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This report is submitted in partial fulfillment of the requirements established in the contract of the "Agricultural Technology Development" project and implemented in the form of Technical Assistance provided by specialists of Rutgers and Cornell Universities to the Institute for Agricultural Research of Panama (IDIAP). The activities and accomplishments of the project on its Technical Assistance component for the period indicated (October 1 to December 31, 1984) are described in detail in this report and also contains tabulated results of experiments that were initiated before this quarterly period.

The quarterly report No.10 is divided into four sections, each corresponding to individual reports submitted by the four specialists of the Rutgers/Cornell team: I. Specialist in Tropical Pastures, Dr. Pedro Argel; II. General Agronomy Specialist, Dr. Mark Gaskell; III. Soils Management Specialist, Dr. Luis Manrique and IV. Animal Production Specialist, Dr. Alfredo Serrano. The report of the Soils Management Specialist is only briefly described here, in this document, since a more elaborated report was prepared by Dr. Manrique as part of the final report submitted by Cornell University as a subcontractor to the project.

Signed: Dr. Carlos A. Neyra
Project Coordinator/Panama

REPORT/AID-PANAMA PROJECT
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ACTIVITIES OF PROJECT SPECIALISTS

I. TROPICAL PASTURES SPECIALIST
Dr. Pedro Argel,

Background Because of the importance of pastures in Panamanian cattle production, the activities of the Rutgers/Cornell research project have been directed, from the beginning, to an evaluation of a high number of pasture species adaptable to infertile acid soils—63% of the Panamanian soils are acid, mainly ultisoles. In addition, seed production of promising species has been evaluated as well as live weight gain on selected germplasm. Other activities include studies of weed control in the establishment of legumes and shrub control in pastures.

The research activities have been supported by the Pastures Program of CIAT, primarily in relation to the germplasm and methods of investigation. This association has been very productive and benificial to IDIAP as well as to CIAT. The advances and achievements up to now are presented here.

Germplasm

Regional Type A Experiments (ERA) Using an evaluation method described in the Regional Experiments, a large number of grasses and legumes have been evaluated on sites in Los Santos (Dry pre-mountain forest), Calabacito (humid tropical forest—subecosystems derived savannah) and Sona (very humid tropical forest).

Although the sites mentioned do not cover all of the ecosystems present in Panama, they are representative of a large percentage of the area of the country where cattle raising is double purpose.

Calabacito and Sona characteristically have acid soils with a high saturation of Al and low levels of P (ultisoles), whereas Los Santos is predominantly an inceptisol with neutral pH, low Al presence in the organic horizon, low content of P and high levels of Ca and Mg. The major interest on this site is that the plants are subjected to a dry period of approximately 6 months extending each year from December to June.

Table 1 shows the number of ecotypes established in each site. There are a high number of species that are evaluated in the same manner in three locations; however, in Los Santos the germplasm established includes species of known drought tolerance, such as Cenchrus. Native or naturalized forage crop ecotypes have also been included, which has permitted the comparison of the level of adaptation and production of the germplasm introduced with that commonly found or used in the area.

Visual periodic disease evaluations and measurement of production of dry matter during a complete cycle of dry season and rainy season,

TABLE 1. Forage Germplasm Included in Type A Tests at Different Sites in Panama

LEGUMES		CIAT No. OR ECOTYPE	EVALUATION SITE		
			SONA	CALABACITO	LOS SANTOS
Aeschynomene	histrix	9690, 9666	+	-	-
Alysicarpus	vaginalis	Nativo	-	+	+
Calopogonium	mucunoides	Nativo	+	-	+
Cannavalia	sp.	Nativo	-	-	+
Centrosema	brasilianum	5234	+	+	+
Centrosema	brasilianum	5247	+	+	+
Centrosema	brasilianum	494	+	-	-
Centrosema	macrocarpum	5062	-	+	+
Centrosema	macrocarpum	5434	+	+	+
Centrosema	macrocarpum	5065	+	+	+
Centrosema	macrocarpum	5478 A	-	-	+
Centrosema	pubescens	5126	-	+	+
Centrosema	pubescens	5189	+	+	+
Centrosema	pubescens	438	+	-	-
Centrosema	sp.	Nativo	-	+	+
Centrosema	sp.	5112, 5278	+	+	+
Centrosema	pascuorum	5190, 5192	-	-	+
Desmodium	canum	13032, Nativo	+	+	+
Desmodium	barbatum	Nativo	+	-	+
Desmodium	ovalifolium	3784	+	+	+
Desmodium	heterophyllum	349	+	-	-
Desmodium	ovalifolium	350	+	-	-
Desmodium	gyroides	3001	+	-	-
Galactia	striata	964	-	+	+
Neonotonia	wightii	204, 206	-	-	+
Macroptilium	sp.	506	+	-	+
Pueraria	phaseoloides	9900	+	+	+
Stylosanthes	capitata	1019, 10280	+	+	+
Stylosanthes	capitata	1441, 2044	-	+	+
Stylosanthes	capitata	1315, 1693, 1728	+	-	-
Stylosanthes	macrocephala	1643, 2133	-	+	+
Stylosanthes	guianensis	136, 184	+	+	+
Stylosanthes	guianensis 'Tardio'	1280, 1283	+	+	+
Stylosanthes	guianensis 'Tardio'	1020	-	+	+
Stylosanthes	hamata	118, 147	-	-	+
Stylosanthes	humilis	Nativo	+	+	+
Stylosanthes	scabra	1047	-	+	+
Stylosanthes	leiocarpa	1087	-	+	-
Stylosanthes	sympodialis	1044	-	-	+
Zornia	sp.	7847	+	+	-
Zornia	latifolia	728	+	-	-
Zornia	sp.	Nativa	+	-	-

+ Established on the site
- Not included

TABLE 1. Continued

GRASSES		CIAT No. OR ECOTYPE	EVALUATION SITE		
			SONA	CALABACITO	LOS SANTOS
Andropogon	gayanus	621, 6200	+	+	+
Brachiaria	decumbens	606	+	+	+
Brachiaria	dictyoneura	6133	+	+	+
Brachiaria	humidicola	679	+	+	+
Brachiaria	radicans	Local	+	+	-
Brachiaria	ruziziensis	Local	+	-	-
Cenchrus	ciliaris	678, Molopo, Nunbank, Gayndah, Nueces	-	-	+
Cynodon	plectostachyus	Local	+	-	-
Dichanthium	aristatum	Local	+	-	+
Digitaria	swazilandensis	Local	+	+	+
Digitaria (Pangola)	decumbens	Local	-	+	+
Digitaria (Transvaala)	decumbens	Local	-	-	+
Hyparrhenia	rufa	Local	+	+	+
Panicum	maximum	604, Indiana, Guinea	-	-	+
Pennisetum	orientale	Cowboy	-	-	+

+ Established on the site
- Not included

TABLE 2. Promising Germplasm Adaptation Level in Different Ecosystems where Regional Type A Tests were Established.

SPECIES		EVALUATION SITE		
		CALABACITO	LOS SANTOS	SONA
GRASSES				
A. gayanus	CIAT 621, 6200	excellent	good	excellent
B. dictyoneura	CIAT 6133	excellent	excellent	excellent
B. humidicola	CIAT 679	good	good	excellent
B. decumbens	CIAT 606	good	excellent	good
C. ciliaris 'Numbank'		-	excellent	-
C. ciliaris 'Molopo'		-	excellent	-
LEGUMES				
C. sp.	CIAT 5112, 5278	good	good	fair
C. macrocarpum	CIAT 5434	excellent	good	good
C. macrocarpum	CIAT 5062, 5065	good	good	good
P. phaseoloides	CIAT 9900	excellent	good	excellent
S. capitata	CIAT 10280	good	poor	good
S. macrocephala	CIAT 2133, 1643	good	poor	-
S. guianensis	CIAT 184, 136	excellent	excellent	good
S. guianensis 'Tardio'	CIAT 1280, 1283	good	good	good
S. guianensis	CIAT 1175	-	-	excellent
G. striata	CIAT 964	poor	excellent	-

has emphasized the most outstanding germplasm whose adaptation is comparable or superior to those commonly used in the respective area. Condensed details are given in Table 2 for the three sites.

Some ecotypes stand out well in the different ecosystems, which shows their high level of adaptation. A. Gayanus and ecotypes of Brachiaria are examples. Centrosema, particularly C. macrocarpum, adapts broadly; as is the case with P. phaseoloides. The most outstanding Stylosanthes have been common and late S. quianensis. S. capitata 'Capica' has shown poor results in the ecosystem in Los Santos. The pests commonly observed have been leaf-sucking insects and leaf-eating insects and in addition, fungus diseases such as anthracnosis in Stylosanthes and Rhizoctonia in Centrosemas, Galactia and Phaseolus. The last has been the most frequent and has caused the most damage in the different sites.

Generally the native species have been considerably below the new introductions in terms of production, Native S. humilis, for example, is an annual and practically disappears during the dry season. However, the seeds are very persistent, efficient, and are produced in abundance. They germinate easily with the first rains; the plants invade neighboring plots, but dry matter production is insignificant.

Naturalized grass species or species presently in commercial use included in the experiments have shown a tendency for less production after each uniform cut and under the experimental conditions. It is evident that many of these species, especially grasses, even though adapted, need high applications of fertilizers to maintain adequate production for longer time periods. The naturalized grass and the one predominant in Panama, H. rufa (Faragua), has confirmed its broad range of adaptation in the different ecosystems even though it tends to be less vigorous in the sites like Calabacito with low pH and high saturation of Al. The H. rufa production of dry matter has been lower than the introduced grass A. gayanus CIAT 621 and CIAT 6200—4 ton/ha for the Faragua compared to 14 and 9 ton/ha respectively for the A. gayanus ecotypes in the periods of highest precipitation.

In addition, during the dry season, once it has completed its reproductive cycle, Faragua offers very little forage, which is its principal disadvantage. However, persistance of the seed, resistance to fire and tolerance to pests and diseases shouls be emphasized.

Regional Type B Experiments (ERB) In August, a Type B experiment was established in El Ejido (Los Santos) with germplasm selected for its good results in the Type A experiment located in the same area. A total of 12 legumes and 15 grasses were established and included some species used in the area such as Cynodon sp. (Estrella), Bothriochola sp. (Pangola de pobre), Digitaria swazilandensis (Swazi), Panicum maxium (Guinea and Indiana) and H. rufa (Faragua), in addition to the introduced grasses Cenchrus ciliaris (Molopa and Nunbank), A. gayanus (CIAT 621 and 6200), B. decumbens CIAT 606 and B. dictyoneura CIAT 6133.

The legumes include C. macrocarpum CIAT 5062 and 5434, C. brasilianum CIAT 5234, C. pubescens CIAT 5189, C. sp. 5278, P. phaseoloides CIAT 9900 S. guianensis CIAT 136 and 184, S. hamata CIAT 147, S. scabra CIAT 1047, S. sympodialis CIAT 1044 and Galactia striata CIAT 964. All species have established normally, although Faragua and Swazi stand out among the grasses for their vigor and the outstanding legume ecotypes are P. phaseoloides CIAT 9900, C. macrocarpum 5434 and Stylosanthes CIAT 147, 184, 136 and 1044. However, the last has shown greater susceptibility to flower rot caused by Rhizopus sp. It should be noted, however, that this year precipitation has been higher than reported earlier during the ERA evaluation, which has contributed to a greater incidence of diseases.

Brachiaria Ecotypes A total of 23 Brachiaria ecotypes, including 6 species of B. decumbens, 6 of B. humidicola, 3 of B. ruziziensis, and a hybrid, plus a commercial test type B. decumbens CIAT 606, has been established in three different sites in Panama, to evaluate the level of adaptation in terms of seasonal production of dry matter, disease tolerance, and resistanct to sucking insects. These sucking insects are frequently found in forage grasses in Panama, including the commercial Brachiarias. The establishment sites are: Calabacito (ultisol), Finca Chiriqui (ultisol) and the Gualaca Station (inceptisol). The species are completely established in Gualaca and are in the process of establishment in the other sites mentioned. The experimental plots are 2 x 3 meters and there are 3 repititions.

TABLE 3. Percentage of coverage 12 weeks after establishment of 21 Brachiaria ecotypes in Gualaca, 1984.

SPECIES	CIAT NO	% COVERAGE
B. decumbens	Commercial	90
B. decumbens	6132	100
B. decumbens	6131	95
B. decumbens	6009	85
B. decumbens	6012	92
B. decumbens	6130	97
d. decumbens.	664	87
B. humidicola	6709	77
B. humidicola	6707	87
B. humidicola	679	87
B. humidicola	6705	88
B. humidicola	675	83
B. humidicola	682	82
B. ruziziensis	6291	94
B. ruziziensis	654	100
B. ruziziensis	6419	100
B. eminii	6241	92
B. eminii	6134	100
B. dictyoneura	6369	93
B. dictyoneura	6133	73
B. sp. (hybrid)	6298	92

Note: Neither B. radicans (Commercial) nor B. brizantha CIAT 6016 were at this site but were at other sites.

The production of dry matter is determined by cuts every eight weeks during the rainy season and the presence of pests and diseases are determined by nymph count/m^2 (for salivero) and the visual rating of percentage of damage for diseases. The evaluation of the level of establishment at 12 weeks of the Gualaca planting is shown in Table 3. Even though there is a high percentage of coverage with all species, only four show total cover; among those B. ruziziensis, which is outstanding for its spreading ability, but tends to show the first symptoms of nutrient deficiency, and a greater susceptibility to leaf fungus diseases, especially Rhizoctonia.

The experiment will last a minimum of 18 months and it is expected that ecotypes superior to those in commercial use in terms of resistance to salivero and other attributes will be found.

Leucaena Ecotypes In cooperation with the National Agricultural Institute (INA) located in Divisa, 16 ecotypes of Leucaena were established during July. These are shown in Table 4. The germplasm includes three hybrids and four ecotypes of L. diversifolia; this has shown more tolerance to the acidity in the experiments carried out in CIAT (Colombia) and broadens the range of use of the species in ecosystems with intermediate acidity and drought which are experienced in the central provinces of Panama. The ecotypes CIAT 17477 and 17491 began blooming at the end of October, while the others are in the vegetative state. The natural production variability of these ecotypes

TABLE 4. Established Leucaena ecotypes for evaluation of eatable dry matter and mimosine content at INA, Divisa, Panama, 1984.

CIAT NO	Species
17461	L. diversifolia 30
17388	L. diversifolia 31
17485	L. diversifolia 26 (78-49)
17503	L. diversifolia 25 (78-3)
17467	L. leucocephala 32
17495	L. leucocephala 11 (78-15)
17498	L. leucocephala K 29
17488	L. leucocephala K 132
17502	L. leucocephala cv. Cunningham
17475	L. leucocephala 18-9/2-15 Hybrid
17477	L. leucocephala 23-1/12-12
17491	L. leucocephala
17489	L. pulverulenta Hybrid K 340
17490	L. pulverulenta Hybrid AJO 3279
17487	L. shannoni 78 - 70
17478	L. sp. 30/4 - 11

will be studied through cuts every eight weeks at a height of 40 cm. and production of dry eatable material and mimosine content of the most outstanding ecotypes will be observed. This experiment will continue for a minimum of one year.

Agronomy

The effect of P, Mg, K, and S, on A. gayanus CIAT 621 and S. capitata 'Capica', alone and combined, has been evaluated during the establishment phase in an ultisol in Calabacito. The soil is characterized by acidity, low levels of P, high saturation of Al and intermediate values of K and Mg (0.2 and 0.4 meq. in the first 15 cm. respectively). Other characteristics of the soil are given in Table 5. The sources

TABLE 5. Physicochemical parameters of a ultisol in Calabacito, Panama, November 1984.

Depth (cm)	Sand	Silt (%)	Clay	Bases (meq/100 g)					pH (H_2O)	MO (%)
				Ca	Mg	Na	K	Al		
0-15	16.5	39.0	44.5	5.1	0.4	-	0.2	0.8	4.8	2.9
15-26	10.7	27.6	61.7	0.8	0.1	-	-	4.4	4.8	1.6
26-43	10.9	32.1	57.0	0.2	TR	TR	-	4.8	5.1	1.1

of the elements used were triple superphosphate for phosphorus (P), potassium chloride, sulpomag, magnesium oxide and sulphur which are essential for the potassium (K), magnesium (Mg), and sulphur (S) respectively. The fertilizers were applied and incorporated before planting.

The evaluations have been carried out through cuts every eight weeks and the results of yield of three successive cuts are presented in Table 6. S. capitata responded to successive increases of P_2O_5, even though these were significant ($P<0.01$) only at the highest level (60 kg/ha). There was no result for the levels of K nor Mg, even though there was a slight increase in yield. However, the greatest result was obtained with S at the level of 20 kg/ha; in this case the yields of dry material increased 59% in the presence of the middle level of phosphorus. The combination of all the elements produced significant yields ($P<0.05$) only at the highest level of phosphorus and this is probably due to the positive interaction between this element and sulphur.

A. gayanus did not respond significantly to any of the elements, though there was a tendency to increase the yields when the effect of each element is observed individually, particularly in phosphorus and sulphur; however the interaction of the highest level of phosphorus with the other elements was highly significant ($P<0.01$). In this case the yield increased 30% compared with the control. This grass responded in a similar manner when it was planted with a legume, but this last sample showed greater variability in yield within the combination, due mainly to problems of establishment and strong competition from the grass in the mentioned ecosystem. Only 10% of the total biomass in this combination corresponds to the legume, even though an increase in the last cuts was observed.

TABLE 6. Results during establishment of A. gayanus CIAT 621 and S. capitata 'Capica' alone and combined at different levels of P, K, Mg, and S in an ultisol in Calabacito, Panama.

	TREATMENTS (Kg/Ha)				YIELD (Kg DM/Ha)		
	P_2O_5	K_2O	MgO	S	S. capitata	A. gayanus	A. gayanus S. capitata
1.	0	0	0	0	1,052.4 *	2,840.9	1,761.9 211.5
2.	0	50	20	20	1,278.6	2,828.5	1,876.9 239.5
3.	15	0	0	0	1,363.6	2,968.6	2,319.0 248.4
4.	15	50	20	20	1,488.3	2,740.0	2,122.8 337.7
5.	30	0	0	0	1,294.0	3,092.4	2,249.6 355.8
6.	30	50	20	20	1,629.7	3,173.0	2,396.0 228.2
7.	30	0	20	20	1,374.9	3,328.5	2,309.9 314.3
8.	30	0	0	20	2,134.3	3,518.3	2,789.4 328.4
9.	30	0	20	0	1,534.3	3,115.0	2,280.2 324.9
10.	30	50	0	0	1,351.9	3,504.1	2,494.6 341.8
11.	60	0	0	0	1,743.5	3,343.4	2,291.1 210.7
12.	60	50	20	20	1,862.8	4,052.3	3,322.7 299.4
				DMS 0.05	342.1	842.3	1,014.2 (only A. gayanus)
				0.01	465.0	1,149.9	1,367.2

* Average of three cuts at eight week intervals.

The results of the species studies were not only in terms of the total biomass produced, but also in vigor and speed of establishment. It was evident from the beginning and following the germination that there was greater growth in the fertilized plots, particularly those where phosphorus and sulphur were present. This is important for faster coverage of the soil and greater competition with weeds in the critical stage of establishment.

Seed Production

Seed activities have been oriented toward multiplication of experimental lines and increase of promising semicommercial species or those actually used by producers (basic seed). Observations have also been made of management and harvest practices to gain information on forage seed production technology.

Table 7 presents the grass and legume species harvested, as well as the area and site of harvest. With the exception of C. macrocarpum CIAT 5065, all species bloomed and formed seed during the 1983-1984 period. This species began blooming at the end of November 1983, but reverted to a vegetative state with the occurance of sporadic rains from that date. It seems that the species needs a greater water stress in the soil to bear fruit normally, once blooming has been induced.

TABLE 7. Forage seed yield and production parameters in Panama during 1983-1984.

Species	Harvested area. (ha)	Harvest Site	Date of Bloom	Date of Harvest	Yield (kg/ha)*	Total Harvest (kg)*
Leguminosas						
Stylosanthes guianensis CIAT 136	0.15	Gualaca	7-11-83	30-1-84	30.00	4.50
Stylosanthes capitata (capitata)	0.33	Gualaca	29-9-83	10-1-84	589.0	194.50
Pueraria phaseoloides CIAT 9900	1.00	Gualaca	10-12-83	Feb.-Mar.'84	22.50	22.50
Centrosema macrocarpum CIAT 5065	0.40	Gualaca	28-11-83	Feb.'84	-	-
Gramíneas						
Andropogon gayanus CIAT 621	2.0	Gualaca	29-9-83	23-11-84	431.00	862.00
		Calabacito	25-9-83	-	-	860.00
Brachiaria humidicola Comercial	5.0	Fca.Chiriquí	14-6-83	20-7-84	75.0 **	375.5
Brachiaria decumbens Comercial	2.5	Gualaca	16-20 May	18/6-4/7-84	191-47	479.68

* Rough seed
** Combined yield, others correspond to manual harvest.

The other legumes bloomed abundantly under identical conditions of humidity, but the seed yield was significantly reduced by vine anthracnose in P. phaseoloides and by the bud borer (Bosqueella sp.) in S. quianensis. The yields of S. capitata were high compared to other production sites, mainly in Colombia. However, during the second growth cycle the crop has lost vigor and has been invaded by weeds which make a second harvest unlikely. The greatest difference between the blooming cycles has been high precipitation—over 4,500 m.m. during 1984, which has been over the average precipitation of previous years. Apparently Capica does not prosper in conditions of such high precipitation. A high percentage of S. quianensis CIAT 136 died after the harvest cut—20-25 cm from the ground—but regenerated normally from seed with good density and plant development.

All the grasses bloomed abundantly at the different sites in Chiriqui province. Greater blooming and fruit bearing in the Brachiaria occurred mid-year (May, June), during the months of high precipitation in this province. However, these plants continued blooming at least until October, which permited more than one harvest per year. The results shown in Table 7 are from one harvest.

The yield of A. gayanus is acceptable but the plant lost vigor during the present growth cycle due mainly to excess humidity through high precipitation. In conditions of high saturation of the soil, plants have died after uniform cutting following grazing. B. decumbens shows great potential for yield even though it was harvested during the rainy period. There is a high occurrence of infertile and immature seeds (see Table 8).

TABLE 8. B. decumbens seed maturation and yield in Gualaca, 1984.

Date of Bloom	Date of Sample	No. of floral Shoots/m	Yield Potential of Rough Seed kg/ha	Seed Harvest Yield kg/ha	
				Raw	Processed
16 - 20 May	18 June	455	2,820	191.68*	25.84 **
	2 July	311	3,441	-	-
	10 July	312	2,717	-	-

* Harvested between June 18 and July 4, 1984.
** Undetermined purity.

The yield of processed seed—purity undetermined, but relatively high—is only 13.5% of that expressed as raw seed, and only 0.9% of the potential yield. There is great need for research with this specie, especially related to the efficient harvest management and study of management and nutrition factors of the plants that increase the formation of caryopses. The seed yield can be increased substantially.

The harvested seed has been used mainly for private producers and IDIAP, as illustrated in Table 9. Since, in Panama, there is no organized industry of forage seeds, IDIAP must supply, in some form, the commercial seed demand. This situation will probably change in the future, but slowly and thus, the research policies of the institution should be adjusted accordingly.

TABLE 9. Harvested forage seed distribution in Panama during 1983-1984

Applicants	No.	Purpose	Seed Quantity (kg)		
			Grasses	Legumes	Total
Private Producers	14	Commercial planting	204.7	5.0	209.7
Institutions including IDIAP	3	Forage evaluation	140.3	3.0	143.3

Establishment and Management

The activities related to management have been oriented toward weed control and the establishment of forage legumes and shrub control in the pastures. The first experiment was established in the Gualaca Station to observe control and selectivity of seven pre- and post-emergent herbicides in the established forage legume P. phaseoloides (Kudzu). Table 10 shows the treatments, combinations and dosage of a total of 20 treatments including an absolute and mechanical control. Observations made after 24 days show that the preemergent that performed best regarding control and selectivity was Oxyflourfen at a dosage of 0.50 kg/AI/ha. The dosage of 1.12 kg/AI/ha of herbicide produced a

TABLE 10. Weed control in established Kudzu (P. phaseoloides) through pre and post-emergent herbicides. Gualaca, 1984.

A. Pre-emergent

Treatment	Dosage (kg ia/ha)	Weed control % No. days after		Damage to Kudzu No. days after	
		21	48	21	48
Oxyfluorfen	0.50	92.0	65.0	9.0	1.0
Oxyfluorfen	1.12	97.0	97.0	21.0	31.0
Oryzalin	1.40	70.0	47.0	21.0	26.0
Oryzalin	2.80	73.0	57.0	85.0	61.0
Alachlor	2.24	69.0	35.0	16.0	12.0
Alachlor	4.48	79.0	55.0	22.0	26.0
Linuron	1.0	53.0	32.0	37.0	43.0
Linuron	2.0	82.0	81.0	93.0	100.0
Linuron + Alachlor	1.5 + 1.0	82.0	67.0	92.	95.0

B. Post-emergent*

	Dosage (kg ia/ha)	Weed control % No. days after		Damage to Kudzu No. days after	
		16	40	16	40
Pendimentamina	1.30	38.0	14.0	51.0	17.0
Pendimentamina	2.60	48.0	10.0	78.0	17.0
Acifluorfen	0.30	11.0	10.0	3.0	2.0
Acifluorfen	0.60	27.0	13.0	6.0	1.0
Fluazifop-Butyl	0.50	0	0	0	0
Fluazifop-Butyl	1.0	0	0	0	0

* Post-emergent products applied 35 days after emergence.

C. Pre and Post-emergent**

Treatment	Dosage (kg ia/ha)	Weed control % No. days after				Kudzu damage % No. days after			
		PRE		POST		PRE		POST	
		21	48	16	40	21	48	16	40
Alachlor + Acifluorfen	2.24 + 0.30	76.0	57.0	24.0	8.0	6.0	11.0	2.0	1.0
Oxyfluorfen + Fluazifop-Butyl	0.50 + 0.50	88.0	56.0	19.0	0	12.0	33.0	0	0
Oryzalin + Fluazifop-Butyl	1.40 + 0.50	62.0	55.0	0	0	56.0	75.0	0	0
Mechanical control				100.0				0	
Absolute control				0				0	

** Post-emergent products applied 35 days after emergence.

similar control but its leaf toxicity increased to 31 percent. Following in order of effectiveness and selectivity are Alachlor at a dosage of 2.24 kg/AI/ha, even though its residual control effect diminishes after 48 days. Linuron showed the best control but was highly fitotoxic for legumes, especially at a dosage of 2.0 kg/AI/ha. The same happened with the combination of Linuron and Alachlor.

None of the postemergents stood out in both control and selectivity. However, the high selectivity of Fluazifop-butyl at double dosage

should be noted. The poor control shown by this product is due to the combination of weeds which contained a high proportion of broad-leaf species, dominated by Borreria alta and Croton trinitatis. This is consistent with the recommendations of the product as a narrow-leafed herbicide. Likewise, the control observed with the system of pre- plus postemergents is due to the action of the first, even though Acifluorfen inhibited the growth of broadleaf weeds and in some cases caused severe leaf deformity.

Shrubs cause serious problems in pasture management in Panama for two reasons: resistance to conventional weed control methods and their strong competition with desirable species. Some are poison and/or have thorns that injure the cattle. During the rainy period (1984), an experiment was established in the Gualaca Station to evaluate the level of control of the herbicide Picloran plus 2,4-D amine in water and diesel of the shrubs chumico (Curatella americana), portobelillo (Casearia javitensis), and guayabo (Psidium sp.). The two systems of application were employed: to the stump and to the base of the stem, in addition to various dosages which are detailed in Table 11. Picloran plus 2,4-D amine does not disolve in an organic medium—diesel for example. But through the use of a surfactant at 2.0% it was possible to get an emulsion with a certain level of stability, especially with frequent agitation, which is compatable with commercial methods of applying herbicides.

TABLE 11. Controlling the shrubs Chumico (Curatella americana), Portobelino (Caesaria javitensis) and Guayabo (Psidium sp.).

A. STUMP APPLICATION

Treatment	% of regrowth - Time period					
	Chumico		Guayabo		Portobelillo	
	30 days	60 days	30 days	60 days	30 days	60 days
1. Picloran + 2,4-D amina 1.0% in water	50	100	20	60	0	40
2. Picloran + 2,4-D amina 1.5% in water	20	100	0	80	0	60
3. Picloran + 2,4-D amina 2.0% in water	80	100	20	80	0	40
4. Picloran + 2,4-D amina 1.0% in diesel*	80	100	60	100	0	60
5. Picloran + 2,4-D amina 1.5% in diesel	70	100	25	25	0	0
6. Picloran + 2,4-D amina 2.0% in diesel	20	40	0	0	0	25

B. STEM BASE APPLICATION

	% of defoliation					
1. Picloran + 2,4-D amina 1.0% in water	13	11	6	5	6	6
2. Picloran + 2,4-D amina 1.5% in water	4	6	10	6	1	7
3. Picloran + 2,4-D amina 2.0% in water	5	8	10	15	20	22
4. Picloran + 2,4-D amina 1.0% in diesel	56	61	22	35	17	48
5. Picloran + 2,4-D amina 1.5% in diesel	68	77	14	23	11	47
6. Picloran + 2,4-D amina 2.0% in diesel	65	63	23	21	71	73

* Mix achieved using a 2.0% surfactant.

Observations at 60 days have shown regrowth of the Curatella americana in all treatments using the stump application. Only when the application of herbicide at 2.0% with diesel, was the regrowth reduced to 40%. The application to the stem base has shown increasing defoliation, especially when used with diesel. During the same period the treatment of herbicide at 2.0% in diesel has hindered the regrowth of the stump in Psidium sp. and maintained at very low levels in Casearia javitensis. Greater defoliation has occurred in the treatments with

diesel than with water in the stem base applications of the same species. This experiment will be evaluated for a minimum period of 150 days to gain more reliable results.

Pasture Productivity and Evaluation

Of the planned experiments on animal production and pasture persistence, the most advanced is Type C done in cooperation with the Agronomy College (Chiriqui). The total area established is 2.6 ha. and the treatments consist of 5 combinations—A. gayanus CIAT 621 and H. rufa (Local) combined with S. capitata 'Capica' and C. macrocarpum CIAT 5065 respectively; and B. humidicola combined with P. phaseoloides (Kudzu). Three animal loads will be evaluated—1.25, 2.0 and 2.5 AU/ha—grazing seven days and resting 35 days. Grazing evaluation will begin during the next rain cycle.

Advances have been attained in the establishment of Type C and D in the Gualaca Station, The grass species chosen for the persistence test Type C include A. gayanus CIAT 621 and H. rufa, combined with the legumes A. guianensis CIAT 136, Centrosema sp. CIAT 5277 and A. capitata 'Capica', in a total area of 3.13 ha. The grazing system is 7 days grazing and 35 days rest. The chosen species for the animal production test Type D are A. gayanus CIAT 621, H. rufa (Local) and B. humidicola alone and combined in a total area of 24 ha. and under a rotational system of management of 7 days grazing and 49 days rest. Both experiments are more than 50% completed.

Smithsonian Research Institute (SRI)

Due to the severe problems of erosion around the Canal watershed, SRI has begun to take action toward finding management alternatives to avoid destruction of the ecosystem in the area important to Panama. An important point is the selection of forage germplasm that can be adapted to the environment and that will have good production potential. It must also have erosion control qualities and be attractive to the wildlife. Species were selected and offered to SRI for multiplication and evaluation as shown in Table 12. The plots are

TABLE 12. Germplasm established for the Smithsonian Research Institute (SRI) at Area De La Pavas (Canal Zone), June-Jul, 1984.

Species

1. As a seed source and mulch

   Brachiaria humidicola 'Commercial' - 1.0 ha.
   Brachiaria decumbens 'Commercial' - 1.0 ha.
   Pueraria phaseoloides 'Comerrcial' - 2.0 ha.

2. For adaptation and production evaluation (two repetitions on 5 x 10 m plots)

   Brachiaria humidicola CIAT 6707, 682
   Brachiaria decumbens CIAT 6132, 6131, 6009, 6012
   Brachiaria ruziziensis CIAT 6291, 654
   Brachiaria dictyoneura CIAT 6133, 6369
   Brachiaria eminii CIAT 6241
   Brachiaria radicans 'Commercial'
   Digitaria swazilandensis 'Commercial'
   Desmodium ovalifolium CIAT 350
   Centrosema macrocarpum CIAT 5478A
   Centrosema sp. CIAT 5112, 438
   Stylosanthes capitata 'CAPICA'
   Stylosanthes guianensis CIAT 136

now established and behavior will be evaluated for one more year with the objective of using the most desirable species. There are great expectations for this germplasm due to the potential offered as an alternative to the traditional grasses which are deteriorating and show low production.

Training

There was active participation in the organization and presentation of the first course on collection, preliminary evaluation of germplasm, and seed production conducted in Santiago, Veraguas from November 27 to December 13, 1984. The course was financed by FAO and organized by GREDPAC (Grupo Regional de Pastos de Centroamerica y el Cariba) and IDIAP. There were five scientists from the CIAT Pastures Program who acted as instructors, four technicians from IDIAP and one from RENARE. Sixteen technicians participated from various teaching and research institutions. Partipation by country included: Mexico 1, Costa Rica 2, Honduras 5, El Salvador 2, Panama 8 (6 from IDIAP and 2 from the University of Panama). The course was oriented toward theory and practice in which the pasture evaluation and seed production plots established in the central provinces during the last season were very useful.

The course was successful in that it taught methods of pasture evaluation and motivated the technicians in the different disciplines and subjects. The standard and timeliness of the presentations was very high. Favorable comments were heard at the end of the course and it was evident that there is interest in continuing this type of activity in the coming years. GREDPAC and IDIAP gained leadership in Central America but they must not underestimate the commitment and responsibility that this entails.

The contribution of the scientists from the Pastures Program at CIAT was important. It should be noted that this group of scientists is highly qualified, which contributed positively to the course.

Future Plans

Evaluation of germplasm for production in the different ecosystems and multiplication of promising seeds will be continued. In cooperation with CIAT, a native germplasm collection tour is planned for the beginning of 1985.

Tests on promising identified forage species—mainly Brachiarias, Stylosanthes, and Centrosemas—will continue. Weed control at the establishment level and brush and shrub control will continue. More emphasis will be given to chemical and mechanical weed control methods.

The first plots for evaluation with animals through experiments Type C and D will be established or will be in the final process of establishment in 1985. Cooperation with organizations such as SRI and the University of Panama will continue.

It is hoped to attain more complete national integration concerning the evaluation methods of forages and in setting priorities in the reasearch. Seminars and meetings in the different areas to reach these objectives have been planned. It is also planned to continue with the individual training or group training through short courses or field days.

II. GENERAL AGRONOMY SPECIALIST

Dr. Mark Gaskell,

The research program of the project General Agronomist is concentrated in two of IDIAP's priority geographic research sites in Chiriqui Province; Cerro Punta/Bambito in Bugaba District and Caisan in Renacimiento District. The crop focus is in onions in Cerro Punta/Bambito/Boquete and in maize and dry beans (Phaseolus vulgaris) in Caisan.

Onion Research

Background The onion research program which Dr. Gaskell has initiated is a new program for IDIAP and was developed in response to the high levels of importation of onions which exists over the eight months of rainy season when onions are not harvested. The research focus is on alternatives for extending production over more of the year and on the development of economical on-farm onion drying capability. Figure 1 illustrates the normal onion growing period in Panama and two alternative production patterns which are being evaluated by the onion research program.

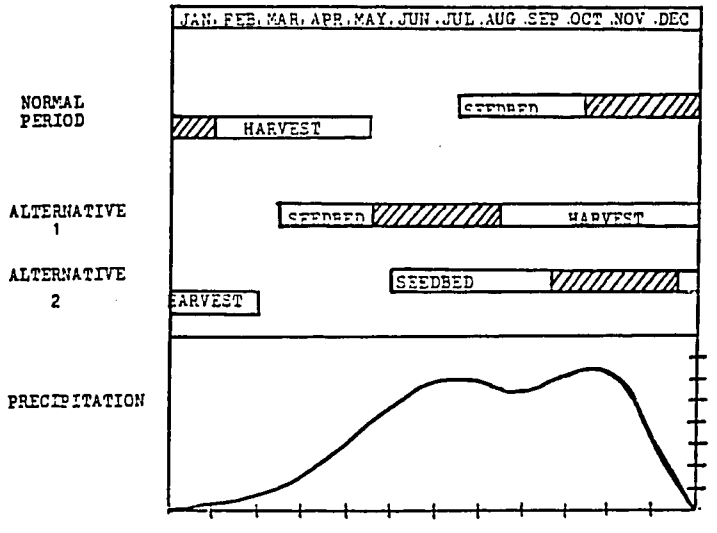

Figure 1. Alternatives for rainy season onion production in the highlands of Panama to provide domestic onions during periods of traditionally high importation.

Current Activity Alternative 1 involves the planting of irrigated seedbeds during the dry season for transplanting at the beginning of the rainy season. Analysis of data from on-farm plots harvested in Boquete in early September (see Progress Report No. 9) show that this alternative can be quite profitable under typical rainy season Boquete growing conditions. Yield averages were found to be in the 800 to 1000 quintal/ha. range and onions from that harvest brought $22/quintal. An effort is now underway to attempt to document the costs of production of rainy season onions but this cooperating producer estimated his costs at $4500 to $5000 per hectare.

Other plots now being harvested on a farm near Cerro Punta at 2200 meters above sea level which had also been planted according to the Alternative 1 regime have required an additional 3 1/2 to 4 months to mature; requiring a total of 9 months from planting to harvest. The Boquete farm is at 4800 meters and the differences in growing season requirement is undoubtably due to temperature differences. The costs of production are considerably higher at the higher altitude however, because of the larger number of fungicide applications required. The two areas have similar rainfall patterns but fungicides are applied every 4-7 days during rainy weather and three to four additional months considerably increases the number of applications required.

Yields from these plots near Cerro Punta average near 700qq./ha. but are quite variable; also perhaps due to the longer growing season requirement and this greater opportunity for yield to be adversely affected by diseases. No data is available on relative disease incidence between the two sites.

The major problem for this producer in harvesting at this time of year is the difficulty in selling his onions because of widespread availability of imported onions. Poor importation scheduling by the Agricultural Marketing Institute (IMA) continues to cause more problems for Panamanian onion growers than the weather.

The second Alternative illustrated in Figure 1 involves the planting of onions in seedbeds at the beginning of the rainy season to allow earlier onion harvest. This means that the onions in effect spend their entire lives in high rainfall conditions. Research is focusing on means of improving transplant production. There are normally very high losses in traditional Panamanian onion seedbeds, primarily due to the high rainfall. This problem will seriously limit Alternative 2 if a means is not found to improve seedbed management practices.

The research activity is concentrating on the development of an economical seedbed cover design. The research program has now passed through several different designs and has arrived at one that appears very promising. Early research reported in previous progress reports showed greater seedling survival under the cover and a warmer microclimate. Recent experiments have now evaluated the seedbed cover design under on-farm conditions in Boquete and Volcan (Tables 1 and 2).

TABLE 1. Rainy season seedbed onion survival at four plant densities in the open and under plastic seedbed cover. Volcan, Panama. 1984.

DENSITY SEEDED	NUMBER OF VIABLE SEEDLINGS*			
	EMERGENCE + 30 DAYS	AT † TRANSPLANT	EMERGENCE + 30 DAYS	AT TRANSPLANT
	- per 250 cm.^{2} -		- per gram seeded -	
OPEN A 1#/41m^2	32 ±7	--	60 ±8	--
COVERED	84 ±21	--	158 ±23	--
OPEN B 1#/20m^2	58 ±14	--	54 ±12	--
COVERED	107 ±20	--	100 ±18	--
OPEN C 1#/10m^2	72 ±9	--	33 ±4	--
COVERED	117 ±26	--	53 ±13	--
OPEN D 1#/5m^2	65 ±16	--	16 ±3	--
COVERED	126 ±24	--	29 ±4	--

* ± Standard Error
† Only transplants which had developed under plastic were transplanted because of high losses and retarded development of seedlings grown in the open.

TABLE 2. Rainy season seedbed onion survival at four plant densities in the open and under plastic seedbed cover. Boquete, Panama. 1984.

DENSITY SEEDED	NUMBER OF VIABLE SEEDLINGS *			
	EMERGENCE + 30 DAYS	AT † TRANSPLANT	EMERGENCE + 30 DAYS	AT TRANSPLANT
	- per 250 cm.^{2} -		- per gram seeded -	
OPEN A 1#/41m^2	45 ±5	48 ±13	56 ±8	90 ±23
COVERED	89 ±4	93 ±4	166 ±7	171 ±8
OPEN B 1#/20m^2	72 ±3	59 ±15	68 ±3	55 ±14
COVERED	94 ±10	83 ±15	88 ±9	78 ±14
OPEN C 1#/10m^2	90 ±22	22 ±5	41 ±10	10 ±2
COVERED	123 ±25	81 ±8	55 ±12	38 ±18
OPEN D 1#5m^2	90 ±19	21 ±1	21 ±5	5 ±.23
COVERED	198 ±30	51 ±6	48 ±7	12 ±1

* ± Standard Error
† This transplant date was optimum for open grown seedlings. The producer stated that optimum transplant date for covered seedlings from these plots preceeded open-grown seedlings by 2-3 weeks.

This data shows very clear advantages to the seedbed cover and suggests that producers could perhaps seed one-half the amount of seed they are currently planting if they planted under plastic covers. It is common for highlands growers to plant 7-9 lbs. of seed/ha. and seed costs are $35 to $60 per pound. The initial costs of establishing the seedbed cover are less than $1 per m^2 of bed and recurring costs would be minimal. Thus, it would not be unrealistic to expect that a producer would pay for the seedbed cover costs only with the savings in seed expenses from one year and that the bulk of subsequent years savings would be additional income. Additionally, there are several "hidden" benefits of a covered seedbed related to more rapid and healthier seedling development which are more difficult to quantify.

Some question still remains over optimum planting density beneath the seedbed cover. Density A is the standard planting density in the area and the data suggests that the highest yield of transplants results from this density under seedbed cover. It is possible, however that a management can be developed for increasing plant density under the seedbed covers and thereby significantly decreasing seedbed area and production costs. Experiments planned for 1985 will seek to validate these results with a second year of data and to more precisely define optimum planting density beneath the seedbed covers.

Conversations with both cooperating producers indicate that they are pleased with the seedbed cover design and both are planning to use covered seedbeds in the 1985 growing season. The seedbed cover uses bamboo or wooden posts with #8 or #10 wire as the support struture. Smaller pieces of split bamboo are wired in place with finer wire every 5 meters to provide rigidity to the structure. Four mil clear polyethylene is used to cover the wire and the plastic is held in place with clothespins. All materials are readily available in Panama.

Onion varietal trials consisting of several commercial and experimental onion varieties were planted during the rainy season at several locations in Cerro Punta and Boquete (see Progress Report 9). The earliest of these trials should be harvested during the month of January. The trial in Cerro Punta has not fared as well as the one in Boquete because a general lime application which had been made over the Cerro Punta research station in early 1984 did not include the terraces where the onion seedbeds were planted and the pH had fallen to 5.2-5.3. Nevertheless some varieties have developed reasonably well and the trials should provide valuable information when harvested.

Dr. Gaskell visited the research facilities of ARCO Seed Co. in El Centro, California during a recent trip to attend the Annual Meetings of the American Society of Agronomy in Las Vegas, Nevada. Plans were made during the visit to evaluate several commercial onion varieties in at least four different onion growing areas of Panama in a similar manner to the varietal evaluations now underway. ARCO agreed once again to supply seed in exchange for copies of the results of the experiments.

IDIAP researcher Lineth Carranza de Iamboglia is working toward the M.Sc. in Horticulture at Rutgers and plans for her to take charge of the highlands onion research program upon her return to Panama have been discussed with IDIAP's Director General. Dr. Gaskell also discussed with ARCO researchers the possibility of Ing. Carranza spending time at ARCO facilities in El Centro to become familiar with onion breeding and seed production procedures following completion of her M.Sc. training at Rutgers in 1985. ARCO was very receptive to the idea and an effort is now underway to seek formal approval by IDIAP and ARCO administrators.

Designs for several different solar onion dryers have now been provided by Dr. Mark Singley and Mr. Gonzalo Villalobos with the assistance of the Department of Agricultural Engineering at Rutgers. Plans are underway to modify the solar dryer that was built in early 1984 in Bambito to include a chimney to move heated air through the onions. A separate smaller field dryer is also being built to try under field conditions during the 1985 season. Dr. Gaskell has contacted ARCO Solar, a division of Atlantic Richfield which manufactures photovaltaic cells, inquiring as to the possibility of testing photovoltaic equipment as a means of powering a fan on the dryer under remote on-farm conditions in Panama. Three of the solar dryer designs could conceivably be improved by a photovoltaic system under circumstances where electricity is not available as is the case on many onion farms in the highlands.

In early October, Dr. Gaskell and IDIAP's Cerro Punta research station hosted the regular meeting of the National Onion Commission. Several lowlands onion growers from Nata and Los Santos attended, as well as highland growers, representatives from the Horticultural Cooperative in Boquete, MIDA, IMA, ENASEM, and other Commission members. Dr. Gaskell presented a seminar entitled "Alternatives for Rainy Season Onion Production in Panama" and led a tour of the onion experiments underway at the Cerro Punta research station. Plans are underway to host a second meeting in Cerro Punta in early January for a discussion of onion drying alternatives.

Caisan Area

Background The predominant cropping pattern in the Caisan area is a maize-dry bean rotation. Maize is grown from March until early September and dry beans from late October until February. Dr. Gaskell has developed a research program which seeks to complement on-going research in the area and provide opportunities for training Panamanian researchers in the field. Research with both crops is attempting to develop improved crop management recommendations.

Research with dry beans has been directed toward a more in depth evaluation of their nitrogen and phosphorus fertility requirements. IDIAP researchers in the area in their 1983 annual report concluded that nitrogen is not a limiting factor in dry bean

production in Caisan. Results from research conducted during the 1984 growing season (see Progress report No. 9) suggests that this is not the case and that there is a very significant response to nitrogen if phosphorus is applied in adequate amounts. Phosphorus is likely the critical problem because the soils are capable of fixing high amounts of phosphorus and it is likely that insufficient phosphorus was applied in previous experiments to satisfy the soil phosphorus fixation capability. Research with maize has also been directed at fertility requirements as well as the relationships among variety, planting density and potential maize productivity in the Caisan region.

Current Activity - dry beans. 1985 dry bean experiments were planted in late November and early December. The rainy season staved on until the end of November and one earlier planted experiment was destroyed by washout from the high late season rainfall. Data collection has begun on on-farm experiments to validate and more precisely define the nitrogen and phosphorus response observed in 1984.

Other experiments which are new this year are evaluating the response of dry beans to the post-emergent application of the herbicides bentazon (Basagran) and fluazifop-butyl (Fusilade) at three plant densities. Both herbicides are expensive but if they are sufficiently effective, they could perhaps be paid for by yield increases resulting from higher planting densities in narrower rows.

The majority of previous research with row width and planting density in dry beans throughout the Latin American tropics has shown a yield advantage to narrower row and higher plant densities. This is especially true with the Type 1 determinate bush beans which predominate in the Caisan area, because individual plants exhibit relatively little yield elasticity. Thus, once per plant production reaches a maximum, yield increases must come from higher seeding rates. The problems arise with weed control in narrow rows at higher densities and to a lesser extent, diseases if it is unusually rainy. These experiments will provide valuable information on dry bean plant density/row width/ weed control relationships in Caisan.

The economic analysis of the nitrogen and phosphorus fertility experiments with dry beans in 1984 has been completed. Yield response data was reported in Progress Report No. 9. The economic analysis results from experiments on two farms in the Caisan area show a strong economic return for the application of 100 kg./ha. of nitrogen as urea if 50 kg./ha. of P_2O_5 is banded with the seed at planting (Table 3).

TABLE 3. Economic analysis of no-till dry bean fertilization experiments from two farms in Caisan, Panama. 1984.

FERTILIZATION N (kg./ha.)	P_2O_5 (kg./ha.)	YIELD (kg./ha.)	ADDITIONAL YIELD VALUE ($)	FERTILIZER PRICE ($)	ADDITIONAL RETURN ($)
		- Arauz Farm -			
0	0	1500	--		
50	0	1950	531.00	43.00	488.00
0	50	1606	125.08	52.00	73.08
100	50	2586	1281.48	138.00	1143.48
		- Gonzalez Farm -			
0	0	1910	--		
50	0	2609	824.82	42.00	781.82
0	50	1889	--	--	--
100	50	2829	1084.42	138.00	946.72

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The phosphorus is apparently critical to the nitrogen response as the response to nitrogen without phosphorus is more variable. There was no consistent response to phosphorus without nitrogen. These results suggest that these precocious, determinant bean types in the Caisan area are incapable of fixing sufficient nitrogen for optimum yield. With a good response to nitrogen and phosphorus and with good bean prices relative to fertilizer prices we see good return for fertilizer application. The experiments now in the field will validate these observed responses at other locations in a second year and will also more precisely define optimum nitrogen and phosphorus fertilizer needs for dry beans in the Caisan region.

Current Activity - maize The data has now been analyzed from 1984 maize fertility experiments. A significant response to nitrogen was observed on both farms and in each case that response was enhanced by the application of phosphorus (Figure 2). The overall yields of both control and fertilized plots particularly on the Gonzalez Farm, although higher than average yields in the area are not as high as one expects of well managed maize and in good years the area is capable of producing higher yields. Foliar diseases were quite severe in the area this year and local farmers report that the severity was what one might see in the area every 1 in 5 to 1 in 10 years.

An economic analysis of the maize fertility results (Table 4) shows that although there is a significant yield response to nitrogen and phosphorus fertilization, the yield increases generally do not justify the costs of fertilizer. A small profit was realized on one of the two farms but this would likely be consumed by hidden increased management costs such as fertilizer transport, etc.

These maize response values should be considered preliminary until they have been confirmed with a second season of data. If the maize response to nitrogen and phosphorus is not economical in a significant portion of the years, it is possible that maize would show a residual response of phosphorus applied to beans,

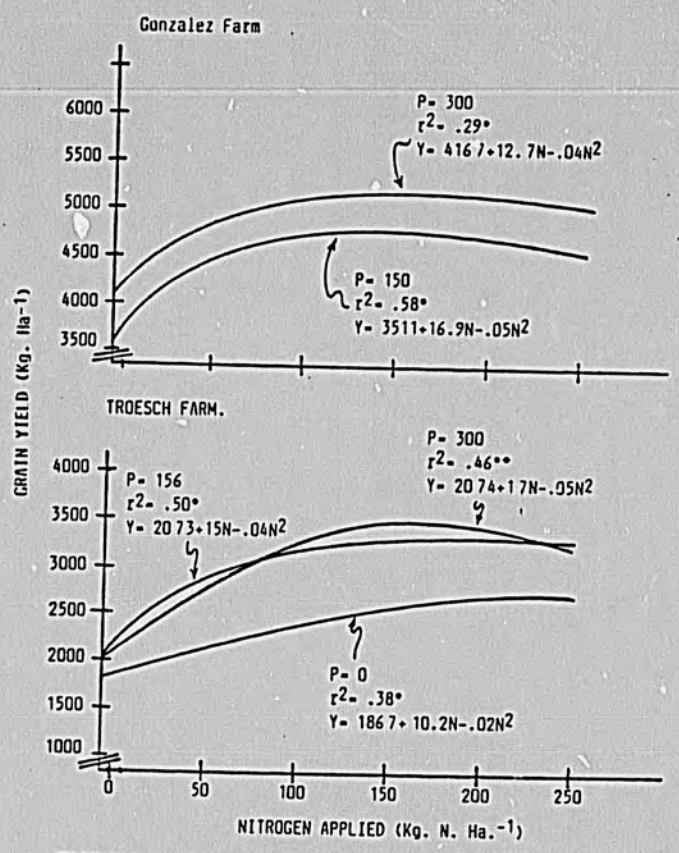

FIGURE 2. No-till maize grain yield response to nitrogen and phosphorus fertilization on two farms in Caisan, Panama. 1984. P equals kg./ha. P_2O_5.

Table 4 . Economic analysis of no-till maize fertilization experiments on two farms in Caisan, Panama. 1984.

FERTILIZATION N	P2O5 (kg./ha.)	YIELD (kg./ha.)	ADDITIONAL YIELD VALUE ($)	FERTILIZER PRICE ($)	ADDITIONAL RETURN ($)
		-Gonzalez Farm-			
0	0	4137	--	--	--
0	150	3511	--	--	--
0	300	4167	7.20	157.50	--
100	150	4701	135.36	242.00	--
100	300	5037	216.00	400.00	--
150	150	4920	186.00	285.00	--
150	300	5172	245.86	442.50	--
		-Troesch Farm-			
0	0	1868	--	--	--
0	150	2973	49.20	157.50	--
0	300	2074	48.93	345.00	--
100	150	3173	313.20	242.00	71.20
150	150	3423	373.20	285.00	88.20
150	300	3499	387.36	442.50	--

since most farmers in the area rotate the two crops and the application to beans appears to be profitable. A research effort on the residual value of fertilization in the two crops should be initiated in the area as soon as possible, however it will be difficult because IDIAP does not own or rent a parcel of land in the area and all work is done on farmer's fields. Thus, access to the same parcel of land cannot be assured from crop season to crop season.

The problem really lies in the overall low yields and the slope of the fertilizer response curve. Two factors are apparently ultimately limiting yields under good management; diseases and low solar radiation. In some years the high rainfall contributes to a foliar disease complex that is capable of so severely infecting maize fields in the area that it in effect terminates the grain filling period early. In many fields in the Caisan area in 1984, plants were so severely affected by foliar diseases so as to appear mature 10 to 15 days after pollination. The long term solution to this lies in a breeding program to incorporate disease resistance into the OP maize varieties which prediminate in the area. A foliar disease breeding program should be initiated in the area as soon as possible.

The second factor that is apparently keeping a cap on maize yield in the area is the overall low levels of solar radiation; particularly during the grain-filling period. The cloudiness and high rainfall in the area severely restrict solar radiation. Although direct measurements have not been made in Caisan, estimates based on 10 year averages of nearby station values suggest levels of 330 and 360 cal/cm^2/day during the months of July and August (1). Recent research reported from Hawaii in which 15 maize hybrids were planted monthly over a 41 month period shows a close relationship between solar radiation and maize grain yield (Figure 3).

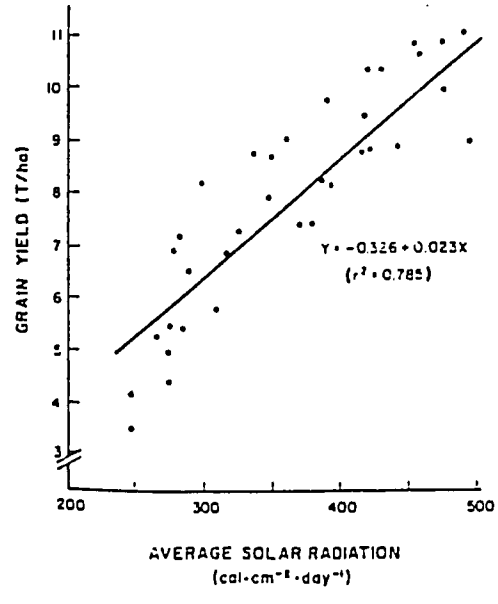

Figure3 . Relationship between grain yield and average solar radiation in monthly plantings.

(from Jong et al. 1982. Effects of solar radiation on the performance of maize in 41 successive monthly plantings in Hawaii. Crop Sci: 22: 13-18.)

This data suggests that hybrid maize yields in Caisan under high management may be limited to about 7 t./ha. The variety which predominates in the area is an OP variety which would have a somewhat lower yield potential and this combined with foliar diseases and lower plant population reduce yields to the 3 to 5 t./ha. range. With these yield levels, nitrogen or phosphorus is not severely limiting to production.

There are two possible solutions to the solar radiation problem; produce maize in a time of the year where solar radiation would be higher or increase plant population. The problem with the first alternative is that it would cause interference with dry bean planting and dry beans are a more profitable crop. The second alternative is a possibility although IDIAP researchers in the area have determined in previous research that 50,000 plants per hectare is optimum. One would suspect an interaction between plant population, soil fertility, and foliar diseases which means that plant population experiments should be conducted at several sites over several years and with high soil fertility.

Results of preliminary experiments from 1984 suggest that barrenness does not set in even at plant populations of 70,000 plants per hectare. Thus, one might expect higher yields from more efficient harvesting of the low solar radiation and the production of many more smaller ears. It is important that these plant density/variety experiments be continued in coming seasons at as many sites as possible under high fertility conditions.

In late November, Dr. Gaskell presented two papers at the International Section of the Annual Meetings of the American Society of Agronomy in Las Vegas, Nevada, summarizing work in which he has been involved in Panama. One paper was entitled "Building Institutional Agricultural Research Capability in Western Panama" by J.P. Arauz and M.L. Gaskell, and summarized an organizational strategy for managing on-farm research at the local level and for connecting that research to extension. The second paper, "Response of No-till Dry Beans to Nitrogen and Phosphorus in Panama" by M.L. Gaskell, M. Acosta and R. DeGracia summarized 1984 dry bean fertility research from Caisan.

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1. Villareal, Carlos M. 1984. Soil Water Balances for the Province of Chiriqui (in Sapnish). RENARE - Ministry of Agricultural Development, Panama, Rep. of Panama.

III. SOILS MANAGEMENT SPECIALIST
Dr. Luis A. Manrique,

A technical soils bulletin on the Benchmark Soils of Panama was going to be prepared to summarize current knowledge on soils, crops and environment of most experiment stations in Panama. The preparation of this bulletin was outlined in Dr. Manrique's work plan and approved by IDIAP in February 1984. Several months were spent to collect published available information on soils of Panama. In addition, weather data for most experiment stations were collected and computer programs have been developed for climatic analysis. Crop data of several agronomic experiments in IDIAP stations have been analysed and interpreted. In May 1984 a proposed outline of the technical bulletin was prepared and sent to Drs. Scott, Bryant and Van Wambeke of Cornell University, Gaskell of Rutgers University. and Dr. Jonas of IDIAP. In August 1984, Dr. Bryant visited Panama and helped Dr. Manrique to organize portions of the soils bulletin regarding morphological, physical, chemical and mineralogical characterization of the Benchmark Soils of Panama. Continuation of this research will depend upon whether the soils bulletin content is compatible with IDIAP's goals and objectives. Dr. Jonas and Mr. Jaramillo, soil scientists from IDIAP, are reviewing the scope and content of the soils bulletin.

Three small weather stations were installed in Ultisols of Ocu, Santiago, and Calabacito. Rainfall, air temperature, solar radiation, relative humidity and soil temperature are being recorded on a daily basis. The object was to provide local scientists with weather data that will help them to incorporate the effects of the environment on crop performance. Whereas the Santiago and Calabacito weather stations are still operational, the weather station at Ocu was vandalized, its weather instruments destroyed, and is no longer in use.

A systematic climatic analysis at national level was initiated in June 1984 to assess the impact of weather on crop performance in most IDIAP experiment stations. Simple SAS computing programs were prepared to calculate potential evapotranspiration, dependable rainfall, moisture availability index and available energy (Thermal units and Temperature function units). A data base management program was prepared to handle, organize and retrieve climatic data and assessment outputs. In early September, inputs for climatic analysis were arranged in a computer format and handed to Dr. Jonas, IDIAP's soil coordinator, for computing analysis. The research on climatic analysis is currently at halt pending the computer outputs.

IV. ANIMAL PRODUCTION SPECIALIST

Dr. Alfredo Serrano,

General Considerations

During his third quarter of residency in Santiago, Veraguas, the animal production specialist continued work on originally planned research; designed a record system for use on IDIAP's experimental and commercial herds; he participated in an International meeting in Lima, Peru; advised IDIAP's Animal Science technicians and organized two training events. During this same time period, he attended to the visit of Dr. Reed Hertford, Director of the International Agricultural and Food Program at Rutgers University and Dr. Jim Wolth, Nutritionist in the Animal Science Department at Rutgers University. Dr. Serrano organized a meeting with the Director of IDIAP, the Director of Animal Science Department and Dr. Reed Hertford to discuss the project's progress and to elaborate goals for 1985.

Specific Areas of Activity

Diagnosis and prevention of diseases of economic importance.

Incidence and causes which determine the slaughter of fertile cows.

Background In 1982, there were 1,456,300 head of cattle with an average growth rate of 1.3% during the period 1984-1982. During this same period, as annual average of 16.2% of the cattle were slaughtered. The low growth rate is attributed principally to lack of applied improved management practices and the low commercial value of the meat which, in turn, caused the slaughter of a high percentage of cows.

The average annual slaughter of cattle in Panama and in Santiago, Veraguas, is presented in the following chart:

YEAR	PANAMA	SANTIAGO
1973	194,778	23,410
1974	206,580	23,074
1975	222,391	26,758
1976	241,124	28,985
1977	239,755	28,659
1978	216,322	26,866
1979	196,534	22,879
1980	214,896	26,433
1981	238,741	31,602
1982	276,633	43,851

The fluctuation in the statistics in the last ten years is due to the quota of exportation and climactic factors such as the summer of 1982 where farmers were forced to slaughter animals for lack of forage; however, the farmer in general is in agreement that small financial gain in recent years has obliged them to sacrifice a large number of cows.

Progress The collection and identification of cows' reproductive organs continues in the Santiago Slaughterhouse and there presists a high incidence of pregnant cows slaughtered. The most common reproductive disorders which affect cow fertility are secondary to factors of nutritional and hereditary origen and to stress factors. The most common abnormalities are a) cycling ovaries with mature follicles b) granular vaginitis c) static ovaries d) persistant corpus luteum and e) metritis.

Future Plans Dr. Serrano will complete the study of case identification, expand the research to other slaughterhouses in the country and survey the farmers and intermediaries to discover in detail the reasons for which the farmer feels the necessity of slaughtering fertile cows.

To obtain this end, samples will be taken for analysis and isolation of germs which affect cattle reproduction; fro example, 2% of the slaughterhouse employees react positively to Brucelosis. There are no statistics in this country on the prevalence of viral diseases and there exists little information on leptospirosis; it is also necessary to study the incidence of trichomoniasis and campilobacteriosis.

Calf Raising on Dual Purpose Farms.

The object of this experiment was to establish an association between the grass Swazilandensis and the legume, Stylosanthes capitata as a source of protein for calf raising.

There have been problems in demonstrating such association. The plot was sown in September with Stylosanthes seed. Due to the problem of weed control, it has not been possible to sow Swazilandensis and the possibility of such sowing is less now that the dry season has begun.

The effect of temporary calf weaning on the reporductive efficiency of dual purpose cows.

Background As mentioned in earlier reports, the majority of researchers in the American tropics associate low reproductivity in dual purpose cows with the stress of lactation and inadequate nutrition especially in the dry season. The practice of early weaning or of temporary weaning of the calf has proven to be a good alternative in reducing pospartum anestrus (PPA) identified and recognized for many years.

Progress The first experiment began with a group of ten cows on IDIAP's experimental farm in Calabacito. The cows were Brown Swiss x Zebu with a postpartum anestrus of 2-4 months. The calves of these cows were separated for 48 hours. In order to study the cow' reproductive cycle and to study the condition of the ovaries, the cows' ovaries were palpated rectally by palpation immediately before the calves were taken away and then at 14, 28, 60 and 90 days.

After three initial examinations it was found that the cows continued in anestrus and their ovaries remained inactive. The examination at 90 days found four out of ten cows with ovaries cycling while the rest continued in anestrus (neither estrus nor heat).

In the first week in October, four additional cows were stimulated during temporary weaning in a 72 hour period. The ovaries of those cows were checked before temporary weaning and they were found to be static. Later, at 14, 28 and 60 day examinations, the ovaries of those same cows continued inactive.

As a conclusion to the first finding, one can speculate that this crossbred cow, Brown Swiss x Zebu, in order to respond to the stimulus of temporary weaning, must receive a better diet and a diet minerally balanced; the soils of Calabacito are deficient in P, S, N, Ca, Mg, and S.

A second experiment was begun on the farm of Mr. Gregorio Villarreal, a farmer from Los Santos, Herrera. Sixteen Zebu-type milking cows, 3-7 months postpartum, with calves were selected for the experiment. At palpation, the cows were cycling, but were not pregnant. Nine calves were separated from their respective mothers immediately after milking for five consecutive days. The rest of the cows were allowed to remain with their calves. Milk production and calf weight were recorded daily for the five days of the experiment.

At 60 days, the cows were palpated and it was found that 1) three cows were pregnant between 30-60 days, 2) three cows were pregnant between 70-90 days 3) one cow serviced the same day and 4) two cows not pregnant.

In the control group, seven of the cows were pregnant between 75-110 days and one cow was pregnant at 45 days.

The results of the experiment show that a) the season of the year influences cow fertility when the cows are well fed, b) that it is possible to improve herd pregnancy rates with temporal weaning and c) it is necessary to do more research on early weaning and temporary weaning.

Correlation between Testicular Development and Body Weight

Background As stated in earlier reports, no information exists in Panama on the correlation between testicular development and potential body weight.

Progress Due to priority of other work, only five more cases were studied.

Results of the studies are presented in the following chart, however, due to the reduced number of cases studied to date, there will be no comments made related to the present research.

Productive and Reproductive Parameters of Beef Cattle Slaughtered in the Santiago Slaughterhouse

No. Cases	Age Years	Weight in lbs. Body	Weight in lbs. Carcass	Scrotal Circum. cm.	TESTICLES Left Dim. cm.	TESTICLES Left Wt. gms.	TESTICLES Right Dim. cm.	TESTICLES Right Wt. gms.	EPIDIDYMIS Left	EPIDIDYMIS Right	DUCTUS DEFERENS mm
1	2.5	852	488	30.5	L-10.0 W- [illegible] D- 5.5	240	L-10.5 W- 5.0 D- 5.0	240	L-1.5 W-1.0 T-2.0	L-1.0 W-0.5 T-2.0	Left 3.0 Right 3.0
3	3.0	839	469	28.5	10.0 5.5 4.5	333	10.0 5.0 5.0	333	4.5 2.0 0.5	4.5 3.0 0.5	Left 3.5 Right 3.3
1	4.5	1207	648	30.5	10.5 6.0 5.5	290	10.0 6.0 5.0	290	4.0 9.5 1.0	5.0 9.0 1.5	Left 2.0 Right 3.0

L=length cm=centimeters H=head
W=width mm=millimeters B=body
D=depth T=tail

Future plans Study of cases will continue until 100 cases have been studied.

Supporting Activity

Sr. Serrano collaborated with the Bayano Corporation in evaluating 177 cows and 9 bulls used during the last breeding season. The object of such work was to train Dr. Victor Escudero in the methodology employed in reproductive evaluation of herds.

A system of records for herd production and reproduction was designed and implemented on the experimental farms of Calabacito and Arenas.

Dr. Serrano participated in the evaluation of research in the Animal Science Department and presented and evaluation of reporductive behavior in dual purpose herds on the Calabacito experimental farm. He suggested the design for an interdisciplinary research project aimed at solving the problems of low soil fertility in the Calabacito area.

Dr. Serrano visited the INA installations and discussed a program of inter-institutional cooperation with Dr. David Quiros, IDIAP-INA and Dr. Ernesto Rodriguez, MIDA-INA.

Training

Continued training was offered to the veterinarians and technicians of the Animal Science Department by means of field practices.

In the area of Chepo, IDIAP's eastern region, a conference was given on "Methodology Used in the Evaluation of Bulls." Nineteen people attended the conference. (Technicians: IDIAP - 4, Bayano - 4, Banco de Desarrollo Agricola - 4, MIDA - 4, and local farmers - 3.

On December 19 to 20, a workshop was organized on "Techniques of Bull Semen Freezing and Embryo Transplant." Seventeen professionals from various institutions were invited (IDIAP, MIDA, INA, Ministry of Health, Banco Nacional de Panama).

Other Activities

As a guest of FAO-IAEA Division of Isotpe and Radiation, Dr. Serrano attended the first coordination meeting of "A Regional Network to Improve the Reproductive Management of Beef and Dairy Cattle in Latin America. The meeting was held in Lima, Peru, November 5-9, 1984. Dr. Reato Barrera, IDIAP veterinarian attended a training course on techniques used in radioimmunoassay and its application to animal production. The course was financed by FAO-IAEA and asted six weeks. Drs. Serrano and Barrera have designed two research projects on radio immunoassay techniques and are currently soliciting FAO-IAEA via IDIAP, technical cooperation to initiate their project.

Dr. Serrano and technicians from the Animal Science Department of IDIAP, headed by Dr. Carlos Moran, organized the visit of Dr. Reed Hertford and Dr. Jim Wolth from Rutgers University. Drs. Hertford and Wolth visited work sites in the eastern, central and western regions of Panama.

Dr. Wolth, Nutrition Specialist, contributed significantly with suggestions and recommendations for the 1985 work plan.

Lastly, a meeting was held with the General Director of IDIAP, the Director of the Animal Science Program and Drs. Serrano, Hertford and Wolth and Dr. Mark Gaskell to discuss this year's accomplishments, various problems and to define work priorities for 1985.