Agricultural Technology Development Project in Panama

Technical Assistance Component

FINAL REPORT

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EXECUTIVE SUMMARY

The USAID Agricultural Technology Development Project in Panama concluded in December 1987, after seven years and about $12.0 million of expenditures by the Agency. It focussed on IDIAP (one of Latin America's national institutes of agricultural research, established in 1975) and sought to raise farm productivity, income and employment through applied research and related technology transfer programs. This report summarizes activities and accomplishments of the project's technical assistance team from Rutgers, The State University of New Jersey, which first arrived in Panama in mid-1982. Most detail is provided on the last three years of the team's tenure in the country, when five faculty were resident in Panama City and in two interior regions. More extensive information is contained in quarterly reports submitted by the University over the five years of its contract.

The Rutgers team members, including backstopping faculty from campus, oriented their efforts along three main lines. One, diagnosis, involved assistance for research priority and problem selection, together with program evaluation. Another, research, involved conducting collaborative research and technology transfer (from outside Panama to Panama and from within Panama to farmers and extension personnel). A third, development, included assistance with staff development and with development of the Institute as a new, important actor in the agricultural economy of Panama. Distinctions between these activities are appropriately blurred in the report, reflecting the fact that faculty viewed them as highly complementary and integrated.

Activities of the team are described in this report from commodity, discipline and region-specific perspectives. One person in the Western Region focussed on horticultural crops. Two concentrated on cattle: one in the Western Region on pasture improvement, and another in the Central Region on complementary forage and nutrition improvement. A fourth person, posted to the Central Region, provided cross-commodity support to a national soils program, directed primarily to areas with acid and less fertile soils, evidencing problems of aluminum toxicity, phosphorus fixation, and essential mineral nutrient deficiencies. A fifth person, posted to Panama City, served as Chief-of-Party and took leadership for most development activities of the team.

Seven years (five of technical assistance) are all too few to achieve the full range of ambitious objectives adopted by the project--and, indeed, its continuation had been planned for and anticipated by IDIAP, Rutgers and USAID before mid-1987. Nonetheless, very significant accomplishments are reported here which will constitute a solid foundation for further progress when Panama's economic and political stability is restored. Among those are the consolidation of new institutional mechanisms

to conduct more effective applied research, a sharply increased number of scientists trained through the M.S. and Ph.D., and expanded contacts by IDIAP with its farmer clients. All reflect the fact that the project and its technical assistance successfully nurtured a new institution from infancy to mature adolescence.

The stock of knowledge and availability of specific, appropriate technologies were also expanded; and these gains, with which most of this report deals, will not be lost on current events. Specific examples in four areas of Rutgers' responsibility include:

1. Horticultural crops. Panama has a fine tradition of research on tomatoes, largely for industrial production, dating from the 1960's. This was expanded by Rutgers assistance into onions. With applied research and close grower involvement, national onion production increased two-fold in just two years and imports were halved by extending the production period from four to nine months. These accomplishments resulted in local growers' later agreeing with IDIAP to support additional research on broccoli, peppers, cauliflower, and fresh tomatoes to permit their production year-round. Initial trials had produced promising yield increases for these latter crops by the time the project ended.

2. Pastures. Four improved grasses and ten legumes were selected, following the introduction of over 160 ecotypes and agronomic studies of adapted species using low inputs. A seed multiplication program was launched successfully, and enough basic seed was produced to project improved pastures for at least 30,000 hectares by 1992--enough for Panama to increase production to cover fully its export potential in U.S. markets. This was a truly collaborative effort, with vital inputs being made throughout by IDIAP, Rutgers, CIAT, the Faculty of Agronomy of the University of Panama, the National School of Agriculture and the National Bank, which greatly accelerated progress. In fact, Rutgers' technical assistance catalyzed collaboration in all areas reported here, focussing scarce resources on high priority production problems and helping overcome barriers to the integration of an effective national effort on applied research and technology transfer.

3. Livestock Nutrition. Most promising was the work underway on legume protein banks. It was shown that small (half hectare) banks of Kudzu and *Centrosema macrocarpam* could reduce calf mortality from 20 to 1-2 percent in small herds of 25 cows grazing 25 hectares of improved grass, or 65 to 70 hectares of native grasses. This produced savings of two calves and supported the production of two additional cows per herd. Valuing the calves at $180 each, and assuming that two cows produce 1,000 liters at $0.23 per liter, direct gains of almost $600 result--far in excess of the $175 required to establish the

protein bank for one herd. Though these data do not include the modest added costs of fencing and labor associated with establishing protein banks, they also do not include the positive effects of the banks on reproductive performance of the cows. Hence, these data probably underestimate the net gain of this promising new strategy. At the time the project ended, several farmers were adopting the practice, which is further evidence of its financial rewards.

A few protein bank experiments had been mounted before Rutgers faculty helped design the ones described here. However, they had not been successful. Rutgers faculty decreased the bank size from five hectares to a half hectare (more in keeping with the restricted resources of small dual purpose cattle producers), and introduced new legumes emerging from the pastures research.

4. Soils. The improved management of Panama's acid, infertile soils, which account for more than 60 percent of the country's agricultural land area, was a major challenge for Rutgers' technical assistance. The soils specialist was strategically placed in the Central Region, where most such soils are found, and was instrumental in the development of a National Program for the Management and Fertility of Acid Soils. He was also a main contributor to fertilizer recommendation tables for acid soils, which were based on data obtained from the National Soils Laboratory in Divisa.

One important strategy followed was the introduction of germplasm able to adapt and yield well in acid soils. Outstanding results were obtained with fast-growing trees. These, together with several crop species with competitive yields, like sorghum, soybeans and cassava, opened new opportunities for crop diversification in areas with limited economic alternatives. In addition, liming in combination with low fertilizer use was shown to be widely beneficial. For example, five tons of lime per hectare reduced by 50 percent the amount of fertilizer needed for good yields and fruit quality in pineapples. Net returns to farmers per hectare almost doubled. Similar results were obtained with several grain and forage crops.

One of Rutgers major accomplishments was to recruit two well-suited individuals from its regular faculty ranks to the position of Chief-of-Party--Dr. Mark L. Gaskell, an Assistant Professor in the Department of Soils and Crops, who served during the first half of the period of the University's contract, and Dr. Carlos A. Neyra, an Associate Professor in the Department of Biochemistry and Microbiology, who served during the second half. Dr. Gaskell laid down the tracks and largely set the course for Rutgers' technical assistance effort; Dr. Neyra helped expand and refine it, and then successfully brought it to conclusion.

Dr. Neyra was instrumental in accelerating the implementation of the overall USAID project, including especially its training component, and in helping IDIAP sharpen its definitions of research priorities, strategies, and evaluation methodologies. Five documents he authored alone, or spearheaded with local professionals and Rutgers faculty, provided the basis for significant improvement in the country's Agricultural Technology Management System, and in the effectiveness and productivity of its technology generation and transfer programs. He was formally commended by IDIAP's management for his contributions and support to the opening of the Institute's third regional research center in Chepo for the Eastern Provinces. His backstopping support from national headquarters also helped launch the project-financed national soils laboratory at Divisa, plus two other labs for livestock research and plant protection, and a new tissue culture facility at the University of Panama. He also effectively served as the hub of IDIAP's contacts with the international scientific and donor community and can take credit for attracting three projects to Panama through AID's Office of the Science Advisor (for a total of almost $350,000) and for opening doors for Panama to the International Tissue Culture Network.

I. INTRODUCTION

The Agricultural Technology Development Project started in Panama in September 1979. Originally designed for five years, it was extended to December 31, 1987. In addition to a US $9.0 million loan, US $2.7 million were provided for technical assistance by Rutgers, The State University of New Jersey. The loan funds supported staff expansion, short and long term training, the acquisition of equipment and materials, and the construction of offices and laboratory facilities for IDIAP, The Panamanian Institute of Agricultural Research, the project's principal beneficiary.

The project was to "establish a research capability that will help small operators increase their land and labor productivities, and ultimately their income and employment opportunities". This was to be achieved through the generation, adaptation and dissemination of agricultural production technologies, appropriate for the ecological, agronomical and socioeconomic conditions of Panamanian farmers. Activities were focussed at the outset on eight priority areas: six in Chiriqui Province and two in Veraguas Province. At least two more in the Western Region were added by IDIAP. Farming systems research methodologies were to be employed with cooperating small and medium sized enterprises

The technical assistance provided by Rutgers University to IDIAP had two objectives:

* to help develop the basic technical knowledge needed to improve the returns to production resources;

* to strengthen IDIAP's capacity to identify and solve problems affecting Panamanian agriculture.

To meet these objectives, Rutgers placed a faculty team in-country in mid-1982 to provide assistance with research, long-term and short-term training, and institutional development. In addition, there was an active program of faculty exchanges and consultancies. For example, during just the last two years of the project (1985-87), 25 Rutgers faculty engaged in short-term consulting and information gathering assignments. In the same time period, Mr. Ron Levin, Director of USAID/Panama, visited the Rutgers Campus with Ing. Ezequiel Espinoza, Director General of IDIAP; later, the new Director General of IDIAP, Dr. Carlos Moran, spent a week in New Brunswick. And, in response to formal invitations from USAID/Panama, the University of Panama, the Ministry of Agricultural Development (MIDA), and IDIAP, Rutgers President Bloustein and Vice President (Academic Affairs) Pallone toured Panama in November 1986, further strengthening the highly

productive relationships between IDIAP, the University of Panama, USAID/Panama, and Rutgers that prevailed throughout the project, and that contributed to its success.

Administration of the project was shared between IDIAP, Rutgers and USAID/Panama. IDIAP was represented by the Director General in all matters of project implementation, and was assisted by the Planning, Administration, Crops Research and Livestock Research Divisions of the Institute, and by Rutgers' Chief-of-Party. Participating Rutgers units were coordinated by the Director of the International Agricultural and Food Program (IAFP), who also acted as the University's Project Manager. The Chief-of-Party served as the liaison between the program in Panama and Rutgers, and as in-country coordinator of the University's technical assistance. USAID/Panama's involvement was led by its Project Officer (of which there were only two during the life of the project), supported by the Chief of the Agricultural Division and the Mission's Director.

By the conclusion of the project, IDIAP evidenced some very significant achievements:

* Broad national coverage and operational decentralization. Research was organized around three regional centers (Eastern, Central and Western). These facilitated priority selections of commodities and research planning of relevance to each agroecological region. They also permitted continuous contact with collaborating farmers, giving IDIAP national recognition and a capacity to develop technological packages tailored to most of Panama's production areas.

* An increased number of researchers. During the life of the project, IDIAP's research staff increased from 45 to 176. In addition, the aggressive training program funded through the project helped increase the proportion of scientists with MSc and PhD degrees to 30 percent of the total.

* Direct contact with a large number of farmers. By March 1986, IDIAP had completed 1655 on-farm field trials, or over 400 more than expected for the project. Most of these were in the Western and Central Region, as called for by the project paper.

* Development of improved technologies adapted to farmers' circumstances in project areas. Examples of these, supported directly by the Rutgers' team, include:

- Technologies to increase onion production during the rainy season, which doubled national production and halved the volume of imports.

- Improved pastures, including four grasses and ten forage legumes of excellent nutritional value. A related seed multiplication program has initiated commercial production of all these species. Their commercial use on 30,000 hectares is anticipated in five years--enough for Panama to increase beef production to cover fully its export potential in U.S. markets.

- Generation of innovative technological alternatives to improve livestock nutrition and management during the dry season. These include the use of supplementary feeding with mineral salts, treated agro-industrial subproducts, and silage.

- Implementation of a "Fertility Program for Acid Soils" based on soils analysis. New refined methods of analyses and recommended practices were made available for numerous crops.

II. RESEARCH ACCOMPLISHMENTS

A. Background

Productivity at the farm level of basic commodities is low in comparison to other Latin American countries. Cereal grain yields in Panama average only 1100 kg/ha compared to 2400, 2100, 2200, 2200, 1700 for Argentina, Colombia, Dominican Republic, Mexico and El Salvador, respectively. Experimental yields, on the other hand, often double farm yields.

Basic grains research and production is essentially aimed at domestic consumption. Low yields and high production costs of these commodities confer no competitive advantage on Panama. Nonetheless, basic grains research at IDIAP, on corn and rice in particular, have been historically the top priority, reflecting a research tradition and food self-sufficiency goals. Both corn and rice have had to be subsidized by the government to counterbalance their high production costs. Horticultural crops, on the other hand, have received much less attention, though significant research has been conducted on industrial tomatoes, highland potatoes, and onions.

Agricultural production of annual crops covers 240,000 hectares, of which about 200,000 are devoted to rice, corn and sorghum. Horticultural crops, on the other hand, occupy only 3,000 hectares, with tomatoes alone covering 1,700. Thus, vegetables are grown on a very limited scale as compared to the

cereal grains. Availability of new land for increased production of vegetables may be a future constraint. A re-focus of IDIAP's research priorities, and diversification of current land use with vegetable crops, was recently proposed with Rutgers' technical assistance (see "Strategic Plan for the ATD Project").

A large portion (over 60 percent) of the soils in Panama are acid and infertile, with problems of aluminum toxicity, phosphorus fixation, and essential mineral nutrient deficiencies. Poor quality soils, together with marked seasonal dry periods, represent the main challenges to achieving higher productivity. A program entitled "Fertility and Management of Acid Soils" was implemented as a component of Rutgers' technical assistance.

In the livestock sector, animal nutrition is a limiting factor for beef and milk production. Over 90 percent of the area available for grazing cattle is occupied by a grass of low nutritional quality and productivity (Hyparrhenia rufa). Efforts were dedicated to the introduction and evaluation of new forage species with potential for increasing livestock productivity. This program was substantially improved and accelerated with the incorporation of a tropical pastures specialist and a livestock management and nutrition specialist under Rutgers' technical assistance.

During the project period, use was made of laboratory, experiment station, and on-farm applied research. Knowledge and expertise available in-country, as well as outside, were employed; and the participation and formal collaboration of the University of Panama (in particular, the Faculty of Agriculture), producer cooperatives and independent farmers were actively sought. Important linkages were also developed with the Regional and International Agricultural Research Centers (CIAT, CIMMYT, CATIE, CIP, and ISNAR) and with backstopping faculty teams based at Cook College (Rutgers University).

The following sections highlight four research programs supported by Rutgers' technical assistance in the areas of agronomy/horticulture, fertility and management of acid soils, tropical pastures, and livestock nutrition and production.

B. Highlights of the Agronomy/Horticulture Program.

Technical assistance in this area concentrated on horticultural crops grown in the Chiriqui highlands in collaboration with IDIAP researchers and two producer cooperatives. Under the leadership of Dr. Mark Gaskell, it was first implemented in 1983 in the highland vegetable areas of Cerro Punta and Boquete, with emphasis on rainy season onion production. Beginning in 1986, it was expanded to include peppers, tomatoes, broccoli and cauliflower. Results of these efforts have been communicated in five technical papers and bulletins.

By 1986, the on-farm research program for rainy season onion production had produced technologies adopted by local producers which increased national onion production two-fold and reduced imports by 50 percent by enabling the extension of the harvest and sale period from four to nine months (Figure 1).

These successful results led to a "Memorandum of Understanding" between IDIAP, marketing cooperatives and vegetable producers for a sustained research effort, supported financially by local producers. The agreement included an expansion of the on-farm research program to broccoli, peppers, cauliflower and tomatoes. Work on the latter four vegetables was directed at their continuous production. Newly developed field greenhouse structures for intensive rainy season production of tomatoes and peppers resulted in substantial yield increases in initial trials. Likewise, work with cauliflower and broccoli helped identify superior, adapted varieties for year-round production.

One of the most promising technologies for rainy season onion production is the use of cost-effective postharvest onion driers. A satellite project was jointly conducted with the Department of Agricultural Engineering at Rutgers to design and implement a solar powered onion drier. One of the models produced was experimentally tested at the Cooperativa Horticola in Boquete (Chiriqui), and has a drying capacity of 5,000 pounds in four days. Work continues to improve the drying efficiency of this model.

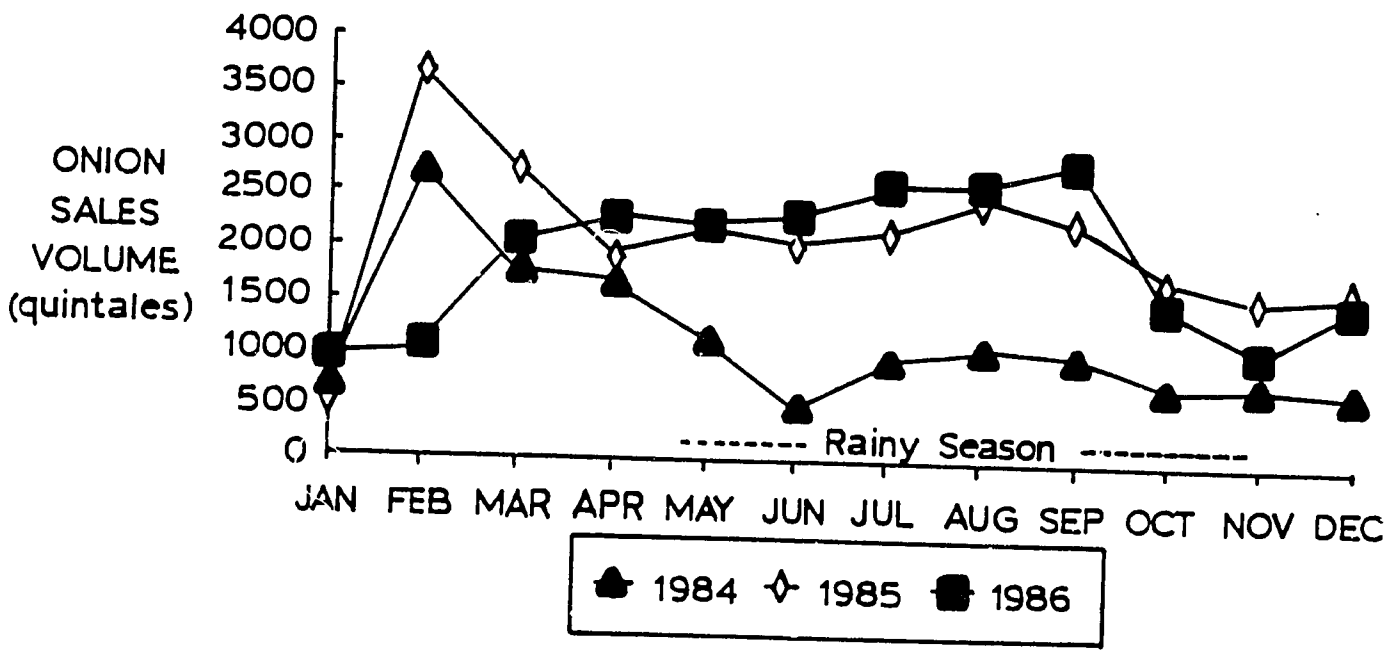
Onion curing is still not widely practiced by producers in the highlands, who have adopted the new rainy season technology. This is because of the high prices paid for onions in the rainy season, and little selection by the consumer. Thus, producers at present can sell all of the onions produced, and curing under these circumstances represents weight and profit loss. As the availability of dry, high-quality imported onions stabilizes in the market place, onion curing will likely become more important.

C. Highlights of the Program for Fertility and Management of Acid Soils

1. Germplasm Introduction and Testing

A collaborative program for the introduction of fast-growing trees was initiated with IDIAP, RENARE (Renewable Natural Resources Institute), and CATIE. *Acacia mangium*, *Eucaliptus camandulensis* and *Gmelina arborea* were found to be better adapted to acid soils and to produce more timber in less time than the control, a native forest species (*Genipa americana*). Two of these superior species (*Acacia* and *Eucaliptus*) have been selected for future use, and plantings of them have been expanded. Additional experiments, combining fast-growing trees with

Figure 1. **PANAMA:** MONTHLY ONION SALES VOLUME BY THE HORTICOLA MARKETING COOPERATIVE, BOQUETE, 1984-86.



pastures, are underway at the Calabacito Experiment Station in Veraguas Province.

Work with annual crops included grain legumes and sorghum. From 21 introductions, two promising varieties of pidgeon peas (Cajanus cajan) were identified in experimental trials conducted at the Calabacito Experiment Station. However, yields without soil amendments were disappointing (400 kg/ha). Another high protein grain legume with good agronomic potential for acid soils is the vigna bean (Vigna sinensis). Eighty varieties were tested, and three yielded very well (about 1,000 kg/ha). These results are highly promising since complete production packages have yet to be developed.

Also, 60 soybean varieties were tested at Calabacito for yield potential in acid soils. Eight yielded between 1,800 and 2,000 kg/ha. Though these results were obtained in experimental conditions, they compare well with yields elsewhere in the American tropics and indicate that a good potential exists for soybeans in the acid soils of Panama.

Cassava is known to adapt well to low fertility and acid soils, but farm yields can be greatly improved by designing appropriate technological packages and selecting high yielding genotypes. Current farm yields are in the range of 10 tons of fresh roots/ha. Experiments conducted in Calabacito and the Llanos de Ocu (an important cassava growing area) revealed that two genotypes, Brasilena and Dayana, could produce over 20 tons/ha of fresh roots without increasing significantly production costs.

Another crop with promise for use in acid soils is grain sorghum. Experiments conducted at Calabacito identified at least four superior genotypes with yields of over 3,000 kg/ha.

These results of intensive experimentation have opened significant new opportunities for crop diversification in acid soils.

2. Improvement of Soil Fertility

Liming helps improve the physiochemical characteristics of acid soils, increases phosphorous availability, and reduces aluminum toxicity.

The correction of soil acidity with 5.0 ton/ha of lime reduced by 50 percent or more the amount of fertilizers needed for good yields and fruit quality in pineapples. Net returns per hectare to farmers were almost doubled by this practice.

Two new rice varieties (Panama 1048 and Panama 1537) were released by IDIAP in 1986 for commercial production after five years of intensive selection. These two varieties respond

very well in acid soils to 30 kg P_2O_5/ha. Increases of 1.3 tons/ha of grain over the control were recorded.

One problem encountered commonly in Panama is the high cost of establishing improved pastures, in part because of low soil fertility. Modest applications of phosphorus and sulphur were shown to aid the establishment of forage legume protein banks of Kudzu (Pueraria phaseoloides) and Andropogon gayanus and Centrosema macrocarpum.

Rutgers faculty also assisted with the development of fertility leaflets, containing recommendations for the most important crops and pastures grown in acid soils with high acidity:

- Rice
- Sugar Cane
- Corn
- Tomatoes
- Peppers
- Onions
- Sorghum
- Coffee
- Diverse Pastures

D. Highlights of the Tropical Pastures Program.

1. Introduction

Objectives of the Tropical Pastures Program were contemplated in a cooperative agreement between IDIAP, Rutgers and CIAT (Colombia). Specific objectives were: (a) the introduction and selection of promising forage germoplasm to ecosystems of economic importance to the country; (b) agronomic studies of adapted species, using low inputs; (c) seed multiplication of promising species; and (d) establishment, evaluation and grazing management of selected species adapted to low fertility soils.

2. Introduction and Selection of Pasture Species

A total of 84 ecotypes of forage legumes and 87 grasses were evaluated in several sites of the country. The evaluation methodology used was similar to that of the Tropical Pastures Program of CIAT, known as the methodology for Regional Trials Type A (ERA). Species selected were mostly those with adaptation potential to acid soils with high aluminum saturation and low in interchangeable basis since about 64 percent of Panama's soils are acid, infertile, and inceptisol and ultisol types. Predominant ecosystems in sites where these evaluations were carried out include the tropical rainforest (Fht), the tropical humid forest-derived savanna (Fht-ds), the premontane rainforest (Phf), the tropical dry forest (Tdf), and the pluvial premontane

forest (PphF). All these ecosystems are present on the Pacific side of Panama, where agriculture and livestock are concentrated.

Results obtained from the most outstanding germplasm are summarized in Table 1. The grasses A. gayanus CIAT 621 and 6200, B. dictyoneura CIAT 6133, B. decumbens CIAT 606, B. humidicola CIAT 679 and 6369 were species and ecotypes with a wide range of adaptation to soil, climate, pests and diseases. In Volcan, at 1,100m above sea level and 20.7°C mean temperature, B. decumbens CIAT 606 outyielded other Brachiarias; in other sites, this ecotype showed high susceptibility to diseases and pests, such as spittle bug (Aenolamia spp.). Genera Centrosema, Pueraria and Stylosanthes were legumes with better adaptability; however, C. macrocarpum did not adapt to the Volcan ecosystem, perhaps because of the combined effects of high humidity and low temperatures. On the other hand, S. capitata CIAT 10280 adapted very well to sites of high acidity and rainfall of 2,500 mm or less, like Calabacito. Within this genera, S. guianensis CIAT 184 showed better adaptability, and it was highly tolerant to leaf blight (Colletotricum goesporoides). P. phaseoloides CIAT 9900 (Kudzu) also evidenced wide adaptability, but suffered severe defoliation during the dry season, marked deficiency of mineral nutrients, and poor nodulation in ecosystems such as Calabacito.

3. Agronomic Evaluation of Promising Germoplasm

Agronomic evaluations covered forage plants that showed good adaptation potential and productivity in preliminary trials. The evaluation methodology used was CIAT's agronomic evaluation methodology for Regional Trials Type B (ERB). Evaluations were conducted in Chepo (East Region), Rio Hato, Penonome, Divisa, Los Santos, Sona y Calabacito (Central Region), and Gualaca, Chiriqui and Hornito (West Region). The main results follow:

Andropogon gayanus CIAT 621

This species was introduced in 1979 and released commercially with the name of Veranero in 1983 by IDIAP/Rutgers/CIAT, the University of Panama's Faculty of Agriculture, and the Banco Nacional. Agronomic trials were conducted in Calabacito and Finca Chiriqui, ecosystems with high soil acidity and low nutrient content, mainly phosphorus (P). Table 2 shows responses of this species mixed with S. capitata CIAT 10280. Table 3 shows A. gayanus mixed with C. macrocarpum CIAT 5062.

Approximately 1,500 ha are presently using A. gayanus in Panama, mainly in the Central Provinces that combine both prolonged dry periods and/or soil acidity. The joint actions of IDIAP and the Banco Nacional have contributed enormously to the commercial use of this species.

Table 1. PANAMA: ADAPTATION OF NEW FORAGE GERMPLASM TO DIFFERENT ECOSYSTEMS, 1983-87.

GRASSES	Site of Trials					
	VOLCAN	CALABACITO	TORTI	LOS SANTOS	CHEPO	SONA
Andropogon gayanus CIAT 621	-	Excellent	Excellent	Excellent	Excellent	Excellent
Andropogon gayanus CIAT 6200	-	Excellent	-	Good	-	Excellent
Brachiaria dyctioneura CIAT 6133	Fair	Excellent	Good	Excellent	Excellent	Excellent
Brachiaria humidicola CIAT 679	Fair	Good	Good	Good	Good	Excellent
Bra iaria humidicola CIAT 6369	Fair	Good	-	-	Good	Excellent
Brachiaria decumbens CIAT 606	Good	Good	Good	Good	Good	Good
LEGUMES						
Arachis pintoi CIAT 17434	-	Fair	Good	-	-	Excellent
Centrosema macrocarpum CIAT 5434	Poor	Excellent	Excellent	Excellent	Excellent	Good
Centrosema macrocarpum CIAT 5062	Poor	Good	Good	Excellent	Excellent	-
Centrosema macrocarpum CIAT 5065	Poor	Good	-	Good	-	-
Centrosema acutifolium CIAT 5278	Poor	Good	Good	Good	-	Fair
Pueraria phaseoloides CIAT 9900	Poor	Good	Excellent	Good	Good	Excellent
Stylosanthes guianensis CIAT 184	Good	Excellent	Excellent	Excellent	Excellent	Excellent
Stylosanthes guianensis CIAT 136	-	Good	Good	Fair	-	Excellent
Stylosanthes capitata CIAT 10280	-	Excellent	-	Poor	Good	Good

Table 2. PANAMA: RESPONSE OF VERANERO AND S. CAPITATA SINGLE AND IN MIXED CROPPING TO P_2O_5 IN CALABACITO, 1986-87.

Amount of P_2O_5 (KG/HA)	Species		
	S. *Capitata*	A. *Gayanus*	A. *Gayanus* + S. *Capitata*
		KG MS/HA*	
0	1052.3 a**	2841.0 a	1751.7 a***
15	1364.0 a	2969.0 a	2500.7 a
30	1294.0 a	3092.6 a	2605.3 a
60	1743.0 a	3343.3 a	3132.0 a

* Mean of three cuts during the rainy season

** Means followed by the same letter are not significant ($P<0.05$) (LSD)

*** Mean content of S. *capitata* was 11.1% (Range 7.2 - 15.8%)

Table 3. PANAMA: EFFECT OF SULPHUR (S), PHOSPHORUS (P) AND POTASSIUM (K) ON YIELDS OF THE ASSOCIATION C. MACROCARPUM CIAT 5062 AND A. GAYANUS CIAT 621 IN AN ULTISOL IN CHIRIQUI, 1986-87.

Nutrients (kg/ha)			Yield DM (kg/ha)		
S	P	K	A. gayanus	C. macrocarpum	Total
0	0	0	1882 c	253 e*	2135 c
0	0	60	2660 bc	332 cd	2992 bc
0	100	0	1958 c	435 cd	2393 c
0	100	60	2489 bc	283 de	2772 bc
40	0	0	3835 a	462 bc	4297 a
40	0	60	4023 a	620 a	4643 a
40	100	0	3403 ab	506 abc	3909 ab
40	100	60	3840 a	681 a	4521 a

* Mean values followed by the same letter are not significant ($P<0.05$). Harvested 96 days after planting.

Brachiaria ecotypes

This genus has a great variety of species adapted to the soil and climate conditions of Panama. A total of 21 ecotypes were initially evaluated in Gualaca and Finca Chiriqui (Table 4).

The B. humidicola and B. dictyoneura ecotypes showed higher yields in both sites despite high spittle bug populations. On the other hand, the B. decumbens, B. brizantha, B. eminii and B. ruziziensis ecotypes significantly reduced yield in Finca Chiriqui, where recurrent spittle bug infestations occur every year. B. decumbens CIAT 606, that corresponds to the commercial variety presently used in Panama, yielded adequately in Gualaca, but reduced significantly productivity in Finca Chiriqui, despite a low spittle bug incidence. This indicates that there is no relation between the nymph population and the level of damage in this Brachiaria, and that tolerance mechanisms are independent of the number of nymphs present in the plant. A combined analysis of this information showed highly significant effects of site and ecotype, but the interaction site x ecotype effects were not significant. This verifies the good adaptation of this germplasm to highly contrasted sites.

These observations, complemented by records on drought tolerance and leaf/stem relations, led to the selection of three highly promising ecotypes of Brachiaria: B. dictyoneura CIAT 6233, B. humidicola CIAT 6369, and CIAT 6707. Table 5 shows results of these Brachiarias with applications of nitrogen (N), phosphorus (P) and sulphur (S) in Gualaca and Finca Chiriqui. There is adequate biomass production without fertilizer, which verifies the good adaptation of these species. Only fertilization with 150 kg N/ha, 90 of P and 60 of S increased substantially yields of B. humidicola CIAT 6707 and B. dictyoneura CIAT 6133 (respectively) in Finca Chiriqui and Gualaca.

Leucaena ecotypes

The evaluation of 16 Leucaena ecotypes was carried out in collaboration with the Faculty of Agriculture (University of Panama) and the Instituto Nacional de Agricultura (INA), located in Divisa. The germplasm evaluated involved six ecotypes and two hybrids of L. leucocephala, two hybrids of L. pulverulenta, and one of L. shannoni. Final results are presented in Table 6 for edible dry matter yield--stems less than 5 mm diameter, mimosine content and regrowth height every eight weeks. Higher yield, during the rainy and dry seasons, was produced by L. leucocephala CIAT 17467, a CIAT introduction collected in Peru. Equally outstanding were the hybrids L. pulverulenta CIAT 17490 and Leucaena sp. CIAT 17478. In general there was variability between and within species; the commercial variety Cunningham (L. leucocephala CIAT 17502) had intermediate yield values and high

Table 4. PANAMA: DRY MATTER YIELD AND SPITTLE BUG INCIDENCE ON BRACHIARIA ECOTYPES PLANTED IN GUALACA AND FINCA CHIRIQUI*, 1986-87.

		Yield kg DM/ha		
Ecotypes	N° CIAT	Gualaca	Finca Chiriqui	Nymphs/m^2 Fca. Chiriqui
B. humidicola	675	2722.9 a	1695.0 a	92.4 ab
B. humidicola	679	2665.1 ab	1299.5 ab	92.4 ab
B. humidicola	6707	2258.3 abc	1622.2 ab	80.9 ab
B. humidicola	6709	2340.8 abcd	1225.3 b	31.9 ab
B. decumbens	606	2310.1 abcd	627.5 c	24.5 ab
B. humidicola	682	2264.0 abcd	1550.0 ab	85.4 ab
B. humidicola	6369	2234.3 abcd	661.5 c	67.0 ab
B. humidicola	6705	2189.5 abcd	1567.1 ab	99.1 a
B. dictyoneura	6133	2171.5 abcd	1211.6 b	86.5 ab
B. brizantha	6298	1909.0 abcd	331.3 cd	58.2 ab
B. ruziziensis	6130	1780.8 abcd	431.1 cd	14.4 b
B. ruziziensis	6134	1751.4 abcd	264.8 cd	16.1 b
B. eminii	6241	1731.3 abcd	54.2 d	51.0 ab
B. brizantha	6012	1681.9 abcd	672.9 c	31.0 ab
B. ruziziensis	6291	1667.4 abcd	424.8 cd	31.2 ab
B. ruziziensis	6419	1581.5 abcd	297.7 cd	58.1 ab
B. ruziziensis	654	1526.1 abcd	467.7 cd	35.2 ab
B. brizantha	6009	1515.2 abcd	253.2 cd	31.9 ab
B. brizantha	664	1473.4 bcd	362.6 cd	34.7 ab
B. decumbens	6132	1337.7 cd	496.5 cd	37.2 ab
B. decumbens	6131	1255.3 d	531.4 c	17.1 b

Means followed by the same letter are not statistically significant.

($P<0.05$) (Duncan's Multiple Range Test) Means are for seven or eight successive cuttings.

Table 5. **PANAMA:** FIELD RESPONSE OF THREE BRACHIARIA ECOTYPES TO NITROGEN (N), PHOSPHORUS (P) AND SULPHUR (S) IN GUALACA AND FINCA CHIRIQUI, 1986-87.

Treatments			Yield kg DM/ha		
N	P	S	B. humidicola 6369	B. humidicola 6707	B. dictyoneura 6133
(Kg/ha)			(Gualaca)*	(Finca Chiriqui)	(Gualaca)
0	0	0	2286	2083	3668
50	0	0	2428	2050	3415
0	30	0	2423	2406	4053
50	30	0	2053	2205	3664
0	0	20	2058	2270	3447
50	0	20	2107	2597	3490
0	30	20	1777	2701	4280
50	30	20	2175	3003	3808
25	15	10	2270	2997	4053
75	15	10	2308	2145	3497
25	45	10	2383	2890	4069
25	15	30	2242	2533	3890
150	90	60	2433	3022	4216

* Mean of nine cuts every five weeks during the rainy season; others are means of three cuts.

Table 6. PANAMA: MEAN EDIBLE DRY MATTER YIELD (EDM) AND MIMOSINE CONTENT OF LEUCAENA ECOTYPES ESTABLISHED IN DIVISA, 1986-87.

Species	No CIAT	Yield * kg EDM/ha	Mimosine Percent **	Mean Regrowth During the Rainy Season (cm)
L. leucocephala	17467	3577.0 a	4.1	46
L. pulverulenta (Hib)	17490	2859.1 ab	3.7	63
Leucaena sp. (Hib)	17478	2757.6 ab	3.0	89
L. leucocephala (K132)	17488	2464.5 ab	4.6	81
L. pulverulenta (Hib)	17489	2405.5 bc	3.9	51
L. diversifolia	17503	2397.4 bc	3.2	55
L. leucocephala (unn)	17502	2219.7 bc	4.3	56
L. shannoni	17487	2153.9 bc	4.1	57
L. diversifolia	17461	2050.0 bc	3.5	43
L. leucocephala (K29)	17498	2028.8 bc	4.0	59
L. leucocephala (Hib)	17475	2007.0 bc	3.5	43
L. leucocephala (Hib)	17477	1975.5 bc	3.1	57
L. leucocephala	17495	1895.5 bc	4.8	50
L. diversifolia	17388	1813.9 bc	4.2	61
L. leucocephala	17491	1759.4 bc	3.6	53
L. diversifolia	17485	1516.1 bc	3.8	75

* Mean of 12 cuts every eight weeks (six during the dry season and six during rainy season)

Means followed by the same letter are not significant at P=0.05.

** Dry base

mimosine content. L. diversifolia tended to show low yields, but the opposite occurred with L. pulverulenta; these had mimosine content below 4.0 percent. There was no consistent relation between yield and height of regrowth, since this observation did not take into account lateral branching of these species.

4. Seed Multiplication

Seed multiplication was a main activity of IDIAP/Rutgers/CIAT. Table 7 summarizes results obtained with promising germplasm, or commercially available species like A. gayanus CIAT 621. A total of 3,868 kg of basic seed was produced of this species in different sites.

C. macrocarpum was selected as a promising legume for several Panamanian ecosystems. Seed yields were highly variable. In Gualaca the ecotypes CIAT 5062 and 5434 had high yields during 1986 due to favorable climatic conditions that stimulated flowering and abundant seed set; this did not happen in Calabacito, which explains the low yields obtained there.

B. dictyoneura CIAT 6133 is, perhaps, the most promising grass within the new selections. It flowers and sets seeds better than other Brachiarias. However, the seed has a strong latency, and germination is low during the first six months following harvest.

The seed harvested was destined for experimental plots, new seed multiplication plots, and for sale to farmers (in the case of Veranero). Seed of S. capitata, Capica, C. macrocarpum and B. dictyoneura is being also used for demonstration plots in cattle ranches of the Central Provinces.

5. Weed Control

Weed control is a component of pasture establishment and management. Activities in weed control were oriented to two basic objectives: brush control and the control of other weeds in established pastures such as Cabezona (Paspalum virgatum) and Black fern (Pteridium aquilinum), and also weed control during the establishment of forage legumes.

6. Pasture Evaluation

Two experiments with promising, newly selected germplasm were established in Chiriqui (Faculty of Agriculture) and Calabacito during the period of the technical assistance. The first measured pasture persistance under grazing of the association B. humidicola-Kudzu, and the grasses Faragua and Veranero associated with C. macrocarpum CIAT 5065 and S. capitata CIAT 10280. A rotation system was employed involving seven days grazing and 35 days rest, with three animal stocking rates: 1.25, 2.0 and 2.5 UA/ha. The second experiment was to measure

Table 7. PANAMA: YIELDS AND BASIC SEED PRODUCTION OF TROPICAL FORAGES, 1984-86.

Species	Site of Harvest	Mean Annual Yields of Crude Seed (Kg/ha) 1984	1985	1986
A. gayanus CIAT 621 (Veranero)	Gualaca	431 (862)+	192 (384)	-
	Finca Chiriqui	-	190 (247)	-
	Rio Hato	-	-	250 (250)
	Sona	-	355 (355)	170 (424)
	Chumpaito	-	-	182 (546)
	Calabacito	-	210 (350)	180 (450)
P. phaseoloides (Kudzu)	Gualaca	22 (22)	11 (11)	-
	Calabacito	-	-	40 (40)
C. macrocarpum CIAT 5065	Gualaca	-	25 (10)	60 (24)
C. macrocarpum CIAT 5062	Gualaca	-	-	457 (15)
	Calabacito	-	-	50 (50)
C. macrocarpum CIAT 5434	Gualaca	-	-	521 (7)
	Calabacito	-	-	15 (15)
C. macrocarpum CIAT 5278	Calabacito	-	-	30 (30)
C. brasilianum CIAT 5234	Calabacito	-	-	25 (25)
C. guianensis CIAT 136	Gualaca	45 (7)	-	-
S. capitata 'Capica'	Gualaca	589 (194)	-	-
	Calabacito	-	50 (150)	70 (180)
B. humidicola 'Comercial'	Finca Chiriqui	75 (375)	-	75 (150)
	Calabacito	-	-	100 (100)
B. dictyoneura CIAT 6133	Gualaca	-	-	221 (36)
	Calabacito	-	-	175 (175)

+ In brackets are total kilograms harvested

animal beef production of the grass-legume mixtures B. dictyoneura and B. humidicola with Kudzu, Veranero and Faragua with S. capitata CIAT 10280, and Veranero with C. macrocarpum CIAT 5062 in an alternate grazing system of 28/28 days of grazing/rest. Difficulties arose in the establishment and management of these experiments.

Observations showed good persistance of S. capitata CIAT 10280, particularly associated with Faragua, which is less aggressive than Veranero, in conditions of high soil acidity. The C. macrocarpum CIAT 5065 and 5062 were less persistent after several grazing periods and more susceptible to prolonged dry conditions. Tropical Kudzu persisted in Chiriqui, but practically disappeared in Calabacito. Lack of plant vigor and susceptibility to animal trampling contributed to low persistance. However, in another grazing trial in Gualaca this species showed agressiveness and good persistance, even overgrowing the associated grasses. This site has better soils and more evenly distributed rainfall.

7. Germplasm Collection

A native legume collection trip was organized in 1985 that covered 2,179 Km in the Provinces of Chiriqui, Veraguas, Herrera, Los Santos, Cocle and Panama. A total of 331 native samples of 20 different genera were collected. In decreasing order the number of samples collected of each genus was as follows: Centrosema 66, including 15 samples of C. macrocarpum and one of C. brasilianum (reported for the first time in Panama); Desmodium 54; Calopogonium 32; Aeschynamene 27; Stylosanthes 27; Rhyncosia 24; Teramus 18; Vigna/Macroptilium 18; Galactia 16; Canavalia 11; Dioclea 9; Zornia 8; Mucuna 6; Alysicarpus 4 and 11 of other genera (Desmanthus, Clitoria, Prosopis, Tephrosia, Crotalaria and Flemingia). The germplasm was made available to IDIAP and CIAT, and evaluations are underway.

E. Livestock Nutrition Program

1. Problem Statement

Livestock production in Panama is largely dependent on the quantity and quality of grassland resources. Environmental factors affecting the feed supply are most influential. Yearly rainfall distribution and soil characteristics determine a marked seasonal availability of feed and impose a limitation on the nutritive value and carrying capacity of native pastures. Also, these same factors reduce the possibilities of using more productive germplasm. Agroindustrial by-products and non-traditional feedstuffs available during the critical periods of the year represent alternative feed sources not fully researched nor extensively adopted in Panama.

A major effort of the Livestock Nutrition Program was the implementation of a strategy aimed at the improvement of cattle nutrition through the more efficient use of available resources and the generation of technology with four characteristics: ease of use, minimal use of machinery, low costs, and compatibility with existing livestock production systems. This strategy incorporated a strong on-farm research component.

The program focussed primarily on two specific goals:

* The identification of cost-effective practices to reduce nutrient constraints of cattle during the dry season.

* The validation of year-round nutrition practices that could increase animal productivity.

The following two activities were conducted in support of the first goal.

2. Improving the nutritive value of low quality forages.

A practical alternative to improve the nutritive value of locally available low-quality forages was developed experimentally and implemented with four producers. The technique is based on the application of a urea solution to low-quality forages under airtight conditions. Table 8 shows some of the feedstuffs treated and the extent of nutritional improvement. This work was conducted with the National Agricultural Institute (INA) through its General Director, Dr. Santiago Rios, assisted by Ing. A. Calderon. Collaborating IDIAP technical staff included Dr. M. Jaen, Ing. L. Tason, Ing. E. Arosemena and E. Vargas. The reactions of producers to this alternative technology were very positive.

3. Conservation of green forages and non-traditional feedstuffs, using non-conventional technology.

This program included two alternative technologies. One has already been implemented, and the second is under development. Both alternatives reduce constraints identified at the farm level for the conservation of forages through ensiling efforts. The first is based on the fact that an ammonia environment prevents moulding of forage. The application of a urea solution under airtight conditions to green forage produced satisfactory results in the conservation of whole cassava, King Grass, and sugar cane. The second approach reduces or eliminates the producer's dependence on specialized equipment (tractor, chopper, silos), traditionally needed to obtain conditions of anaerobiosis for fermentation. This has been implemented through the application of vacuum to a stack of whole plants covered with

Table 8. PANAMA: IMPROVEMENT IN TOTAL NITROGEN CONTENT (TN) OF LOW QUALITY FEEDSTUFFS AFTER TREATMENT WITH A UREA SOLUTION, 1986-87.

	Treatment*	
Materials	Controls	Urea
	-------Percent TN-------	
Corn Stover	.37	1.06
Rice Straw	.77	1.63
Sugar Cane Tops	.83	1.89
HAYS:		
Pangola (Digitaria decumbens)	.66	2.42
Brachiaria (B. humidicola)	.46	2.18
Faragua (Hyparrhenia rufa)	.22	1.65

* Fresh material treated with a 5% urea solution (urea:water 1:3).

a plastic sheet. Significant progress was achieved at the Calabacito Experiment Station, where Ing. E. Arosemena and M. Flores collaborated. The recent withdrawal of Government support for agricultural machinery services to producers has accelerated interest in this technology.

The following six activities were conducted in support of the second goal:

4. Practical evaluation of pasture germplasm through animal performance.

Two legume protein banks (Kudzu, Pueraria phaseoloides and Centrosema macrocarpum) were evaluated. The Kudzu protein bank was used as a strategic supplement to early lactating cows, and in the rearing of suckling calves, both in dual purpose cattle systems. Results are illustrated in Table 9; additional results are contained in previous quarterly reports. These activities took place at the Calabacito Experiment station, with technical support from Ing. E. Arosemena and Dr. J. L. Alba of IDIAP. The establishment and evaluation of a protein bank of Centrosema macrocarpum was conducted on a dual purpose farm near Ocu, in collaboration with Dr. Pedro Argel, Dr. J.L. Alba, and Ing. L. Tason from IDIAP.

These banks reduced calf mortality from 20 to 1-2 percent in small herds of 25 cows grazing 25 hectares of improved grass, or 65 to 70 hectares of native grasses. This produced savings of two calves and supported the production of two additional cows per herd. Valuing the calves at $180 each, and assuming that two cows produce 1,000 liters at $0.23 per liter, direct gains of almost $600 result--far in excess of the $175 required to establish the protein bank for one herd. Though these data do not include the modest added costs of fencing and labor associated with establishing protein banks, they also do not include the positive effects of the banks on reproductive performance of the cows. Hence, these data probably underestimate the net gain of this promising new strategy. At the time the project ended, several farmers were adopting the practice, which is further evidence of its financial rewards.

A few protein bank experiments had been mounted before Rutgers faculty helped design the ones described here. However, they had not been successful. Rutgers faculty decreased the bank size from five hectares to a half hectare (more in keeping with the restricted resources of small dual purpose cattle producers), and introduced new legumes emerging from the pastures research.

5. Effects of protein supplementation on milk production.

Two on-farm trials, one at Ocu and the other at Ponuga, were conducted to study the production response to fish meal

Table 9. PANAMA: EFFECTS OF A PROTEIN BANK (KUDZU, *PUERARIA PHASEOLOIDES*) ON ANIMAL PERFORMANCE IN A DUAL-PURPOSE CATTLE SYSTEM, 1986-87.*

Treatments[1/]	Marketable Milk (kg/cow/day)	Average daily gain (grams): Cows	Calves
Control	3.6	508	214
Cassava plus molasses/urea	4.4	606	188
Kudzu	4.5	506	464

1/ Treatment: Control= No supplement. 24 ha grazing of B. *humidicola*. Cassava+molasses/urea= Same control plus 1.5 kg/cow/day. Kudzu= 0.5 ha grazing of kudzu plus B. *humidicola*.

* Total number of cows included in this experiment were 27 (nine groups per treatment).

supplementation. Dr. J.L. Alba from IDIAP collaborated in this work. Both farms contrast markedly in terms of their technology and productivity. Depending on the stage of lactation and season, a net profit of from 2.0 to 14.0 cents per cow per day above the cost of the fish meal supplement was obtained. Both producers fully adopted fish meal as a supplement for their cows, following these trials, and the spread of this technology to other producers is anticipated.

6. Improving the mineral status of grazing cattle.

Farming systems characterization studies performed previously by IDIAP indicated severe mineral deficiencies in cattle. As a result, three limiting factors were addressed at the farm level: lack of knowledge about the mineral composition of commercial mixtures, lack of technical advice, and losses of minerals in the field due to improper mechanisms used to supply available mixtures. With the collaboration of Dr. L.R. McDowell from the University of Florida and Dr. M. Jaen from IDIAP, it was possible to provide Panamanian cattlemen with practical recommendations on mineral mixture formulations, based on laboratory analyses of commonly available sources, using an innovative mineral box. A model is depicted in Figure 2. Eight of these mineral boxes are now in use, and validation trials are underway with an equal number of producers in five different provinces of Panama.

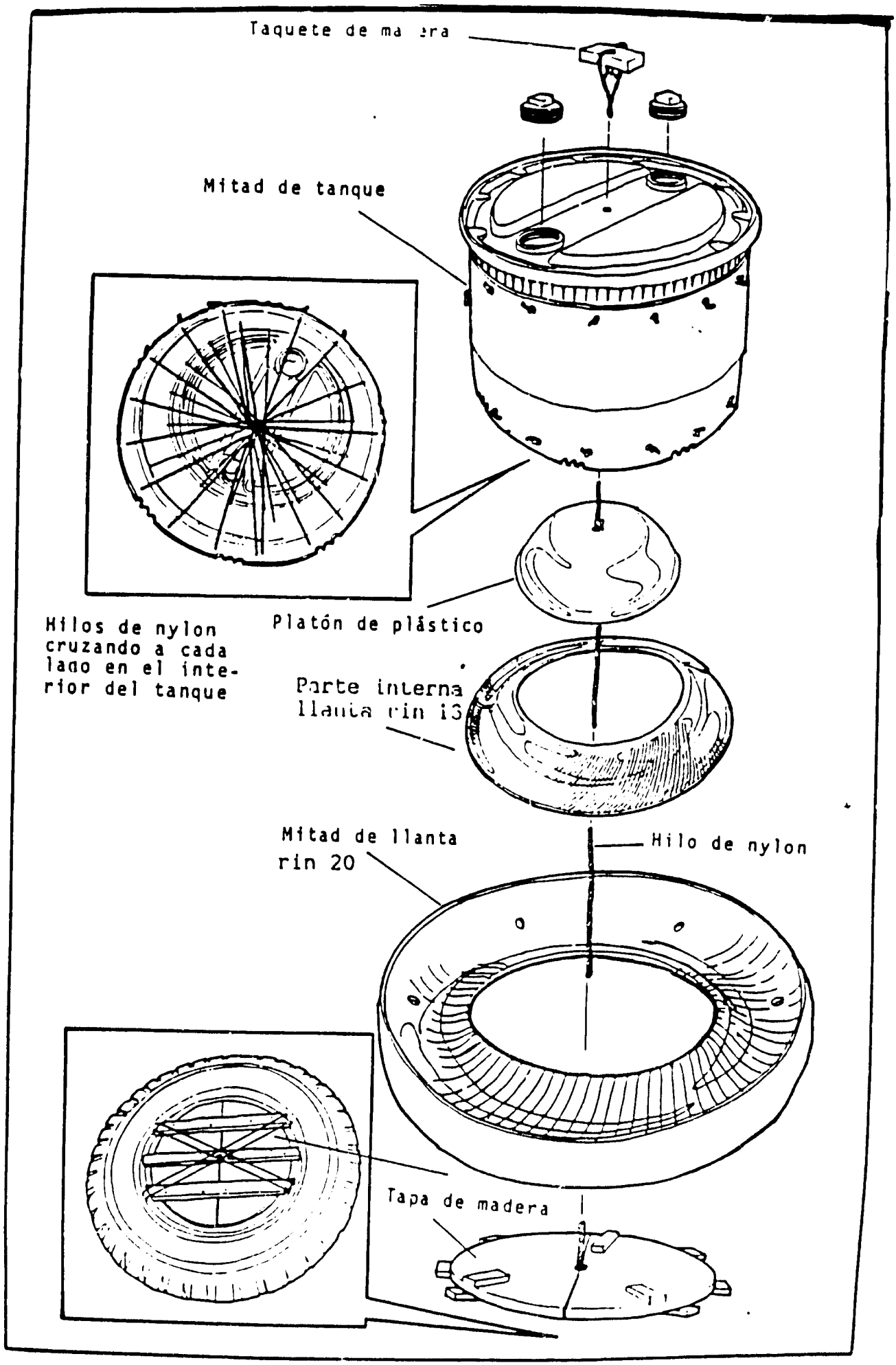
7. Implementation of non-conventional grazing systems.

Based on observations of grazing behavior of cattle and traditional grazing practices developed elsewhere in the Latin American Tropics, a controlled rotational grazing strategy was implemented in one commercial beef herd, "Finca Los Negros," in Colon Province. Animals were confined every morning to a small paddock during the hottest hours of the day, and allowed evening grazing of adjacent areas, during a two month period (October-December 1986). Animal productivity showed an average daily gain of 1.1 lb/head under the new grazing scheme, as compared to .87 lb/head under the traditional practice. By the end of the second month of grazing, it was possible to save one entire paddock.

8. Identification of reproductive-ecological-managerial interrelationships.

By following for five years the reproductive performance of a commercial beef herd in Cocle Province, it was possible to identify the effects of the traditional movement of cattle from the lowlands to the highlands during the summer months (dry season), and their return to the lowlands at the beginning of the rainy season, on reproductive activity. Better reproductive performance was found during the dry season (grazing of highlands) than during the wet season (grazing of lowlands).

Figure 2. IDIAP: DISENO PARA LA CONSTRUCCION DE UN SALERO PARA GANADO.



It was concluded that, under traditional herd management practices, supplementary feeding is more important for the wet than the dry season. Modifications in the breeding scheme of this herd have now been introduced, and Dr. M. Jaen of IDIAP is monitoring their results.

9. Bio-economic comparisons of a dual purpose farm and a dairy farm in the central provinces of Panama.

Data on animal performance and cash flows on two farms were obtained for a period of one year. One farm operated as a typical dual purpose farm, milking once a day with the calf, and the second practiced two milkings, without the stimulus of the calf. The dominant pasture at the dual purpose farm was Faragua (Hyparrhenia rufa), while the dairy farm used Tanner Grass (Brachiaria radicans). Supplementation was practiced in both farms. The dual purpose farm used molasses-urea at the time of milking, plus free access to a mineralized salt, and the specialized farm offered freely a concentrate based on rice polishing and bran, molasses, fish meal and minerals during milking. Both herds were composed of an undefined mixture of cebu x european, similar in phenotype.

Preliminary results showed pronounced differences in animal performance (Tables 10 and 11). Nevertheless, both systems seemed financially viable, though the dairy system showed a better cash flow. However, a much higher investment is needed to maintain that system, and it requires more sophisticated management practices.

III. HUMAN RESOURCES DEVELOPMENT

Long-term and short-term training was implemented under the project to help strengthen IDIAP's capability to identify and solve problems affecting Panamanian agriculture.

The long-term program increased the absolute number (and proportion) of researchers holding MSc and PhD degrees (Tables 12, 13, and 14). The proportion of researchers with postgraduate degrees was calculated at 17 percent in 1980 and at 27 percent in 1985. By the end of the project (December 1987) the proportion rose further to 30 percent. Most of the fellowship awardees earned MSc degrees. Additional training should augment the number of PhDs in IDIAP.

The in-country Rutgers team contributed significantly to the success of the long-term training program. It provided advice in the design of the overall training program and helped establish an internal institutional training committee to speed the process of graduate scholarship candidate selection within IDIAP. It also helped obtain admission for selected candidates in U.S. universities. In addition, the training committee was charged with the preparation of a training manual containing rules and

Table 10. PANAMA: COMPARISON OF ANIMAL PERFORMANCE BETWEEN A DUAL PURPOSE FARM AND A SPECIALIZED DAIRY FARM IN THE CENTRAL PROVINCES, 1986-87.

Parameter	Production system: Specialized	Dual Purpose
Farm size, hectares	137	61
Herd size:		
Cows, one or more calvings	90	32
Milking cows (yearly range)	60-70	10-20
Daily milk production, liters:		
Milking cow	9.8	2.9
Cows in herd	7.4	1.5
Hectare	4.3	0.8
Annual milk production liters/hectare	1574	285
Milking efficiency (*)	75.5	52.1

(*) Milking efficiency: total number of milking cows per year divided by total number of cows in the herd per year.

Table 11. PANAMA: ECONOMIC COMPARISONS BETWEEN A DUAL PURPOSE FARM AND SPECIALIZED DAIRY FARM IN THE CENTRAL PROVINCES, 1987.

Variable	Production system: Dairy	Dual Purpose
Investment (Balboas = US Dollars)		
Fixed	268,700	81,465
Operating (annual)	74,400	6,832
Indirect annual cost (1)	31,300	1,198
Total	374,400	89,045
Annual income (Balboas = US Dollars)		
Culling	42,000	3,810
Milk	62,000	4,000
Gross	104,000	7,810
Net (2)	29,600	1,428
Capital annual return (percent)		
Fixed	11.0	2.13
Operating plus indirect	28.0	10.6
Estimated cost of production, cts/lt		
Over operating capital	16.55	14.8
Over operating plus indirect capital	32.55	55.5
Net daily income/annual animal productive unit (Balboas)		
Cows in the herd	1.01	0.12
Milking cows	1.34	0.23
Total annual expense/hectare (Balboas) (3)	766	124
Minimum economic milk production/hectare, lts (4)	2,394	540
Annual operating expense/hectare, (Balboas) (5)	543	105
Marginal economic milk production/ hectare, lts (6)	1,697	455

(1) Indirect annual cost = fixed and operating capital opportunity cost, using a 10 percent annual interest.
(2) Net income = gross income - operating costs.
(3) Annual total expense/hectare = operating plus indirect costs/hectare.
(4) Minimal economic milk production/hectare = annual total expnese/hectare divided by price of a liter of milk.
(5) Annual operating expense/hectare = operating expenses divided by area.
(6) Marginal economic milk production = annual operating expense/hectarea divided by price of a liter of milk.

Table 12. IDIAP: DISTRIBUTION OF PROFESSIONAL STAFF BY LEVEL OF TRAINING, 1980 AND 1985.

Level	1980	1985
MSc/PhD	15	47
Agricultural Engineers (BSc equivalent)	24	68
Agronomists (no BSc)	33	45
Economists	4	6
Veterinarians	2	4
Others	8	6
Total	86	176

Table 13. IDIAP: ATD PROJECT FELLOWS GRADUATE AND WORKING CURRENTLY IN PANAMA, 1980-85.

Name/Field	Degree	University Attended	Graduation Year
1. Alejandro Delgado Rural Development	MS	Inst. Tecnologico, Mexico	1982
2. Jorge Jonas Soils	PhD	Univ. Phillipines	1982
3. Pedro Him Crop Genetics	MS	Sao Paulo, Brazil	1981
4. Domiciano Herrera Animal Nutrition	MS	Chapingo, Mexico	1984
5. Roman Gordon Entomology	MS	Puerto Rico	1984
6. Marcos Navarro Weed Science	MS	Louisiana State	1984
7. Susana Pons Physiology/Tissue Culture	MS	Cornell	1984
8. Manuel H. Ruiloba Animal Nutrition	PhD	Florida	1984
9. Medardo Peralta Aquaculture	MS	Alabama	1984
10. Edilberto DeLeon Biometrics	MS	U. Antonio Navarro Mexico	1984
11. Beyra Jaen Sociology	MS	Missouri	1985
12. Lineth de Lamboglia Horticulture	MS	Rutgers	1985
13. Hermel Lopez Agricultural Econ.	MS	Rutgers	1985
14. Arnold Munoz Agricultural Econ.	MS	Rutgers	1985
15. Alfonso Singh Soils	MS	Rutgers	1985
16. Jose A. Yau Agronomy/Seed Production	MS	Mississippi	1985
17. Lourdes Charles Irrigation	MS	California/Davis	1985
18. Said Caballero Microbiology	MS	Mexico	1985
19. Elizabeth de Ruiloba Communications/ Education	PhD	Florida	1985
20. Tomas Vasquez Silviculture	MS	Idaho	1985
21. Miguel Avila	MS	Texas A&M	Incomplete

Table 14. IDIAP: ATD PROJECT FELLOWS COMPLETING DEGREE REQUIREMENTS, 1987.

Name/Field	Degree	University Attended	Graduation Year
1. Pedro Guerra Animal Genetics	MS	Nebraska	1986
2. Eric Candanedo Lay Nematology	PhD	North Carolina	1986
3. Manual De Gracia Animal Nutrition	PhD	Nebraska	1986
4. Roberto Quiroz Animal Nutrition	PhD	North Carolina	1986
5. Eulices Ramos Business Administration	MS	Mexico	1986
6. Miguel Sarmiento Agricultural Economics	MS	Missouri	1986
7. Kilmer Von Chong Plant Pathology	PhD	North Carolina	1987
8. Renato Barrera Animal Production	MS	Puerto Rico	1987
9. Raul Gonzalez Fruit Production	MS	Puerto Rico	1987
10. Julio Lara Plant Pathology	MS	Puerto Rico	1987

procedures. All 30 candidates trained under the project were reviewed and processed by this committee. Second, the Rutgers team provided advice throughout the implementation of the training program. Finally, the team helped prepare an account of the training plan, and its progress, as requested by USAID/Panama. Training plans were prepared under the leadership of the Rutgers' Chief-of-Party and approved by both IDIAP and USAID/Panama.

The project paper specified a total of 35 trainees by area of specialization. Priority areas were as follows: general agronomy, nine; livestock/animal sciences, nine; plant protection, five; and social sciences, eight. Until 1985, 28 trainees were placed in several institutions (20 in U.S. universities); three additional fellows initiated their training in 1986. The success rate (completed degrees/number of fellowships) was 90 percent, which is an indication of the seriousness of IDIAP's commitment to human resources development.

Short-term training was implemented throughout the life of the project to help IDIAP staff become familiar with technical knowledge relevant to research in Panama. This type of training took place both in-country and at the Regional and the International Agricultural Research Centers. It involved short courses, seminars, workshops and exchange visits. These efforts were importantly supported by the Rutgers' in-country team through in-service training (Table 15).

IV. RESEARCH ADMINISTRATION AND MANAGEMENT

Rutgers provided from February 1985 to September 1987 the services of an Agricultural Research Administration and Management Specialist in Panama to help improve the overall management and administrative capacity of IDIAP. This specialist also acted as the Chief-of-Party during his tenure.

An integrated effort between IDIAP and Rutgers was set in motion to redefine and sharpen the focus of agricultural research in Panama, and it resulted in the production of the following documents:

* "Objectives, Projections and Strategies of Agricultural Research for the next five years (1986 -1990)"

* IDIAP: Training Program (1980 - 1987)

* ATD PROJECT EVALUATION: A working document

* EXPANSION AND REORIENTATION OF THE ATD PROJECT:

  a. A Concept Paper
  b. A Strategic Plan

Table 15. IDIAP: RESEARCH COLLABORATORS AND IN-SERVICE TRAINEES WORKING WITH RUTGERS' TECHNICAL ASSISTANCE TEAM, 1985-87.

Research Program	Rutgers Specialist	IDIAP Collaborators
Horticulture/General Agronomy	M. Gaskell	6
Soil Fertility and Management	A. Cordero	12
Tropical Pastures	P. Argel	10
Livestock Nutrition	J. Zorrilla	7
Agricultural Administration and Management	C. Neyra	15
Total		50

All were intended to improve the basic functional and organizational cost-effectiveness of IDIAP.

A. Objectives, Projections and Strategies of Agricultural Research (1986 - 1990).

The Rutgers specialist provided impetus for IDIAP to initiate the preparation of a document to help improve the planning of agricultural research. IDIAP appointed a study commission. The resulting document was prepared with the direct participation of IDIAP's Central Administration (Director and Deputy Director), the National Directorate of Planning, the National Directorates of Crops and Livestock Research, and staff of the regional centers. Meetings were held at each of the three regional centers on numerous occasions. Objectives and strategies were defined, taking into consideration the spirit of the law creating IDIAP, the policies of national economic development, and the guidelines of the Ministry of Agricultural Development (MIDA), contained in its own Five Year Plan.

The strategic components recommended were:

* Consolidation of the institutional development plans and structural organization.
* Strengthening of the research programs through the appropriate selection of methodologies to pursue well defined research priorities.

* Strengthening of coordinating and consultative mechanisms through improved inter-institutional links at the national and international levels.

B. IDIAP: Training Program (1980 - 1987).

This was discussed in Chapter III of this report.

C. ATD Project Evaluation.

A major evaluation of the ATD project was undertaken in 1986 by a six-person team selected by USAID/Panama. Rutgers' Chief-of-Party and resident team members all collaborated. Rutgers' Chief-of-Party met with, and was interviewed on several occasions by, the evaluators.

The final document (January 1987) contains over 80 written pages. Comments concerning the long-term technical assistance provided by Rutgers University are extracted below:

* "The long-term technical assistance provided by Rutgers in the field has been

effective.... The IDIAP/Rutgers field teams have developed mutual respect and have earned the confidence of farmers."

* "The evaluation team was particularly impressed by the work and achievement of the horticulture and pasture programs and praised their ability to work effectively with their Panamanian colleagues."

* "Rutgers has facilitated the success of research programs in several important ways: first, it has provided some short-term assistance to supplement on-going programs; second, it has assisted the placement in-country of young and highly capable professionals; and third, by using its association with several international organizations, Rutgers has furnished IDIAP and USAID with documentation,studies and services beyond those specified in the project paper."

* "The second area of Rutgers technical assistance thrust has been at the national headquarters, primarily on policy and research organization. Here Rutgers has sought to establish research priorities, to organize and rationalize the administration of the Institute (IDIAP), and to integrate internal review policies and procedures."

* "Efforts have been made by Rutgers to improve research relationships with the Faculty of Agronomy and to increase what might be termed the "academic" orientation of the institution. This has been done by establishing relationships with other faculties of the University located in Panama City."

The evaluation report also identified several areas requiring attention:

* Deficiences in the process of budgeting and finance. It made strong recommendations for improvement in IDIAP's current budget and for the more timely release of funds by the central government to meet financial obligations and research schedules.

* Planning and priority setting. IDIAP covers a broader range of commodities than is consistent with its budget limitations. It should concentrate efforts on a smaller number of well selected commodities after defining research priorities against the availability of economic, human, and physical resources. A work plan should be elaborated early in the year to help with the implementation process.

* Internal evaluation processes and professional recognition or reward need to be strengthened.

* Closer links with the technology transfer program of MIDA should be fostered.

* Training of both technical and administrative personnel should be continued and reinforced.

* More support to the on-farm adaptative research efforts should be provided.

V. EXPANSION AND REORIENTATION OF THE ATD PROJECT

These efforts were initiated with the preparation of a Concept Paper written by the Agricultural Research Administration and Management Specialist to help formulate a new "Action Plan" and strategies to improve vegetables, tropical fruits and beef as export commodities. This effort was complemented by the development of a "Strategic Plan for the ATD Project in Panama, 1987-92," prepared under the leadership of Carlos G. Moran (Director General, IDIAP) and Reed Hertford (Director, IAFP/Cook College), backstopped by the scientific/technical staff of IDIAP, Rutgers' faculty and team members in Panama. The Strategic Plan constitutes a "reference document" for agricultural research in Panama for the next five to ten years. It describes objectives, strategies, necessary human resources, and work calendars to increase production (mainly for export) and marketing of horticultural and livestock products.

VI. TECHNICAL ASSISTANCE TEAM

Table 16 summarizes information relating to the team Rutgers placed in the field under the ATD Project.

TABLE 16. PANAMA: TECHNICAL ASSISTANCE TEAM

Name	Appointment Period in Panama*	Position	Residence
Pedro Argel	2/83 - 8/87	Pastures Specialist	David
Alvaro Cordero	7/85 - 6/87	Soils Specialist	Santiago
Thomas Dowe	7/82 - 9/82	Pastures Specialist	David
Mark Gaskell	7/82 - 8/87	General Agronomist	Volcán
Luis Manrique**	1/84 -12/84	Soils Specialist	Santiago
Carlos Neyra	2/85 - 8/87	Agricultural Research Administration and Management Specialist	Panama City
Thomas Scott**	9/82 - 7/83	Soils Specialist	Santiago
Alfredo Serrano	1/84 - 7/85	Livestock Research Specialist	Santiago
Jose Zorrilla-Rios		Livestock Research Specialist	Panama City

* The period is inclusive of the month/year shown.

** Appointed through a subcontract with Cornell University.

VII. PUBLICATIONS AUTHORED BY THE RUTGERS TEAM

A. General Agronomy/Horticulture.

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2. J.R. Arauz and M.L. Gaskell. 1984. Building institutional agricultural research capability in Western Panama. American Society of Agronomy. Las Vegas, NV.

3. Sands, Michael, J.R. Arauz, M. Gaskell, W. Bejarano, and L. Hertantains. Management experiences from three farming system research/extension projects in Panama. In Farming Systems Research and Extension - Management and Methodology. A symposium held Oct. 13-16. Kansas State University, Manhattan, KS.

4. Gaskell, M.L. 1985. Recommendations for improving the research extension connection in Panama. Report prepared for the Panamanian Agricultural Research Institute and the Agency for International Development, Panama City.

5. Degracia, R., M. Gaskell, M. Acosta, and F. Gonzalez. 1985. Agronomic and economic response of dry bean (Phaseolus vulgaris) to fertilization in Caisan, Panama. Proceedings of the 31st Annual Meeting of the Central American Food Crops Improvement. Cooperative Program. San Pedro Sula, Honduras, April 1985.

6. Gaskell, M. and C. Serrano. 1985. Improvement of rainy season onion production in the highlands of Panama. Proceedings of the 31st Annual Meeting of the Central American Food Crops Improvement Cooperative Program. San Pedro Sula, Honduras, April 1985.

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8. Gaskell, M.L., C. Serrano, and M. Singley. 1985. Alternatives for rainy season onion production in Panama. Hortsci. 20:99. (Abstr).

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11. Gaskell, M.L. 1986. Research needs for export of fruit and vegetables from Panama. In Reed Hertford and Carlos Moran (eds.) A Strategic Plan for Focusing Agricultural Research in the Panamanian Agricultural Research Institute. Special Report to the Agency for International Development. Panama City.

12. Flory, Robert, K.C. Ting, M.E. Singley, and Mark Gaskell. A photovoltaic air heating onion dryer for Panama. Ann. Meetings of the American Society of Agricultural Engineers, New Brunswick, N.J. August, 1987.

13. Sanchez, E., M. Gaskell, and C. Serrano. 1987. Onion varieties for rainy season production in the highlands of Chiriqui. IDIAP Research Bulletin. Panamanian Agricultural Research Institute. Panama City. (in press).

14. Gaskell, M.L. 1987. Soil Management. In Vegetable Production Manual. Charles Atlee (ed.) Ministry of Agricultural Development. Panama City. (in press)

15. Gaskell, M.L. 1987. Onions In Vegetable Production Manual. Charles Atlee (ed.) Ministry of Agricultural Development. Panama City. (in press)

16. Arauz, J.R. and Mark Gaskell. 1987. Management of on-farm research. IDIAP Technical Bulletin. Panamanian Agricultural Research Institute. Panama City. (in press)

17. Gaskell, M.L. and Esteban Sanchez. 1987. A producer-supported on-farm research program with vegetables in Panama. Farming Systems Research Symposium. Winrock Int'l./University of Arkansas, Fayetteville, Arkansas (in prep).

18. Ting, K.C., R. Flory, M.E. Singley, and M. Gaskell. 1987. Solar direct electric/thermal cogenerators for onion curing. Amer. Society of Agricultural Engineers Winter Meetings. Chicago, Ill. December, 1987. (in prep)

B. Tropical Pastures.

1. Duque, O.; Argel, P. y Schultze-Kraft, R. 1985. Recolección de germoplasma nativo de leguminosas forrajeras en Panamá. Pasturas Tropicales-Boletín 8 (1) : 10-14. Panama.

2. Pitty, N.; Rodriquez, M. y Argel, P. 1985. Evaluación de persistencia y producción de carne de varias asociaciones de especies forrajeras. En: E. Pizarro (ed.), Red Internacional de Evaluación de Pastos Tropicales. Resultados 1982-1985. 5a. Reunión de la RIEPT, Octubre 21-24, 1985. Centro Internacional de Agricultura Tropical, CIAT, Cali, Colombia. Vol II, 1059-1062.

3. Gonzalez, G. y Argel, P.J. 1985. Rendimiento Estacional de 16 ecotipos de Leucaena. Ibid. Vol ii, 955-956.

4. Argel, P.J. 1983. Conceptos generales sobre producción de semillas forrajeras tropicales. En: Reunión Anual del PCCMCA. Instituto de Investigación Agropecuaria de Panamá. pp. 235-239.

5. Argel, P.J.; Avila, M. y Aranda, H. 1987. Perspectivas de Producción de Semillas Forrajeras Tropicales en Panamá. Mimeo. 21 p.

6. Pinzon, B.; Argel, P.J. y Montenegro, R. 1985. Control de malezas en el establecimiento de Kudzú Tropical. Pasturas Tropicales. Boletín 7 (2) : 6-9.

7. Hertentains, L.; Troetsh, O. y Argel, P.J. 1987. Control químico de la maleza Cabezona (Paspalum virgatum). Ciencias Agropecuarias (Panamá) (En imprenta).

8. Argel, P.J.; Peralta, A. y Pizarro, E.A. 1987. Experiencia Regional con Centrosema: América Central y México. Memorias Primer Simposio Mundial sobre Centrosema: Biología, Agronomía y Utilización. CIAT, Febrero 23-28, 1987. 38p. (En imprenta).

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10. Zorrilla-Ríos, J.; Arosemena, E. y Argel, P.J. 1987. Evaluación de germoplasma forrajero en Finca de Productores. Una propuesta metodología. Mimeo. 7 p.

C. Livestock Nutrition.

1. Zorrilla, J., Jaén, M. y L.R. McDowell. 1987. Suplementación mineral del ganado en Panamá. IDIAP.

2. Zorrilla, J., Arosemena, E. y M. Jaén. 1987. Diseño para la constructión de un salero para ganado. IDIAP.

3. Tason, L., Arosemena, E., Vargas, E., Caballero, A. y J. Zorrilla-Ríos, 1987. Mejoramiento del valor nutritivo de forrajes pobres. I. Pruebas químicas y de consumo. IDIAP: Notas de Investigacción en Progreso. ISSN 0257-7127.

4. Jaén, M. y J. Zorrilla-Ríos. 1987. Reproductive performance of a commercial beef herd at the Cocle Province in Panama (submitted to IDIAP for publication).

5. Tason, L., Jaén, M., Arosemena, E. y J. Zorrilla-Ríos. 1987. Tecnología no convencional para mejorar el valor alimenticio de forrajes balanceados nutritivamente y para la conservación de forrajes frescos. IDIAP, Jornadas Científicas, XII Aniversario.

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8. Zorrilla-Ríos, J., Alba, J.L., Mirones, S. y C. Carrizo. 1987. Comparación biológica y económica, entre un sistema doble propósito y especializado en la producción de leche en provincias centrales de Panama. IDIAP. Jornadas Científicas, XII Aniversario

D. Fertility and Management of Acid Soils.

1. Martinez, L., Diaz, J.F., Name, B., Navarro, M. y A. Cordero. 1987. Resultados preliminares de la investigación de arroz en Cocle. IDIAP. Jornadas Científicas, XII Aniversario.

2. Name, B., Cordero, A. y J. Bernal. 1987. Alternativas para el uso y manejo de suelos ácidos en Panamá. IDIAP. Jornadas Cientificas, XII Aniversario.

3. Name, B. y A. Cordero. 1987. Recomendaciones para la fertilización de suelos: hojas guías por cultivo. IDIAP. Jornadas Cientificas, XII Aniversario.

4. Name, B. y A. Cordero. 1987. Determinación de aluminio intercambiable como base para el encalado de los suelos ácidos de Panamá. IDIAP. 31 p.

E. Research Administration and Management.

1. Cuellar, M., Ocaña, B., Ríos, S., Neyra, C. y H. Lopez. 1985. Objectivos, proyecciones y lineamientos estratégicos del IDIAP (1986-1990). Committee Report submitted to IDIAP and MIDA.

2. Neyra, C. 1986. IDIAP: Training Program under the ATD Project. Analytical Report to IDIAP and USAID/Panama.

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