In the north coast of Colombia with more fertile soils the performance of Mulato is very good and could be an alternative to grasses with very poor performance in the dry season as is the case of *Bothriochloa* sp., which is the predominant grass in many cattle regions with 6 month dry season.

4. In both the Llanos and the north coast we observed in Mulato and damage caused by the insect *Antonina graminis*, but the problem seems to be easily managed by intensive defoliation.

4.1.2.2 Release of *Brachiaria* hybrid cv Mulato

A major event this year was the release in Colombia of the *Brachiaria* hybrid cv Mulato by a private seed company (Semillano). The field day to introduce cv. Mulato to farmers in the Llanos was held on Tuesday, 17 June. CIAT staff from headquarters, from Central America and from the Llanos gave a series of short presentations to an audience of 80-90 participants, mostly farmers. Presentations were followed by a visit to the Costa Rica farm, where a 15-ha Mulato pasture was established (with maize) last year (Photo 18). The seed company had Mulato seed (from Papalotla) for sale, in attractive 1-kg, sealed tins. The aggressive promotion of Mulato by Semillano is impressive, as they also had a similar event in the north coast (Turipana-Corpoica) to present cv Mulato to farmers (Photo 19).

Photo 18. *Brachiaria* hybrid cv Mulato established with maize in the Llanos of Colombia (Costa Rica farm)

Photo 19. *Brachiaria* hybrid cv Mulato pasture in the north coast of Colombia (Turipana Research Station-Corpoica)

4.1.3 On-farm evaluation and diffusion of shrub legumes for dairy systems in the Llanos of Colombia

Contributors: C. Plazas and C. Lascano (CIAT)

In February 2001 we started a 2-year project funded by PRONATTA (Programa Nacional de Transferencia de Tecnologia Agropecuaria) in the piedmont of the Llanos of Colombia to evaluate the utility of *Cratylia argentea* (Cratylia) in smallholder dairy farms. We were particularly interested in defining with farmers different uses of Cratylia as a supplement for milking cows in the dry season and in developing a seed supply system as a means of promoting the use of Cratylia in the region.

To implement the project we selected 14 farms in which the main activity was milk production. With active farmer participation we evaluated in the different farms the use of Cratylia for cut and carry, direct grazing and seed production. A total of 12.5 ha were planted in the 14 farms (range 0.12 to 1.0 ha) out of which 6 ha were for cut and carry, 3 ha for direct grazing and 3.5 ha for seed production.

In what follows we report results on performance of Cratylia in the different farms, on milk yield with supplementation of Cratylia and on seed production. Finally we discuss some of the lessons learned in the project.

Agronomic performance and quality of Cratylia. In the different farms were we established Cratylia we measured seasonal yield and leaf: stem ratio in the forage harvested. In the wet season the mean green dry matter (GDM) yield across farms was 3337 Kg/ha of which 67% was leaf (Figure 66). Plants averaged 1.21 m of height at the time of harvest, which was carried out every 45 to 55 days. In the dry season forage yield of plants of 1.12 m averaged 600 K GDM with 52% leaf (Figure 67).

In one farm we measured yield of plants with and without an uniformization cut (20 cm above ground surface) following grazing. Results showed that days of regrowth forage yield was greater (490 vs. 787 Kg DM/ha) with plants that were not cut but the leaf proportion was considerably less (29 vs. 54%). In the dry season crude protein (CP) content of Cratylia averaged 22% as compared with 6.5% in the grass available in the pastures (Figure 68). The CP content of Cratylia in the dry season has been similar to *G. sepium*, which is a well known legume used by few farmers in the region to supplement milking cows.

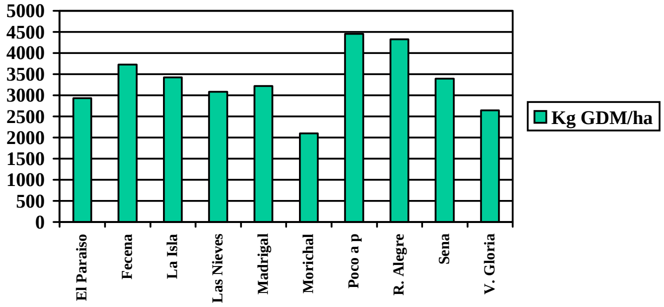

Figure 66. Forage yield (green dry matter) of *Cratylia argentea* harvested during the wet season in different farms in the Piedmont of the Llanos of Colombia

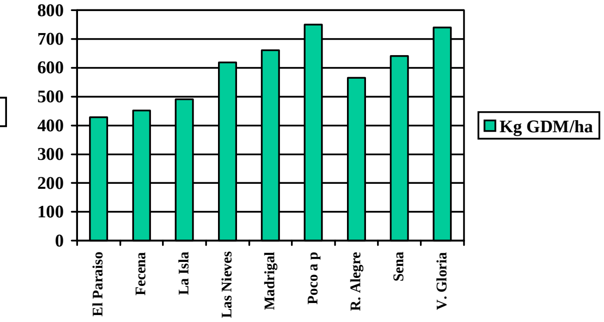

Figure 67. Forage yield (green dry matter) of *Cratylia argentea* harvested during the dry season in different farms in the Piedmont of the Llanos of Colombia

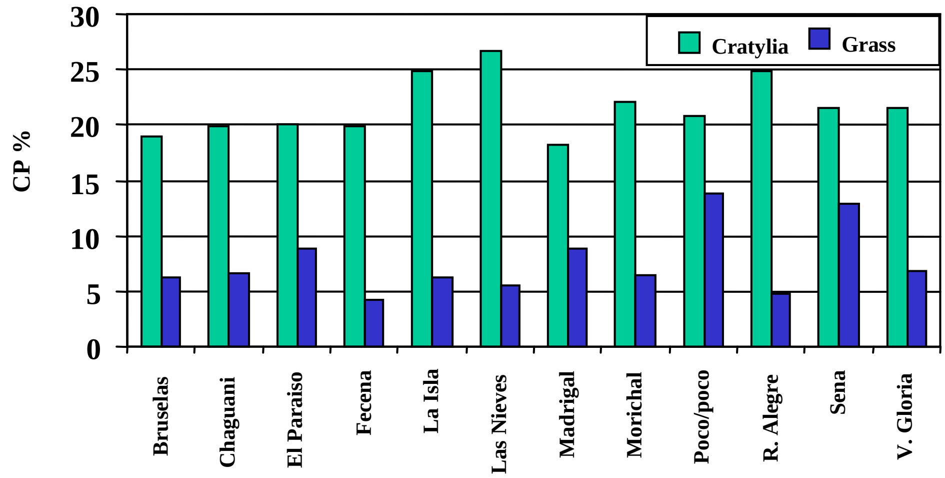

Figure 68. Crude protein (CP) content in *Cratylia argentea* and in the grass available in pastures grazed by milking cows during the dry season (Piedmont- Llanos of Colombia)

The combination of Cratylia with maize silage, an initiative of some farmers, has as expected increased CP content of the silage (7 to 10%) and this has reflected in more milk yield.

Milk yield of cows supplemented with Cratylia

It has not been easy to measure the effect of supplementing Cratylia on milk yield during the dry season given that the farmers do not want to loose money as they clearly see the benefit of the legume. In the period December 2001 to May 2003, we measured milk production in the same cows with and without supplementation of Cratylia in several farms in the project. Results showed that in some cases there where was positive response to the legume whereas in other cases there was no response (Table 57).

Table 57. Milk yield of grazing cows with and without supplementation of *Cratylia argentea* **(Piedmont- Llanos of Colombia)

Farm	No of Cows	Grass (l/cow/d)	Grass + Cratylia (l/cow/d)
1	7	8.5	8.5
2	10	8.0	8.5
3	14	5.2	6.3
4	6	5.9	6.0
5 (AM Milking)	8	6.6	8.0
5 (PM Milking)	8	6.3	6.0
6	10	6.9	6.5

**Measurements carried out from December 2001 to May 2003)

In spite of this, farmers are very impressed with the improved body condition of cows receiving Cratylia after the dry season, which should have a positive effect on reproduction. In addition, farmers see other benefits of feeding Cratylia as discussed bellow.

Seed Production of Cratylia. One important goal of the project was to establish seed multiplication plots of Cratylia to allow diffusion of the technology in and outside the region. In seed plots established in 7 farms we were expecting to harvest 650 kg of clean seed based on yields obtained in Costa Rica. In February of this year we began the seed harvest and only harvested 100 kg. The seed yield per plant varied from 25 g to 67 g with an average of 47 g/plant for 4 farms.

During the dry months (February and March) 90% of the seed harvested was of excellent quality and germination, but once the rains started in April the quality of the seed dropped significantly (from 90% to 40% good seed).

The cost of production of the seed harvested was in the order of $US 4.50 /kg, which makes attractive the activity of seed multiplication given that the current price of Cratylia seed in the market varies from US $ 14 to 15/ kg.

In spite the high potential economic benefits of producing Cratylia seed in the Piedmont of the Llanos of Colombia, it became clear that it was not an ideal region for this activity given the low yields obtained associated with a short rainy season. As a result a Cratylia Network was established with participants from contrasting regions in Colombia. One initial objective of the Network is to define seed production potential of Cratylia in contrasting eco-regions (north coast, Magdalena Valley, Coffee zone) of Colombia.

Lessons Learned. Given the participatory approach used in the project farmers were able to define alternative uses of Cratylia, which at the end were quite different from those initially suggested by the technical staff in the project (Photo 20).

A

B C

Photo 20. Different uses of *Cratylia argentea* in smallholder dairy systems in the Piedmont of the Llanos of Colombia (A= Cut & Carry; B= Silage; C= Direct grazing)

The original idea was for farmers to use Cratylia in a Cut & Carry system but some realized that this system was associated with high labor cost. The alternatives to Cut & Carry of Cratylia that some farmers implemented were silage production and direct grazing all year round using in electrical fences. Grazing of Cratylia has not caused plant mortality and in some farms a very productive association of the legume with *Brachiaria decumbens* (the grass originally in the plots) was formed.

Through farmer experimentation we have also learned that it is possible to reduce cost of establishment of Cratylia by intercropping maize or other crops such as tomatoes, and cucumbers.

Finally, one of the most important lessons learned is that criteria of farmers to assess the utility of forage plant like Cratylia may be quite different from the criteria of researchers. We had postulated that the main benefit for dairy farmers in the Piedmont would be increased milk production in the dry season and consequently more cash flow.

It was interesting however, to learn that farmers saw other benefits when using Cratylia:

a) Possibility of having high quality forage for cows in the middle of the rainy season when pastures were difficult to graze due to high soil moisture
b) Replacement of purchased supplements in the dry season which has economical implications
c) Possibility of milking cows in the dry season and get higher price for the milk sold
d) Improved body conditions of cows which has been associated with improved reproductive performance

The adoption of Cratylia in the Piedmont of the Llanos of Colombia is an ongoing process which is being promoted not only by extension people who received training from the Project but also by enthusiastic farmers who have seen the benefits of the legume in there farms. In spite of this, adoption of Cratylia in the Piedmont and other regions of Colombia could be enhanced if commercial seed was available. There is a need to identify regions in Colombia suitable for Cratylia seed production and farmers willing to invest money and effort on seed multiplication.

4.1.4 Evaluation of multipurpose legumes as green manures in the Llanos of Colombia

Contributors: C. Plazas, M. Peters, Luis H. Franco and B. Hincapie (CIAT)

Rationale

One of the aims of the Forage Project is to develop alternative green manures for maize and rice based systems (Photo 21) in the Llanos of Colombia. It is expected that suitable legumes will reduce the need for external inputs (herbicides, fertilizer) and thus make the crops more competitive.

Photo 21. Rice following green manure incorporation in the llanos (C.I. La libertad)

Materials and Methods

Two types of potential green manures were selected for different temporal niches. 1) Rapidly establishing legumes to be used as green manures (incorporated 80-90 days after planting) and 2) Slower establishing species to be utilized for fallow improvement. The following species and accessions were evaluated:

Green manures	Fallow improvement
Vigna unguiculata (IT86D-716)	*Cajanus cajan* CIAT 913
Vigna unguiculata (IT6D-733)	*Centrosema macrocarpum* CIAT 5713
Vigna unguiculata (IT89KD-288)	*Centrosema pubescens* CIAT 15160
Vigna unguiculata cv. Cabecita negra.	*Canavalia brasiliensis* CIAT 17009
Mucuna pruriens CIAT 9349	*Pueraria phaseoloides* CIAT 9900
Stylosanthes guianensis CIAT 11844	*Stylosanthes guianensis* CIAT 11844
Stylosanthes guianensis CIAT 11833	*Stylosanthes guianensis* CIAT 11833
Stylosanthes guianensis CIAT 184	*Stylosanthes guianensis* CIAT 184
Stylosanthes guianensis population 3	

Green manure in upland rice: Results on the performance of green manures were summarized. in the AR-2002. In Figure 69, the residual effects of the green manure on a 2nd rice crop (1 year after green manure incorporation) are presented. Results indicated no significant green manure effects on rice yield. Differences in yield of rice due to green manure species were only evident with the application of N (40 kg/ha). This confirms previous results that there are no positive effects of using short term green manure on upland rice systems, for the first crop in the piedmont area of the llanos.

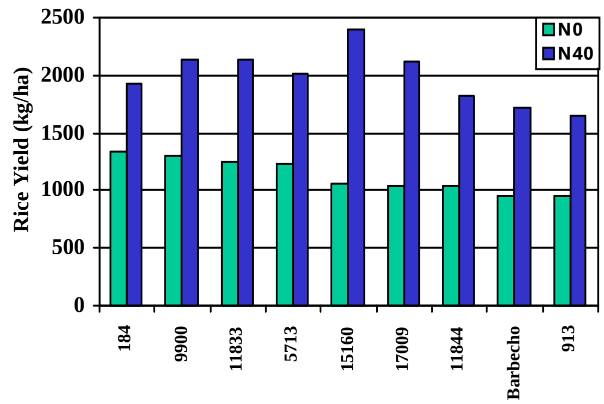

Figure 69. Residual effects of green manure as affected by N fertilization on rice grain yield, C.I. La Libertad, Piedemonte, Llanos Orientales de Colombia, 2003.

Short- term green manure species for maize and rice cultivation: In view of the increasing importance of maize in the Altillanura of Colombia, short-term green manure species were tested for their effect on succeeding maize. The experiment was established on an Oxisol at the Hacienda Matazul. 7 accesions of legumes were sown, i.e.: *Mucuna pruriens* CIAT 9349, *Vigna unguiculata* IT89KD-288, *Vigna unguiculata* IT6D-733, *Vigna unguiculata* var. Cabecita negra, *Stylosanthes guianensis* CIAT 184, *Stylosanthes guianensis* CIAT 11833 and *Stylosanthes guianensis* Población 3.

All materials were incorporated at the same time (after 11 to 12 months). Results indicated that short-term use of legumes planted after native savanna does not have any effect on subsequent maize in the Altillanura. It is possible that after continuous cultivation of maize the effect of planting short-term legumes as green manure may be beneficial.

4.1.5 Participatory evaluation of improved forages for multipurpose use in hillsides of Haiti

Contributors: Pedro Argel (CIAT), Garline Amboise, Mirtho Jerome, Levael Eugene, and Jean Osmy Chéry (CIAT/HAP) and Luis H. Franco (CIAT)

To contribute to the objective of HAP, the Tropical Forages Project relied on the large number of herbaceous and woody forage species held in the Genetic Resources Unit of CIAT and on preliminary results from the Hurricane George Recovery Program on adaptation of different grasses and legumes to contrasting soils types in Haiti. Methodology developed by CIAT for participatory selection of forages for smallholder systems were to be used to define grass and legume options suitable to environmental and socio-economic conditions in hillsides of Haiti. Demonstration to farmers of the value of improved forages to feed livestock and to improve soil fertility for crop production was to be a major component of CIAT's Forage Adaptive Research Strategy. These activities would be complemented with the development of sustainable seed delivery systems of improved forages.

The methodology proposed for the HAP in Haiti was as follows:

Multilocational Testing. Different grass and legume species pre- selected on the basis of previous knowledge on adaptation to calcareous and acid soils, and potential utility to feed livestock and to enhance soil fertility are evaluated in small plots with farmer participation. Staff from different NGO's collaborating with HAP will be trained in forage agronomy and in participatory methods. Representative plots in the HAP target areas will be selected to establish a wide range of pre-selected forage species using methodology developed by CIAT. Farmers will be involved in the selection of grasses and legumes using there own selection criteria, which will then be compared with criteria used by researchers. The main output of this activity will be the selection with farmers of adapted "elite" grasses and legumes for subsequent on –farm testing and seed multiplication.

On- farm Testing. Elite grasses and legumes will multiplied by CIAT to assess their value as feed resources for bovines and goats and as covers to enhance soil fertility for annual crops. Farms with plots in different stages of degradation will be selected in the HAP target areas to plant selected grasses and legumes. Grasses will be evaluated for ease of establishment, seasonal biomass production, and acceptability to livestock when offered at different stages of maturity. Legumes will be evaluated for ease of establishment, ground cover, seasonal biomass production, seed quality, acceptability to livestock and effect on soil fertility through yields of an indicator crop (maize and /or beans). The main output of this activity will be the demonstration in selected and representative farmer's fields of the utility (biological and economical) of improved grasses and legumes to feed livestock and to improve soil fertility for annual crop production.

Effective Seed Delivery System. Seed of selected commercial grass and legume cultivars will be multiplied and purchased outside of Haiti through linkages to be developed with the private sector in Haiti. This will allow good quality –low cost seed availability to farmers in a sustainable manner. Seed multiplication of selected grasses and herbaceous and woody legume specie not commercially available in the regional market will be mainly carried out in Haiti through contracts with NGO's that have the capacity to manage seed plots, process and store seed.

A strategy to involve local Farmer Groups in seed multiplication of selected grasses and legumes will be promoted as an other means of providing income and allowing effective diffusion of improved forages. The main output of this activity will be a mechanism in place for diffusion and adoption by farmers of improved forages for multipurpose use.

After 1-½ years of work in HAP the funds for CIAT work were cancelled in midyear with short notice and consequently we could not meet our objectives. In what follows we present a summary of the accomplishments and difficulties encountered in establishing forage trials in different regions of the hillsides of Haiti.

Forage trials in the Jacmel region

It has been difficult for the field staff of the project in Haiti to establish the forage trials that were planned. Sev eral reasons account for that situation. Small and medium-size farmers have been reticent to yield their plots to set up forage trials because they believe that by doing so, they:

a) Would not have enough land to grow cash crops like corn, beans or vegetables
b) Will be kept out of their plots for too long a period of time (two years on the average) according the protocol for the forage trials

c) Will be denied the possibilities to get their usual revenues and crop production from their small piece of land

In spite of all the difficulties, the field staff succeeded establishing three forage trials during the first cycle and another three during the second cycle (Table 58). The main objective of the forage research activities was to identify forage species that would:

a) Adapted to local conditions,
b) Contribute to improve the soil fertility level,
c) Provide feed to livestock, and
d) Serve as living barriers in order to protect the soil and reduce the level of erosion on hillsides.

Table 58. Forage trials established in the Jacmel region

Trials	Zone	Planting date	Altitude	Growing stage
Cowpea Lines (4 + Check)	Cap-Rouge	June 13, 02	700	Normal
Grasses (5 + Check)	La Vallée	May 17, 02	800	Poor emergence
Live Barriers (4 +2 Checks)	Fd Jn-Noël	April 5, 02	1225	Destroyed by repeated heavy rains
Shrub Legumes (6)	La Vallée	May 17, 02	800	Normal, was planted twice
Grasses (5 + Check)	La Revoir	August 23	800	Poor emergence
Shrub Legumes (6)	La Revoir	August 23	800	Poor emergence
Herbaceous Legumes (4 Species)	Cap-Rouge	August 16	700	Good germination
Shrub Legumes (6)	Cap-Rouge	August 29	700	Good germination

In Table 59 we present initial results on plant emergence, vigor and plant cover during the first 9 weeks of the trial. All cowpea lines established well, although the local line was showing better adaptation followed by the introduced lines 391, 716, 277-2 and 1088-4. The second aspect of the cowpea trial involves the planting of corn in half of the plots after incorporating the cowpea biomass into the soil. The second half of the cowpea plot will be used to measure cowpea grain yield. To estimate the N contribution of cowpea to the soil, maize will be sowed using six (6) nitrogen doses within three (3) replications. Finally, since farmers indicated that they could not spare there plots used for crop production to carry out forage research work, we decided to plant test forages along the borders of the plots. It was a decision that many farmers welcomed with interest.

Table 59. Mean seedling emergence, plant vigor and cover after 9 weeks of growth of five Cowpea accessions established in Cap-Rouge

	Week 2	Week 4		Week 6		Week 9		
Entry	Emergence (%)	Vigor	Cover (%)	Vigor	Cover (%)	Vigor	Cover (%)	Height (cm)
391	19.7	3.3*	28.3	3.5	35.3	3.7	41.7	29.0
716	17.3	2.3	16.7	2.8	22.7	3.2	28.3	20.7
1088-4	19.0	3.3	25.7	2.8	27.3	2.7	30.3	22.3
277-2	19.3	3.0	26.7	3.2	29.7	3.3	41.0	20.1
Local	17.7	3.3	30.0	3.7	41.3	4.0	51.7	19.7

* Vigor is rated as 1=poor vigor; 5=highly vigorous plant

Forage Trials in the Cap Haitien region

Evaluation of Cowpea as grain and green manure

This trial was established at the locality of El Matador, near Dondon. Data for biomass yields were collected and looked pretty interesting; and the biomass has been already incorporated into the soil. Among others, the accession IT86D -716 showed high yield performance as shown in Table

60. Corn was just being planted afterwards to complete the second phase of the trial. In a participatory evaluation session the accession IT86D-716 ranked first based on the selection criteria that had been set up for the exercise. A few farmers indicated their concern about the labor and the cost to incorporate the biomass into the soil at the pre-flowering stage.

Table 60. Yields of Cowpea (*Vigna unguiculata)* lines established as grain and green manure in Haiti.

IITA No.	Foliage green yield (kg/ha)
IT86D-716	3533 a
IT90K-277/2	3000 ab
Local line	2033 bc
IT89KD-391	2000 bc
IT95K-1088/4	1666 c

a, b, c Means followed by the same letter are not statistically different (P<0.05)

Bertin Site: The forage accessions did not germinate well due to drought conditions and probably to the methods of planting. They were re-planted again at mid-September 02. Some species like *Panicum maximum* cv. Mombasa and *B. brizantha* cv. Toledo performed quite well.

Foundation Vincent Site: The trials set up at Foundation Vincent did not germinate well and consequently the material was planted several times. Seedling emergence was quite acceptable in a re-planting carried out in September, but it has been noted also the urgent need to set up a fence around the trial plot to stop stray goats coming from a nearby neighborhood that feed on the vegetative materials of the trial.

In Table 61 we show results of one evaluation carried out approximately one year after planting. The legumes *Arachis pintoi* and *Stylosanthes guianensis* failed to establish, due mainly to the unreliability of the rains and the grazing of the plots by uncontrolled goats. Nevertheless the legumes *Centrosema macrocarpum* and *C. pubescens* established well and had acceptable plant cover and vigor one year after planting.

The grasses P. *maximun* cvs Mombasa and Tanzania showed good plant vigor, as well as the *Brachiaria* cvs Toledo and Mulato. At the evaluation date, plant height of these grasses was close to 1 m per plant that indicates the possibility of utilizing them in a cut and carry system, which is widely used in Haiti and considered as a viable alternative for animal feeding in the country.

Table 61. Mean plant height, cover and fresh weight at first cut of legumes and grasses established at Foundation Vincent (North of Haiti)

Species	CIAT No.	Plant height (cm)	Plant cover (%)	Fresh weight (g/m^2)
C. macrocarpum (Ucayali)	25522	34.5	76.8	1.4
C. pubescens	15160	44.0	85.0	2.4
B. brizantha (Toledo)	26110	98.3	76.3	11.3
P. maximum (Tanzania)	16031	93.5	97.8	7.8
P. maximum (Mombasa)	-	97.0	87.0	5.5
P. atratum (Pojuca)	26986	96.8	82.0	3.3
B. hybrid (Mulato)	36061	104.5	78.0	9.0
B. decumbens (Basilisk)	606	91.3	79.7	5.3
P. purpureum (Elephant)	-	115.3	78.8	13.0

As a result of the evaluation of different forage species in Haiti we selected for on regional testing and seed multiplication a number of forage species:

a) Grasses*: Panicum maximum* cv Mombaza (for better soils and for cut and carry), *Brachiaria decumbens* cv Basilisk (for poor soils and for grazing) and *Brachiaria brizantha* cv Toledo (for poor soils, for cut and carry and for grazing).
b) Herbaceous perennial legumes: *Centrosema pubescens* CIAT 15160 and *Centrosema macrocarpum* CIAT 25522 (for low fertility soils for forage and/or long- term green manure).
c) Woody legumes: *Cratylia argentea* (for poor soils and for cut and carry as dry season feed)
d) Herbaceous annual legumes: Cowpea (IITA-716 for the North and IITA- 1088 for the South East for short-term green manures, for forage -hay or grain).

If funding becomes available to continue forage/ livestock work in Haiti we would need to concentrate on: a) evaluation with farmers of grasses, herbaceous (annual and perennial) and woody legumes selected in Haiti based on adaptation to biotic and abiotic constraints in hillsides and incorporation of selected forage species in current farming systems, b) development of forage conservation technologies for dry season feeding that are appropriate for small farmers and c) development of seed systems to promote diffusion of improved forages.

4.1.6 Participatory introduction of improved forages in smallholder dairy systems in Hillsides of Nicaragua

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Rationale

Scaling up of research results is considered as the most important issue to be addressed in current R&D activities due to increasing pressure from donors and civil society that money spent in agriculture must result in a lasting impact on the lives of the rural poor. Furthermore, it was recognized that many relevant technologies and approaches are not achieving their full potential impact due to low levels of adoption, which has led to more emphasis on the effectiveness of research to produce adoptable technological options. There is a need not only to increase impact, but also to show good quality research results, which attract different stakeholders in the R&D environment (e.g. NGOs, farmer associations) in order to achieve a high degree of adoption in combination with a faster dissemination process.

The BMZ funded project 'Farmer Participatory Research in Action: Selection and Strategic Use of Multipurpose Forage Germplasm by Smallholders in Production Systems in Hillsides of Central America' has had several achievements: a) development of a technology package made up of different components such as participatory diagnosis and stakeholder analysis, b) availability of forage germplasm for farmer participatory evaluation and selection, c) on-farm animal production trials including economic analysis, d) complementary training modules (participatory evaluation and selection, forage utilization/management, participatory monitoring and evaluation), and d)seed systems (informal and formal public and private).

The package developed by the CIAT- led project attracted the attention of the ASDI-funded bilateral development project FONDEAGRO (Fondo de Desarrollo Agropecuario) based in Matagalpa as a key input to enhance milk production in the projects' target region Matiguás and Rio Blanco in Nicaragua. The target group consists of approx. 1000 livestock holders in three zones. After adapting the technology package to the specific needs of FONDEAGRO, CIAT was asked to implement the package within their project.

Materials and Methods

CIAT was contracted to 1) select and implement three forage nursery trials in different sites offering a wide basket of germplasm options to farmers, (2) implement on-farm animal production experiments to demonstrate pasture management and increased milk production based on improved grasses and grass-legume associations, (3) implement dry season feed opportunities based on the shrub legume *Cratylia argentea* in combination with cut and carry grasses, (4) conduct training modules on forage agronomy and pasture management, participatory methods for evaluation and extension, seed production and participatory monitoring and evaluation, and (5) develop seed production system within the project in order to secure long term sustainability and adoption of the selected forage options.

Results and Discussion

The project started in late August 2002 with the selection of the three sites and their preparation. Nursery plots were sown at the beginning of October. A range of grasses (18), herbaceous legumes (12) and shrub legumes (9) species were established across three different sites with three replicates (Table 62). At one site, Ubú Norte (Photo 22), a fertilizer treatment was applied in order to demonstrate fertilizer effects on yield of grass species. Not all of the 367 plots could be established in 2002 due to unusual high precipitation, which made the establishment difficult. Establishment if the forage species was completed after the dry season in June 2003.

Table 62. Forage options established in target zones in Nicaragua

Grasses	Herbaceous legumes	Shrub legumes
B. brizantha CIAT 6780	*A. pintoi* CIAT 18744	*C. argentea* CIAT 18668
B. brizantha CIAT 26110	*A. pintoi* CIAT 22160	*C. argentea* CIAT 18516
B. brizantha CIAT 16322	*D. ovalifolium* CIAT 33058	*C. calothyrsus* CIAT 22310
B. brizantha CIAT 26646	*C. pubescens* CIAT 15160	*C. calothyrsus* CIAT 22316
B. brizantha CIAT 26124	*C. brasiliensis* CIAT 17009	*L. leucocephala* CIAT 17263
B. brizantha CIAT 26318	*C. pascorum* cv. Cavalcade	*D. velutinum* CIAT 13953
B. brizantha CIAT 26990	*C. plumieri* DICTA	*Cha. rot. grandifolia* CIAT 18252
B. brizantha “Mixe“	*P. phaseloides* CIAT 7182	*Cajanus cajan* (local)
B. decumbens CIAT 606	*S. guianensis* CIAT 11844	*Gliricidia sepium* (local)
B. humidicola CIAT 679	*Lablab purpureus* (local)	
B. dictyoneura CIAT 6133	*Mucuna pruriens* (local)	
B. ruziziensis CIAT 654	*Vigna umbellata* (local)	
B. hybrid CIAT 36061		
B. hybrid CIAT 36062		
P. maximum CIAT 16051		
P. maximum CIAT 16031		
Pas. plicatulum CIAT 26989		
Pas atratum CIAT26868		

Forage options were presented to selected farmer groups at all three sites. Agronomic and participatory evaluations are being followed on a regular basis. As expected, farmers initial interest was on grass species, in particular the new cultivars *Brachiaria brizantha* cv. Toledo (CIAT 26110) and *Brachiaria* hybrid cv Mulato (CIAT 36061). Since cv. Mulato was introduced commercially into Nicaragua in 2003, a field day was organized in the target area in collaboration with the seed company Papalotla in order to facilitate specific information on the new grass option. Apart from the mentioned *Brachiaria* species, *Paspalum atratum* and *Paspalum plicatulum* raised farmers’ interest because of their good establishment even under the difficult

Photo 22. Grass plots at reference site Ubú Norte, Nicaragua

waterlogging conditions in 2002 and their high biomass production.

The project also facilitated the establishment of plots with a smaller selection of forage entries in different locations across the target zones. These plots are managed directly by farmer groups under the supervision of Technoserve, an extension company (30 technicians) also contracted by FONDEAGRO. The acquisition and import of 530 kg of grass and legume seed mainly from Honduras and Costa Rica was facilitated by CIAT in 2003. CIAT's Seed Unit in Atenas, Costa Rica, played a vital role in this effort.

In order to demonstrate milk production potentials of the new forage options on offer, large grazing plots (1-2 ha) (Photo 23) were established in each zone. *B. brizantha* cv Toledo (CIAT 26110) and *B.* hybrid cv. Mulato (CIAT 36061) was chosen for this effort. Parts of the plots were established with association of grasses and *Arachis pintoi* CIAT 18744. Since September 2003 milk production is being recorded in comparison to the traditional pastures available in the area and preliminary results indicate a milk increase of 15%. This has to be confirmed through further grazing cycles. Nevertheless, the involved farmer spread the news, which is now triggering interest in the new forage options. Additional field days will be organized to address forage agronomic characteristics and pasture management issues. The establishment of *Cratylia argentea* for dry season feed

Photo 23. *B. brizantha* cv. Toledo (CIAT 26110) pasture in Ubú Norte, Nicaragua

purposes resulted very difficult due to high precipitation and the inherent slow initial growth of the shrub legume. Only at the Ubú Norte site, a uniformity cut could be applied so far. Further investigation involving farmers is necessary for defining factors associated with the establishment of *Cratylia* in order to speed up initial growth and reduce the risk of failure under different environmental conditions.

Training is a major activity in the project. This includes training of project technicians (30) but also of a small group of key farmers. So far, training courses were held on forage germplasm characteristics (Sept 2002/May 2003), participatory monitoring and evaluation (Feb 2003), forage seed production (Mar 2003) and pasture management (Apr 2003) (Photo 24).

Photo 24. Measuring pasture yields in order to calculate stocking rates – Training course on pasture management in Matiguás, Nicaragua, April 2003

Courses on dry season feeding and seed multiplication will follow in October, November and December 2003. Training on seed production will be of major importance since formal seed markets in Nicaragua are only beginning to evolve with prices often beyond the economic ability of farmers. Furthermore, only grass seed of few selected species is available so far. Farmers interested in seed production are currently being organized with the intention to establish a seed production group similar to PRASEFOR (see 4.1.8) in Honduras. A visit was made to the Yorito, Honduras in March 2003 (Photo 25) in order to expose interested farmers from Nicaragua to the seed multiplication and processing experiences of farmers in Honduras. The visit was complemented by a seed-training course at CIAT's Seed Unit in Atenas, Costa Rica. Efforts were made to initiate the seed production of *B. brizantha* cv. Toledo, *Arachis pintoi* and *Pueraria phaseoloides*. CIAT will continue to facilitate this process.

Although establishment of the different forage options was not as fast as anticipated, the effects of the new basket of options are already visible. High interest is evolving among farmers who in the past have spent little time and effort on improving feed resources for their animals. Natural pastures were the main source of nutrition for livestock. Now, farmers establish their forage plots and buy seed on their own account. Further effort will be necessary to maintain the participatory focus of the project. Technicians will receive a further training course in participatory methodologies in order to avoid traditional top down extension practices which could prove detrimental to the farmer-led process being implemented.

Photo 25. Mobile seed cleaner demonstrated during training visit to PRASEFOR group at Yorito, Honduras, March 2003

4.1.7 On-farm evaluation of green manures in hillsides of Nicaragua

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Rationale

Farmers are increasingly concerned of the increased price of inputs input used for agriculture production such as fertilizers. At the same time soil fertility on farmer fields is decreasing and weeds become a larger problem over time. In order to overcome these limitations and backed up by CIAT, the local farmer organization "Campos Verdes" initiated a project to introduce, evaluate and promote the use of cover crops and green manures (CCGM) in the communities of San Dionisio in 2001.

The CCGM legumes may significantly contribute to enhanced soil fertility, water and soil conservation and weed suppression. Some of these green manure legumes can be used as forage or even for human consumption. It was also taken into account that growing CCGMs may result in a smaller amount of applied agrochemicals, which are already contaminating the scarce water resources of the people in San Dionisio. Further objectives were the demonstration of the multiple uses offered by CCGM including their drought tolerance, participatory learning about CCGM, their management within the local community and the identification of key farmers to provide feedback on local soil organic matter management.

Materials and Methods

A workshop was held in San Dionisio in April 2001 to which all members of Campos Verdes had been invited. A total of 27 farmers participated in the event and the proposed project was presented and discussed.

Sites with different soil and climate conditions throughout San Dionisio were identified and CCGM options discussed. Farmers chose *Mucuna pruriens*, *Canavalia ensiformis* and *Lablab purpureus* as CCGMs for the experiment. At the end of September 2001 the experiments were established on 8 farms in different communities of San Dioniso (Table 63).

The experiments consist of seven treatments, which were arranged, in a randomized block design with 3 replicates at each site. The treatments are summarized in Table 64. CCGM legumes were sown in maize plots (4 x 4 m) at the traditional bean sowing distance (0.4 x 0.4 m).

Table 63. Location and site description of on-farm cover crop/green manure experiments in San Dionisio, Nicaragua.

Farmer	Community	Latitude	Longitud	Altitude	Observations
D. Salgado	Piedra Colorada	12° 49’ 47.2 N	85° 51’ 51.1” W	504	River valley
A. Castro	Susuli central	12° 48’ 29.2” N	85° 50’ 24.5” W	564	Slope
J. Hernández	Susuli arriba	12° 47’ 48.0” N	85° 50’ 05.2” W	565	Steep slope
V. Cebilla	Corozo	12° 47’ 02.2” N	85° 52’ 17.6” W	484	Slope
J. Orozco	Carizal	12° 47’ 08.2” N	85° 54’ 15.0” W	715	Moderate slope
J. Jarquín	Piedras Largas	12° 43’ 32.6” N	85° 49’ 43.1” W	474	Slope
J. Hernández	Jícaro	12° 46’ 19.2” N	85° 50’ 15.6” W	530	Very steep slope
E. Ochoa	Ocote arriba	12° 45’ 23.2” N	85° 53’ 17.3” W	735	Slope

Table 64. Treatments included in on-farm cover crop/green manure experiments in San Dionisio, Nicaragua.

Treatment	Year 2001*	Year 2002
1	Maize	Maize without N-fertilizer (Control)
2	Maize	Maize with low N-fertilizer level
3	Maize	Maize with high N-fertilizer level
4	Maize	Maize with very high N-fertilizer level
5	Maize with *Mucuna*	Maize without N-fertilizer
6	Maize with *Canavalia*	Maize without N-fertilizer
7	Maize with *Lablab*	Maize without N-fertilizer

* Cover crops/green manures were sown into existing maize plots in September when the maize was entering its mature stage.

The evaluation of the legumes sown as green manures was carried out on a monthly basis. All CCGMs were kept in the maize plots throughout the dry season 2001-2002 and maize was planted into the CCGM mulch on the onset of the wet season 2002. Fertilizer treatments were applied and plant height, biomass production and maize yields were recorded at harvest in November 2002. Field days were held throughout the participating communities in order to demonstrate and discuss practical management issues with farmers. By discussing soil fertility issues farmers to provide feedback on local soil organic matter management were identified.

In September 2002 a German student from the University of Hohenheim initiated a survey on local soil organic matter management among the identified key farmers in San Dionisio. Farmers using any kind of organic matter to improve soil organic matter contents were interviewed and their experiences and techniques documented. In collaboration with the PE-2/TSBF –Project additional information on farm nutrient balances were also collected.

Results and Discussion

The absence of rainfall at the beginning of October 2001 affected the CCGM establishment and biomass production at all sites, reducing potential fertility effects on the subsequent maize crops. The effect of green manures was small at high-altitude sites such as Ocote arriba, Carrizal and the Susuli sites on the more humid eastern zone of San Dionisio. On the other hand, plots at Susuli central were lost due to massive leave cutting ants infestation. Plant growth at the Jicaro and Piedras largas sites were heavily influenced by early drought conditions and biomass production was very low.

In Table 65 we show plant height, soil cover and biomass production of all green manure species prior to the maize crop. Maize plants sown after cowpea suffered from a dry spell in August 2002 and became stunted. Subsequently, these sites had to be eliminated from the experiment. Reliable data where only obtained from the Carrizal and Susuli sites. Data recorded by farmers at Corozo, Piedra Colorada and Ocote arriba were found to be unreliable due to inconsistencies and anticipated harvest.

Table 65. Plant height, soil cover and biomass production of green manure species prior to maize crops at San Dionisio (15 weeks after establishment)

Location	Species	Plant height (cm)	Soil cover (%)	Biomass (g/m^2)
Ocote arriba	*Mucuna pruriens*	30	100	456
	Canavalia ensiformis	55	100	325
Piedra colorada	*Mucuna pruriens*	30	75	178
	Canavalia ensiformis	55	40	68
	Lablab purpureus	55	60	103
Susuli arriba	*Mucuna pruriens*	42	100	388
	Canavalia ensiformis	67	100	299
Carrizal	*Mucuna pruriens*	40	100	255
	Canavalia ensiformis	57	75	108
	Lablab purpureus	15	40	89
Corozo	*Mucuna pruriens*	25	50	122
	Canavalia ensiformis	40	60	77
	Lablab purpureus	12	40	60
Susuli Central	-	-	-	-
Jicaro*	Cowpea IITA 637-1	41	80	389
	Cowpea IITA 284-2	39	60	175
	Cowpea IITA 719	36	50	194
Piedras largas*	Cowpea IITA 637-1	51	80	299
	Cowpea IITA 284-2	44	100	234
	Cowpea IITA 719	46	80	253

* Data recorded 9 weeks after establishment

Results from Carrizal indicate that the application of CCGMs can replace the local high fertilizer application level (N high = 92 kg 15-15-15) in maize crops. *Mucuna pruriens* and *Lablab purpureus* show a slightly better effect on plant height, biomass production and maize yield than *Canavalia ensiformis* (Table 66).

At the Susuli site effects were not as pronounced as at Carrizal. This was expected since the Susuli site was heavily hit by hurricane Mitch in 1998 when much of the top soil layer was lost. Production data are somewhat below the average production level for San Dionisio, which, might be attributed to experimental, and data recording errors in this farmer-led experiment.

Partial replacement of chemical fertilizer in San Dionisio can be achieved through the use of CCGMs as demonstrated in this experiment. While differences in organic matter contents were not obtained, it could be shown that soil fertility is affected by CCGMs when grown before the long dry season. This is especially important for the improvement of the prevailing maize-bean system that is running down more and more soil fertility at hillsides locations such as San Dionisio.

Table 66. Plant height, biomass production and maize yield under different fertilizer and cover crop/green manure treatments at San Dionisio, Nicaragua

Location	Treatment	Plant height (cm)		Biomass (g/m2)		Maize yield (g/m2)	
Carrizal	N 0	105	e*	341	e	43	d
	N low	140	d	545	d	89	c
	N high	162	c	806	b	93	b
	N S-high	188	a	1362	a	125	a
	Canavalia	165	c	681	c	92	b
	Mucuna	177	b	885	b	111	b
	Lablab	175	b	843	b	105	b
Susuli arriba	N 0	80	b	255	c	23	b
	N high	100	a	634	a	77	a
	Canavalia	95	a	514	b	66	a
	Mucuna	98	a	620	a	74	a

N 0 = no fertilization; N low = 46 kg 15-15-15; N high = 92 kg 15-15-15; N S-high = 92 kg 15-15-15 + 100 kg urea)

* Within columns means followed by the same letter are not statistically different ($P<0.05$)

The survey on the soil organic matter management in San Dionisio revealed that certainly the majority of the interviewed farmers had positive experience growing CCGMs, but only few continued to grow them. Reasons indicated were: lack of time, lack of land, the invading growing habit especially of *Mucuna* sp. and the difficulty of obtaining seed.

Mucuna sp. was the CCGM, which was grown most in the target area. The majority of the farmers visited, who cultivated *Canavalia*., *Lablab,* and/or *Mucuna,* did grow CCGMs in monoculture. The majority of the interviewed farmers had at least once experiences with organic compost. Because of high investments in time and effort, farmers use organic compost only in high value crops. Mainly the farmers growing organic coffee used compost regularly. Animal manure was not mentioned as a source of organic matter improvement.

In general the survey indicated that farmers consider CCGMs as beneficial, but lack sufficient information and consciousness to adopt these technologies. Without doubt, projects on CCGMs have to take into account the greater necessity to work in a participatory framework in order to offer real alternatives in complex production systems.

Complemented by outputs of further CIAT activities on soil fertility, the above described on-farm CCGMs and survey results were presented at a soil improvement workshop in December 2002. During the workshop farmers suggested an integrative project approach capitalizing on obtained results from the different activities presented since the year 2000. A project proposal was developed combining the findings of the work with multipurpose forage germplasm (cowpea, *Canavalia brasiliensis*, *Mucuna pruriens*, *Lablab purpureus*) with production system alternatives. In collaboration with local farmer organizations (Cooperativa Sueños Realizados y Campos Verdes) CIAT developed a project proposal for a small grant from FUNICA, which was approved in May 2003. Different systems alternatives are validated on 31 farms in the Wibuse-Jicaro watershed for a time period of two years. Erosion is monitored in the large validation plots (20 x 20 m) and reliable data for economic analyses are recorded. Farmer field days on a regular basis ensure the on-going debate on project objectives and evolving problems. Participatory evaluations complement agronomic data collections. The initiated project can be seen as a further step to scale our activities in CCGM from plot levels to watershed levels.

4.1.8 Forage seed production by small farmers in Honduras and Nicaragua

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The adoption of new forage technologies are intimately connected to the availability of good quality seed at reasonable prices. Small farmers, often located in remote areas, do not have the economic ability to buy commercial seed and have no direct access to seed markets. Furthermore, not all recently developed forage germplasm is available through conventional market channels. In order to overcome this traditional bottleneck for adoption, we supported farmer groups in initiating their own forage seed production schemes for selected species such as *Brachiaria brizantha* (CIAT 26110) cv. Toledo and *Cratylia argentea* (CIAT 18668). The objective was not only to increase seed availability for participating farmers and their communities, but also to connect these farmers through a value-added forage product (seed) to local, regional and national markets. Furthermore, results from these production efforts complement our knowledge about seed production potentials under different environmental conditions in Central America.

In December 2002, a small but dedicated farmer group (12 farmers) in Yorito, Honduras, harvested 350 kg of *B. brizantha* cv. Toledo in close collaboration with DICTA and CIAT. This was a slightly lower seed yield than farmer had expected. The group, already working under their new own label – "PRASEFOR" (Productores Artesanales de Semillas Forrajeras), began to explore marketing opportunities at the beginning of 2003. Market demands such as seed quality and packaging requirements were identified. Quickly, demand for seed from PRASEFOR exceeded supply (Photo 26). While some seed was sold on the local market or were kept for the expansion of production area in 2003, FONDEAGRO, a development project in Nicaragua, which assists 1000 small livestock holders in the Matiguás region, bought most of the available seed.

On the bases of this success, the group defined a seed production target of 1,600 kg for 2003. This means further expansion of production areas (to a total of 20 ha), additional training in production aspects, post-harvest technology, seed quality, storage and marketing. First contacts were made with the formal seed sector to explore sale potentials.

A comparable development is taken place in Pantasma, Jinotega, Nicaragua, where CIAT in collaboration with INTA is working on the formation of a group similar to PRASEFOR. A total of 5 farmers started out to established cv. Toledo in 2002 but failed to produce seed at the end of the year. Further technical assistance was provided for the group and a training course will be conducted prior to the harvest in December 2003. The already established and working small farmer seed enterprise PES San Dionisio, experienced in the production of bean and maize seed, will be collaborating in post-harvest technology and marketing. It remains to be seen if production levels in grasses will allow for competitive prices on the Central American seed market, where Toledo seed is now offered for more favorable prices. Forage legume seed, in contrast, seem to enter a non-competitive market offering good opportunities for small scale farmer seed enterprises.

In view of these changing market opportunities farmers in Nicaragua with interest in seed production were encouraged to plant the shrub legume *Cratylia argentea*, since demand is constantly raising and seed supply was again short throughout 2002-2003. A total of 6.9 ha of Cratylia were established on-farm at different locations (Managua, Cuidad Dario, Siuna, Rivas, San Juan del Sur, El Suace, Posoltega, Santo Tomás, Jinotega, Esteli, Condega) (Photo 27) throughout Nicaragua which complement the already established plots at CIAT's reference site in San Dionisio, Matagalpa (1.6 ha). While seed harvesting and post-harvest operations are technically less demanding for Cratylia, first considerable seed production can only be expected in the second year after establishment. Plots in San Dionisio will be harvested in January 2004.

A major advance for the work in seed production was the completion of the regulation on seed production in which CIAT was heavily involved. Standards and guidelines are now in place for seed certification, import and export, sale and quality aspects. INTA and MAGFOR will assist in achieving the certification of seed produced by small farmers.

Photo 26. A farmer group (12 farmers) in Yorito, Honduras, harvested 350 kg of *B. brizantha* cv. Toledo in close collaboration with DICTA and CIAT

Photo 27. *Cratylia argentea* establishment for seed production in Nicaragua

4.1.9 Farmer participatory research in action in Central America

Contributors: L. A. Hernández Romero, M. Peters, A. Schmidt, L.H. Franco and G. Ramírez (statistician), with the collaboration of NARS (C. Burgos, DICTA Honduras, M. Mena, INTA Nicaragua, W. Sanchez, MAG Costa Rica) and NGO (M. Posas, SERTEDESO Honduras, J Bustamante, Fundación Ecotropica Costa Rica) partners, technicians (H. Cruz and C. Davies) and many farmers in Honduras, Nicaragua and Costa Rica

Rationale

Forage germplasm in its multiple uses - for example as feed, for the suppression of weeds, maintenance and improvement of soil fertility and for erosion control - could play an important role in improving the well being of the small and medium size farmers in Central American hillsides. However, adoption - particularly of forage legumes - has been limited, possibly due to lack of direct interaction with the farmers. Therefore it is necessary to develop forage technologies with farmers, using participatory approaches. To address this issue, CIAT in collaboration with NARS, NGO's and farmer groups is identifying forage options with farmer participation.

We anticipate that the work in Central America will contribute to the development to a strategy by NARS for the diffusion of forage-based technology for small farmers. Thus the interaction with national partners – alongside the farmers – will be of paramount importance to the success of the approach.

4.1.9.1 Farmer Criteria for Selecting Forages

Utilizing farmer criteria, the procedure for participatory selection of forages described in the 2002 Annual Report was analyzed using a different statistical procedure. Utilizing an updated database containing 1623 records from Honduras, Nicaragua, and Costa Rica (data collection until July 2003), correspondence factorial analysis (CFA) was employed and compared with results from Principal Components Analysis (PCA, see Annual Report 2002).

The classification of criteria and technologies using factorial analysis of correspondence is a classical method used to analyze large matrix of data that includes qualitative variables (Guinochet, B.1973. Logistic regression, survival analysis and the Kaplan-Meier curve. J. American Statistical Association 83: 214-225). This is the case for matrixes of numbers of coexistence between sets, i.e. sets of technologies and the set of criteria given (in this case by diverse producers groups). The analysis consists in calculating the distance between elements of each one of the sets, taking as pairs (clones and related criteria with the respective rankings).

Following the sequence of analysis described in the 2002 Forages Annual report (see also Annual report 2001-2003 Project SN-3, page 115) the procedure used for this analysis included the following steps: a) validation of criteria for forage technologies, based on farmer input, and b) determination of relative importance of criteria using relative frequencies and CFA for different forage technologies evaluated (i.e grasses, herbaceous, legumes, shrubs legumes and green manures).

According to a cross tabulation of frequencies, across all forage technologies, plant color was the most important criteria in farmer assessment. Across seasons this criteria was given more importance in the dry season (greater frequency). Yield was the next important criteria followed by cover, leafiness and competitiveness. Similar results have been found with PCA analysis utilizing a smaller data set (928 records) in 2002.

Disaggregated analysis according to specific forage technologies

Grasses: In the wet season, the most important criteria were: color, yield, leafiness, cover, competitiveness, reproductive capacity, height, and softness (frequencies in descending order).

The global analysis for the wet season showed that, the first four Dims (row coordinates factors) explained 86.2 % of the variation, a high percentage in analyzing participatory work. Height, competitiveness, and yield were defined in Dim 1, while cover, softness, and reproductive capacity were the most important parameters in Dim 2. Leafiness was the most important criteria in Dim3, while color was the most important criteria defined in Dim 4.

The global analysis for the dry season showed that the first three Dims explained 92.80 % of the variation.

Color, yield, leafiness, and softness were defined in Dim 1, while competitiveness and reproductive capacity were the most important parameters in Dim 2; cover was defined in Dim 3

These results indicate that for farmers it is important that grasses have good establishment and yield and compete effectively with weeds, regardless of season of the year. In the wet season, height was an important additional criterion in grasses. Color is important throughout seasons indicating healthy productive plants in the wet season and drought tolerance in the dry season. Confirming the results shown in the 2002 Annual Report, *Brachiaria brizantha* cv. Toledo and *Brachiaria* hybrid cv. Mulato were the grasses best meeting farmers 'criteria, the latter having a particular high acceptance in the dry season. Other forage options attractive to farmers were *Panicum maximum* cv Camerún and *B. brizantha* CIAT 26646. For king grass there was a close relation between height and preference probably related to the use of this material for cut and carry.

Herbaceous pasture legumes: For herbaceous legumes 3 Dims explained 91.2 % and 98.6 % of variation in the rainy and dry season, respectively. Among the legumes, *Desmodium ovalifolium* CIAT 33058, *Centrosema plumieri* DICTA and *Arachis pintoi* 22160/17844 were the options for the dry season meeting most criteria by farmers. When taking into account both seasons of the year, the selection criteria used by farmers to select pasture legumes included cover, color, competitiveness, yield and leafiness. Comparable tendencies were found with PCA in 2002. However, subsequent analysis with farmers showed that preference of farmers for herbaceous pasture legumes is low, as at least in our sites farmers since the main interest of farmers are new grasses, followed by shrub legumes and legumes for green manures.

Shrub legumes: For shrub legumes the first three Dims explained 96.7 % and 94.7 % of variation in the rainy and dry season, respectively. Most important farmer selection criteria were in descending order color, leafiness, yield, reproductive capacity and (fuel) wood. The most preferred species across seasons were *Leucaena leucocephala* CIAT 17263 and *Cratylia argentea* CIAT 18668. *Calliandra calothyrsus* CIAT 22316 was the most preferred accession for providing (fuel) wood. Similar results were found in 2002 using PCA analysis.

Green manure legumes: For the green manure legumes, three Dims explained 82.1 % of the variation in the wet season. Due the annual nature of most species dry season results were not measured. Criteria of major importance in selection of forages are in descending order: color, competitiveness, yield, cover and leafiness. The species that met most of these criteria were *Lablab purpureus*, *Mucuna pruriens* and *Pueraria phaseoloides*.

In response to the above findings, in subsequent participatory experiments *Canavalia brasiliensis* and *Vigna unguiculata* were introduced as options that meet farmers criteria for green manures; farmers are quickly taking up these materials for further testing, as described in sections 4.2.1 and 4.2.2. New accessions of *Lablab purpureus* were introduced in 2003, but no information of farmer preferences exists yet.

4.1.9.2 Scaling of forage options in hillsides of Honduras and Nicaragua

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In Tables 67 and 68 we show results from uptake of forage options in Honduras and Nicaragua, over the past 2 to 2.5 years.

In Honduras now more than 400 farmers are now testing and employing various forage options, sown on about 180 ha, indicating a steady increase over time. The largest areas are planted to *Brachiaria* hybrid Mulato (CIAT 36061) and *B. brizantha* cv. Toledo; increase in area for the latter is driven by seed multiplication through the farmer-led seed enterprise PRASEFOR (see Section 4.1.8) or purchase of the materials now known to farmers from commercial seed producers. Though areas are still small there is an increasing farmer interest in *Cratylia argentea* and various cowpea (*Vigna unguiculata*) and Lablab accessions. In Nicaragua uptake of forage options by farmers also is gaining speed, with now more than 150 farmers testing and employing forage options on their farms. Preferred options are *B. brizantha* cv. Toledo and *Brachiaria* hybrid cv. Mulato. There is a recent interest in testing *Calliandra calothyrsus*, utilization as fuel wood, which is an important selection criteria.

Table 67. Distribution of forage materials in Honduras, 2001-2003

Forage Species	Honduras							
	2001		2002		January – August 2003		Total	
	Area (ha)	Farmers (No.)	Area (ha)	Farmers (No.)	Area (ha)	Farmers (No.)	Area (ha)	Farmers (No.)
A. gayanus 621	0.24	6			0.09	2	0.33	8
B. dictyoneura 6133	0.52	12					0.52	12
B. brizantha 26110 *	1.11	25	16.29	19	3.29	37	20.69	81
B. hybrid 36061			12.30	6	45.10	23	57.4	29
P. maximum 16031	0.68	17					0.68	17
P. purpureum cv. Camerún	0.64	16	0.51	3			1.15	19
A. pintoi 22160	0.04	1					0.04	1
C. argentea 18668	0.89	15	3.44	24	0.83	6	5.16	45
C. pubescens 15160	0.04	2					0.04	2
L. leucocephala 17263	0.55	11					0.55	11
L. purpureus	0.10	1			0.03	8	0.13	9
S. guianensis 184	0.12	6					0.12	6
M. pruriens IITA BENIN	0.10	1			0.04	1	0.14	2
V. unguiculata (Verde Brazil)			0.14	2	0.29	8	0.43	10
V. unguiculata CIDICCO 1					0.12	17	0.12	17
C. brasiliensis CIAT17009					0.013	3	0.013	3
C. ensiformis					0.063	6	0.063	6
Local cowpea					0.035	3	0.035	3
L. purpureus 106471					0.004	4	0.004	4
L. purpureus 34777					0.009	7	0.009	7
L. purpureus 52535					0.011	7	0.011	7
L. purpureus L987					0.004	4	0.004	4
P. vulgaris					0.002	1	0.002	1
V. unguiculata 1088/2					0.041	11	0.041	11
V. unguiculata 1088/4					0.021	3	0.021	3
V. unguiculata 284/2					0.063	16	0.063	16
V. unguiculata 573/5					0.026	6	0.026	6
V. unguiculata 637/1					0.030	6	0.030	6
V. unguiculata 715					0.034	8	0.034	8
V. unguiculata 740					0.021	6	0.021	6
V. unguiculata 9611					0.152	28	0.152	28
V. unguiculata CIDICCO 2					0.090	11	0.090	11
V. unguiculata CIDICCO 4					0.149	26	0.149	26
V. unguiculata FHIA					0.182	33	0.182	33
Total	5.03	113	32.68	54	50.74	291	88.45	458

***Note:** Additionally seed of *B. brizantha* CIAT 26110 (cv. Toledo) sold by PRASEFOR amounts to an additional 14 ha sown in Sulaco, Victoria, Yorito and Yoro. Through commercial seed sale of Toledo another 80 ha were established.

Table 68. Distribution of forage materials in Nicaragua, 2002-2003

Forage Species	2002		2003		Total	
	Area (ha)	Farmers No.	Area (ha)	Farmers No.	Area (ha)	Farmers No.
B. decumbens	0.16	4			0.16	4
B. brizantha 26110	1.48	37	5.35	19	6.83	56
B. hybrid 36061	1.76	44	4.1	14	5.86	58
C. calothyrsus			0.28	35	0.28	35
Total	3.4	85	9.73	68	13.13	153

4.2 Partnerships in Asia to undertake evaluation and diffusion of new forages alternatives

Highlights

- Documented and published the impact of the Project "Forages for Smallholders" in Southeast Asia
- Doubled (247 to 467) in a two year period the number of farmers planting forages in Laos mostly as a result of direct farmer experience rather than promotional efforts
- Farmers in Laos raising pigs see benefits of feeding *Stylosanthes guianensis*: labor saving, and increased survival and growth rates of piglets
- Launched a new project funded by ADB (Improving livelihoods of upland farmers using participatory approaches to develop more efficient livestock systems) for countries in southeast Asia

4.2.1 Completion of Forages for Smallholders Project in Southeast Asia

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Rationale

The project "RETA 5866 (Fourth Agriculture and Natural Resources Research at CGIAR Centers: Developing Sustainable Forage Technologies for Resource - Poor Upland Farmers in Asia"), in short called the "Forages for Smallholders Project" (FSP), started in January 2000. It was funded by the Asian Development Bank for a period of three years, and had an extension of 6 months. The objectives of the project were to:

A) Develop sustainable forage technologies for resource-poor farmers in upland farming systems in Asia.
B) Strengthen the capacity of National Agricultural Research Systems in the Bank's Developing Member Countries to develop and deliver these technologies to farmers.

The FSP was co-coordinated by the Centro International de Agricultura Tropical (CIAT), which is part of the Consultative Group on International Agricultural Research (CGIAR). The implementing agencies in the participating countries were:

China:	Tropical Pasture Research Center (CATAS), Hainan
Indonesia:	Dinas Peternakan, Samarinda and Directorate General of Livestock Services (DGLS), Jakarta
Lao PDR:	National Agriculture and Forestry Research Institute, NAFRI, Vientiane
Philippines:	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), Los Baños, Visayas State College of Agriculture (ViSCA) and Department of Agriculture, Region 10

Thailand:	Department of Livestock Development, Ministry of Agriculture and Cooperatives, Bangkok
Vietnam:	National Institute of Animal Husbandry (NIAH), Ministry of Agriculture and Rural Development (MARD), Hanoi

In what follows the main accomplishments of the FSP are summarized.

4.2.1.1 Development of sustainable forage technologies for resource-poor farmers in upland farming systems

In most countries, periodic surveys of a sample of farmers were carried out to assess changes in forage technologies, areas planted, and multiplication materials and seeds produced. The farmer for these surveys had been selected randomly, although weighed by districts or barangays.

In Lao PDR surveys covered 100% of the farmers. Average area of forages cultivated per household varied from 188 m^2 (Lao) to 4,210 m^2 (Thailand), Table 69. The largest area of forages by site is in Daklak, Vietnam, due to many farmers adopting and relatively large areas per farmer.

Table 69. Areas of forage cultivated in sample areas according to the most recent surveys, and extrapolation of forages in whole project area.

Country and site	Sample size	Total forage area (m^2)	Forage per household (m^2)	No. of house-holds involved	Area extrapolated to households involved (ha)
Philippines					
Malitbog	24	31,418	1,309	385	50.4
Cagayan de Oro	31	48,514	1,565	372	58.2
Cebu and Leyte				670	96.3
Impasugong and Manolo Fortich				236	33.9
Indonesia					
East Kalimantan	30	63,083	2,103	740	155.6
Vietnam					
Tuyen Quang	99	70,510	712	761	54.2
Daklak	60	81,882	3,625	976	353.8
China					
Hainan	30	36,627	1,221	176	21.5
Thailand					
Nakornratchasima	19	80,000	4,210	276	116.2
Lao PDR					
Luang Prabang and Xieng Khuang[1]	343	64,400	188	343	64.5
Total				4,935	1005

[1]FLSP (AusAID) has been operating in Xieng Khuang.

Impact in East Kalimantan, Indonesia

The study was conducted with about 85 farmers in three villages: Makroman, Sepaku and Samboja. Livestock systems varied from stall-feeding improved goats (Makroman), grazing under coconuts on improved pasture by Bali cattle (Samboja), to grazing and stall-feeding improved forages to Ongole cattle (Sepaku).

Forage availability: Before introduction of new forages, some farmers already used King grass for cut and carry. The participatory work on forages with farmers resulted in four technology changes: 1) reduction or disappearance of grazing on communal rangeland and increased pasture fencing (Samboja); 2) prolonged pasture time at home-plot (Sepaku); 3) pasture fencing in upland and old rice fields (Sepaku) and 4) planting of forage in contour lines and as cover crop associated with food and cash crops (Makroman and Sepaku). The average availability of improved forage area was 0.4 ha per farm. Most farmers in Samboja who adopted new forage had enough improved pastures to provide enough fodder for that their cattle. In Sepaku and Makroman, forage availability was still not high enough for optimum livestock production.

Ruminant productivity: Introduction of new forage species increased off-take of animals due to shorter inter-parturition periods, in all species and breeds. Twinning rate in goat increased in some herds. Improvement was also perceived through better body condition of animals resulting in better carcass quality and higher prices paid by butchers. Since new forage introduction in Makroman, farmers have doubled their herd size of goats. Increases in cattle numbers were less pronounced.

Reproduction rate of Bali cattle in Samboja was higher than for cattle and goats in Sepaku and Makroman. Off-take rate (animals sold in a period divided by the mean herd size during the period) in Samboja increased from 21 to 23.5% after adoption of forages. In Makroman en Sepaku, new forages associated to food and cash crops enhanced soil fertility and prevent erosion.

Labor requirements and gender: The adoption of new forage technologies reduced time needed to collect fodder as well as for forage crop maintenance. The spared time was put to good use, either for feeding more animals or by doing more off-farm work. Mean time saved was close to 20%.

The effects of new forage technologies on labour division were generally gender neutral. In one sub-district, youth were less often involved and in another, women were slightly more frequently involved. Sometimes women were more frequently involved in fodder collection as she replaced the husband doing off-farm activities. All genders appreciated new forage introduction positively as the impact on household income was high. To make immigration settlement possible, Indonesia developed infrastructures in swampy mostly uninhabited areas, and the original population also participated in FSP. Unequal income distribution in rural areas couldn't be attributed to FSP. FSP strategy improved fodder balance and increased the possibilities to extend livestock ownership, a major generator of rural income.

Other benefits and economic performance: Manure applied on food and cash crops contributed approximately 40% to farm household income from livestock in Makroman and Sepaku. This indicates the dependency of households on manure for soil fertility maintenance. In these two sub-districts market value of manure was approximately ten times its estimated mineral value. Apart from application on crops, farmers sold manure for cash income and estimated they applied less then 15% of manure on forage crops. As a result, productivity and quality of new forages was low. The use of manure on food and cash crops does not conflict, however, with the overall objectives of FSP, namely to improve livelihoods.

On average, increased ruminant productivity in the study area, in terms of cash income from sales of livestock and manure, resulted in an increased gross margin of 35 % per household. In addition to increased animal productivity, on average 24 % labor input was saved in the new forage systems in terms of days worked per year. The saving of labor amounts to an extra 28 % increased income from the livestock system, when time is valued in money.

The average rural income in the province in 2001 was US$ 184 per capita per year. The average income from livestock in the three villages increased from US$ 73 to US$ 92 per capita per year. This corresponds to an increase of 10.3 % of total income per capita per year. Saved labor could have contributed to another 11 % increase of total income per capita, depending on the availability of casual labor opportunity or the investment of saved labor in farm enterprises.

Impact in Mindanao, Philippines
Livelihood consisted of a variety of crops, dairy cattle, dairy buffaloes, beef cattle and goats and other small livestock. The average number of large ruminants per farm was 4.2.

Forage availability: Before the introduction of new forages, no cutting and carrying were practiced. Animals were tethered on roadsides or fields, or herded on hillside rangelands and fed with residue. The project had a significant effect on the quantity and quality of available forage; farmers who were growing forages derived 67 % of the feed resources from these forages.

Ruminant productivity: Farmers mentioned several benefits of new forage introduction: improved body condition and overall health of animals; increased length and quality of work by draught animals; greater pig and poultry production; larger amounts of available manure due to reduced herding-time and more animals.

Farmers observed increased numbers of offspring and shortened anoestrus after parturition: from three to one month in goats; one year to three months in cattle; and 10 to four months in buffaloes.

Labor requirements and gender: Time spared due to new forages was estimated at 30 minutes to 2 hours per day. This time was either invested in increasing the number of animals, or other farm activities such as tending to vegetables and fishponds, off-farm trading, and roadside food selling. Farmers could also make themselves and an animal available for hire for off-farm work or use the time to attend meetings and pursue administrative problems. More time and energy was available for social activities inside the household and in the community. In some areas, the reduction in time needed in the wet season was limited as the forage for cutting and carrying was often a long way from the village.

Life became more relaxed as it was easier to plan activities when animals were not grazing. The reduction or disappearance of tethering and herding also resulted in less destruction of crops. Consequently the production of maize, banana and vegetables, and the income from animals' work outside the farm, increased.

Most farm households that had ruminants prior to forage adoption increased their herd size after joining FSP. More labor input was required due to the increase in livestock numbers and as a consequence the time available for non-farm work decreased. The increased need for on-farm labor had a negative trade-off on the income from firewood as farmers did not have time to cut in nearby forests. However, this was a positive change for the environment.

The introduction of new forages had a gender effect in the Philippines: the involvement of women and children in tasks like herding and cutting diminished, and men were responsible for more livestock tasks. A large increase in the number of animals owned by early adopters resulted in the need for greater labor input. This created labor in rural areas and reduced labor migration by young people.

Other benefits and economic performance: In the Philippines, improved forage species increased animal production, improved soil conservation and saved farmers time. Net yearly income per household from animal production increased from $54 to $157 in the farming community at Malitbog, and from $68 to $503 in Cagayan de Oro. Planting forages in contour lines increased crop production slightly and contributed another $22.50 to yearly income. The reduction in labor requirements allowed households to make $36 per year from other activities.

Impact in Tuyen Quang, Vietnam
Livelihood consisted of a variety of crops, a variety of animals including fishponds, and several sources of off-farm income. The average number of large ruminants per farm was 0.8. Comparing farmers who had adopted them several years ago with farmers who had started

less than one year ago was used to assess the impacts of new forage technologies.

Forage availability: Farmers reported higher yields of forages compared to native grass. The high yields of new forages allowed farmers to keep more animals or to keep animals in zero grazing. Improved forages enabled other farmers to start keeping animals, as they were able to produce sufficient fodder from their small plots. The average estimated contribution of new forages to animals' diets was 53 % during summer and 32 % during winter.

Ruminant and fish productivity: Ruminant productivity increased through faster growth of animals, higher price received for the animals at the market due to better body condition, increased working capacity of draught animals, and increased amounts of manure available. The productivity of fish also increased the period until marketing was reduced from 11 months to nine months due to the availability of new forages.

Labor requirements and gender: Saved time was an important benefit for most farmers keeping ruminants. This was not the case for those who had increased their number of animals, or had just started keeping buffalo or cattle, since the introduction of new forages. The number of labor days per year required for large ruminants reduced from 258 to 149 for farmers with and without forages, respectively. Farmers with forages had saved on average 120 days per year in the ruminant system. The mean number of saved days for fish production was 30 days per year, which corresponds to approximately 40 minutes per day. Two-thirds of adults' saved time was used for productive farm activities. Family members used the remaining saved time for leisure, training and study.

Positive gender effects were significant in Vietnam. Women and children benefited most from the reduction in time spent cutting, carrying and herding. They used this extra time for educational and cultural activities. According to women, forages had a positive effect on other crops due to soil conservation and manure availability. Labor saved from livestock was used to better manage crops, resulting in higher yields. Higher yielding crops then required increased labor time for harvesting and processing. Saved time was invested in a range of farm activities including cash crops like rice, cassava, beans, sugarcane and fruit trees. Activities women appreciated more were planting forages and feeding fish.

Other benefits and economic performance: In Vietnam, improved forage systems also had a pronounced effect on income levels and welfare. Net income from ruminant-fish production systems increased from $99 to $199 per year. Saved time also allowed households to increase their income from other, mainly agricultural, activities. This contributed to an additional yearly income of $52 per household. Farmers were grouped in four income classes; the majority was in the class that earned between US$ 301 and US$ 736 per year per household. An increase of $ 152 from the livestock system therefore corresponds on average to an increase in total household income of 29 %.

Poorer farmers who depended more on livestock due to small land area, benefited most from the improved forages. Improved forages allowed them to keep large ruminants—increasing their income from livestock— and intensify their production systems. Other positive effects on rural development included a reduction in the number of farming conflicts, rehabilitation of barren land and reduced use of pesticides.

4.2.1.2 Scaling-up forage technologies from farm to community and provincial levels

At the end of 1999, about 1750 farmers spread over 19 sites in Indonesia, Philippines, Vietnam and Lao PDR were evaluating forages on-farm, in the FSP project funded by AusAID. In 2000, the ADB funded FSP project adopted several sites from the earlier project: East Kalimantan in Indonesia, Malitbog and Cagayan de Oro in the Philippines, Tuyen Quang and Daklak in

Vietnam, and Luang Prabang in Lao PDR. Some other sites were added in 2000: akornratchasima in Thailand and Hainan in China. A strategy for scaling-out was developed with the focus sites playing a central role. The expertise of researchers and field workers at the focus sites in research on forages and facilitating the technology development was used to train other new staff in neighbouring districts or provinces.

Participatory diagnosis (PD) and planning remained a key activity for starting the technology development process at new sites. Farmers at the focus sites who had been experimenting with forages for several years were asked to host cross-visits and receive farmers from the neighboring villages, districts and provinces. The scaling process within countries in the FSP is shown in Table 70.

Table 70. Scaling out to new sites within countries.

Year	Indonesia (East Kalimantan prov.)	Philippines (Mindanao and Visayas)	Vietnam (Daklak and Tuyen Quang prov.)	Lao PDR	Thailand (Nakornrat-chasima prov.)	China (Hainan prov.)
2000	Penajam Paser Utara[1] Samarinda[1] Kutai Balikpapan Bulungan Berau	Malitbog[1] Cagayan de Oro[1] Impasugong Manolo Fortich	Madrak[1] Ea Kar Han Yen[1] Yen Son Son Duong	Luang Prabang[1]	Sungnuen Sikhew Dankhuntod	Baisha Ledong Danzhou
2001	Penajam Paser Utara Samarinda Kutai Balikpapan Bulungan Berau	Malitbog Cagayan de Oro Impasugong Manolo Fortich Cebu Leyte	Madrak Ea Kar Han Yen Yen Son Son Duong	Luang Prabang Savannakhet	Sungnuen Sikhew Dankhuntod	Baisha Ledong Danzhou
2002	Penajam Paser Utara Samarinda Kutai Balikpapan Bulungan Berau East Kutai Central Kutai	Malitbog Cagayan de Oro Impasugong Manolo Fortich Cebu Leyte	Madrak Ea Kar Han Yen Yen Son Son Duong	Luang Prabang Savannakhet	Sungnuen Sikhew Dankhuntod Pakchong	Baisha Ledong Danzhou Dongfang

[1] Adopted sites from FSP phase 1.

In Table 71 we show an overview of how many PD and cross visits were conducted, how many farmers participated, and how this led to new farmers experimenting with forages on their farms. On average about 18 farmers would participate per PD, and about 77 % of those farmers would start planting forages. Many of those farmers were encouraged by what they saw and heard during the cross visits. As a result, a total of 4200 new farmers have started to grow and experiment with forages during the duration of the project.

Table 71. Scaling-out activities and number of new farmers experimenting with forages.

Year	No. of participatory diagnoses (PD) conducted	No. of farmers participated in PD	No. of new groups	No. of cross visits organized	No. of farmers partic. in cross visits	No. of new farmers planting forages
2000	45	1087	52			748
2001	151	2173	179	187	1330	1537
2002	101	2148	52	141	1833	1870
Total	297	5408				4155

There have been efforts of monitoring what happened to the early and subsequent experimenting farmers in terms of adoption, expansion within their farm, and continuation to grow forages. A large drop out was observed in Luang Prabang, where at the beginning of the wet season in Luang Prabang there were 262 farmers growing forages; eight months later there were 170 farmers remaining. Another big drop out was observed at Malitbog. Some farmers naturally drop out due to various reasons such as:

- Feed shortage was not a problem (e.g. in Luang Prabang).
- They expected livestock dispersal on loan from the government, but no animal was received (e.g. in Malitbog).
- They no longer have ruminant livestock, due to emergency sales.
- They abandon their farm to seek employment elsewhere.
- They get absorbed in other dominating farm activities such as cash crops.
- Forages were overgrown by weeds due to labor pressure in early stage.

As said earlier, there were already farmers growing forages at the focus sites, which were inherited from the previous FSP. Out of those 1750 early farmers, about 800 were found in the focus sites of the new FSP. At he end of 2002 there were 4780 farmers, including early adopters, growing forages at the sites where FSP phase II was active (Table 72). The total number of drop -outs therefore was about 200 (4752 – 800 – 4155).

Table 72. Total number of farmers growing forages at FSP sites at December 2002, per country.

Country	Indonesia (East Kalimantan prov.)	Philippines (Mindanao and Visayas)	Vietnam (Daklak and Tuyen Quang prov.)	Lao PDR (Luang Prabang Prov.)	Thailand (Nakornrat-chasima prov.)	China (Hainan prov.)
No. of farmers	740	1663	1737	160	276	176
Grand total:	4752					

Guidelines for scaling-up forage technologies. The FSP is an example of how a research project started in a conventional way, with little farmer participation before 1995, with on-farm experiments being largely contractual. More than 500 species and varieties of forages were screened in a few locations. From 1995, FSP phase II and I engaged farmers in research on forage with progressing levels of participation. Research went from centralized community plots of well laid out test plots of 10-20 best bet species and varieties to plots on-farm where farmers decided on the species and varieties to test, the lay out of the plots, and the methods of harvesting. There are three new dimensions that this phase of research entered: (1) the move from test plots to forages integrated with other food or cash crops, either as cover crops, intercrops, relay crops, live erosion barriers or live fences, (2) the forage crops were evaluated not only for growth characteristics but also for feed for livestock, (3) larger areas of one or two favorite species or varieties were grown at farm level (Figure 70).

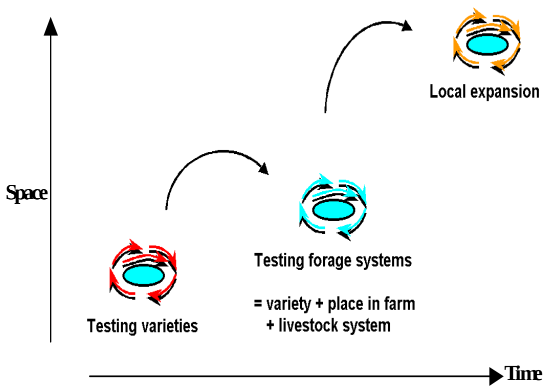

Figure 70. Adoption: from on-farm test plots to on-farm expansion (Adapted from Horne et al., 2000).

The process described in Figure 70 plays within the boundaries of a farm. Scaling out and scaling up, however, implies spreading of technologies across farm boundaries. There are principles to be considered for successful and sustainable scaling out. The FSP has developed a conceptual framework to guide national teams of fieldworkers, scientists, administrators and policy makers in this process (Figure 71).

There is a natural sequence of research activities (stages 1 – 11 of Figure 71). The first step for either starting research at a focus site, or scaling out to a new site is to gather secondary information and to carry out a rapid rural appraisal with a wide range of stakeholders. If a need for forage R&D is perceived, extension workers of the Local Government Units (LGU) are trained in forage agronomy, participatory research, and gender analysis. During these courses, the more active and motivated extension workers, who can effectively lead work in the project, are identified (step 2). The selected extension workers are assisted in their first

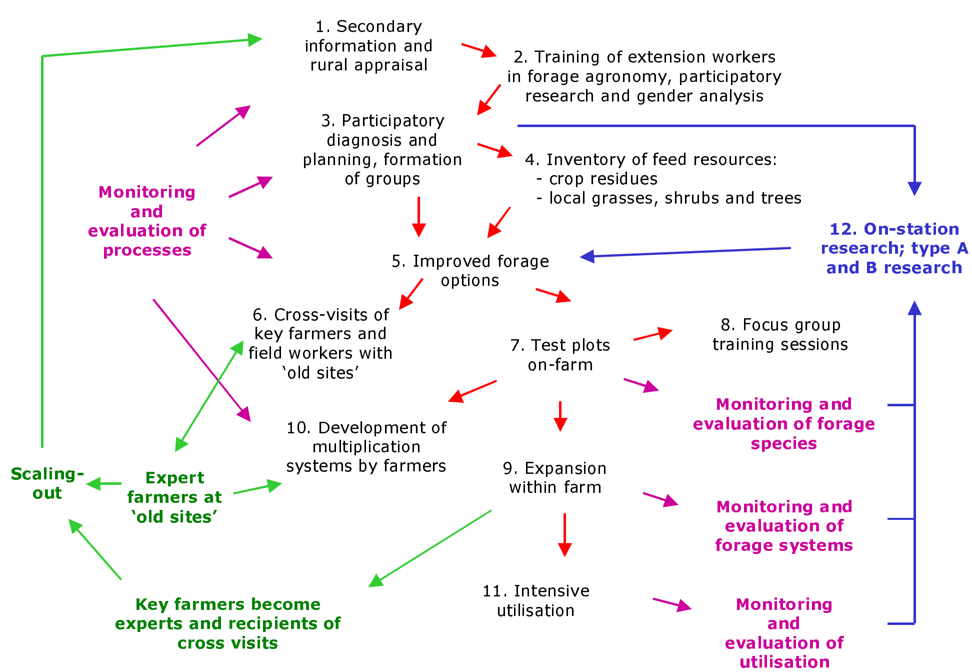

Figure 71. Research and development processes in FSP

participatory diagnosis and planning exercises with their communities (step 3). Community inventory of existing feed resources greatly assists the identification of suitable improved possible forage systems, which are offered to farmers (steps 4 and 5). If focus sites with experienced farmers exist elsewhere, cross-visits are facilitated for farmers to visit them at the new sites, even if it might involve extensive travel (step 6).

About 1 year after initial planting, farmers are likely to perceive effects on animal productivity, soil fertility, or erosion control. Farmer groups are sometimes trained on specific issues relevant to their stage of research or development with forages. Multiplication of planting materials or seeds is an essential step in the scaling out process (steps 7 to 11).

The green arrows in the diagram pointing left indicate the processes of scaling out, whereas the purple arrows indicate the different levels of monitoring and evaluation, which provided feedback to stakeholders, and assisted in identifying strategic research issues (step 12). Many tools were used to facilitate the scaling out process (Figure 72). A case study was written entitled 'Issues and Strategies for Going to Scale: A Case Study of the Forages for Smallholders Project in the Philippines' (Roothaert and Kaaria, in press).

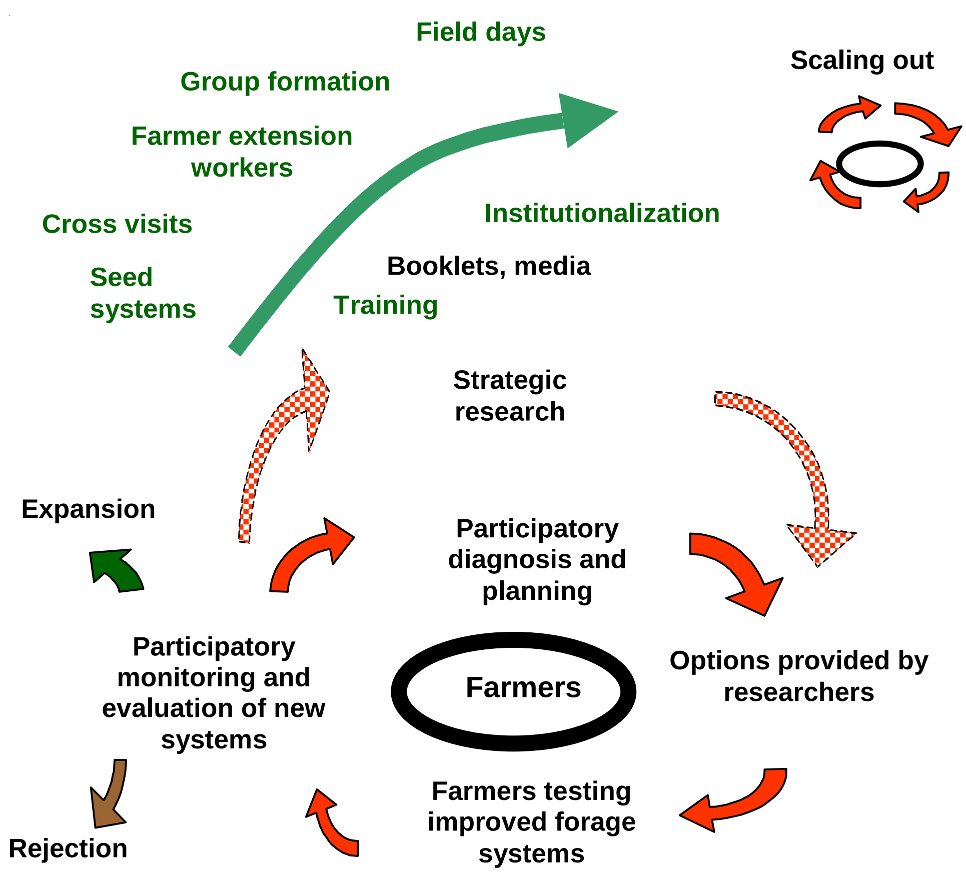

Figure 72. Farmers research process and tools for scaling out.

4.2.1.3 Capability in member countries for developing and disseminating forage technologies using farmer participatory approach (FPA)

Many training activities have been conducted towards capacity building of project staff and their partners in PR China, Indonesia, Lao PRD, Philippines, Thailand and Vietnam. Training activities were either technical or methodological in nature, or a combination of the two. An examples of a technical course is the course on 'Forage growing and animal production', held in September 2001 in Hainan, China. An example of training in methodology is the course on 'Participatory Diagnosis' held in January 2001, in Lao PDR . An example of where both technical and methodological issues were combined in one course is the course on 'Development of forage technologies with farmers' held in June 2001, Samarinda, Indonesia (Table 73).

Table 73. Capacity building on technical and methodological topics.

Type of training	Year	Project staff trained	Farmers trained	Training topics
Forage science and related technologies	2000	3	653	Forage management, animal nutrition, livestock management, legume trees, forage utilization, milk production and processing, forage technologies, forage production, body weight monitoring, agronomy, fodder tree nursery management, goat raising, animal health, duck raising, utilization of fodder trees, seed production, cattle fattening, integrated farming system, conservation farming
	2001	44	1805	
	2002	87	2464	
Participatory research approaches	2000	32	0	PD, participatory development and gender analysis, dissemination of forage technologies, participatory monitoring and evaluation, participatory extension, participatory tools, data recording and analysis
	2001	57	35	
	2002	45	40	
Combination of science and participatory approaches in one course	2000	120	0	Developing forage technologies with farmers
	2001	100	13	
	2002	33	4	
Total 3 years		521	5014	

4.2.2 On-farm evaluation of new grass and legume options for livestock systems in northern uplands of Laos

Contributor: Peter Horne (CIAT)

Rationale

CIAT has been conducting forage research in Southeast Asia since 1992, commencing with forage varietal selection and evaluation, both in experimental plots and on farms, in seven countries. One main outcome of this work was the identification of ~40 broadly adapted and robust forage varieties with demonstrated potential to deliver significant impacts on smallholder farms throughout the region. The outcomes of this research are documented in several CIAT publications (Horne and Stür, 1999; Stür et al., 2000; Stür and Horne, 2002; Stür et al., 2002). In 2000, CIAT secured funding from the Australian Agency for International Development (AusAID) for a five year project to "integrate forage and improved livestock management strategies into upland farming systems of Laos using participatory research approaches" (FLSP). The project works with 36 partner staff from national, provincial and district government agencies, conducting research and extension aimed at:

- Increasing income by improving the productivity of small and large livestock;
- Increasing labor efficiency and reduce women's workloads in the livestock production systems;
- Enhancing sustainable cropping systems by increasing soil fertility and reducing soil erosion; and,
- Sustaining livestock production within the national policy of stabilising shifting cultivation

In the first field season (starting June 2001), the project supported small scale testing on farms during which time farmers evaluated forage varieties in small plots and sorted out which they preferred and wanted to expand. This was a time when the district and provincial staff also learned about the varieties, their environmental adaptation and the process of working in partnership with farmers.

Building on the experiences of the first year, the second field season (starting June 2002) was a period of expansion based on targets set by the project (e.g. the number of villages was doubled and the number of farmers tripled) or targets set by farmers (based on the desire to get large enough areas of forages to have some significant quantities of feed for their animals). Farmers generally started to look for ways of utilizing the most promising forage varieties to either help resolve current problems or to develop new opportunities. During that second year the project challenged field staff with new villages, new technologies and many new farmers to encourage them to move away from a dependence on the very intensive one-to-one processes that had been used in the first field season and move more towards farmer group processes.

Leading up to the third field season of the project (starting June 2003), interesting, sometimes novel, often unexpected impacts started to emerge. The district staff had become very familiar with the processes of working in partnership with farmers. Indeed these processes are now becoming their 'comfortable norm' back to which they will retreat naturally, given the support of their organisations. Further expansion will not now be driven by project targets but by IMPACTS. This focus on "impacts driving expansion" will be the focus of the project for the next two wet seasons. By 2004, the project will be supporting the most experienced and confident farmers as field extension workers to help with the expansion of impacts to more people and more villages. At the same time the Extension Managers (the bosses of the field staff) will become much more actively involved in the process.

4.2.2.1 Project Review

In August 2002, AusAID sent a technical reviewer to:

i) Assess FLSP progress to date in relation to achievement or likely achievement of project objectives
ii) Identify problems and issues that either presently impact on FLSP implementation or are likely to do so in the future, and suggest cost effective strategies to alleviate any negative impacts and
iii) Make recommendations as appropriate to enhance the quality of FLSP implementation in a manner that does not lead to significant project cost increases.

The review concluded that "the project is on course for meeting its objectives and is pursuing the wider outcomes necessary for the sustainability of the program, as indicated by the following:

- The innovations are appropriate. Agricultural productivity is increasing. Planting forages close to homes, thereby also increasing substantially the productivity of labor, reduces environmental pressure on the uplands.
- The program is farmer-led.

- The project is institutionalizing a participatory, facilitative extension strategy consistent with a farmer-led program whilst ensuring and increasing the technical competence of staff.
- Promotion of a sense of Lao ownership of the program at all levels.
- Food security is increasing.

The review went on to recommend that to continue this process and to accelerate adoption, the project needs to:

i) Expand the extension strategy concept to an enlarged community-based group approach with selected farmers having a training role,
ii) Increase the capacities of extension staff in on-farm analysis of options within smallholder farming systems,
iii) Focus in the coming year on consolidation of impacts and on skills of field staff rather than just on expansion,
iv) Increase its outreach to rural women,
v) Prioritize the issue of nutrient recycling
vi) Implement the proposed strategy of disease minimization to meet farmers' needs for improved animal health

These recommendations defined the project's field activities in 2003, which aimed to:

- Enhance information exchange, (i) between farmers within villages (ii) between villages and (iii) between extension workers and farmers
- Generate genuine impacts not just increases in area.
- Work with focus groups in the field rather than individual farmers
- Work with women's groups
- Develop case studies to quantify impacts not just outputs
- Expand to new farmers and villages only where there is real momentum
- Support district teams with the training, mentoring and resources they need to be able to organize cross visits / field days
- Develop extension materials for scaling out from local successes.

4.2.2.2 Forage Technology Development

As a result of the work done by district, provincial and national staff during the second field season (June-October 2002), the total number of farmers planting forages increased from 247 in 2001, to 467 in 2002 (Table 74). This is almost a doubling in the number of farmers and so a very substantial increase. It is worth looking at where this increase comes from in more detail:

Number of farmers continuing	238
Number of farmers dropping out	9
Total number of new farmers	230
New farmers in 'old villages'	60
New farmers in 'new villages'	170

The number of new farmers in the 'old villages' gives an indication that sustained expansion is occurring, based on farmers' direct experiences. This must be distinguished from the number of new farmers from 'new villages', which is due to the 'promotional efforts' of the district staff being successful. The increase of 60 new farmers in these old villages was about 24% over the number of farmers in the first year. This is a reasonable figure of expansion. There was little to distinguish between the scaling-up between the two provinces.

There were just 170 new farmers (on average slight more than 8 farmers / village) recruited in the new villages this year. This is a much lower figure than last year (on average 14 farmers / village) indicating that the district staff now recognize that they need to start with a number of farmers in the first year which they can reach and support.

The total number of farmers particularly in an early stage of establishment of a new enterprise can hide both good and poor progress. Staff estimated that about 30% of all the farmers were developing significant forage systems and would be enthusiastic supporters of expansion. In any extension process this would be regarded as a positive initial outcome.

Table 74. Number of farmers and forage areas planted in target villages

District and Village	2001		2002			2003					
						Number of farmers who					
	Number of Farmers	Forage area (m^2)	Number of Farmers	New forage area in 2002 (m^2)	Total forage area in 2002 (m^2)	Mainta in their area	Increas e their area	Are new	Total farmers	New forage area in 2003 (m^2)	Total forage area in 2003 (m^2)
PEK											
Ta	8	7,400	13	7000	14400	9	4	3	16	2700	17100
Phonekham	35	4,500	26	2,850	7350	20	6	3	29	3850	11200
Dong	7	750	14	450	1200	14	0	0	14	0	1200
Xang	12	6,400	17	5,850	12250	14	3	0	17	2450	14700
Mouan	0	0	9	3,800	3800	3	6	4	13	3200	7000
Lek	0	0	15	3000	3000	14	1	0	15	300	3300
Vieng Khouan	0	0	11	1,850	1850	0	10	2	12	3750	5600
Or An	0	0	11	4,850	4850	10	1	1	12	1250	6100
Vieng	0	0	0	0	0	0	0	11	11	1600	1600
Nakhone	0	0	0	0	0	0	0	13	13	3600	3600
Bee	0	0	0	0	0	0	0	22	22	4700	4700
Sub-total	**62**	**19050**	**116**	**29650**	**48700**	**84**	**31**	**59**	**174**	**27400**	**76100**
NONGHET											
Houay Khiling	8	2,500	9	3200	5700	6	3	1	10	1950	7650
Nonghetai	9	1,400	12	1950	3350	12	0	0	12	0	3350
Paklak	8	1,300	10	3050	4350	9	1	1	11	400	4750
Khanganien	14	2,800	14	9950	12750	8	4	0	12	5350	18100
KeoPaTu	0	0	8	2750	2750	3	5	0	8	3800	6550
Pha ‘En	0	0	9	2500	2500	8	1	2	11	1000	3500
Sandon Koe	0	0	7	2950	2950	5	2	1	8	1150	4100
Tham Toum	0	0	8	5550	5550	6	2	1	9	4200	9750
Nongkob	0	0	0	0	0	0	0	6	6	2700	2700
Nongle	0	0	0	0	0	0	0	5	5	2600	2600
Tamseua	0	0	0	0	0	0	0	9	9	1800	1800
Sub-total	**39**	**8000**	**77**	**31900**	**39900**	**57**	**18**	**26**	**101**	**24950**	**64850**
XIENG NGEUN											
Kieuw Chaluang	23	14500	23	1500	16000	17	6	1	24	1200	17200
Kieuw Talun Noi	6	200	12	1400	1600	6	6	10	22	3200	4800
Kieuw Talun Nyai	12	1250	16	4700	5950	9	7	15	31	7600	13550
Phonesaad	7	2050	19	9850	11900	10	9	9	28	8300	20200
Long Or	0	0	8	2850	2850	7	1	5	13	1650	4500
Houay Hia	0	0	8	4100	4100	0	8	6	14	5550	9650
Kieuw Nya	0	0	7	4050	4050	3	4	8	15	6100	10150
Nam Mok	0	0	3	900	900	1	2	17	20	6800	7700
Houay Yen	0	0	0	0	0	0	0	9	9	4800	4800
Silaleck	0	0	0	0	0	0	0	16	16	4700	4700
Ensavanh	0	0	0	0	0	0	0	9	9	2100	2100
Suandala	0	0	0	0	0	0	0	9	9	2100	2100
Sub-total	**48**	**18000**	**96**	**29350**	**47350**	**53**	**43**	**114**	**210**	**54100**	**101450**
LUANG PHABANG											
Long Lao 2	26	4600	26	1200	5800	24	2	7	33	1700	7500
Nong Tawk	9	1500	13	1200	2700	8	5	8	21	1850	4550
Kok Wan	13	650	20	1550	2200	17	3	5	25	1300	3500
Bo Hae	16	1750	18	800	2550	16	2	5	23	1000	3550
Houay Leuk	16	650	17	1300	1950	14	3	3	20	1100	3050
Dansavanh	18	1000	19	950	1950	15	4	9	28	2150	4100
Nadon Koun	0	0	5	600	600	3	2	4	9	1600	2200
Pik Noi	0	0	6	900	900	2	4	8	14	2050	2950
Phadeng	0	0	4	900	900	3	1	5	9	1000	1900
Pik Nyai	0	0	7	1000	1000	4	3	11	18	2250	3250
Pak Pa	0	0	4	1600	1600	3	1	3	7	850	2450
Long Lan	0	0	21	4700	4700	15	6	8	29	2400	7100
Nasao	0	0	0	0	0	0	0	4	4	1400	1400
Paksi	0	0	0	0	0	0	0	13	13	4500	4500
Nounsavad	0	0	0	0	0	0	0	5	5	800	800
Sub-total	**98**	**10150**	**160**	**16700**	**26850**	**124**	**36**	**98**	**258**	**25950**	**52800**
PAK OU											
Had Pang	0	0	11	7000	7000	5	6	20	31	10950	17950
Somsanouk	0	0	5	1900	1900	3	2	10	15	2750	4650
Pakcheck	0	0	3	300	300	0	3	6	9	750	1050
Hadxoua	0	0	0	0	0	0	0	2	2	300	300
Houay Tun	0	0	0	0	0	0	0	3	3	300	300
Sub-total	**0**	**0**	**19**	**9200**	**9200**	**8**	**11**	**41**	**60**	**15050**	**24250**
TOTAL (All Districts)	**247**	**55200**	**468**	**116800**	**172000**	**326**	**139**	**318**	**803**	**147450**	**319450**

During the second field season (June-October 2002), the area of forages increased from 5.5 hectares in 2001, to 17.2 hectares. This is a trebling of the area planted in 2001. This figure can also be examined further;

Total new area of forages	11.7ha
'Old villages' new forage area	5.9ha
'New villages', new forage area	5.8ha

Thus the forage areas within the old villages more than doubled. This can be compared to the increase in farmers in the old villages of just 24%. This is different from the expansion dynamics commonly experienced with crops, where the increase in area tends to lag behind a more rapid increase in the 'number of farmers testing'. The expansion of forage areas in the old villages has come mainly from 'old farmers' expanding their plots, and is an indication of emerging impacts driving expansion.

By comparison, at the start of the third field season (June 2003), the total number of farmers planting forages had increased from 467 in 2002 to 803 (see Table 1). This is another almost-doubling in the number of farmers working with the project, despite the fact that expansion this year was based on nascent demand, not project targets. Once again, it is worth examining this expansion in more detail:

Number of farmers continuing	465
Number of farmers dropping out	2
Total number of new farmers	338
New farmers in 'old villages'	202
New farmers in 'new villages'	136

The number of new farmers in the 'old villages' (202) was a substantial increase, indicating that the experiences of the 'early adopters' are sustaining expansion. This expansion is not, however, expected to continue, as a ceiling of adopters is likely to be reached in each village after three years. This ceiling will vary from village to village but 25% of adopters would be regarded as very successful. The number of new farmers from 'new villages' (which this were supposed to come from nascent demand resulting from cross visits, field days and promotional information) was 136; a doubling of the number from the second year.

The 136 new farmers recruited in the new villages this year averaged slightly more than 9 farmers /village; a much more reasonable number than some of the villages in the first year (some >30). This indicates that the district staff are becoming more comfortable and experienced with the methods and the need to be able to support a small group of farmers early in their learning process.

At the start of the third field season (starting June 2003), the indicative area of forages planted increased from 17.2 hectares in 2002 to 31.9 hectares. This figure can also be examined further:

Total new area of forages	14.7ha
'Old villages' new forage area	10.7ha
'New villages', new forage area	3.0ha

Thus the forage areas within the old villages doubled, as happened in 2002. Of the total number of farmers in the 'old' villages, only 30% were new farmers this year, so the expansion of forage areas in the old villages continues to come mainly from 'old farmers' expanding their plots, and is an indication that the desire for increasing impacts is driving expansion.

The forage varieties that are most popular with farmers are (i) grasses for cut and carry feeding of cattle and buffalo (mainly *Panicum maximum* TD58 "Simuang", *Brachiaria brizantha* CIAT 6780 "Marandu", *Brachiaria decumbens* CIAT606 "Basilisk", *Paspalum atratum* BRA9610 "Terenos" and *Andropogon gayanus* CIAT 621 "Kent") and (ii) *Stylosanthes guianensis* CIAT184 "Stylo184" for feeding pigs. This year the *Brachiaria* hybrid "Mulato" was introduced for evaluation by >150 farmers. Early indications are that farmers are impressed by its rapid growth (and regrowth) and the fact that it can be fed to all animals, but its potential in comparison to the other grass varieties cannot be adequately assessed until after one complete dry season. The figures reported here are outputs of the technical work on forages. The FLSP is also working to report impacts (see later in this report) (Figure 73).

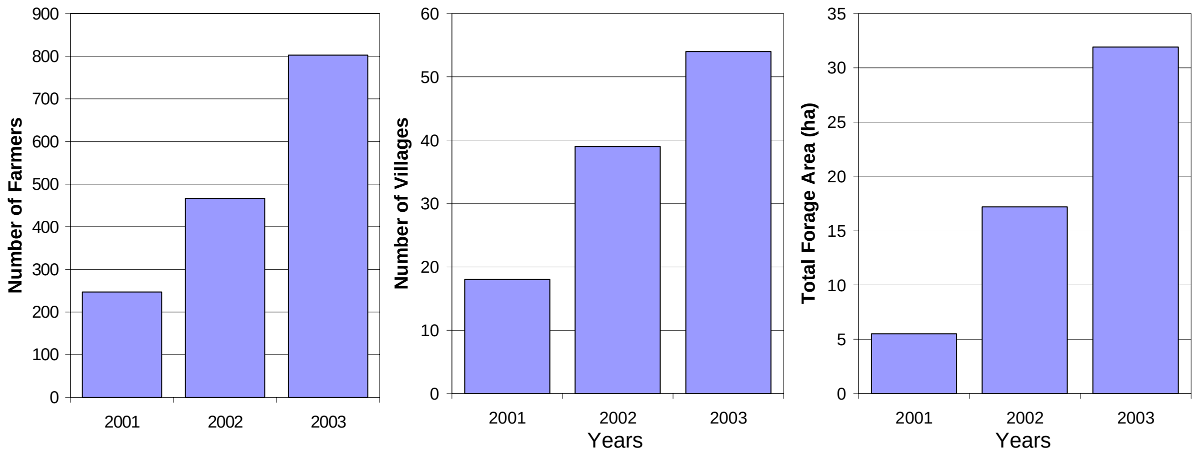

Figure 73. Summary of the expansion occurred in the first three field seasons of the project.

It is worth noting that:

(i) The outputs being reported are a moving target, with changes happening on individual farms for different reasons. Farmers are inherently responsive to the opportunities and constraints within their environments. Forages (and other feed and animal health resources) become just another set of 'cards' they can play in response to the changing interplay of factors in their livelihood systems. Each family and each farm is different.

(ii) The outputs are averages, which hide the huge variation between farmers. Some farmers have rapidly expanded to more than 1ha of forages while others have kept relatively small areas. The project is documenting the cases of expansion to try to understand the opportunities and constraints that have allowed some farmers to do this and others not.

(iii) Large impacts come from relatively small areas of forages. Unlike crops, which are harvested once a year, forages can be harvested 6-8 times per year. Casual observers are usually skeptical that large impacts can come from small areas...but they do…and the FLSP is documenting these from farmers reported experiences.

(iv) Forages are changing the whole dynamic of smallholder livestock systems. In many areas where we work, farmers have traditionally kept livestock as an additional activity to cropping. They are a safety net; a bank. They were often let loose in the forests and grazing lands, with little management. Now, however, these grazing lands are becoming over-utilized. In the past, government extension agencies have suggested farmers improve their livestock management systems but without a reliable feed resource, this was not possible. We are seeing that planted forages are allowing farmers, for the very first time, to start moving into livestock production as a livelihood system not just as livelihood security. That is, they can start cranking up their livestock production to produce cash for buying staple foods rather than expending huge amounts of labor to grow these staple foods. Once again, the FLSP is documenting these cases of impacts to help drive further expansion.

v) Freeing up labor is a major impact of forages. Many of the farmers we work with are flat-out keeping their families fed. In many cases they spend 2-4 hours per day looking for cut feed for their animals. Planting forages can reduce this time to less than one hour per day. Freeing up labor is a key factor in allowing farmers the 'breathing space' to start developing alternatives to their current farming systems in the steep uplands.

4.2.2.3 Development of other Feed Resources

To ensure the potential benefits of introduced forages as a supplement to livestock in villages, the FLSP is also investigating Non-Forage Feed Resources for smallholder livestock systems. In the field season of 2002, four main feed resources were tested: (i) sweet potato varieties (sourced from CIP, Vietnam), (ii) QP maize varieties (sourced from CIMMYT), (iii) cassava varieties (sourced from CIAT) and (iv) new robust lucerne varieties (sourced from an ACIAR project managed by SARDI, Adelaide).

All four technologies were selected because of their potential as feed resources in smallholder pig systems. Rearing pigs is a common household livelihood activity in the northern uplands of Laos, especially among the Hmong ethnic group in which pigs constitute up to 60% of household cash income. It is an activity almost exclusively controlled by women, for whom pigs constitute a savings bank that can be converted to cash as and when required. Feeding is the single most time consuming activity, often taking 2 – 4 hours per day 4 – 7 times per week just to collect tubers, banana stems and leafy vegetables from the forest to supplement meager supplies of maize and rice bran.

Compounding this problem is the fact that all sources of pig feed are in short supply at the start of the wet season and many piglets get thin and die from malnutrition. Recently, farmers in northern Laos working with the FLSP have been reporting substantial benefits from planting forage legumes (especially *Stylosanthes guianensis*) for feeding pigs. These include labor savings in collecting feed at critical times of the year (savings of up to 3 hours per day), higher survival rates of piglets (from 10 – 30% without supplementation to 80 – 100% with supplementation) and greater growth rates of piglets (reaching saleable weight 2 months earlier than unsupplemented pigs).

Of the four technologies, the new sweet potato varieties caused immediate and strong interest among farmers. This was partly because of their immediate impacts on pig feeding but also because of the potential that they can be used as human food. The project decided to expand field evaluation of the sweet potato varieties in 2003 by importing 5 tons of planting material (vines and tubers) of 7 varieties of sweet potato that have been selected by CIP for feeding pigs. By the end of June 2003, >120 farmers in the five districts were growing the seven varieties. Formal evaluations will be conducted at the end of the 2003 wet season. Field evaluations of the other three technologies are to be expanded in 2004.

4.2.2.4 Development of Animal Health and Livestock Management Strategies

To ensure the potential benefits of introduced forages as a supplement to livestock in villages, the FLSP is also developing and evaluating practical approaches to improving animal health in villages that are expanding their forage resources. In late 2002, two animal health consultants identified the three priority health issues in smallholder livestock systems in the north of Laos:

1. *Toxocara vitulorum* infection in buffalo and cattle calves
2. Epidemic diseases (Classical Swine Fever and non-specific bacterial diseases) in pigs
3. Epidemic diseases (Fowl Cholera and Newcastle Disease) in chickens and ducks.

Control of *Toxacara vitulorum* in buffalo and cattle calves is being implemented and monitored in all villages where the project is working. Control methodologies for pig and poultry diseases are more complex and so are being trialled in only 15 villages. The fundamental principle of the strategy is that (i) there are no ‘magic bullet’ solutions to animal health in villages, (ii) the most promising way to improve productivity in smallholder livestock systems is to combine basic improvements in feeding and management with strategic use of veterinary chemicals and (iii) to drive intensification of livestock systems, we need to document impacts from this strategy on improved animal productivity.

CIAT has no in-house expertise in Asia to implement such a strategy, so in 2003 we worked with the Lao Department of Livestock and Fisheries and CSIRO Animal Health Laboratory (AAHL) to develop a new ACIAR-funded project to work on diseases of smallholder pig production systems and their management. The project, "*Improved diagnostic and control methodologies for major livestock diseases in Lao PDR*" has been approved and will start in July 2003 and operate for 3 years. The following description is extracted from the project document:

> *"The broad objective of the proposed project proposal is to use improvements in husbandry and disease control as an entry point to conduct research on the implementation and impact of CSF vaccination in the village pig production systems. Using the participatory approach for working with farmers on technology adaptation and adoption that has been developed under the AusAID – funded Forages and Livestock Systems Project (FLSP) with CIAT in Laos, the project will introduce a CSF vaccination program to villages and determine the most effective and practical strategy to maintain the level of herd immunity necessary to prevent outbreaks of disease.*
>
> *The Lao – CIAT FLSP will be a key collaborator in the field, having developed innovative ways to link participatory research with extension, thus providing an excellent vehicle for introducing the concept of vaccination and disease control to village pig producers. By working in collaboration with the FLSP, the proposed project will be able to implement vaccination strategies in the field and develop a working system for local animal health workers to improve disease management in village pig production systems. An additional benefit of this collaboration is that the potentially high economic and social benefits of reduced pig mortalities can only be realised through parallel improvements in feed resources, which are being developed by farmers working with the FLSP."*

This project will provide the specific expertise in animal health that FLSP lacks, opening the opportunity for a synergy to develop where the combination of improved health and improved feeding can deliver more sustained impacts to smallholder pig production systems.

A second initiative aimed at providing additional support to our work on forages in Laos was developed in the first half of 2003. A proposal was submitted to the Swiss Agency for Development Cooperation (SDC) to appoint a smallholder livestock systems specialist to work for CIAT in Laos with three broad objectives:

1. to expand the impacts of the FLSP in two new districts using participatory research activities in livestock feeding, management and health
2. to scope the opportunities for new development-oriented livestock systems research and development in the northern uplands of Laos, using Oudomxay and Xieng Khouang provinces as case study areas.
3. to develop the outline of a practical handbook on livestock management options for smallholders in the uplands (with collaboration from ACIAR, ILRI and VSF)

The proposal was approved an the specialist appointed to commence work in Laos, initially for one year, starting in October 2003.

4.2.3 Establishment of a living forage germplasm bank for Southeast Asia in Laos

From 1992 – 1999, CIAT conducted a series of forage germplasm evaluations in Southeast Asia to identify a small suite of broadly adapted and robust varieties that had the potential to deliver substantial impacts to smallholder farmers. Preliminary nursery evaluations of the >600 most promising varieties were conducted in three countries (Malaysia, Indonesia and Philippines). The resulting 100+ varieties were introduced into regional evaluations in six countries targeted for on-farm evaluation and forage development. This added to our understanding of their agronomic performance across a range of climates and soils. As the work progressed, the enormous value of farmer evaluation of forage varieties on their own farms was realized. A smaller suite (~50 varieties) were evaluated using participatory research approaches allowing forages program to base species selection not only on environmental adaptation but also on farmers' needs and opportunities in resource-poor upland areas.

The program also conducted a genotype x environment experiment of the main varieties at 12 sites across 6 countries over two years. Through this lengthy process, ~35 broadly adapted, robust forage varieties suitable for smallholder farmers across the region. Details are available in Horne and Stür, 1999 and Stür et al., 2002.

Since this work was completed CIAT's forages program in Asia has continued to evaluate a small suite of new varieties, either as they become available or for particular niches. The main focus of the program has, however, become the integration of the promising forage varieties into smallholder livestock systems. At the same time, it is essential that the selected varieties are maintained by CIAT, both as seed and as a living forage germplasm resource. Currently seed of all the selected varieties is kept in store at the CIAT office in IRRI, Philippines. To ensure that this seed collection is continually updated and that small quantities of seed and cuttings are available to support regional evaluation, a "Living Germplasm Bank for Southeast Asia" was established in July 2003 at the Lao National Livestock Research Center (LRC), 45 km from Vientiane. CIAT will continue to work with LRC to maintain (and, where necessary, expand) this collection for the benefit of all countries in the region.

4.2.4 Livelihoods and Livestock Systems Project in Southeast Asia

Contributors: Ralph Roothaert and Werner Stür (CIAT)

A new Project entitled 'Improving livelihoods of upland farmers using participatory approaches to develop more efficient livestock systems' (LLSP) is being funded by the Asian Development Bank (ADB), and convened by the Centro Internacional de Agricultura Tropical (CIAT). The Technical Assistance Agreement was signed in January 2003, referred to as RETA No. 6067. The purpose of the project is to:

1) Improve the sustainable livelihood of small farmers in the uplands through intensification of crop-livestock systems, using farmer participatory approaches to improve and deliver forage and feed technologies; and
2) Improve delivery mechanisms in participating DMCs for the dissemination of these technologies.

The project is based on the results of the previous CIAT-ADB project 'Developing sustainable forage technologies for resource poor upland farmers in Asia', in short 'Forage for Smallholders Project (FSP-II)' which is ending in June 2003. The new project builds on previous experiences in the Philippines, Indonesia, PDR. A new country, Cambodia, will join, and a reduced program is envisaged in Thailand and Lao PDR. The project will expand research activities to incorporate integrated feed systems using indigenous forages and crop residues. It will also expand to more farmers in the participating countries and further develop participatory monitoring and evaluation systems to enable community learning and provide feedback. Capacity building will stretch beyond field level to institutional heads to bring about institutionalization of approaches and technologies. Research will also aim to address constraints to increased livestock production beyond the forage and feed components, such as increased commercial orientation. Synergies will be established through existing networks and new collaboration with development projects to accomplish the following outputs:

1. Integrated feeding systems for livestock, that optimise the use of improved and indigenous fodders and crop residues, and farm labour;
2. Improved methods to develop forage feed systems and extend them to new farmers, optimising the use of M&E for feedback to others in the community;
3. Increased capacity in DMCs, at different levels, to expand the use of improved forage and feed systems and respond to local needs;
4. Comparison of development opportunities, and market and logistic constraints, for intensification of smallholder livestock systems across sites in five countries;
5. Improved regional interaction and linkages with national and donor funded development projects that ensure synergistic and multiplier effects.

A meeting to launch the new project was held in Hainan, PR China this year. The meeting provided an opportunity for each country of the FSP-II to show what had been achieved in the last three years, the lessons learned, and the research needs for the new project. Objectives of the new project were presented, related questions were clarifications were discussed, and countries indicated the priorities they would allocate to each objective. Participants grouped by country were given more than a day to develop and fine- tune country research objectives, strategies and workplans. Summaries of the strategies were presented towards the end of the workshop, but detailed workplans would be completed during the first quarter of the project. The ADB senior agricultural specialist provided guidelines for improving indicators that were mentioned in the TA framework. A lot of consideration during the working group sessions went into making the indicators more realistic and closer to the project purpose and objectives.

The management structure will be different from FSP-II. The previous network coordinator, Dr. Ralph Roothaert, is leaving to take up a new position in Africa. The new project management will consist of a team of a senior international scientist, Dr. Werner Stur, and two regional scientists, Mr. Francisco Gabunada and Mr. Phonepaseuth Phengsavanh. Dr. Rod Lefroy will remain the Regional Coordiator of CIAT in Asia, and Ms. Pratima Dayal will be the ADB project officer.

In each country a national coordinator was identified and letters of commitment, otherwise called Memorandum of Agreement (MoA), will be composed in collaboration with the management team and the implementing institutions in each country, before April 2003.

It was agreed that the planning workshops would continue to be held on an annual basis, each time in a different country to enable delegates to directly learn from regional experiences during the field day. The newsletter of the 'Southeast Asia Feed Resources Research and Development Network' (SEAFRAD) will continue to be produced by country editors on a rotational basis, although the timing will be more flexible.

The next two issues will be edited and produced by Mr. Yi Kexian, China. A new name was accepted for the relatively long project title 'Improving livelihoods of upland farmers using participatory approaches to develop more efficient livestock systems', which became 'Livelihoods and Livestock Systems Project' (LLSP). It was accompanied by a new logo, reflecting gender focus, feed resources and livestock systems.

4.2.5 Participatory Evaluation of *Brachiaria* hybrid "Mulato in South East Asia"

In many parts of Southeast Asia (particularly Indochina) the climate is characterized by high annual mean rainfalls (typically 1500-2500mm) but with relatively long and severe dry seasons. This results in highly variable feed availability, which limits the potential for intensification of smallholder systems which rely on locally-available feed resources. The genus Brachiaria includes many varieties that are well adapted to such conditions but there is huge intra-specific variation in adaptation to drought within the genus. One species, *Brachiaria ruziziensis* "Ruzi", is widespread throughout Indochina (especially Thailand) mainly because of its fast growth rates in the wet season and ease of seed production. It performs very poorly, however, in the dry season or on low fertility soils and many farmers re-sow it after 2-3 years. For this reason, CIAT has been assisting work researchers from the Thai Department of Livestock Development (DLD) since 1997 to identify alternative varieties to Ruzi that are both reasonably productive in the dry season and can produce commercial quantities of seed. After four years of trials, the line that emerged as showing most promise (CIAT1873) is the hybrid that was subsequently renamed "Mulato".

In March 2003, the Driector of the Mexican seed company which owns the rights to "Mulato" (Papalotla), visited staff from DLD and CIAT in Thailand to evaluate the work that has been done by DLD and plan joint activities during the wet season of 2003. Experimental work conducted at the Animal Nutrition Research Center at Pakchong indicated that the Thai seed collection system based on hand shaking of seed heads could produce up to double the yields achieved in Mexico. Forage seed production in Thailand is mainly with smallholder producers. There are about 3000 producers in the country. Typically a smallholder producer is contracted to produce seed from 2 *rai* (1 ha = 6.25 *rai*), but often they plant larger areas for sale outside the government system. Seed is mainly produced using intensive harvesting methods (shaken by hand or the seedheads are bagged with nets). Typically yields of 90% pure Ruzi seed are about 80kg/*rai* and the estimated total production last year was ~500 tons. The current subsidised price within the government system for Ruzi seed is 60 Baht/kg (1USD = 40 Baht). In 2003, market demand within Thailand for forage seed exceeded the supply and prices for Ruzi seed in the open market reached 100 Baht/kg. Papalotla agreed to fund DLD to conduct several trials in Thailand to evaluate the forage and seed production potential of "Mulato":

i) On-farm seed production trials near Khon Kaen

   In 2003, 6 farmers are producing Mulato seed on 2 *rai* each. Each farmer will evaluate two seed harvesting methods: shaking seed heads or bagging seedheads. DLD staff will measure

   - seed yield and quality (%MC, Purity, 1000 seed weight, Germination, Viability) compared between two harvesting methods
   - cost of production/rai

In 2004, the same 6 farmers will remove 1 rai of Mulato and replant to compare seed production between "New" Mulato versus "Second Year Stand" Mulato

ii) On-farm utilization trials near Khon Kaen

   In 2003, 2 dairy farmers each planted 1 *rai* Ruzi, 1 *rai* Simuang Guinea (*Panicum maximum* TD58), 1 *rai* Tha Pra Stylo (*Stylosanthes guianensis* CIAT184) and 1 *rai* Mulato. The forages will be irrigated in the dry season and farmers' observations on Mulato compared with the other forages recorded, especially productivity in the wet and dry seasons, regrowth capacity, plant vigour, weed issues and palatability.

iii) On-station seed production trials at Pakchong

   Last year DLD staff harvested 13 kg of pure seed from 288 m^2 of Mulato plots (equivalent to 450kg pure seed/ha). This was part of a trial being conducted to look at nitrogen application rates and closing date on seed yields. This trial will continue in 2003.

iv) On-farm utilization trials at Pakchong
Four smallholder dairy farmers are evaluating Mulato compared with Ruzi for forage and livestock production on farm. Each planted at least 2 *rai* of Mulato and 2 *rai* of Ruzi. Their observations of both varieties (and measurements made by DLD staff) are being monitored, with reference to productivity in the wet and dry seasons, regrowth capacity, plant vigour, weed issues and palatability.

At the same time CIAT is conducting evaluations of Mulato with smallholder farmers in Laos. Seed was provided by Papalotla and distributed to >200 farmers in July 2003. District staff will record farmers' observations in village focus group meetings. Two students from the National University of Laos are also working with CIAT conducting formal trials with farmers to (i) compare yields of Mulato with four other forage grasses and (ii) conduct preference analyses with farmers about all five varieties. The trials will be continued until the end of the dry season in 2004 to compare the varieties across both wet and dry seasons.

4.3 Development of methods for participatory evaluation of multipurpose forages in crop-livestock systems

Highlights

- Developed a conceptual framework for participatory evaluation and selection of forages for different uses
- A higher proportion of farmers in higher altitude areas in the reference site in hillsides of Honduras are testing legumes (i.e. cowpea) for food (grain) and soil fertility improvement than for livestock feed
- Farmers in the reference site in hillsides of Honduras selected *Brachiaria brizantha* cv Toledo because of drought tolerance and high seed yield (possibility to harvest sees for own use and for sale)

4.3.1 Development of participatory research procedures to identify, test and evaluate multipurpose forage-based technologies

Contributors: R. van der Hoek, V. Hoffmann (University of Hohënheim), M. Peters (CIAT)

Rationale

Research procedures are being developed for identifying, testing and evaluating multipurpose forage based technologies with farmers within the framework of the BMZ/GTZ supported project on participatory research on selection and strategic use of multipurpose forage germplasm in Central American hillsides.

Materials and Methods

A key component of forage research in Central America is to understand the interactions between people, biophysical and socio-economic environments and the decision processes in selection of technologies. The research process is characterized by a large variability of different approaches and types of experimentation that could be employed by farmers.

These are being compared in order to define which processes and approaches may be the most efficient in relation to forage technologies (Figure 74).

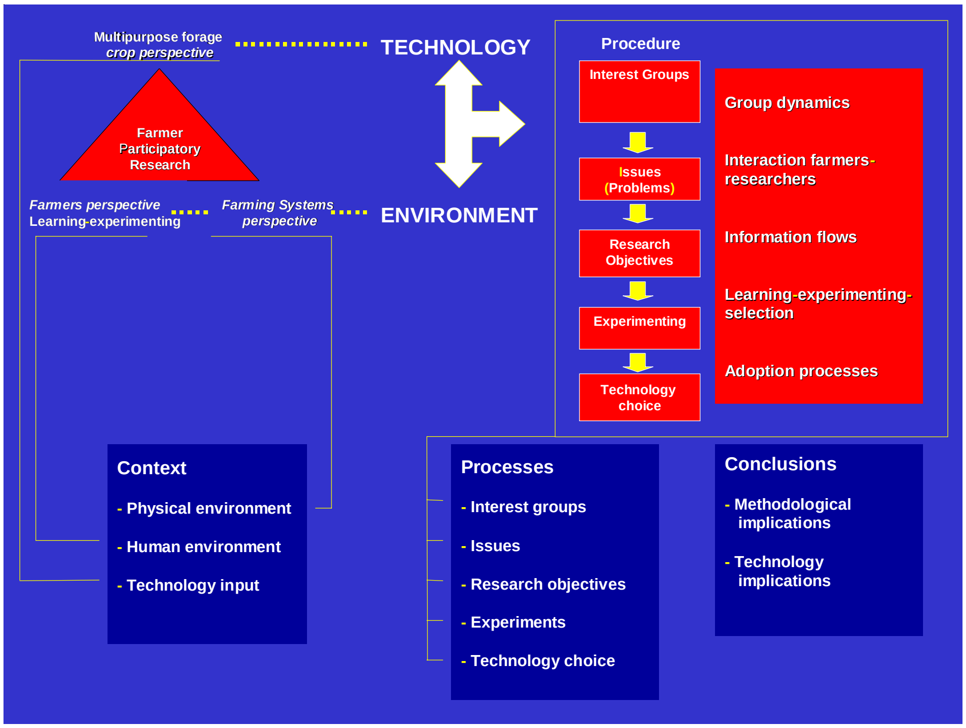

Figure 74. Forage participatory research framework. Left side the main components – i.e. the central theme (Participatory research) surrounded by the contextual elements consisting of the human environment (Farmers' perspective), the biophysical environment (Farming systems perspective) and the technology input (Multipurpose forage crop perspective) – and the research procedure determined by the processes mentioned at the right side.

Results and Discussion

In the department of Yoro, central Honduras, farmers in more than 15 communities have conducted experiments with different types of multipurpose forages like grasses, leguminous cover crops and shrubs in three different agro-ecological zones, characterized by being in different altitudes, during the Primera and Postrera seasons of 2002 and the Primera season of 2003 (Table 75). The methodology being used includes farming system analysis, problem identification and prioritization, formulation of research objectives, implementation and evaluation of experiments, which are carried out using participatory methods and based on farmers' demand. The proportion of farmers testing multipurpose forage -based technologies to enhance animal (cattle) production is relatively low, compared to testing the use of mainly legumes for food and soil fertility maintenance/improvement (Figure 75). This is due to the fact that in the research area only 20% of the farmers possess cattle whereas food security is the main concern of a large proportion of the population, especially those living in the higher areas. For more details, see CIAT Annual Report 2002.

Table 75. Number of experiments per altitude, forage category and growing season (Yoro, Honduras)

Altitude category	Forage category	2002 Primera[1]	2002 Postrera[2]	2003 Primera	Total
Low altitude	Grasses	3		2	5
	Legumes	2	4	11	17
	Shrubs			2	2
Medium altitude	Grasses	3		7	10
	Legumes	5	5	8	18
	Shrubs	5			5
High altitude	Grasses	3		1	4
	Legumes	8	7	11	26
	Shrubs	5		1	6
Total		34	16	43	93

[1] First growing season
[2] Second growing season

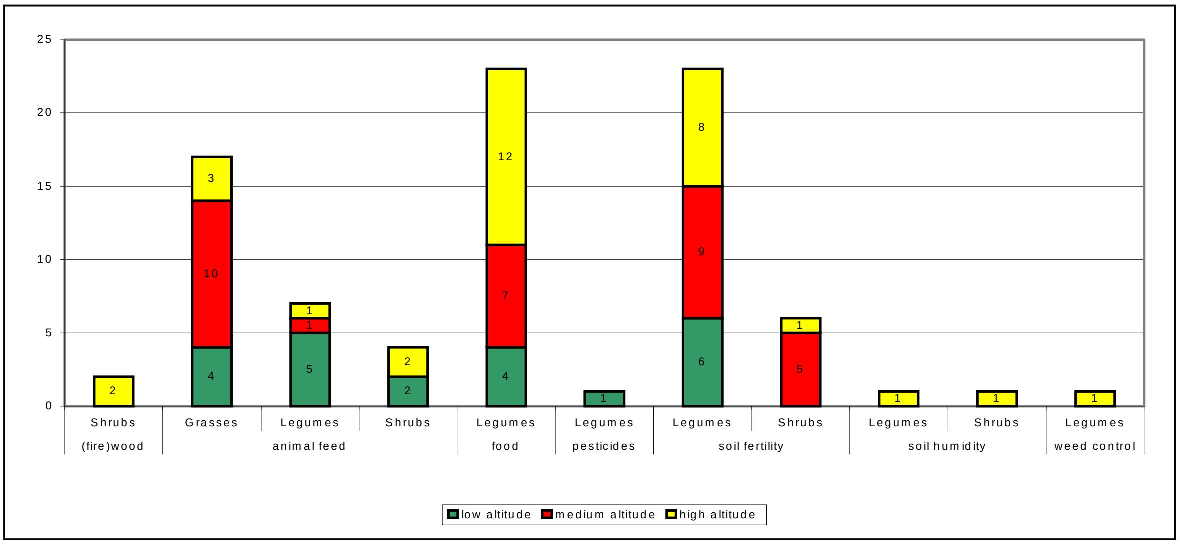

Figure 75. Forage-based experiments for different farmers' objectives, forage categories and altitudes (2002-2003) (Yoro, Honduras)

Of the 90-implemented experiments, 39% were carried out individually (by individual farmers on individual fields), 17% on a semi-collective basis (in which at least part of the work – planting, weeding - is done as a group, but on individual farmers' fields) and 44% collectively (all activities carried out together on fields allocated to the group). Some examples are shown in Table 76.

As mentioned in Figure 74, the major processes involved in the research being carried out are:

- Group processes: relationships between group members, role of "leaders", relationship of the group with the community
- Interactions between farmers and researchers: "neutrality" of facilitator, influence on perceived problems and solutions, role of fringe benefits of intervening institutions
- Information flows: between farmers, between institutions and farmers

Table 76. Some typical examples of experiment objectives and modalities for different altitudes

Altitude	Individual	Semi-collective	Collective
Lower (< 800 m)	Adaptation trial with *Brachiaria brizantha* 26110 "Toledo" for grazing and seed production	None	Comparison trial of different cowpea varieties by youth CIALs as food crop (green pods, grains) and green manure
Medium (800- 1200 m)	Comparison trial of different cover crops (Lablab, Canavalia, Cowpea) as green manure	Adaptation trial of *Cratylia argentea* to improve soil fertility	Comparison trial of *Brachiaria brizantha* 26110 "Toledo" with *Andropogon gayanus* for grazing and seed production
Higher (> 1200 m)	Comparison trial of *Canavalia brasiliensis* with *Canavalia ensiformis* as a green manure	Comparison trial of *Cratylia argentea* with *Calliandra calothyrsus* for animal feed and firewood	Comparison trial of different Lablab varieties for food production and as a green manure

- Learning, experimentation, selection: importance, use of local knowledge, ways of experimenting (try out", informal or formal comparisons, with/without repetitions), choice of experiment sites in relation to perception of land use, monitoring and evaluation of experiments criteria for selecting technologies
- Adoption processes: extent to which farmers invest in new forage based technologies, possibilities/ideas to modify technologies

In the final analysis, the detailed descriptions of these processes will be used to define strategies for the different interest groups.

Collaboration with other projects and institutions: At the request of representatives of a group of 10 CIALs in the municipality of Vallecillo, department of Francisco Morazán, around 20 experiments were started this year in collaboration with IPCA (Investigación Participativa en Centro América). Most of these experiments are focused on improving pastures (using *Brachiaria brizantha* 26110 "Toledo" and *Cratylia argentea*) and comparing cowpea varieties. Because of the availability of natural resources (more fertile soils than in Yorito area) and the proximity to markets (Tegucigalpa) perspectives for further production and processing of multipurpose forages are promising. Furthermore, collaboration has started with the Youth Project (partly implemented by CIAT Communities & Watersheds). Five youth CIALs have implemented around 10 experiments, comparing different cowpea varieties, improving pastures with *Brachiaria brizantha* 26110 "Toledo" and testing *Cratylia argentea* to produce animal feed and improve soil fertility.

4.3.2 Determination of the suitability of different multipurpose forage-based technologies in smallholder farms

Contributors: R. van der Hoek, V. Hoffmann (University of Hohënheim), M. Peters

Rationale

It is well recognized that forage-based technologies can play an important role in improving the environmental and socio-economic sustainability of smallholder production systems in the tropics, especially in situations with a fragile balance between the availability of natural and economic resources and their utilization. Forages can serve multiple objectives, such as provision of animal feed, enhancing soil conservation and maintaining and improving soil fertility. Forage species that are widely adapted, productive and palatable have been identified, but farmer adoption has often been low. One explanation is that too much emphasis has been placed on supply-driven research with little participation of farmers. Hence in this research participatory methods are applied to define forage based technologies suited to smallholder systems.

Materials and Methods

The methodology utilized includes the following elements:

1. Introductory meetings with farmer groups to obtain information on the state of knowledge on forages and its uses and to obtain basic information on farming systems
2. Field visits to forage demonstration sites to inform farmers on the range of options available and their potential utilization
3. Problem ranking with farmers
4. Definition of research and forage priorities with farmers
5. Design and planning of experiments with farmers
6. Execution of farmer-led experiments
7. Identification of suitable forage technologies by farmers
8. Definition of constraints to scaling of forage based technologies

Results and Discussion

Figure 76 shows the farmers' rating of the experiments carried out in 2002. Performance of legumes (*Lablab purpureus*, *Vigna unguiculata*, *Canavalia ensiformis*) was highly variable. Failure in the Primera season (first growing season) was mainly due to seed quality, whereas in the Postrera season (second growing season) the main reasons for failure were adverse weather conditions (first drought, and then a cold period which also caused failure of the Postrera bean crop) and pests like rabbits. Poor performance was caused by the fact that the germplasm was not always suitable for the local conditions like poor soils, poor management and some pests (insects).

Shrubs showed for the most part disappointing results, *Cratylia argentea* being mainly responsible for this. Although looking promising at the *SOL* site in Luquigüe and very much liked by the farmers for its characteristics (high quality fodder, leaves covering the soil improving soil fertility and maintaining soil humidity, producing firewood), the plant does not appear to adapt well to many sites in the region, often being characterized by clayish and alkaline soils. Some other shrubs did well though, like *Cajanus cajan* and *Calliandra calothyrsus*.

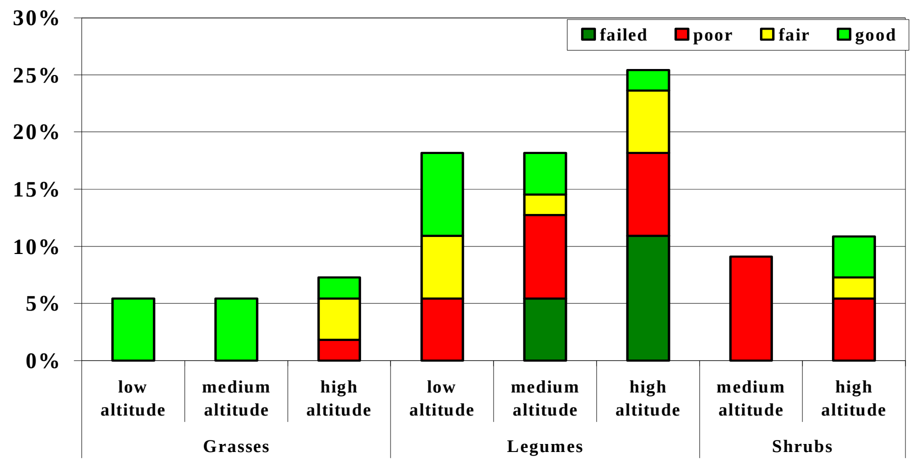

Figure 76. Rating of experiments per crop category (*Primera* and *Postrera* seasons, 2002)

Grasses (*Brachiaria brizantha* cv Toledo , *Andropogon gayanus*, *Pennisetum* spp.cv Camerún and cv King Grass) performed generally well. They were all sown in the main growing season (Primera) and plots were mostly well maintained.

Figures 77 and 78 show for some selected forage farmers' ratings and primary causes of poor performance and failure. The poor performance of *Brachiaria brizantha* 26110 "Toledo" and *Cratylia argentea* in certain plots is mainly due to poor soils and management, whereas the cowpea varieties suffer more from pests and adverse weather conditions. In what follows we present as an example the results of the evaluation of cowpea accessions by a group of farmers in Victoria, Honduras.

Case study: Cowpea trial in Guachipilín, Victoria, Postrera 2002

In March 2002 a group of male farmers of Guachipilín, a hillside village at 1000 masl in the municipality of Victoria, requested "CIAT-forrajes" to start working with them to increase the number of options for animal feed production. After a comparison trial of *Brachiaria brizantha* 26110 cv Toledo and *Andropogon gayanus* in the Primera growing season, they decided to continue with an experiment with five cowpea varieties: 9611, 1088/2, 716 (all via CIAT from IITA), FHIA (from the Foundation Hondureña de Investigación Agrícola, La Lima) and CIDICCO 4 (from CIDICCO, Tegucigalpa) (Figure 79). The cowpea was sown in October in a maize field

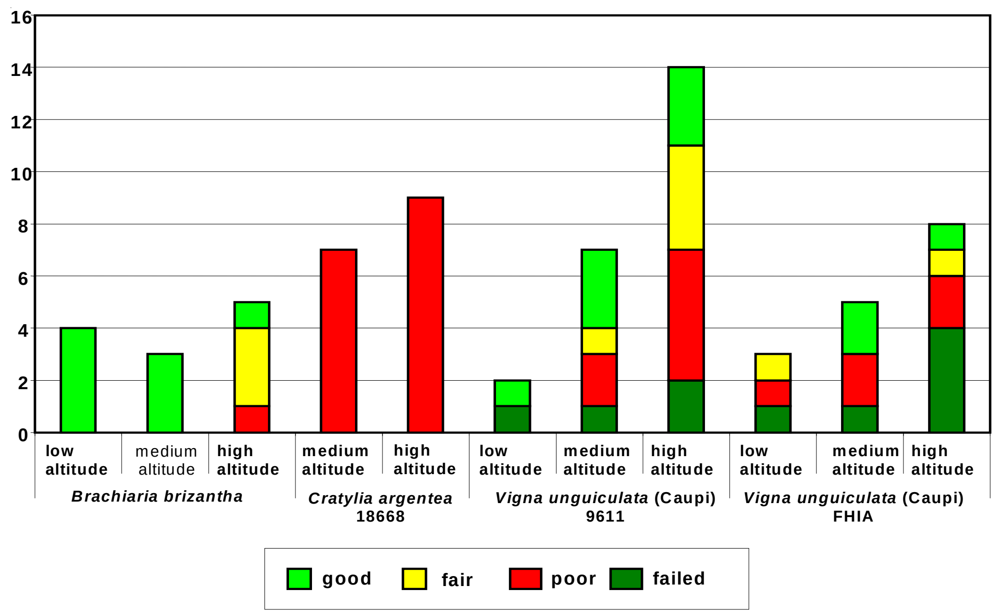

Figure 77. Rating of plots with some selected crops (Primera and Postrera seasons, 2002) (Yoro, Honduras)

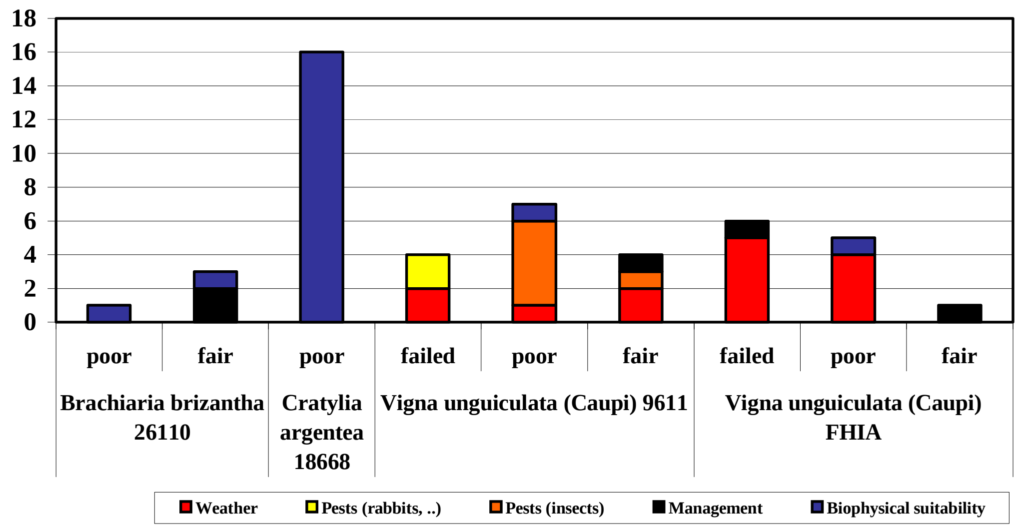

Figure 78. Primary causes of poor performance and failure for some selected crops (2002, number of plots) (Yoro, Honduras)

(which had been planted in June), in the “dead furrows” between the maize plants (Photo 28). At the time of sowing the maize stalks were bent (as usual in this growing stage) which improved the exposure to light for the cowpea. Harvest of both maize and cowpea took place in December, yields were measured and an evaluation was held with the nine group members and six of their wives (the group members themselves suggested that their wives might be interested regarding the characteristics of the plant).

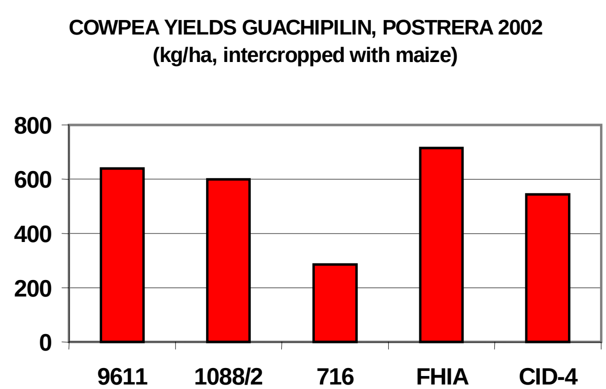

Figure 79. Dry matter yield of five cowpea varieties selected by the farmers at Guachipilin

Some observations were:

- Their most important objective of trying cowpea was production of green manure ("hojas para nutrir la tierra") in rotation with other crops
- Four varieties have good yields and other important advantages: FHIA produces food fast, CIDICCO 4 is resistant against pests and suitable as animal feed, 1088/2 ripens unevenly, allowing picking of green pods (*"habichuelas"*) during a prolonged period, 9611 has various purposes: animal feed, green manure and food. The 716 varieties yielded less because pods started to rot.

Our results with cowpea indicated that:

- Cowpea as green manure is regarded as the most important and promising product.
- Cowpea accession 9611 is the true multi-purpose genotype.
- To make use of the different characteristics of the different cowpea accesions they could be sown in rotation.
- There might be good possibilities to use the seed and leaf meal of cowpea as pig feed ("siempre hay mercado para carne").
- In spite of the bad Postrera season, which caused many crops to fail, yields of cowpea were acceptable and somewhat higher than of common bean.

In general, results of this year look promising given that farmers as well as researchers have learned from their mistakes made last year and as a result, the great majority of 43 experiments underway will be successful. Cowpea (in total 15 accessions) accounts for 40% of the trials, in terms of plots for almost 75% of which some already have been harvested.

Other materials being tested by farmers include grasses (e.g. *Brachiaria brizantha* cv Toledo), legumes (e.g. some accessions of *Lablab purpureus*, *Canavalia ensiformis*, *Canavalia brasiliensis*) and *Cratylia argentea* (to try on some specific more promising niches).

Photo 28. Group of farmers testing cowpea as green manure in maize fields in Honduras

Conclusions

Grasses

- *Brachiaria brizantha* cv Toledo generally performs well with some management in relatively good soils at altitudes up to 1600 masl. Farmers like the grass because of its growth, its drought tolerance and its seed production characteristics, which enables them to increase pasture areas and to generate income by selling seed, even by non-cattle owners.
- *Pennisetum spp.* Camerún and King Grass almost invariable show satisfactory results, the former slightly preferred because of the absence of '*guate*' which causes itching while carrying the stalks.

Herbaceous legumes

- Cowpea is of considerable interest to farmers. Cowpea accessions grown in the Postrera season of 2002 showed in general disappointing results. In spite of this, the farmers continued to grow cowpea and established 130 plots in this Primera season.
- The main reasons to experiment with cowpea are to improve food security (65%), to enhance soil fertility (27%) and to produce animal feed (8%).
- Some pests like lice are prevalent but hardly affect cowpea production. Others are more

damaging, like *zompopo* (an antlike insect which destroys leaves) and rabbits. In general, farmers comment that cowpea is more resistant to pests and diseases than common beans but is susceptible to cold periods, especially at the higher altitudes.

- *Lablab purpureus* varieties show varying results, in some cases being susceptible to pests and lacking vigour at higher altitudes. In 2003, new accessions of Lablab are being introduced, which may perform better under the prevalent conditions.

- Canavalia (both *C. ensiformis* and *C. brasiliensis*) is well adapted, showing vigorous growth, at both lower and higher altitudes.

Shrub legumes

- In the first year of trials, *Cratylia argentea* appears not to be suitable for the higher altitudes in the region, which are predominantly alkaline. Generally, the plants germinated well but showed poor growth and many died off after some weeks. For adaptation to alkaline soils, further studies to test the performance over longer time and the addition of fertilizer to enhance establishment need to be carried out. However, farmers are still interested in *Cratylia* because of its characteristics and some of them have proposed to plant the crop at specific sites, which are more suitable (with slightly acid, sandy soils).
- Some positive results have been obtained with *Cajanus cajan* (intercropped with maize) and *Calliandra calothyrsus*.

4.4 Forage seeds: Multiplication and delivery of experimental and basic forage seed

Highlights

- The Seed Unit of Atenas- Costa Rica and CIAT- Palmira delivered 500 and 1,000 kg respectively, of seed to partners in different countries

- The growth-controlling hormone (Cytokinin) did not improve plant development or seed set when applied to *Brachiaria* hybrid cv Mulato

4.4.1 Multiplication and delivery of forage seeds in the Seed Unit of Palmira (JWM)

Contributors: A. Betancourt; J. Muñoz; J.W. Miles

Seed is the vehicle by which improved plant selections are generally made available to potential users. The tropical forages project maintains a small seed multiplication unit at CIAT headquarters to service seed needs of project members, the wider CIAT community, and, where excess supply is available, to the wider public and private community, free for small quantities, or on a cost basis for larger seed volumes. Seed production plots are established at CIAT headquarters, CIAT-Quilichao, and at CIAT-Popayán. Owing to the small scale of the operation, all harvesting and seed processing is done by hand. Requests for seed are addressed as possible according to seed supplies. One hundred fifteen distinct accessions of 15 species were multiplied and processed for total production of over 900 kg of seed (Table 77). Relatively large quantities of *B. brizantha* (225.8 kg) and *Cratylia argentea* (411.4 kg) were produced, plus much smaller quantities of the other species.

Over one ton of seed was distributed, in 354 individual seed samples sent to eight different countries (Table 78).

Table 77. Seed multiplication at the CIAT-Quilichao, CIAT-Popayán, and CIAT-Palmira experimental stations. (September 2002 to September 2003), totals by species.

Genus	Species	Number of Accessions	Harvest (kilograms)
Arachis	*pintoi*	8	13.400
Brachiaria	*brizantha*	14	225.800
Brachiaria	*decumbens*	2	8.300
Brachiaria	*lachnantha*	1	12.000
Calliandra	*calothyrsus*	4	16.850
Calliandra	sp.	1	0.800
Centrosema	*macrocarpum*	1	10.000
Cratylia	*argentea*	12	411.410
Desmodium	*heterocarpon*	1	42.000
Flemingia	*macrophylla*	1	4.700
Lablab	*Purpureus*	21	45.110
Leucaena	*leucocephala*	2	56.000
Rhynchosia	*schomburgkii*	2	0.650
Stylosanthes	*guianensis*	5	21.400
Vigna	*unguiculata*	40	68.400
Total		115	936.82

Major quantities of *C. argentea*, *Brachiaria* spp., and *Desmodium heterocarpon* were distributed, reflecting interest in recent legume releases. A total of 354 samples, representing 1,015.43 kg were distributed.

Table 78. Seed dispatched from CIAT forage seed multiplication unit (September 2002 to September 2003).

Genus	Kilograms	Number of samples
Arachis	1.04	5
Brachiaria	171.879	64
Cajanus	2.1	2
Calliandra	0.3	1
Canavalia	9.715	3
Centrosema	8.698	7
Chamaecrista	0.002	1
Clitoria	0.002	1
Cratylia	607.999	183
Desmodium	111.931	40
Flemingia	11.785	4
Galactia	0.085	1
Lablab	60.375	16
Leucaena	3.15	4
Mucuna	15.277	8
Neonotonia	0.002	1
Pueraria	3.108	5
Stylosanthes	6.524	6
Vigna	1.533	2
Total	1,015.43	354

These samples were sent to eight (8) countries: Costa Rica (4); Philippines (1); Germany (5); Honduras (4); Nepal (3); Nicaragua (8); USA (4); and Colombia (313). Within Colombia, distribution was to: CIAT (122), NGOs (1), Universities (5), NARs (Corpoica) (5), Private individuals (180). A total of 354 samples, representing 1,015.43 kg were distributed.

4.4.2 Multiplication and delivery of selected grasses and legumes in the Seed Unit of Atenas

Contributors: Pedro J. Argel and Guillermo Pérez (CIAT)

Seed multiplication activities of promising forage germplasm continued during 2003 at the Atenas Seed Unit (Costa Rica) in collaboration with the Escuela Centroamericana de Ganadería (ECAG). The seed produced is destined to support advanced evaluations and promotions of forage germplasm both by CIAT's projects and regional research/development institutions. From September 2002 through August 2003 a total of 418.88 kg of experimental and basic seed was either produced at Atenas or procured from associated collaborators. The bulk of the seed was formed by *Cratylia argentea* (129.95 kg), *Brachiaria* spp. (27.20 kg), *Brachiaria* hybrid cv. Mulato (5.45 kg), *Arachis pintoi* (47.0 kg), *Leucaena* spp. (30.44 kg), *Centrosema* spp. (5.79 kg), *Panicum maximum* (15.18 kg) and *Paspalum* spp.(12.31 kg). Small quantities of experimental seed were also produced of *Desmodium velutinum, Chamaechrista rotundifolia* spp. *grandiflora* and other forage species.

During the period September 2002-August 2003 a total of 494.10 kg of experimental and basic seed were delivered by the Seed Unit of Atenas

(Costa Rica). Table 79 shows that 56 seed requests were received from 6 countries, where most of the requests came from Costa Rica, the host country of the forage project. However, a significant amount of seed was delivery to Nicaragua (196.75 kg) and Haiti (53.40 kg), both countries involved in forage projects with the participation of CIAT. A high amount of experimental seed of *Brachiaria* species was delivered, particularly of cv. Mulato, the new hybrid of this genus that is being promoted regionally with the assistance of the private sector.

Table 79. Countries, number of requests and amount of experimental/basic forage seed delivered by the Unit of Atenas (Costa Rica) during the period September 2002-August 2003.

Country	No. of Requests	Forage species (kg)			
		Brachiaria spp.	*A. pintoi*	*C. argentea*	Other species
Costa Rica	50	118.77	36.00	56.80	24.55
El Salvador	1	4.00			
Guatemala	1	0.10		1.00	
Haití	1	13.40		2.00	38.00
Nicaragua	1	10.50	175.00	10.00	1.25
Panamá	2	1.50			0.80
Total	56	148.27	211.00	69.80	64.60

4.4.3 Effect of cytokinin on seed quality and yield of *Brachiaria* hybrid cv. Mulato

Collaborators: Pedro J. Argel and Guillermo Pérez (CIAT

Rationale

There are environmental factors such as temperature, day length, rainfall distribution, as well as soil fertility that influence flowering and seed set in tropical grasses. Additionally, plants have internal hormonal mechanisms that interact with the environment to control plant growth and differentiation. The grass cv. Mulato grows well in the tropics, particularly in fertile well-drained soils; the flowering is abundant and well synchronized, but the seed set of the plant is very poor which traduces in low seed yields. This is a limitation of this cultivar since commercial seed production becomes very inefficient and increases the cost of the seed produced. This factor contributes to high seed prices to the consumers and obviously reduces the demand and the potential adoption of the grass.
For this reason any attempt to promote seed yields of this grass is worth to investigate.

Methods

The growth-controlling hormone cytokinin was applied to one year old plants of *Brachiaria* hybrid cv. Mulato at the rate of 0, 0.1,0.2 and 0.3 cc/ha. A uniformity cut and the fertilization of the grass with 75, 40 and 50 kg/ha of N P K respectively, and 30 kg/ha of S, were carried out in June at the beginning of the rains. The hormone rates were applied at two different dates: 1st of August (vegetative growth), and the 1st of September (at early spikelet initiation). A split plot design was used were the main plot corresponded to date of hormone application and the subplots to hormone rates. Plot size was 3.37 m^2 and the amount of water used utilizing a backpack spray, corresponded to 545 l/ha. Flower initiation, maximum flowering time, harvesting date, number of inflorescences/m^2, caryopsis content, seed unit weight, seed purity and seed yield were measured.

Results and Discussion

Cytokinins are a group of four or five plant hormonal compounds derivatives of adenine that have actions on plant cell division. Commercially products based on these hormones are available and recommended to improve fruit formation, to increase photosynthetic and respiration rates, to stimulate root development and improve nutrient uptake. In general these compounds stimulate healthy plant development and increase crop yields. However, no significant effect of cytokinin was observed for date of application, or for any of the plant measurement taken on cv. Mulato as Table 80 shows. The rates of cytokinin applied corresponded to 1, 2 and 3 liters/ha of a commercial product, which are within the range of recommended application rates for other crops.

Results showed very low percentages of seed purity, which accounts for the relatively low seed yield of this grass, despite the fact that the plant produces a high number of panicle per square meter. The rates of cytokinins applied did not improve plant development or seed set of cv. Mulato.

Table 80. Effect of cytokinin on seed production and quality of *Brachiaria* hybrid cv. Mulato in Atenas, Costa Rica

Cytokinin (cc/ha)	Plant height (cm)	Panicles (No/m^2)	Seed yield (kg/ha)	Seed purity (%)	Seed unit weight (g/100 seeds)
0.0	73.2	644.3	167.9	15.9	0.79
0.1	72.3	592.9	160.7	16.8	0.78
0.2	71.1	658.1	157.8	15.8	0.78
0.3	70.1	541.0	151.4	16.3	0.76

4.5 Enhancing Livestock Productivity in Latin America

Highlights

- The Colombia dairy sector has become over the last 10 years more productive and competitive but less profitable
- Launched a new project (Enhancing beef productivity, quality, safety and trade in Central America) funded by CFC and led by ILRI
- Small farmers surveyed in different eco-regions in Colombia see dairy cattle as a way out of poverty

4.5.1 Evolution of milk production systems in tropical Latin America and its interrelationship with markets: An analysis of the Colombian case

Contributors: Federico Holmann, Libardo Rivas, Juan Carulla, Luis A. Giraldo, Silvio Guzman, Manuel Martinez, Bernardo Rivera, Anderson Medina, and Andrew Farrow

Rationale

The livestock sector in tropical Latin America (LAC) has been one of the main economic activities within the agricultural sector due to a great extent to abundant areas under savannas appropriate for livestock production. Despite its vast forage resources, livestock production in tropical LAC faces acute problems due to low productivity levels and market changes. In addition, internal discussion exists on the viability of these production systems to compete in a free trade economic environment, especially now that negotiations are under way to join the North American Free Trade Agreement (NAFTA). The aim of this document was to study the evolution of milk producing systems taking Colombia as a case study and to analyze their constraints and opportunities in the context of small producers, technological change, and competitiveness of the regional livestock sector.

Materials and Methods

Data came from a survey to 545 farms in five ecosystems during 2000 to calculate variable costs, income, and to characterize farms by productivity and management practices using multiple correspondence and general linear models. Costs and incomes were estimated based on the methodology described in Holmann et al., (1990). Competitiveness was defined as the permanence capacity in the dairy activity and was measured through the unitary cost of milk and/or beef production. Thus, the lower the production cost, the more competitive the farm is. Profitability was defined as annual net income divided by the number of adult cows.

Technological change was measured through the concept of productivity, expressed as production of milk and beef per cow and per hectare per year.

Twelve technologies and/or management practices were evaluated to quantify their impact on productivity, profitability, and competitiveness, which were: (1) proportion of improved pastures established on the farm; (2) number of grazing paddocks used by milking cows; (3) amount of feed supplements offered to milking cows; (4) reproductive system used; (5) breed group used; (6) number of milkings per day; (7) use of fertilization; (8) use of the irrigation; (9) proportion of mature herd in milk; (10) years of experience producing milk; (11) herd size; and (12) de-worming frequency against both external and internal parasites.

Data was analyzed by production system (i.e., specialized dairy vs. dual-purpose) and by region (i.e., two sites in lowland areas: Caribbean and Piedmont; and three sites in highland areas: Coffee-growing area; Antioquia, and Cundiboyacense altiplanicie).

Results and Discussion

Effect of technological change. Depending on the region where farms were located, farmers that adopted more than two thirds of the area allocated to livestock under improved grasses produced 126% to 309% more milk/ha, had 31% to 350% higher net income/cow/yr, and produced milk at 8% to 13% lower cost than farms with a low proportion of improved forages (i.e., less than one third of livestock area). Farms that had more than 20 grazing paddocks for a more efficient rotation of the milking herd produced 12 to 140% more milk/ha, generated 54% to 133% higher net income/cow/yr, and produced milk at 19% to 27% lower cost compared to farms that had less than 10 grazing paddocks.

The use of strategic feed supplementation to the basal diet of forage had mixed effects. The best economic response to this supplementation in lowland regions was with low quantities (i.e., < 0.5 kg DM/cow/day) of feed supplements while in highland regions was with moderate quantities (i.e., between 0.5 and 2 kg DM/cow/day). The use of fertilization and irrigation increased productivity, but reduced net income and increased production costs in all regions and production systems, except in the Cundiboyacense altiplanicie, which suggested the need to allocate research resources to determine the best economic response to various levels of N_2 and H_2O to different improved grasses under various soil types and conditions.

Farms that practiced twice a day milking produced 83% to 520% more milk/ha, generated 25% to 148% higher net income/cow/yr, and produced milk at 15% to 27% lower costs compared to farms that milked once per day. Farms that de-wormed the milking herd with low frequency (i.e., less than twice/yr) for internal parasites obtained 77% to 128% higher incomes and 8% to 35% lower production costs in comparison with farms that de-wormed with higher frequency (i.e., more than 3 times/yr) although there were not differences in productivity. The amount of years of experience from farmers at producing milk was a key factor to increase profits (38% to 120%), although not productivity. The most competitive and profitable breed group in the dual-purpose system was the crossbred with low (i.e. 24% European - 76% Zebu genes) and medium levels of dairy genes (55% European - 45% Zebu genes) but had lower productivity than the purebred group (i.e. 98% European genes). In the specialized dairy system, the purebred group was slightly more profitable, productive and competitive than the crossbred group with medium level of dairy genes, but this difference was not significant.

Independent of production system or region where farms were located, the increase in competitiveness was in direct relationship with herd size. Thus, as herd size increased, production costs per unit of milk and beef decreased and net incomes per cow increased. However, when this increase in competitiveness with associated with increases in productivity, this trend was not observed, which suggested that highly productive farms were not necessarily profitable. The dual-purpose system was the most profitable one in the Piedmont, Caribbean, and Coffee growing regions while in Antioquia and in the Cundiboyacense altiplanicie the most profitable was the specialized dairy system. Thus, Colombia should have different strategies for research and technology transfer in order to exploit more efficiently the comparative advantages of each region.

Evolution of milk production systems. The Colombian dairy sector has become more productive and competitive, but less profitable. Comparing the evolution of dairy farms with studies 12 years ago (Aldana, 1990), milk production per hectare has increased by 44% in dual-purpose herds and by 14% in specialized dairies. This increase in productivity reduced the milk production cost by 16% and 10% in dual-purpose and specialized dairies, respectively, due to an increase in stocking rate by 15% and 17% in dual-purpose and specialized dairies as well as to an increase in investment in infrastructure and equipment by 258% and 37% in dual-purpose and specialized dairies, respectively. However, net income per hectare during this period decreased by 27% and 69% in dual-purpose and specialized dairies due to a reduction in the producer's price of milk and beef of 22% and 20% in dual-purpose systems, and of 41% and 27% in specialized dairies. Nevertheless, this reduction in price to the producer was never translated in lower prices to consumers, but remained in the hands of supermarkets and milk plants which expanded and modernized with long-life technology. Figure 80 shows the percentage of the price paid for one liter of milk by the consumer that is retained by producers. As observed, producers retained in 1989 about 70% of the final price. However, during the 90's this percentage was systematically reduced to only 37% in 2001. This occurred because the adjustments in the price of milk to producers were always below inflation while the adjustments of milk price to consumers usually surpassed the level of inflation (Figure 81).

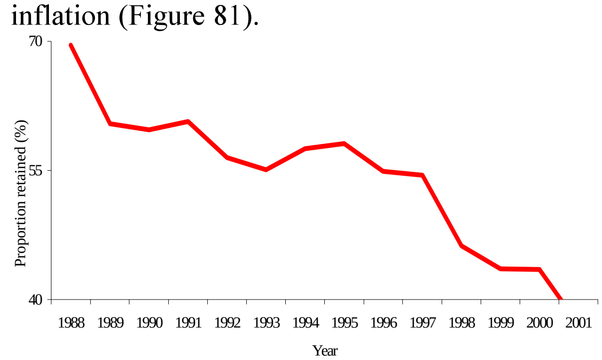

Figure 80. Proportion of the milk price paid by consumers that is retained by producers in Colombia during the period 1989 to 2001.

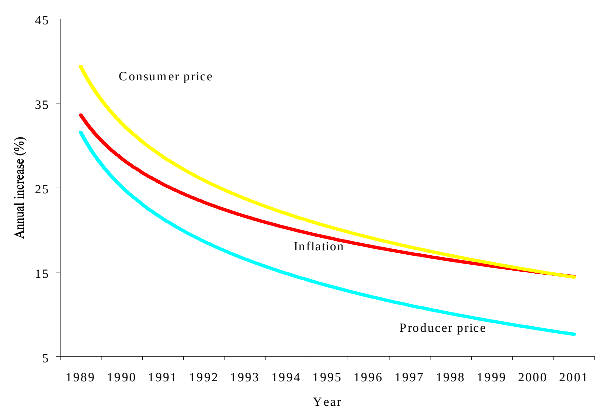

Figure 81. Inflation rate and adjustments in the price of milk paid by consumers and received by producers in Colombia during the period 1989 to 2001.

Development agencies must internalize the fact that policies oriented to markets will be increasingly "oriented to supermarkets". If one adds that in Colombia exists 3 or 4 supermarket chains that control the food retail market, the conclusion is that sectoral policies will need to learn how to deal with a handful of giant companies. This in a huge challenge, and demands an urgent review of ideas and strategies.

The Challenge. The information presented in this case study illustrates the problems and opportunities of the dairy sector in Colombia. However, these systems could represent similar situations in other countries of Latin America. Given the phenomenon of globalization and higher degree of efficiency that these systems are being exposed to, the issues of productivity, technological change, competitiveness, and markets, are critical and of enormous relevance for the performance and survival of the livestock sector in the next decades.

In the coming years, producers cannot limit themselves to participate only in the primary phase of production, but to expand their scope of action to other phases of the market chain to have a higher participation in the formation of milk price and to capture a greater piece of the final price. To achieve this, collective action is required, either through cooperatives or associations, not only to buy or sell at a better price, but also to help small producers to adapt to new patterns with higher levels of competition. Otherwise, the new rules of the game could induce a massive exodus of producers in the short term and in a relatively brief period of time.

Efficiency goes hand in hand with technology and this depends on research and technology transfer. However, public funds allocated to agricultural and livestock research are being reduced (Holmann et al., 2003). The challenge consists that producers in Colombia and Latin America take greater control of livestock research by building alliances with local, regional and international organizations leaders in forage and livestock research. For this it is necessary that producers define and fund their own research agenda.

4.5.2 Enhancing beef productivity, quality, safety, and trade in Central America

Contributors: Federico Holmann, Edwin Perez, Paul Schuetz, Pedro Argel, Carlos Pomareda, and Victor Arrúa

Rationale

Beef is an important commodity in the economies of Central American countries. In 1995, regional beef exports realized more than US$ 126 M and imports cost nearly US$ 17 M. This is especially important to the low-income countries in the region. It is, for example, Nicaragua's most important agricultural activity accounting for 22% of the total Agricultural Gross Domestic Product (AGDP), with exports of fresh and processed meat to El Salvador, Costa Rica, Mexico and the USA among other countries. Guatemala, Honduras and Costa Rica export meat primarily to the USA and Mexico. Total beef exports from the region are showing a declining trend although intra-regional exports increased by 45% in 1998 relative to 1997. However, increases in intra-regional exports are falling behind the total imports by the region. The lost of international markets, particularly the USA, added to the increasing presence of extra-regional competitors and the stagnation of the production and productivity in Central American countries are an indication of the crisis of the beef industry in the region, which affects smallholder producers.

Project Description

This a development-oriented project approved by the Common Fund for Commodities (CFC) that began activities in July of this year, which aims at alleviating poverty by raising smallholder farm productivity, and enhancing trade in beef with improved meat quality and safety. This overall objective is to increase the availability of affordable safe meat products for local consumers and make the Central American beef industry more competitive against imported beef. The project is being executed in the CFC member states Guatemala, Honduras, Nicaragua and Costa Rica.

This is a 4-year project with an estimated cost of US$5 million of which $3.5 millions are being funded by CFC and the remaining $1.5 million from co-funding from counterpart contributions. The project executing agency is the International Livestock Research Institute (ILRI) and the project leader Federico Holmann.

Co-executing agencies are CIAT (Centro Internacional de Agricultura Tropical), SIDE (Servicios Internacionales para el Desarrollo Empresarial), IICA (Inter-american Institute for Cooperation in Agriculture), and CAC (Consejo Agrícola Centroamericano). Local partner organizations are CORFOGA in Costa Rica, MAG-FOR and FAGANIC in Nicaragua, SAG and FENAH in Honduras, and MAGA and ASOBRAHMAN in Guatemala. The project coordinating office is housed within the facilities of the Instituto de Desarrollo Rural (IDR) based in Managua, Nicaragua.

The project's goal is to improve the livelihoods of smallholder producers, make quality safe animal-source foods affordable and available to low income consumers and increase the intra- and inter-regional beef trade in Central America. These activities are conducted as part of the following project components: (1) Improving farm productivity; (2) Beef quality and safety standards and controls; and (3) Project monitoring, impact assessment and dissemination of research products.

The main activities of Component 1 (Improving farm productivity) are:

(a) Identification of technical interventions to improve farm productivity;
(b) On-farm validation of best-bet technologies to improve farm productivity
(c) Implementation of disease surveillance and control measures; and
(d) Strengthening risk analysis capacity to prevent exotic diseases disrupting exports

The main activities of Component 2 (Beef quality and safety standards and controls) are:

(a) Development of food safety and processing procedures along the beef production-to-consumption chain;
(b) Development of a carcass classification systems and regulations for meat quality and safety.

The main activities of Component 3 (Project monitoring, impact assessment and dissemination of research products) are:

(a) Monitoring project progress and assessing the impact of the component activities and providing feedback to stakeholders;
(b) Dissemination of project outcomes and outputs to policymakers and official and private extension agents.

CIAT will participate in the co-execution of Components 1 and 3 in aspects related to increasing on-farm productivity through the introduction of improved-based forages aimed to increase weaning weights of pre-weaned calves and to improve the nutritional status of dams.

The project held an initial planning meeting during July 7-10 in San José, Costa Rica with 20 participants which included representatives from both the private and public sectors from Guatemala, Honduras, Nicaragua, and Costa Rica, as well as from the co-executing agencies. The objectives of the planning meeting were to:

(a) make a presentation of the overall project objectives, goals and activities;
(b) know each other better by making brief presentations of the goals and objectives from each participating institution as related to the project activities;

(c) review the state of the art of the beef sector in the region as well as in each participating country;
(d) present and discuss the project workplan for the first year; and
(e) Discuss operational issues related to the project.

The products from the planning meeting were:

(1) the project workplan for the first year with its corresponding calendar of activities discussed and approved;
(2) Responsibilities from each participant discussed and approved;
(3) Indicators for project monitoring and evaluation selected;
(4) Mechanism for management of project funds discussed and approved; and
(5) Frequency, information required, and format for the technical project reports discussed and approved.

The project will start executing the approved workplan in mid-September with the execution of a baseline study in each of the selected regions, which are: Perez Zeledón in Southern Costa Rica, Boaco and Chontales in Nicaragua, Olancho and Valle del Aguán in Honduras, and Izabal and Baja Verapaz in Guatemala.

4.5.3 The role of livestock in poverty alleviation: An analysis of Colombia

Contributors: Federico Holmann, Libardo Rivas, Juan Carulla, Luis A. Giraldo, Silvio Guzman, Manuel Martinez, Bernardo Rivera, Anderson Medina, and Gerardo Ramirez.

Rationale

The potential of livestock to reduce poverty is enormous. Livestock contribute to the livelihoods of more than two-thirds of the world's rural poor and to a significant minority of the peri-urban poor. The poorest of the poor do not have livestock, but if they can acquire animals, their livestock can help start them along a pathway out of poverty.

Roles of livestock keeping revolve around storing wealth, contributing to food and nutritional security, providing draught power, transport and manure, and serving traditional social functions. In some situations, the "livestock ladder" may allow the poor to progress from modest livestock holdings, such as a few poultry, to acquiring sheep and goats or pigs, or even cattle. Livestock production provides a constant flow of income and reduces the vulnerability of agricultural production. The objective of this study was to understand the perception of agricultural producers in Colombia who currently do not own livestock about the role of cattle in alleviating poverty in their farms.

Materials and Methods

Data came from direct survey interviews during January to June of 2002 to 143 farmers who did not own cattle in the five most important regions of animal production in Colombia to elicit their perception about the role of livestock as a pathway out of poverty. Selected regions were: Piedmont, Caribbean, the Coffee-growing region, the highlands of Antioquia, and the Cundiboyacense altiplanicie.

Results and Discussion

Land Use. Table 81 contains the average farm size and land use by farmers who do not own cattle. Mean farm size varied from 5.7 ha in the Cundiboyacense altiplanicie to 13.4 ha in the highlands of Antioquia.

All farmers depended on both annual and perennial crops for most of their income although it varied significantly across regions. In the Coffee-growing region, producers depended mostly on coffee for their income whereas in the Cundiboyacense altiplanicie they depended on annual crops, mainly potatoes and broad beans (*Vicia faba*). In the Piedmont and Caribbean regions producers depended mostly on maize, cassava, and rice. Fruits were the most important land use in Antioquia and a very important crop in the Piedmont and the Coffee-growing region.

Pastures were an integral part of land use in all farms, even though producers did not have cattle. This was specially the case in Antioquia, where 58% of farm size was under pastures. The reason for this was because most farmers interviewed were coffee growers which during the early 90's switched to fruits trees and fattening steers under intensive pasture rotation using high levels of N_2 fertilization. All interviewed farmers who had steers had sold them due to negative economic returns and were currently fattening pigs. Land under pastures was abandoned, as they did not want to go back to coffee or other agricultural land use at the time the surveys were executed.

With regards to land use, the largest proportion of farms under forest were found in the Piedmont and the lowest in the Cundiboyacense altiplanicie, which makes sense since the former is the agricultural frontier while the latter has been under agricultural production for the longest period of time.

Table 81. Farm size and land use by non-livestock owners in five regions of Colombia during 2002.

Parameter	Region				
	Piedmont (n=33)	Caribbean (n=33)	Coffee (n=23)	Antioquia (n=25)	Cundi-boyacense (n=29)
Farm size (ha)	11.7	9.6	9.9	13.4	5.7
Land use (ha)					
Annual crops					
- Maize	0.5	3.1	0.1	0	0.1
- Rice	1.0	0.3	0	0	0
- Beans	0.1	0.1	0.1	0.1	0.2
- Other [1]	0.8	2.2	0.3	0.9	3.2
Perennial crops					
Coffee	0	0	6.1	0	0.6
Sugarcane	0.1	0.1	0.2	0	0.1
Fruits	1.3	0.8	0.5	2.1	0.1
Other [2]	1.2	0.3	1.5	0	0
Pastures	3.3	1.9	0.4	7.8	1.1
Forest	3.2	0.9	0.9	2.3	0.4

[1] Cassava in the Piedmont and Caribbean; Onions and cassava in the Coffee region; Cassava, potatoes, and broad beans (*Vicia faba*) in the Cundiboyacense altiplanicie.
[2] Bananas and plantains.

The role of cattle in smallholder farms. In Table 82 we present the proportion of smallholders who had cattle in the past and the main reasons for selling or not owning cattle in 2002. Most smallholders interviewed in the Piedmont had cattle in the past (85%), followed by producers in Antioquia (60%) and least in the Coffee-growing region (39%).

The most important reason for selling their cattle in all regions was due to financial crisis and needed cash (i.e., from 27% of smallholders interviewed in the Caribbean and the Cundiboyacense altiplanicie to almost 50% in the Piedmont). Most smallholders surveyed used the money from the sale of animals to pay health bills of family members, to pay off debts, and/or to use the cash to survive due to crop failure from extreme weather conditions (i.e., drought or frost damage).

Table 82. Proportion of farmers who owned cattle in the past and reasons for selling or not owning livestock in five regions of Colombia during 2002.

Parameter	Region				
	Piedmont (n=33)	**Caribbean (n=33)**	**Coffee Zone (n=23)**	**Antioquia (n=25)**	**Cundi-boyacense (n=29)**
Non-livestock farmers who had cattle in the past (%)	84.8	42.4	39.1	60.0	52.2
Reason for selling or not having cattle today (%)					
Due to financial crisis	48.5	27.3	34.8	28.0	27.5
Not enough land to keep cattle	18.2	18.2	0	4.0	27.6
Owning cattle was a bad experience	9.1	6.1	4.3	24.0	0
Cattle died of disease	0	3.0	0	0	13.7
Cattle was robbed	0	3.0	0	4.0	6.9
Low profitability	6.0	0	0	8.0	0
Security problems	12.1	6.1	0	0	0
Other	6.0	0	0	4.0	3.4
Reasons for not owning cattle today but had it in the past (%)					
Not enough land to keep cattle	12.1	51.5	39.1	8.0	37.9
Not enough money to buy cattle	12.1	51.5	4.3	0	34.5
Requires high investment and agriculture is preferred	0	3.0	13.0	16.0	6.9
Does not like to own cattle	3.0	0	13.0	8.3	0
Not enough knowledge on how to manage cattle	0	6.1	0	0	3.4
Security problems	3.0	0	0	0	0
Other					
Producers who currently own livestock other than cattle (%)	72.7	100.0	52.2	36.0	69.0
Average inventory and species of livestock other than cattle (#)					
Laying hens / broilers	35.0	25.0	11.5	0	9.5
Pigs	3.0	10.0	4.0	30.0	0
Sheep	0	0.3	0	0	1.8
Goats	0	0	2.3	0	0
Ducks	0	4.4	0	0	0.1

The second most important reason for selling cattle in smallholder farms in Antioquia was due to low profitability (32%) when producers switched from coffee to fattening steers under intensive grazing during the 90's. In other regions the second most important reason was because of limited amount of land, especially in the Cundiboyacense altiplanicie, the region with the smallest farm size.

Other reasons for selling cattle was due to security problems (12% of smallholders in the Piedmont and 6% in the Caribbean regions), others because owning cattle was an unpleasant experience (9% in the Piedmont, 6% in the Caribbean, and 4% in the Coffee region), and another reason mentioned was due to cattle rustling (3% of smallholders in the Caribbean, 4% in Antioquia, and 7% in the Cundiboyacense altiplanicie).

Even though smallholders surveyed did not own cattle, most of them had in their farm other species of livestock, ranging from 36% of farmers in Antioquia to 100% in the Caribbean. The most common livestock specie owned was poultry (both laying hens and broilers), ranging between 9.5/farm in the Cundiboyacense altiplanicie to 35/farm in the Piedmont. The only region where poultry was not found on farms was in Antioquia.

The second most common specie found was pigs, ranging from 3/farm in the Piedmont to 30/farm in Antioquia, where farmers who had fattening steers switched to pigs. Other species found were sheep, goats, and ducks, but these were not common. These livestock assets provide smallholders with high quality protein (meat and eggs) for household consumption to complement the grain-based diet they have.

Farmer perception about cattle ownership. In Table 83 we show the perceptions on the role of cattle ownership by smallholder farmers who do not own cattle. The most striking result is that 76% of farmers in Antioquia to 97% of smallholders in the Cundiboyacense altiplanicie would like to own cattle if they had the opportunity. The most important reason for owning cattle in all regions was as a mechanism for savings and building capital. The second most important reason in all regions was to obtain milk and beef for family consumption, except in Antioquia where this issue

Table 83. Subjective perceptions about the role of cattle ownership by agricultural producers who did not own cattle in five regions of Colombia during 2002.

Parameter	Region				
	Piedmont (n=33)	Caribbean (n=33)	Coffee Zone (n=23)	Antioquia (n=25)	Cundi-boyacense (n=29)
Farmers who would like to own cattle today (%)	84.8	87.9	82.6	76.0	96.6
Reason for owning cattle (%)					
To obtain milk and beef for family consumption	51.5	87.8	30.4	0	58.6
A mechanism for savings and building capital	54.5	100.0	47.8	74.0	86.2
To reduce and diversify risk due to crop failure	15.2	3.0	8.7	8.0	51.7
To use manure as fertilizer	9.1	0	8.7	0	34.5
Preferred animal category to own (% of farmers)					
Milking cow	81.8	84.9	47.8	52.0	96.5
Female calf	6.1	0	8.7	24.0	31.0
Male calf	0	0	26.1	0	27.6
Steer	15.2	6.1	17.4	0	13.8
Bull	9.1	0	0	0	31.0
Desirable amount of animal category to own (#)					
Milking cow	8.4	13.2	2.3	9.4	5.8
Female calf	1.4	0	0.3	2.5	1.6
Male calf	0	0	1.8	0	1.5
Steer	0.6	0.6	7.4	0	0.3
Bull	0	0	0	0	0.4
Necessary conditions to own cattle (%)					
More land	21.2	78.8	39.1	4.0	75.9
Availability of credit	42.4	63.6	56.5	28.0	17.2
Security	18.2	6.1	0	8.0	0
Improve farm infrastructure	18.2	3.0	8.7	24.0	17.2

was irrelevant. Other reasons for owning cattle were to reduce and diversify risk due to crop failure and to utilize manure as fertilizer. This was specially the case in the Cundiboyacense altiplanicie (Table 83) where most farmers grow broad beans and potatoes and the risk of frost damage is significant and where manure from cattle can be an important source of fertilizer and organic matter.

The preferred animal category to own in all regions was by far the milking cow, ranging from 52% of smallholders in Antioquia to 96% in the Cundiboyacense altiplanicie. In addition, when smallholders were asked to express the desired amount of animals they would like to own, again the milking cow was the animal category with the highest number. When smallholders were elicited about the necessary conditions to own cattle, the most frequent answer was availability of credit in the Piedmont, the Coffee-growing region, and Antioquia, whereas the most frequent answer in the Cundiboyacense altiplanicie and the Caribbean was to have more land as a condition to own cattle. Other important conditions to own cattle was to have the adequate infrastructure and to a lesser extent, to improve the security conditions in rural areas.

Conclusions

Results from this study show that small farmers see cattle as a contribution to the improvement in the quality of life. The milking cow is one of the factors that contributes the most to the well-being due to the role she plays within the farm: utilization of labor with low opportunity cost, security against crop failure, liquidity against financial crisis, as collateral for informal credit, and as a protection against inflation (Estrada, 1995). Smallholders who had sold their cattle in the past were mainly for these same reasons. The challenge is to develop novel mechanisms to provide smallholders with livestock, either through credit loans or through the Fondos Ganaderos of Colombia, whose objective is to help small farmers who have production capacity but lack the resources to buy cattle.

4.6 Expert systems for targeting forages and extension materials for promoting adoption of forages

Highlights

- Beta version of SoFT (Selection of Forages for the Tropics) database completed, based on interaction of partners involved in project and expert consultation.
- Draft tool GEMS (Genotype x Environment x Management System) developed
- Developed extension materials of improved forages for smallholder farmers in Central America and Southeast Asia

4.6.1 Development of a database and retrieval system for the selection of tropical forages for farming systems in the tropics and subtropics

Contributors: B. Pengelly, S. Brown, D. Eagles (CSIRO), J. Hanson (ILRI), B. Cook, I. Partridge (QDPI), A. Franco and M. Peters (CIAT)

Rationale

The demand for livestock products from both ruminants and monogastrics in the developing world is increasing at 6-8% per annum. This situation provides a unique opportunity for smallholder farmers in developing countries to increase income by satisfying that demand, and in some cases will enable them to advance to market-oriented production for the first time. Income obtained from market-oriented livestock production will impact on cash flow and purchasing power, and hence act as a driver for sustainable intensification.

The challenge facing all farmers is to develop strategies to meet the feed demand of their animals and the market demands for livestock products of specified quality. Sown tropical forages can provide part of the feed base that will support this market expansion. Forages can be used to provide improved feed quality and quantity in a range of farming systems, including those based on maize and rice cropping systems, as well as systems that depend almost entirely on continuous grazing of native grasslands. The benefits of including well-adapted sown forages in the diets of animals in these systems has been well documented, but adoption has been limited for a number of reasons, including poor access to appropriate information. These species can provide benefits beyond feeding livestock. In mixed cropping/livestock systems, forages can be integrated with cultivation cycles to improve soil fertility and structure, and in agro forestry and orchard systems, they can be used to suppress weeds as well as feed animals. Stoloniferous and rhizomatous species blanket the soil as live mulch, reducing erosion.

Farmers depend very heavily on advice from extension specialists, development agencies, researchers and seed companies, whose knowledge on forages is often limited because of inexperience in a region, the difficulty in harnessing the expertise of others, and poor access to information. Much of the important information is fragmented, unpublished or published in media of limited circulation. This project intends to synthesize and interpret this information and so overcome this limitation to the wider adoption of forages. This project is bringing together in one-knowledge system (SoFT – Selection of Forages for the Tropics) much of the accumulated information of the last 50 years from across the tropical world, on species adaptation, together with their use and management. Information will be sourced from scientific literature, the plethora of reports, and from unpublished information gleaned directly from agronomists with extensive tropical experience. The completed product will be a computer-based system that can be used to select “elite” forage accessions for a range of uses, farming systems and environments. This synthesis of information on the use (e.g. fish, pigs, mulch) and application (e.g. lay pasture, under trees, relay with rice) of forages, in addition to the conventional genotype x environment information, is unique and made possible by the development of new information management systems.

The specific objectives of the project are:

- To develop a knowledge system for the identification of forages suitable for specified niches within smallholder farming systems.
- To promote the system within the “communities” who are using tropical forages.
- To develop a strategy for maintenance and updating the knowledge system.

The knowledge system will provide users with fact sheets on the use and management of each accession, identify sources of seed and regional specialists, and contain a comprehensive bibliography. It will be available on CD/DVD or via the WEB and will initially be produced in English. Maintenance of the system will be carried out by CIAT, Colombia. The product is primarily intended for use by individuals and agencies providing advice to smallholder farmers.

This target audience in Africa, Asia and the Americas is likely to number in the thousands. Bringing together the partners in this project, CSIRO Sustainable Ecosystems, the Queensland Department of Primary Industries (DPI), Centro Internacional de Agricultura Tropical (CIAT), International Livestock Research Institute (ILRI) and the Food and Agriculture Organization of the United Nations (FAO), provides a unique opportunity to draw on the vast accumulated knowledge from Asia, Africa, the Americas and Australia. The knowledge system will be released at the International Grassland Congress in Dublin, Ireland in June 2005 and will be promoted through CGIAR and other international networks, through collaborating national programs and the Virtual Colombo Plan.

Results and Discussion

Tool development: Immediately after the approval of the project in July 2002 a draft Software tool based on the database Software LUCID was developed. This tool was presented to a range of forage experts from NARS, NGOs, development projects and international research organisations at a design workshop in Bangkok in October 2003. Based on the recommendations beta tools of the database software tool (SoFT-Selection of forages for the Tropics), with expert knowledge on a few well known species was developed until early 2003 (Figure 82). Forage species descriptors for the tool were categorised so that data could be used as an input into GEMS (working title), a GIS based targeting tool. An interface was developed to automatize data input from SoFT into GEMS. In addition, a tool for capturing data from experts was developed for utilization in expert workshops (Figure 83). The possibility to use the tool is via Internet is being tested, as one of the possibilities to access the database tool in addition to CD/DVD –ROM.

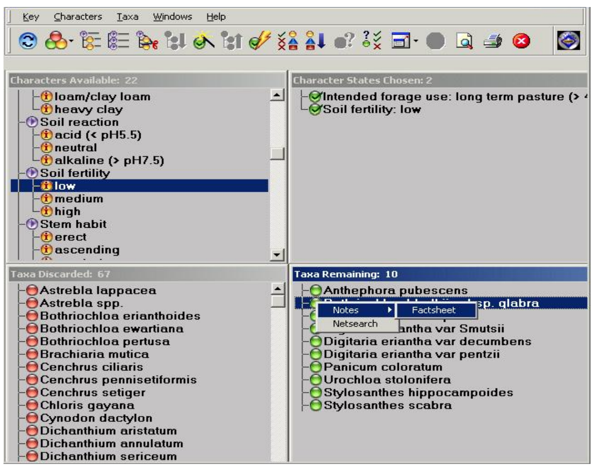

Figure 82. Result of a query to the database, with additional information, i.e. access to Fact sheets

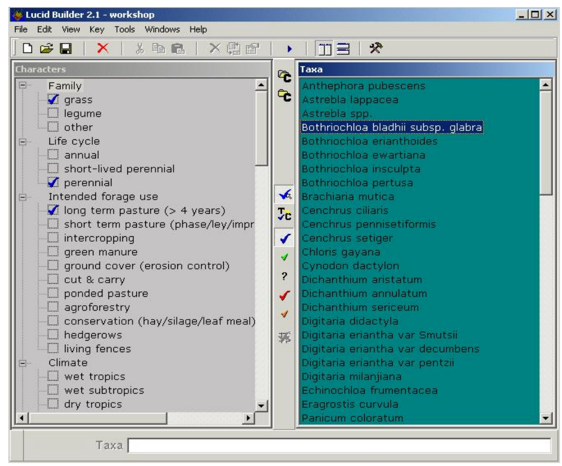

Figure 83. Data capturing interface for SoFT with list of characters and species.

Information gathering from forage experts: Parameters for forage description and range of species were defined in consultation with potential clients. To gather information from forage experts, workshops each with 15 – 30 participants were held in Addis Ababa (for African Forage Experts), and Brisbane (for Australian Forage Experts), Stuttgart Hohenheim (for tropical forage experts based in Europe) and Cali (for American experts), utilizing the above described tool for capturing expert data. Further workshops are planned in Honduras (November/December 2003) and Asia (February 2004). It is planned that by in the first half of 2004 information from all these expert workshops will be available in the tool for further revision.

4.6.2 Incorporating Socio-Economic Data and Expert knowledge in representation of complex Spatial Decision-Making

Contributors: R. O'Brien (PE-4/IP-5, Curtin University), R. Corner (Curtin University), S. Cook, M. Peters (CIAT)

Rationale

The GEMS (Genotype x Environment x Management System) project integrates biophysical, socioeconomic and management data together with expert knowledge to assist farmers' decision-making processes. The approach is based on the following two main assumptions:

- A wealth of information on the agro-ecological adaptation of tropical crop species is available in CIAT-held and other databases. However, the access and hence utilization of this information needs to be improved. In addition, data are often uncertain or missing, and methods are needed to combine existing data with expert knowledge to provide better analysis.
- In evaluations of species adaptation to environmental conditions, agro-ecological information is often separated from socioeconomic factors influencing species adoption.

The above assumptions are particularly the case for forage species, and this project grew out of the perceived need to address these issues for forages. Therefore, while the research is applicable to other crops, in the first instance it focuses on forages. Based on these assumptions, the targeting of forage germplasm is intended to enhance the utility of existing information, and in the future, to integrate environmental and socioeconomic adaptation of forage germplasm for multiple uses. It is anticipated that this approach will allow a more accurate and client-oriented prediction of possible entry points for forage germplasm.

One product of this research will be a fully functional Web-based or CD-ROM tool, primarily designed for targeting forage germplasm in Central America. The primary target users are NGOs, development agencies, national research institutes, and decision makers in government. In conjunction with farmers, these users will be able to more effectively target suitable locations for new forages, with the aid of the tool. This will result in more informed choices being made, thus allowing more effective use of public funds dedicated to agricultural development and natural resource conservation. Tools to better target forages will also help improve the well being of smallholders by assisting them to more effectively utilize their resources in sustainable ways. The addition of carefully selected forages to a farming system has a plethora of benefits both for the farmers and for the environment, as well as the wider community. These benefits derive both from the direct influence of forage planting, and the indirect increase in cattle production and cropping system improvements, and include for example improved sustainable intensification, reduced erosion, and alleviation of protein and micronutrient deficiencies in the community.

Materials and Methods

Review of literature and of existing similar models and software is ongoing, with existing tools currently being evaluated to determine their appropriateness in representing expert spatial decision-making and particularly in targeting forage germplasm. Bayesian modeling has been identified as the most appropriate method, especially for decisions involving sparse and uncertain data.

Case study–design and develop a tool

As a case study, a decision support tool to target forage germplasm is being designed and developed, using GIS technology. This targeting consists of identifying which forages would be suitable or successful in a particular location, given data and/ or knowledge about the forages, and about the location in question.

Data used in this case study include the CIAT (Red Internacional de Evaluación de Pastos Tropicales) RIEPT database (linking forage adaptation, establishment, and production to climate and soil factors), and GIS surfaces of elevation, rainfall, temperature, soil, population density and distance to market for Central America, supplemented with expert and farmer knowledge. The tool is being implemented in Delphi 6.0 with Map Objects LT. It is envisaged that a future version of the tool will be Web-based.

Results and Discussion

Data: Although a large amount of data is available in the RIEPT database, it is characterized by uncertainties, biases, errors, and omissions. Similarly, much of the available data is correlated. Data analysis combined with expert opinion has defined the factors to be used in the modeling process (Table 84).

Table 84. Data used in model specification and model application for a decision support tool to target forage germplasm.

Data	Derived from	Source for model specification	Source for model application
Fine scale (1-4 km grid cells):			
Elevation (m)		RIEPT where available, GIS data	GIS data
Mean annual rainfall (mm)	Monthly rainfall	RIEPT where available, GIS data	GIS data
Consecutive dry months (< 60 mm)	Monthly rainfall	RIEPT where available, GIS data	GIS data
Holdridge life zones	Monthly rainfall, mean monthly temperature	RIEPT where available, GIS data	GIS data
Soil pH		RIEPT	Farmer
Soil texture	% sand, % clay, % silt	RIEPT	Farmer
Soil fertility	% organic matter, P	RIEPT	Farmer
Shade tolerance		Experts	Farmer
Drought tolerance		Experts	Farmer
Salinity tolerance		Experts	Farmer
Water logging tolerance		Experts	Farmer
Aluminum tolerance		Experts	Farmer
Frost tolerance		Experts	Farmer
Intended use		Experts	Farmer
Risk aversion		Confidence in data or knowledge	Farmer
Coarse scale (8-32 km grid cells):			
Population density		GIS data	GIS data
Distance to market	Roads, population centres	GIS data	GIS data
Soil pH	FAO classification	GIS data	GIS data
Soil texture	FAO classification	GIS data	GIS data

Models and algorithms: Literature on models and algorithms for habitat distribution prediction and spatial classification has been reviewed.

Commonly used methods include:
- Multiple linear regression,
- Generalized Linear Methods (GLM),
- Generalized Additive Models (GAM) and other statistical techniques,
- Rule-based systems,
- Habitat envelopes,
- Classification and Regression Trees (CART),
- Probability modeling, including Bayesian modeling and belief networks,
- Artificial intelligence approaches, including Artificial Neural Networks (ANN) and Multi-Agent Systems (MAS), and Cellular Automata.

Most of these methods are inappropriate for the nature of the problem. Lack of reliable and complete data precludes most statistical techniques. An additional requirement is that the model should be transparent, i.e., it should be logical and obvious to the user why a species is being suggested. The best candidates are rule-based systems, CART, and Bayesian modeling. Of these, Bayesian modeling has been selected because of its ability to deal with uncertainties and incorporate expert knowledge.

Tool development: Tool development is progressing for the case study of forages in Central America. The tool allows users to select a location of interest and define characteristics of the location and desired characteristics of the forage species. They are then presented with a selection of suitable forage species, which they can interrogate for more information (Figure 84).

The data and parameters for the tool are derived from RIEPT data updated with expert knowledge. This expert knowledge is either directly input by forage experts, or derived from SoFT (Selection of Forages for the Tropics) data. SoFT is an international project in which CIAT is involved. It began in 2002, and aims to collect and make accessible expert knowledge about tropical forages. Probabilities are updated graphically (Figure 85), and experts can examine maps to verify the parameterization of the model (Figure 86).

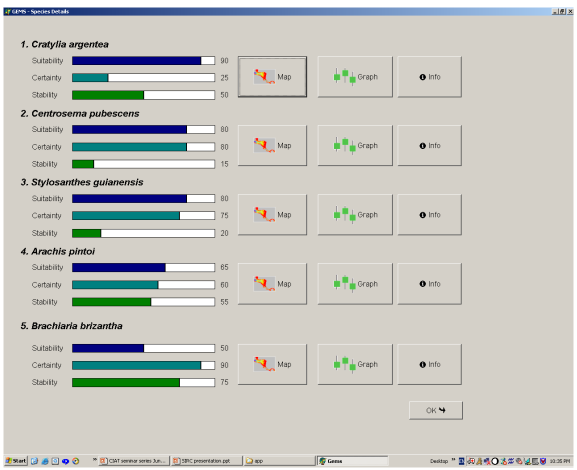

Figure 84.   Suitable forage species with options for interrogation.

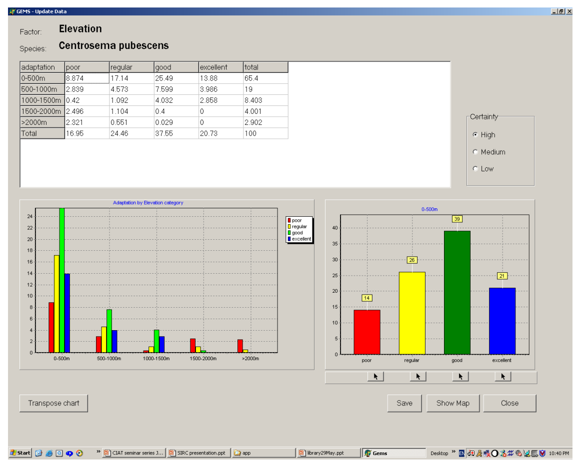

Figure 85. Graphically updated probabilities

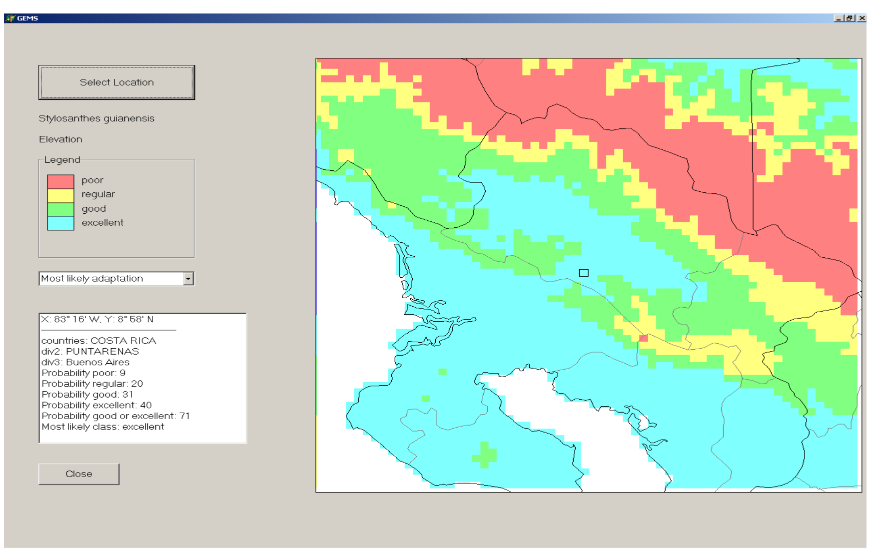

Figure 86.   Map of adaptation related to elevation

4.6.3 Production of materials on forages for use in extension in Central America

Especies Forrajeras Multipropósito: Opciones para Productores de Centroamérica [Multi-purpose Forage Species: Options for Central American Producers]:

Contributors: M. Peters; L.H. Franco; A. Schmidt; B. Hincapié (CIAT)

Publication for smallholder farmers and technicians to select forage species depending on local climate and soil conditions, wit emphasis on Central American environments. The booklet contains easy-to-understand information on forage species. Information was compiled based on work of CIAT with farmers in Costa Rica, Honduras, and Nicaragua. The booklet was developed under the project " Farmer Participatory Research in Action: Selection and Strategic Use of Multipurpose Forage Germplasm by Smallholders in Production Systems in Hillsides of Central America", financed by BMZ/GTZ. The publication has five sections: (1) grasses, (2) herbaceous legumes, (3) cover legumes and green manures, (4) shrub legumes, and (5) other species of interest. Specific information is provided on the different forage species and their multiple uses over a broad range of production systems. The inclusion of color photographs facilitates the differentiation of species, and tables quickly provide the reader with a summary of the uses and characteristics of each species (Photo 29).

Producción Artesanal de Semillas de Pasto Toledo (Brachiaria brizantha, accesión CIAT 26110) [Artisanal Seed Production of Toledo Grass (*Brachiaria brizantha*, accession CIAT 26110)]

Contributors: P. J. Argel; G. Giraldo; M. Peters; C. E. Lascano

CIAT's Tropical Forage Project, together with several national research institutions, development projects and Non Governmental Organizations in Costa Rica, Honduras, Nicaragua and Colombia, is promoting Toledo grass (*Brachiaria brizantha* CIAT 26110. The good acceptance of Toledo in the region has translated into a high demand for seed. This handbook describes the experiences of technicians and of small- and medium-scale producers in Central America, and indicates the minimum management conditions necessary for artisanal seed production. The publication was developed under the project " Farmer Participatory Research in Action: Selection and Strategic Use of Multipurpose Forage Germplasm by Smallholders in Production Systems in Hillsides of Central America", financed by BMZ/GTZ. A summary of the most important information for artisanal production of Toledo seed is also available as a leaflet (Photo 29).

Producción Artesanal de Semillas de Cratylia *(Cratylia argentea* accesiones CIAT 18516 y 18668) [Artisanal Seed Production of Cratylia (*Cratylia argentea* accessions CIAT 18516 and 18668]

Contributors: P. J. Argel; G. Giraldo; M. Peters; C. E. Lascano

Recent studies carried out by CIAT's Tropical Forages Project, together with national research institutions in South America, Central America, and the Caribbean, have demonstrated the high potential of the shrub legume Cratylia *(Cratylia argentea*) in animal production systems. This handbook describes practices for the artisanal seed production of Cratylia to promote its use by small- and medium-scale livestock producers in those areas where drought is a limiting factor. The publication was developed under the project " Farmer Participatory Research in Action: Selection and Strategic Use of Multipurpose Forage Germplasm by Smallholders in Production Systems in Hillsides of Central America", financed by BMZ/GTZ. A summary of the most important information for artisanal production of Cratylia seed is also available as a leaflet (Photo 29).

Photo 29. Production of materials on forages for use in extension in Central America

4.6.4 Production of materials on forages for use in extension in Southeast Asia

Contributor: P. Horne (CIAT)

Throughout 2003, the FLSP worked with province and district staff to discuss the impacts that are emerging from forages, to discuss the important aspects of these impacts that need to be documented and to practice preparing case studies that can be used to drive extension and scaling-out. Case studies are starting to emerge that will excite other farmers, extension staff and extension managers. These cases are being developed into:

1. **Posters** which highlight maybe one to three cases in a single poster around a common theme
2. **Case study sheets** which highlight the main features of each case of impact in detail, to be used by the district staff for field days and cross visits
3. **Fliers** of each case study of impact that can be given to farmers in a small form and posted in villages in a large form

These extension materials developed from cases of impact will be complemented with ***"tech sheets"*** which highlight common technical problems and opportunities associated with each case. Ten case studies have been documented so far. An example case study (and a poster developed from it) are shown below:

Jong tried to escape from shifting cultivation by investing in a cow, heifer and calf for breeding but the management and feeding problems of free-range grazing in the highlands prevented his herd from increasing. All his labour was lost. Planting forages overcame these problems and his herd has now increased to 15 head. At the same time he has been able to reduce his area of shifting cultivation from 1.5 to less than 0.5 ha and wants to stop altogether

Swidden cultivation is the traditional system for cultivating upland rice in the highland areas of SE Asia. Farmers cut areas of forest, let it dry and then burn off the debris, leaving a cleared and fertilized soil, into which they directly seed upland rice. The following year farmers move to a new area, leaving forest to regenerate on the old field. As population pressures build up farmers are forced to leave less and less time for the forest to regenerate. Weeds become the predominate growth and farmers find themselves in a labour trap:- putting in increasing amounts of labour for weeding, on areas with declining soil fertility for reducing yields.

Swidden or slash and burn cultivation is highly destructive of the forest areas, reduces the bio-diversity and causes many downstream problems. Government policy in Laos is for the farmers to cease this system of cultivation to maintain the watersheds. But exploring and establishing a new livelihood does not come easily. Access of these remote highland villages to markets is difficult, and the farmers themselves are working from a declining resource base.

Jong Gor Her is a Hmong farmer with a young family of 4 children living in the village of Kieuwtalun Nyai on a high ridge south of Luang Prabang. Every year they would plant about 1.5 ha of swidden rice fields, beginning with cutting the forest in February and ending with harvest in November. Once the cycle began they could not stop, no matter the weather, their health or their energy. Even after childbirth, his wife would return to field work within a month, with the young baby strapped to her back. And at the end of this cycle they would have only just enough rice to eat. Opium had been grown as a cash crop, but this was no longer permitted. Jong realized that if they continued to rely on swidden cultivation of rice, the future of his family was not bright. In 1992 he put together enough money to buy a cow, a heifer and a young calf.

Addressing Immediate Problems. All the cattle in the village are kept in 4 areas of about 50 ha. each which are cordoned off between the steep limestone hills. Jong would visit his animals about once every 1-2 weeks. Nonetheless they would escape and damage other farmers' crops, resulting in arguments and in Jong paying compensation each year.

The highlands appear deceptively suitable for raising livestock, with large areas of forest and apparent natural feed sources. Feeding was, however, a serious problem when he tethered the cattle close to the house. This was done for different reasons: from May to July when the ticks and blood sucking flies were the worst; or when animals were injured; and when a cow would be calving, (a month before and then a month after birth). During these periods Jong collected native grasses to feed them, spending 2-3 hours each day. *"By the time this was done the whole morning would be gone with no other work done",* he said. This one load of feed (about 50 kg) was really *'just keeping the animals alive'*, and after a week on this diet they would start to grow thin. In the 4 years prior to having forages, the two calves that were born grew weak and both died from malnutrition. Thus in all this time, his herd had failed to increase, and he had only succeeded in adding an extra burden of labour to the family.

Jong joined in forage trials in 1997, planting a small area (about 250 m^2) of six varieties for evaluation. With these forages close by (only 5 minutes walk form the house) he was able to increase the feed for his cows from 1 to 2 loads per day, taking him just thirty minutes to cut and carry. When the children came home from school at midday, they added a third load. Thus, better accessibility to forage more than doubled the feed provided to the tethered cattle. The quality of feed was also better than from the native grasses, as indicated by all the feed being consumed without any residue being left.

After the initial success, it was clear to Jong that his small trial plot would not be enough and he purchased a second similar plot from a neighbour. He then expanded the original block further to 1250 m^2 giving a total area of more than 2000m^2, which he occasionally grazed as well as cut. He has been harvesting forages from these areas for more than 3 years now and they are still productive, regenerating within 2-3 weeks in the wet season. He has inter-cropped in to the forages the tree legume, calliandra, which he regularly adds to the cut forage grass when he feeds the cattle. The most important impact that Jong and his family have experienced is that all the calves born since they started planting forages were strong and have survived. Since 1997 the herd has increased to 15 (5 cows and 10 calves). Without planted forages, Jong said, he would never have been able to tether and feed more than two cattle at a time.

Management of Forages in an Extensive Environment. Jong noticed that the native grasses would die out after being cut more than 2-3 times or after being burned whereas the forage grasses survived all these stresses. He also noticed that if the area was grazed, the trampling of the plants and dropping of seed by feeding cattle was expanding the area of forage grasses wider. On the basis of this, he thought he could establish larger areas of improved forage for grazing by simply broadcasting seed in small plots and allowing the cattle to expand it further in due course. However, although this idea interests him, Jong still wants to keep the animals close to the house if he can. So, he plans to fence an area above his forage block for penning the whole herd there and hand feeding them. This would further reduce the time for carrying the forages to feed them and also allow collection of manure to re-fertilize the forage block (which is starting to show yellowing due to nutrient decline). He realises he will need to double the area of the forage block before he can corral the herd there.

Changing Livelihoods. Jong's family usually slashed and burnt 1.5 ha to grow upland rice each year. In 2001, as his herd began to increase, Jong began to cut back this area. This allowed his wife to put more time into handicraft work. With the income from this, and by selling off one calf, they purchased all the rice they needed. They repeated this again in 2002, selling off another calf. By 2003, they planted less than 0.5 ha. of upland rice and expect to this even further, planting cucumber on their upland fields instead.

This year Jong sold not just one calf but three, for a total of 5 million kip. As well as using this to buy the rice they need, Jong has also purchased some comforts for the family. While the family still maintain their traditional Hmong house with an earth floor and wood fired kitchen, they now enjoy their new TV and VCD player (with movies in Hmong). Jong also purchased one of the small Chinese motorcycles that have become common in Laos. With this he is now able to ride the 2 hours down the mountain road to the Provincial Livestock Department in Luang Phabang and purchase vaccine needed for the livestock in the village. The changes in livestock raising by Jong are quite profound. While he did have the vision to escape from swidden cultivation of rice by better livestock production, his initial use of forages was to solve the immediate problems of free-range grazing typical of most farmers in the highlands. As other benefits became apparent, with his ideas of corralling the animals and hand feeding them, Jong is moving towards an intensification of livestock. Along with this intensification he and other farmers in the village have begun to treat their livestock (pigs as well as cattle) for parasites and vaccinate them against common diseases. Through this intensification of livestock they have begun to stabilize their agricultural system. This has given them the means and the time to begin to diversify into other enterprises, such as handicrafts and vegetable crops. About half the households in the village now grow forages for their livestock (cattle and pigs). Four other farmers have also begun to reduce the swidden area they cultivate after improving their livestock production. As these farmers improve the lives of their families, so others will see to impacts and the trend of stabilization and diversification through livestock production will continue to gather speed in the village. On the following page is a sample poster, to be used in extension, based on this case study of impacts.

Publications. Three new publications were produced during this year, documenting (i) technical details of forages in smallholder farming systems, (ii) participatory research methods that have helped us in developing smallholder forage systems in Laos and (iii) the potential impacts that can come from forages in smallholder systems. The first two of these publications are part of the "CIAT in Asia Research for Development Series" (CARDS); a series of publications that is being produced to "provide research information to development workers in the region in a format and in languages that make the information more accessible to them".

More details about the book series (and free downloads of the books) are available from the CIAT in Asia website (www.ciat.cgiar.org/asia). During the first half of 2003, work commenced on a new book in the series to document cases of impacts from forage technologies on smallholder farming systems in Southeast Asia. The book is being written by John Connell (a new CIAT employee) and will include cases of impacts from forages in Indonesia, Laos, Vietnam and the Philippines. It is expected the book will be published in the first half of 2004.

4.7 Facilitate communication through journals, workshops and the Internet

Highlights

- Tool for electronic access to 'Pasturas Tropicales' developed
- Spanish version of forage web page developed

4.7.1 Publications of Pasturas Tropicales

Contributors: A. Ramirez, C. E. Lascano, B. Hincapie, L. A. Franco and B. Arenas (CIAT)

In the 5 numbers of Pasturas Tropicales that correspond to Volumes 24 (3) and 25 (2) published as of August of 2003 there are 33 papers and research notes coming mainly from Brazil (25) followed by Colombia (7) and Chile (1) Table 85).

There are some reasons for the significant number of contributions from Brazil: (1) The large percentage of area in the ecosystems of tropical low lands dedicated to livestock, (2) the acceptance and wide diffusion of Pasturas Tropicales (distributed within several countries), which is attractive to the authors, (4) the interest of researcher for publishing their work, and (5) the fact that R& D institutions in Brazil give incentives to researcher that publish their work in international journals. These contrasts with to what happens in other countries where universities and other R &D institutions give the same credit to a research paper published in popular magazines as in specialized journal.

In the near future we will launch a campaign to invite forage researchers in the region to write up their work and submit for publication in Pasturas Tropicales. One of the most efficient ways of accomplishing these comes from the direct personal contact through visits to different institutions that collaborate with CIAT's Forage Program. We will also seek assistance from CIAT's Regional Coordinators since they are in close contact with a number of active forage researchers in their regions.

Table 85. Themes and total contributions published in Pasturas Tropicales in 2002 and 2003.

Themes	2002			2003		Country
	24(1)	24(2)	24(3)	25(1)	25(2)	
Pests in pastures	4			1		Colombia (4) Brazil (1)
Economic evaluation of Cratylia		1				Colombia
Simulation Models applied to dual-purpose cattle		1				Chile*
Germplasm Characterization		1				Brazil
Pasture Evaluation		1				Brazil
Pasture Establishment		2				Brazil
Pasture Renovation		1		1		Brazil
Seed Production			1			Brazil
Fertilization			2	1	2	Brazil
Root Systems			1			Brazil
Forage Quality			2	4	2	Colombia (1) Brazil (7)
Fodder Trees				1		Brazil
Forage and Animal Production					2	Brazil
Inoculation/Rhizobium					2	Brazil (1) Colombia (1)
Total	**4**	**7**	**6**	**8**	**8**	

4.7.2 Development of a CD of Pasturas Tropicales (Pasturas Tropicales: Unidas en un solo Volumen) [Tropical Pastures: United in one single volume]

Contributors: B. Hincapié; J. C. Calderón; A. Ramírez; B. Arenas; A. Franco; C. E. Lascano; M. Peters

The introduction of new communication technologies and the increasing access to the Internet allows development of novel web based electronic publications, information easily accessible to a large number of users. One of such publications is *Pasturas Tropicales: Unidas en un Solo Volumen*. This product compiles the complete set of articles published in *Pasturas Tropicales* from 1979 to 2002. Articles can be accessed in an HTML environment. Indexes to consult *Pasturas Tropicales* based on publication year, authors, species and themes are included. Selected articles can be downloaded as PDF files. With this product CIAT hopes to contribute to improved knowledge management, serving as institutional memory and improving efficiency (time, availability and cost) of information diffusion (Photo 29).

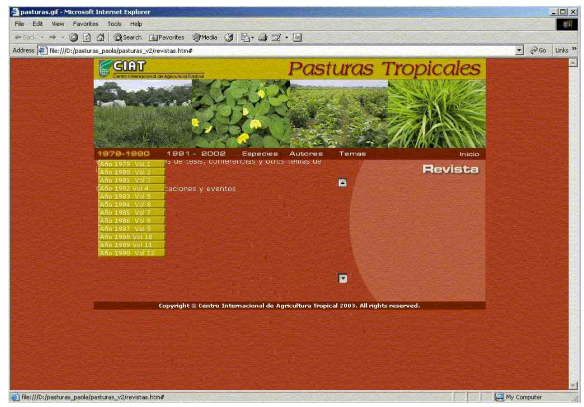

Photo 29. Opening screen of Pasturas Tropicales: Unidas en un solo volumen

4.8 Update of a Forage Web Site

Contributors: S. Staiger, C. Maya, B. Hincapié and M. Peters

Intensive work on the web site of CIAT's Tropical Forages Project commenced in January 2002; since August 2002 this web site is available to a wide range of external and internal users. The web site is the result of teamwork between all Project members, under the general Web site coordination of the Communications Unit and with the support of both the Systems and the Information and Documentation Units.

The Web site has allowed to disseminate our research results extensively and to promptly communicate important news, for example the release of varieties and important new research findings.
The Web Site. The site, accessible in http://www.ciat.cgiar.org/forrajes/index.htm, allows users (universities, research institutes, partners, donors, and the scientific community in general) to:

- Consult the forages database.
- Consult databases on the extensive genetic resources of tropical forages conserved in the CIAT gene bank.
- Make on-line requests of samples of unimproved germplasm, which is available free to researchers and farmers.
- Contact CIAT to obtain samples of improved germplasm.
- Browse the easy-to-use catalog of electronic and printed products, many including useful tools and methods.
- Download PDF files containing the full text of recent publications and documents.
- Obtain specific information about each research theme: germplasm, highly nutritive grasses and legumes, genetic improvement of *Brachiaria*, pathology and endophytic fungi, spittlebug bioecology, host plant resistance to the spittlebug, and adaptation to abiotic stress.
- Access additional information resources, such as a publications list, the full text of

newsletters, background documents, annual reports, and general information about the project (project description, staff list, links to partners and donors).

- Keep up-to-date on the latest advances through Homepage's news section.

Advances 2002/2003: It is expected that by end of 2003 the Spanish version of the Forage web page will be launched (Photo 30). This is an important step forward to reach Spanish speaking users, especially as through new net connection points in CIATs areas of work such as the Llanos Orientales and Cauca, Colombia this information will be available to a large number of smallholder farmers. A webpage was developed to highlight the activities of the forages program in Southeast Asia and provide access to downloadable products on forages. The url is <http://www.ciat.cgiar.org/asia/forages.htm> . In the 13 months between launching in August 2002 and August 2003, 37,566 visits to the web site were recorded; in the same time frame 86, 120 downloads of products produced by the Forages projects such as manuals for evaluation of pastures with animals were made (Figure 87).

Photo 30. Development of Spanish version forages web page

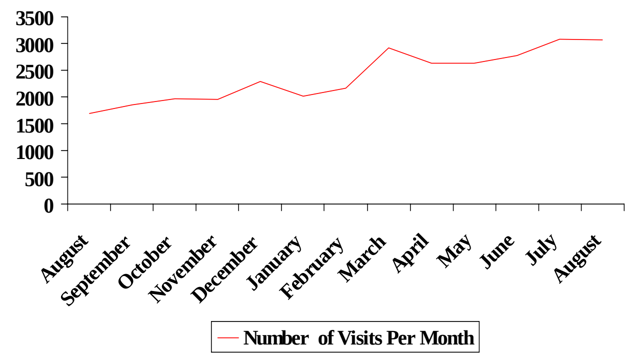

Figure 87. Number of visits to the forage web page between August 2002 and 2003