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EVALUATION STUDIES ON TRAINING OF AGRICULTURAL RESEARCHERS AT CIAT

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C I A T

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CONTENTS

INTRODUCTION

The Centro Internacional de Agricultura Tropical (CIAT) has completed fifteen years of being offering scientific training and other cooperation means to strengthen agricultural research of the commodities within its mandate (rice, beans, cassava and tropical pastures) in Latin America

CIAT's management, therefore, decided to carry out a set of studies to find out how its training activities have contributed to agricultural research in national programs

These training activities can be considered a significant component of the efforts of the Latin American countries and of the international agricultural community to institutionalize the science and its technological applications as a value deeply rooted in the economic and social development mechanisms of these societies

The present report summarizes the work carried out between 1980 and 1983 These studies include the concepts that ex-trainees and their supervisors in the national programs have about CIAT scientific training, the contribution that training has made to the formation of human resources for research in Latin America, and its contribution to the establishment and maintenance of international networks of agricultural researchers In order to have a deeper understanding of its contribution to the strengthening of national programs, four case studies were advanced as follows beans in Guatemala, rice in Ecuador, cassava in Mexico and tropical pastures in Peru

A Objectives

The objectives of these studies are

1 To obtain indicators of the quality and usefulness of research training at CIAT, as assessed by former trainees and their supervisors at national institutions
2 To establish the number and relative proportions of former CIAT trainees who rejoined their sponsor institutions, and continue active in research
3 To determine the participation of former CIAT trainees in networks of researchers
4 To explore, by means of selected case studies, who scientific training has contributed to the strengthening of national research programs

B Independent variables

Relationships between aspects of former trainees' research performance and three selected factors are explored 1) training content, 2) length of training duration, and 3) facilities at home organizations available for research in the fields in which training has been provided Other features of the training experiences are assumed to be similar for all participants the philosophy and goals of the training program, its physical

and organizational setting, the training facilities available at CIAT, and the quality of instruction, e g , quality of instructors delivering methods and training materials

1 Training content is assumed to reflect a substantive variable of the structure of science the knowledge and technology basis available for doing research in different fields of science Variation due to training content is explored by grouping the population in research-related commodities Content is assumed to be similar within each research commodity, but different between them The research and training work at CIAT is organized in four commodities a) rice, b) beans, c) tropical pastures, and d) cassava Therefore, these four categories of training content are separated in these studies

2 Training duration is defined as the time from physical arrival to CIAT to departure from CIAT, and measured in number of months It is grouped in three levels a) short training, when it took up to two months, b) intermediate training, for programs between more than two months up to six months, and c) long training for programs longer than six months

3 Research facilities The availability of support facilities needed for carrying out research once trainees go back to their home organizations is a structural variable which reflects the national priorities assigned to research within the countries as well as the internal constraints within organizations To account for this variable, the Latin American countries which have sent professionals to CIAT for training were classified in eight groups, two per commodity those with more research facilities in each commodity, and those with less facilities

C Population, sampling and data collection

The study population was defined as all former research trainees from Latin America who completed their training between 1969 and December, 1979, in any of the four CIAT commodity programs

Data collection was designed in five stages

1 An exhaustive file-by-file review, in order to organize the data in terms of categories suited to the study objectives

2 A mail census to all Latin America institutions which sponsored individuals for research training at CIAT This census was designed in order to obtain data for objetive 2 It was also instrumental for building a trainees directory required in the subsequent stages of the study

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* The term Latin America is applied in these studies to mean the Western Hemisphere except for U S A and Canada The term Latin America and "the region" are used here interchangeably

3 A network questionnaire sent by mail to all former CIAT trainees from Latin America who engaged in research after training (Objective 3) Following this questionnaire a snow-ball sampling technique was applied to determine the whole network in which former CIAT trainees participate

4 A 16-page detailed questionnaire sent by mail to a stratified random sample of 111 former CIAT research trainees from Latin America This questionnaire was designed to meet the terms of objective 1

5 Four case studies of national research programs designed to better understand trainees' research performance after training (Objective 4)

This report is presented in eight sections I) Distinctive characteristics of these studies' population II) Assessment of CIAT training by former trainees, and their supervisors, III) Former trainees at work, IV) Return to and stay in their institutions, research, and fields of training, V) Participating in networks of researchers, VI) Strengthening research programs, VII) Interpretation,and VIII) Conclusions

I DISTINCTIVE CHARACTERISTICS OF THESE STUDIES' POPULATION

This studies' populations is composed of young scholars who were usually in their first job assignments when they entered CIAT's training, for many of them their stay at CIAT in Colombia was their first trip out of their home land, their first opportunity to interact with members of other cultures and their first chance to become personally acquainted with people whom they regard as highly competent professionals The vast majority of them still do not hold formal degrees beyond the B S level, and occupy middle level professional positions within large, complex agricultural research organizations Their job assignments are usually defined as relatively specialized full-time research In most cases they are not part of an agricultural technology delivery system

In their work often they are not the research designers, but rather mediators between those who produce new S&T for agriculture and the users of such knowledge (farmers, extension staff, people in agrobusiness) As mediators usually they do not live in the capital cities but in the countryside close to the production units (farms) for which they test and make adaptations of already available technology Most of them have not published in international journals and are not listed in the science citation index, and few are influential in the policy-making of their countries

They are seldom taken into account in the development of macrolevel plans for generating an endogenous science for appropriate technology Notwithstanding, these are the researchers who are trying to make technological options relevant and applicable for increasing agricultural production and productivity in their immediate working sites and countries Given the location-specific nature of farm problems in conjunction with part of the agricultural technology, without the continuing work contributions of these researchers a large proportion of new S&T may remain useless for development

A Population distribution in relation to each of the independent variables

The population relevant to these studies in composed by 783 former trainees out of which 173 (22 1%) received training in rice, 245 (31 29%) in beans, 172 (21 97%) in tropical pastures, and 193 (24 64%) in cassava (Table 1) * Although differences in the proportions of trainees who were exposed to each training content are not large, a slightly higher number of persons in beans research is observed

Concerning training duration almost half of the population (49 43%) received a short training period of two months or less, about one third slightly more than one sixth (18 14%), a training period longer than six months (Table 1)

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* For additional data on the distribution of this population see Appendix A, Tables 1-5

As for facilities available for research* at their home organizations, about two thirds (65 65%) of the population was from countries classified as having more research facilities available for research in the area in which they had been trained, and approximately one third (34 35%) was from countries classified as having less facilities (Table 1)

Tables 2 and 3 show respectively how the proportions for training duration and research facilities distribute in relation to training content As for training duration cassava and beans have concentrated in short training periods, rice has focused on short and intermediate training with a slight tendency toward the intermediate ones, and tropical pastures has emphasized intermediate and longer periods with a slight tendency toward longer training (Table 2) Training in rice or cassava concentrates more in those countries classified as having more facilities to do research the proportion, as indicated in Table 3, is 3 1 in rice and cassava, while it is 2 1 for the whole population For the other two commodities, in contrast the proportions are below the general proportion, 2 1, for the whole population being almost even 1 1 for tropical pastures

Table 1 Distribution of the study population by training content, training duration, and facilities available for research at home organizations

Independent variable	(No)	(%)
Training content	783	100 00
Rice	172	22 10
Beans	245	31 29
Tropical Pastures	172	21 97
Cassava	193	24 64
Length of training	783	100 00
2 months or less	387	49 42
2-6 months	254	32 44
6 months or more	142	18 14
Facilities available for research	783	100 00
"More" facilities	514	65 65
"Less" facilities	269	34 35

* For details about this classification see Appendix B

Table 7 Number of research trainees from Latin America, distributed by content and training duration

	Duration (months)							
	2 or less		2<d<6		6 or more		TOTAL	
Content	(No)	(%)	(No)	(%)	(No)	(%)	(No)	(%)
Rice	73	9 32	81	10 34	19	2 43	173	2ℓ 09
Beans	135	17 24	84	10 73	26	3 32	245	31 29
T Pastures	36	4 60	67	8 56	69	8 81	172	21 97
Cassava	143	18 26	22	2 81	28	3 58	193	24 65
TOTAL	387	49 43	254	32 44	142	18 14	783	100 00

Table 3 Research trainees from Latin America, distributed by training content and facilities available for research at home institutions

Content	Facilities: More (No.)	(%)	Facilities: Less (No.)	(%)	TOTAL (No.)	(%)
Rice	133	16 99	40	5 11	173	22 10
Beans	150	19 16	95	12 13	245	31 29
T Pastures	87	11 11	85	10 86	172	21 97
Cassava	144	18 39	49	6 25	193	24 64
TOTAL	514	65 65	269	34 35	783	100 00

B Profile of the study population in terms of age, gender, marital status, education, and country of origin

Most of the research trainees are relatively young married men with an education at the B S level (Table 4) People under 34 years of age represented 60% of the population That nine out of ten are men reflects the historical fact that only recently women have been entering agricultural research careers in Latin America

Regarding marital status, the proportion of married to single people is almost 2 1 A few former CIAT trainees (3 19%) do not have an education at the B S level or the equivalent, most of them come from countries where agricultural education at the university level has been established only recently But the bulk of the study population (86 59 %) has formal education at the B S level One out of 10 has studied beyond the B S level, most of those held a Master's degree at the time of training or were at CIAT carrying out field work for their thesis, some of the individuals classified at the Ph D level had not graduated at the time of their training at CIAT, but were in the last stages of their doctoral work

The ages and educational levels predominant in this population suggest that most of its members were entering research careers when they went to CIAT for their training, many were in their first job, and a high proportion of former CIAT research trainees probably occupied low, or at the most, intermediate positions in their organizations before training

Regarding the country of origin, a high proportion of the study population came from two countries Brazil and Colombia (Table 5) In fact, Brazil sponsored nearly one fourth and Colombia one fifth of former CIAT research trainees for a combined total of 42 4% Seven countries sponsored between 4 and 6% each Ecuador, Mexico, Peru, Guatemala, Venezuela, Honduras and the Dominican Republic, for a total of 36 14% The remaining 17 countries accounted for only 21 46%, with less than 4% each

The concentration of CIAT research training in Brazil and Colombia during the past decade may be associated to country science policies and easy access to CIAT Brazil gives high priority to the development of local scientific capabilities for its productive sectors Since the 1960's Colombia has been actively engaged in preparing human resources for agricultural research The circumstance that Colombia is the host country for CIAT activities has facilitated the access of Colombian agronomist to CIAT's training programs

Other factors which could explain the uneven proportions presented in Table 5 are the lack of awareness in some countries about the research training opportunities available at CIAT, less relevance of CIAT's work for non-tropical countries, e g , Argentina and Uruguay, preference of science policy makers and professionals of some countries for degree training or for the educational facilities offered by more developed countries, and low or no priority assigned to agricultural research in other countries

Table 4 Distributions of the study population in terms of age, gender, marital status, and education

Characteristic	(No)	(%)	Cumulative (No)	Cumulative (%)
Age (years)				
< 30	182	23 24	182	23 24
30 - 34	290	37 04	472	60 28
35 - 39	196	25 03	668	85 31
40 - 44	69	8 81	737	94 12
> 44	46	5 88	783	100 00
Gender				
Women	52	6 64	52	6 64
Man	731	93 36	783	100 00
Marital Status				
Single	283	36 14	283	36 14
Married	500	63 86	783	100 00
Education				
Less than B S	25	3 19	25	3 19
B S or equivalent	678	86 59	703	89 78
M S or equivalent	74	9 45	777	99 23
Ph D	6	0 77	783	100 00

Table 5 Research trainees from Latin America distributed by countries

Country	(No)	(%)	Cumulative (No)	Cumulative (%)
Brazil	185	23 63	186	23 63
Colombia	147	18 77	332	42 40
Ecuador	52	6 64	384	49 04
México	47	6 00	431	55 04
Peru	44	5 62	475	60 66
Guatemala	36	4 60	511	65 26
Venezuela	36	4 60	547	69 86
Honduras	35	4 47	582	74 33
Dominic Republic	33	4 21	615	78 54
Costa Rica	27	3 45	642	81 99
Bolivia	27	3 45	669	85 54
Cuba	21	2 68	690	88 12
El Salvador	19	2 43	709	90 55
Chile	16	2 04	725	92 59
Panama	13	1 66	738	94 25
Argentina	10	1 28	748	95 53
Nicaragua	7	0 89	755	96 42
Guiana	7	0 89	762	97 31
Belize	6	0 77	768	98 08
Haiti	5	0 64	773	98 72
Paraguay	4	0 51	777	99 23
Uruguay	2	0 25	779	99 48
Puerto Rico	1	0 13	778	99 61
Antigua	1	0 13	781	99 74
Jamaica	1	0 13	782	99 87
Trinidad	1	0 13	783	100 00

II ASSESSMENT OF CIAT TRAINING BY FORMER TRAINEES AND THEIR SUPERVISORS

Most former trainees surveyed and their supervisors interviewed for these studies assessed CIAT training as highly valuable for their work at national institutions, as well as for trainees' personal professional development

The data for this section originates from a survey to a random sample of 111 former trainees An 87% rate of response was obtained with the distribution of Table 6

Table 6 Respondents to the mail survey

	Calculated sample (No)	Response obtained (No)	Rate of response (%)
Beans	35	33	94
Rice	22	22	100
Tropical pastures	28	23	82
Cassava	26	18	69
TOTAL	111	96	87

A Suitability of CIAT training

The majority of former trainees assessed CIAT training as appropriate in terms of training duration, content level, amount of information delivered and training structure (Table 7) However, there are some noteworthy appreciations among the minority 1) relatively high proportions tend to assess of training duration as too short, particularly among rice trainees (41%), and 2) the amount of information delivered during their training at CIAT was considered too low by 21% of the bean trainees and excesive by 28% of the cassava trainees

Table 7 Suitability of CIAT training, distributed by commodity program (n = 96)

	Beans (%)	Rice (%)	T Pastures (%)	Cassava (%)	TOTAL (%)
Training duration					
too long	6	5	4	0	4
appropriate	85	54	78	72	74
too short	9	41	18	28	22
Training content level					
too advanced	0	0	0	6	1
appropriate	91	95	100	94	95
too elementary	9	5	0	0	4
Amount of information					
excesive	6	9	4	28	10
appropriate	73	86	91	67	79
unsufficient	21	5	5	5	11
Training structure					
too structured	9	9	17	17	13
appropriate	79	86	70	72	77
too unstructured	12	5	13	11	10

B Best topics

Answering the question of what topics justified the institutional and personal efforts involved in sending people to CIAT for training there is a diversity of judgements (Table 8) For bean and rice trainees the best topics are those related to methodology for plant breeding Agronomy (cultural practices) and phytopathology are among the highest for beans cassava and rice trainees There is no clear preference for a particular topic among tropical pastures trainees except for soils and plant nutrition Economics and biometry are the topics at the bottom of the list (their teaching and learning have always been a problem for CIAT training)

Table 8 Most valuable topics (n = 96)

Topic	PROGRAM				
	Beans (%)	Rice (%)	T Pastures (%)	Cassava (%)	TOTAL (%)
Methodology for plant breeding	70	77	26	22	52
Agronomy (cultural practices)	58	45	39	50	49
Phytopathology	52	77	17	44	48
Soils and plant nutrition	48	32	57	39	45
Germplasm information	45	50	48	22	43
Enthomology	50	30	22	39	34
Weed control	39	27	26	28	31
Plant architecture	36	50	17	17	31
Germoplasm-ecosystem interaction	24	32	39	17	28
Library and documentation centers	21	27	26	28	25
Training methods	15	18	26	6	17
Biometry	21	23	4	11	16
Economics	12	9	4	11	9

C Relevance and applicability of CIAT training

Over four out of every five former CIAT trainees regard their training as having high relevance and applicability to the conditions of their institutions and countries (Table 9) However, the data suggest concern for relevance among some cassava trainees and for applicability through all the commodities In rice, with 100% relevance, the concern with applicability may be related to the emphasis on irrigated rice during the first years of CIAT training

Table 9 Relevance and applicability of CIAT training content (n=96)

Program	High relevance (%)	Low relevance (%)	High applicability (%)	Low applicability (%)
Beans	94	6	88	12
Rice	100	0	91	9
Tropical Pastures	96	4	87	13
Cassava	89	11	83	17
TOTAL	95	5	87	13

Table 10 Degree in which training content has been used by former CIAT trainees in their work

Program	Degree of training utilization		
	High (%)	Intermediate (%)	Low (%)
Bean	67	27	6
Rice	82	18	0
Tropical pasture	52	35	13
Cassava	61	28	11
TOTAL	66	27	7

D Utilization of training content

Most former CIAT trainees report to have utilized what they have learned at CIAT in a high degree, there are some trainees reporting low utilization, particularly in tropical pastures and cassava (Table 10)

E Development and utilization of research skills

In general, there is a close balance between the research skills developed during training at CIAT and their utilization when trainees were back at their work (Table 11) Five types of research skills were examined research problem identification and definition, research design, data gathering, data analysis, and research reporting The development as well as the utilization of such types of research skills were assessed by former CIAT trainees in terms of three levels high, some and none degree of development or utilization

It is important to note that the utilization of data gathering skills tend to be higher than its corresponding development at training, and also that data gathering is more utilized than other research skills, a fact that corresponds with the nature of the population studied, predominantly composed by young, middle level researchers

Research reporting is a type of skill in which development at training is relatively low, particularly if compared to its corresponding high level of utilization by former trainees at work

Table 11 Development and utilization of research skills (n=96)

Skill	Development			Utilization		
	High (%)	Some (%)	None (%)	High (%)	Some (%)	None (%)
Research problem identification and definition						
Beans	56	28	16	65	29	6
Rice	64	36	0	73	27	0
Tropical Pastures	65	31	4	52	48	0
Cassava	78	22	0	67	33	0
TOTAL	64	30	6	60	32	2
Research design						
Beans	34	44	22	45	29	26
Rice	46	45	9	50	36	14
Tropical Pastures	18	65	17	22	43	35
Cassava	28	56	16	39	39	22
TOTAL	32	52	16	39	36	25
Data gathering						
Beans	47	44	9	71	16	13
Rice	55	36	9	50	36	14
Tropical Pastures	48	30	22	61	22	17
Cassava	33	56	11	61	33	6
TOTAL	46	41	13	62	25	13
Data analysis						
Beans	41	34	25	61	16	23
Rice	45	42	13	45	42	13
Tropical Pastures	35	30	35	48	18	34
Cassava	39	28	33	39	44	17
TOTAL						
Research reporting						
Beans	22	34	44	65	16	19
Rice	41	32	27	59	32	9
Tropical Pastures	39	22	39	43	22	35
Cassava	33	39	28	44	39	17
TOTAL	33	32	35	54	25	20

F CIAT support after training (training follow through)

Former trainees report to have received backing support from CIAT after training Most of them made arrangements when still at CIAT to contact with CIAT staff and programs The proportions reporting to have kept in touch with CIAT are slightly higher (Table 12) The number of times this has happened varies amoung trainees from 24 to zero, with an average of five, but it is relatively similar by commodity programs (Table 13) Annual reports, germplasm, scientific advise, information from CIAT library and documentation centers, training materials support to carry out in-country training, admission of colleagues to CIAT training, and invitation to participate in professional meetings at CIAT are the types of collaboration received from CIAT reported by former trainees (Table 14)

Table 12 Proportions of former CIAT trainees who, during their training, made arrangements to keep contacting CIAT staff, and proportions who report to have kept in touch with CIAT (n = 96)

Program	Arrangements (%)	In touch (%)
Beans	82	82
Rice	86	95
T Pastures	91	91
Cassava	72	89
TOTAL	83	88

Table 13 Number of times that former CIAT trainees have been in touch with CIAT personnel after training (n = 96)

Program	Maximum	Average	Minimum
Beans	20	5	0
Rice	20	7	0
T Pastures	24	4	0
Cassava	20	5	0
TOTAL	24	5	0

Table 14 Types of collaboration obtained from CIAT by former trainees after training (n = 96)

Type of collaboration	PROGRAM				
	Beans (%)	Rice (%)	Pastures (%)	Cassava (%)	TOTAL (%)
Annual reports and publications	55	55	30	50	48
Germplasm	36	50	13	22	31
Scientific advise	24	36	30	39	31
Information from library and documentation centers	21	36	30	44	31
Training materials	32	24	9	17	21
Support for in country training	15	18	4	17	14
Opportunities to train other colleagues at CIAT	18	18	9	6	14
Work meetings at CIAT	12	14	4	6	9

G Significance of CIAT training for professional development

Training is a powerful tool for strengthening research programs But it must also be an instrument for achieving of greater individual satisfaction and professional development

CIAT training has been highly successful in this aspect, as reported by former trainees (Table 15) Six are the most significant outcomes for professional development reported by more than 50% of former trainees self-confidence in their personal capabilities to carry out research as a profession, positive motivation toward research access to and involvement in the utilization of scientific literature, research methodology, technical competence, and communication skills

A salient aspect of these findings is that, in spite of the fact that CIAT training is content-centered, factors pertaining to the affective and socio-psychological domains are reported by former trainees among the most significant outcomes of their training That is the case of self-confidence, motivation toward research, and interest in higher education, all pertaining

to the affective domain (attitudes) Socio-psychological outcomes of training highly regarded by former trainees include communication skills and connections with other colleagues

An ordinal arrangement of all these aspects, ordered from more to less significance, are presented in Table 16, distributted by commodity programas

Most of the former trainees indicated that CIAT grew their interest in continuing their education at higher levels A highly appreciated contribution of CIAT training was a research methodology and relevant scientific literature For many of them, CIAT training provided a solid basis to initiate research activities or continue research with a higher degree of motivation, but specially with more self-confidence in their own abilities as agricultural researchers Many also found in CIAT opportunities that they qualified as "unique" to maintain contacts with other scientists and to begin to develope their abilities in this field of communication Others strengthened their philosophical principles of research that they had previously acquired at the university Some emphasize that they obtained scientific training materials and methodologies, as well as germplasm that has been most useful after their training period With very few exceptions, they indicated that most of the training content was related to research aspects given priority at their institutions and that they have used most of that information without having to make major changes or adaptations

Table 15 The most significant outcomes of CIAT training for personal professional development, attained by former trainees (n=96)

Outcomes	Degree of achievement*			
	4 (%)	3 (%)	2 (%)	1 (%)
Self-confidence as a researcher	70	13	9	2
Positive motivation toward research	67	11	9	2
Scientific literature	63	11	17	4
Research methodology	59	10	16	6
Technical competence	58	14	14	0
Communication skills	52	15	17	5
Connections with colleagues	49	10	23	7
New training opportunities at CIAT	46	8	19	3
Interest for educational advancement at higher levels	43	3	13	4
Philosophy for orienting research	43	12	27	1
Germplasm	36	9	7	1
Training methods	35	11	21	4
Connections with research donors	14	8	10	1
Seeds ready for multiplication and distribution	12	7	8	1

* Degrees of achievement

4 = I obtained much of this at CIAT, and it has been highly significant for my professional career

3 = I obtained some of this at CIAT, and it has been highly significant for my professional career

2 = I obtained much of this at CIAT, and it has been of low significance for my professional career

1 = I obtained some of this at CIAT, and it has been of low significance for my professional career

Table 16 Outcomes of CIAT training for personal professional development ordered from higher to lower significance by weighting them in terms of degree of achievement and percentage of trainees who achieved them The list of outcomes is presented in global and distributed by commodity programs

ORDERED OUTCOMES

TOTAL	BEANS	RICE	TROPICAL PASTURES	CASSAVA
Self-confidence	Self-confidence	Sci literature	Self-confidence	Techn competence
Sci literature	Motivation	Motivation	Res philosophy	Sci literature
Motivation	Sci literature	Res methodology	Comm skills	Self-confidence
Res methodology	New training opp	Self-confidence	Res methodology	Motivation
Tech competence	Tech competence	Tech competence	Motivation	Res methodology
Comm skills	Conn with collegues	Conn with collegues	Sci literature	Comm skills
Comm with colleagues	Comm skills	Comm skills	New training opp	Conn with colleagues
Res phisolophy	Res philosophy	Germplasm	Tech competence	Training methods
New training opp	Res methodology	Training methods	Conn with colleagues	Res philosophy
Training methods	Interest in higher ed	Res philosophy	Interest in higher ed	New training opp
Interest in higher ed	Training methods	Interest in higher ed	Training methods	Germplasm
Germplasm	Germplasm	New training opp	Conn with donors	Interest in higher ed
Conn with donors	Conn with donors	Conn with donors	Seeds	Seeds
Seeds	Seeds	Seeds	Germplasm	Conn with donors

H Positive and negative consequences of CIAT training

By far the most positive consequences of CIAT training reported by former trainees consist on the higher credibility as researchers that they gained among their colleagues, and the higher appreciation for their work by the institutions they have worked for after training (Table 17) Other positive results reported include higher prestige in their local communities, higher positions occupied at their institutions, and salary increases Only six trainees reported to have had no positive consequences after CIAT training In contrast, 86% reported to have experienced no negative consequence, those negative results reported are related to difficulties in reentering their institutions and activities after training, salary increases lost, and promotion opportunities lost (Table 18)

Table 17 Positive consequences of training at CIAT (n = 96)

Consequences	Beans (%)	Rice (%)	T Pastures (%)	Cassava (%)	TOTAL (%)
Higher credibility as a researcher	70	82	70	78	74
Higher appreciation for my work within the institution(s) I have worked for	70	68	57	72	67
Higher prestige in my community	64	59	52	28	53
Congratulation letters	39	64	35	28	42
Higher position in the sponsor institution	36	36	39	33	36
Salary increases	39	45	26	17	33
Higher position in other institutions	33	22	26	22	27
None	6	0	0	6	4

Table 18 Negative consequences of CIAT training at CIAT (n=81)

	Beans (%)	Rice (%)	T Pastures (%)	Cassava (%)	TOTAL (%)
None	83	93	75	100	86
Jealous attitute	13	0	5	0	6
Difficulties to reenter	3	7	0	0	2
Lost salary increases	3	7	15	0	6
Lost opportunities to be promoted	0	0	5	0	1

I Former trainees' and supervisors' comments on CIAT training

Following are some selected samples of comments of former trainees and their supervisors These comments help to gain insights into the usefulness of CIAT training for professionals and institutions

1 Former trainees' comments

"I feel much more confidence in myself now Training has made me a much more independent person to conduct my activities and to judge the work of others In a certain way, I can say that training has helped me to overcome my inferiority complexes as a researcher Training motivated me to advance in my research work, and provided me with methodologies and skills to do so All of what I learned and have used here has operated well I learned to be objective, now I enjoy analyzing the pros and cons of each issue I study"

"I used to consider CIAT's scientific staff as something unreachable way over me as a researcher Now I have a more realistic opinion, I respect them but can discuss with them their statements and recommendations At CIAT, I learned to value what we have available for research in my country I managed to be more objective on this matter and was able to distinguish the limitations and deficiencies of our work, but appreciating the positive results that we have been able to obtain Moreover, I could compare our situation with that of other Latin American programs"

"Before receiving CIAT training, I saw no possibility in being able to continue studying I had placed my own mental barrier, I thought that there was no room for me in research and that my abilities were extremely limited You should know that I had no college education I was just the assistant of technician At CIAT I felt the need to learn more and I realized that I was able to do so After my training period at CIAT, I have been doing

well My position has improved Now my team counterparts consider me as another professional, I have received congratulation letters for my work, my salary has increased, I concluded my career as an agronomist and now I have opportunities to complete my M S degree overseas"

"The most important lesson that I received was that our work was not so bad After all, CIAT scientists also make mistakes All of us thought that all at CIAT was better that in our program Now I don't have that same feeling and I think that this is good both for us and for CIAT, because I have been able to maintain more productive collaboration links with CIAT staff"

"At CIAT I learned to be enterprising, to take the initiative and to be more independent Nobody tought me that at CIAT, nor was it part of my training, but my stay there and being able to compare situations, led me to feel at the same level and to carry out my own research without having to ask what I had to do Obviously, I do ask for others' opinions, not to follow them blindely, but to look at the pros and cons and become more critical of my work and that of others' "

"Training made me more autonomous in my thinking I always had to rely on managers to decide on what to study and how to do it I considered them as my superiors in all respects Now I consider the managers as officials that have the responsibility of supporting and facilitating my work, but the decision on how to do the research study is mine In many cases, we have to accept that managers should assign the priorities, I also learned to accept this in an objective manner, if some day I become a manager, I consider that I'll be able to do my job with better criteria than those I had before"

"Now I can see my research work with a wider perspective and can value it not only as a contribution to farmers and consumers but also as a scientific contribution"

2 Supervisors' comments

Supervisors agree in emphasizing the value of CIAT training for their technicians The surveyed supervisors indicate that their technicians returned from CIAT with a wide perspective of the crop and its research and with a high motivation to continue working in this field and with improved skills to do so, in their relationships with other counterpart professionals they show self-confidence in presenting and defending their research work Their performance as researchers is qualified by their supervisors as over the average compared to other professinals at the same level and with similar experience They perform well both as instructors and as technical advisors They have had very few opportunities to perform as managers but when they have done so temporarily, they have performed at the same average level, i e , they are not particularly outstanding but they do their job

Some supervisors indicated two fields in which training, not only at CIAT but in general at the international centers, can become a problem for the national programs 1) distortions of the national research priorities can occur since at their return the technicians want to do exactly what they learned during their training and under the conditions found in the international centers, forgetting the needs and limitations of the national

program, 2) personnel trained in international centers still have a discipline-oriented approach that hinders the improvement of typical production systems found throughout the Latin American agriculture, for which an integrated approach is required rather than a discipline-oriented one The following are two typical comments of these supervisors

"A valuable aspect of CIAT training is that national program researchers understand the way international centers work, the forces and motivations in conflict that operate in those environments and how the international center researchers learn to live with these factors and work productively I know that this is not tought in courses and perhaps it is impossible to do so, but the fact of being in contact with international centers researchers aids the trainees to learn which the factors limiting research in these centers are I believe that this knowledge provides solid bases to the interpersonal relationships on which the international cooperation activities between international centers and national programs have to rely on, in this way simplistic conceptions about the meaning of collaborative research can be avoided as well as the development of dependence attitudes toward international centers by national program researchers, this means that in this way national researchers will not believe that international centers can give them all they need and solve all the problems that they have to face during their work in the national program"

"Often I have observed that our professionals return from their training at CIAT with much more motivation and competence to carry out their work This is highly positive, however, sometimes they would like to continue studying issues that are not a priority for us, and in some occasions they ask for facilities and equipment that are beyond our capabilities or that require a certain amount of time to be developed There is much work that can be done in a simple manner, but with great efficiency This brings problems between managers and researchers I consider this as a negative aspect of CIAT's training"

III FORMER TRAINEES AT WORK

This section of the report attempts to make a look at three aspects of the former trainees' work their orientation toward reference groups, their time distribution, and the changes in position levels experienced after training The section is closed with a set of former trainees' performance ratings

A Reference group orientation

Reference groups are of the outmost importance in research because their influence may determine the selection and definition of research problems and priorities Consequently, pertinent questions are What are the orientations of former CIAT trainees toward relevant reference groups? Is there any change in reference group orientation after training at CIAT? If so, what is the direction of that change?

Three groups relevant to agricultural research, which not necessarily are convergent in their values and visions of the world, are the profession, the institution, and the problems, goals and activities of agricultural development Former CIAT trainees were asked a question on this topic, with the instruction of checking only one option The question was repeated making reference to three time periods before training, immediately after training, and at the moment of the survey

The question was Tell us which of the following groups was the most influential on your decision to select the research problem(s) that you pursued at that time (check only one option)

/__/ I selected that problem because it was considered important by other researchers, for instance, my professors or other colleagues

/__/ I selected this problem because it was considered important by institution authorities, such as directors or managers of the organization I work for

/__/ I selected this problem because it was considered important for people working in agricultural development, for example, extensionists, farmers, businessmen, etc

/__/ Other group (please, indicate) /_____/

Results are presented in Table 19 Before training the total of respondents were almost evenly distributed in their orientation to the three main reference groups However, figures partitioned by commodities show rice and cassava trainees more oriented toward development, and tropical pastures trainees more inclined to their profession Immediately after training there is a clear orientation toward development in total and for beans, rice and cassava trainees, tropical pastures trainees are evenly distributed, this fact representing a departure from their early orientation to their profession Finally, at the moment of the survey, agricultural development is the

predominant reference group for former CIAT trainees in the four commodities This suggests a strong value put in solving practical, socio-economic, pressing problems, with basis on science-based production technology

Table 19 Former CIAT trainees' reference group orientation before training, immediately after, and at the moment of the survey (n=91)

	Reference group			
	Professional (%)	Organization (%)	Ag development (%)	Others (%)
Beans				
Before	31	28	31	10
Immediately after	14	38	45	3
At the moment of the survey	18	25	50	7
Rice				
Before	19	19	43	19
Immediately after	23	27	41	9
At the moment of the survey	20	20	47	13
Tropical pastures				
Before	41	32	18	9
Immediately after	23	23	23	32
At the moment of the survey	12	19	44	
Cassava				
Before	19	25	50	6
Immediately after	0	25	63	12
At the moment of the survey	0	15	77	8
Total				
Before	29	26	34	11
Immediately after	16	29	42	13
At the moment of the survey	14	21	53	12

B Time devoted to research and non-research activities

The pattern of time distribution reflects institutional and personal priorities assigned to different activities A common belief is that to talk about "researchers" means to talk about people doing research 100% of their work time Respondents were asked to give their work time distribution before training, immediately after, and at the moment of the survey This question was asked in order to learn about former trainees' time distribution patterns, and to check for changes in those patterns with respect to CIAT training

Results indicate that former trainees distribute their work time in a set of research and non-research related activities, with a clear emphasis on doing research (Table 20) They also spend some work time on training colleagues, doing research administration, and consulting About one sixth of their work time is devoted to activities not directly linked to research Very infrequently these professionals devote 100% of their work time to research There is no evidence for significant changes in their patterns of time distribution after training

When some of these professional were interviewed in depth (in order to prepare the case studies), it was evident that the working-time distribution patterns varied greatly and that each case had its own pecularities After finishing training, some professionals increased the amount of time dedicated to research, especially in the case of those previously enrolled in the area of administration, extension services or training After having finished their training, other working opportunities were offered to them, which they attribute to having gained more respect as professionals

Almost all persons interviewed, indicated that after receiving training they wanted to work in reseach, part-time or full-time However, not all of them consider CIAT responsible for this motivation Many indicated that it was precisely their interest in research what made them come to CIAT The contrary is also true Professionals, who before recieving training had been dedicated full-time to research, after coming to CIAT accepted other responsabilities, especially training colleagues and, to a lesser extent worked in the area of administration The self-confidence developed during their training, moved them to incursion in other activities different from research

Some professionals completely change their time distribution pattern from one year to the next For example, an agronomist working in rice, before receiving training dedicated 50% of his time to research and 50% to technical assistance services Immediately after receiving training, he dedicated his time almost completely (95%) to reseach Three years later, he was dedicated full time to technical assistance What happened was that his performance has improved noticeably after training, part of his research was conducted in farmers' fields on request of the farmers who askef him to spend 100% of his tima on technical assistance It is worth mentioning that this professional before receiving training, had been oriented toward problem selection in research carried out jointly with his university professors, immediately after training, he oriented himself toward problem solution in the organization, but at the time of the survey, his predominant reference group were the farmers

Table 20 Former CIAT trainees' distribution of time between research and non-research related activities before training, immediately after and at the moment of the survey (n=96)

	Beans	Rice	T pastures	Cassava
Doing research	(%)	(%)	(%)	(%)
Before training	66	67	68	63
Immediately after	67	75	71	61
At the moment of the survey	59	62	65	66
Training professionals				
Before training	3	7	3	1
Immediately after	5	7	2	4
At the moment of the survey	7	5	5	7
Administrating research				
Before	5	8	9	13
Immediately after	8	7	6	15
At the moment of the survey	8	3	6	7
Research consulting				
Before training	3	3	4	2
Immediately after	4	4	3	3
At the moment of survey	6	4	4	3
Non-research related activities				
Before training	23	15	16	21
Immediately after	16	7	18	17
At the moment of the survey	19	26	20	17

C Changes in position level after training

Twenty seven per cent of the former CIAT trainees surveyed reported to have occupied a higher position immediately after training, in comparison to those positions they had before training (Table 21) One out of every three had improved in position by the moment of the survey No one occupied a lower position Only one was unemployed at the moment at the survey, but no one was without a job immediately after training This is a very significant fact given the usually high rates of unemployment prevalent among agricultural professionals in some countries of the region Position improvement has been more frequent among tropical pastures trainees Looking at the institutions as locus of incidence for the improvement in position (Table 22) two results of the survey are 1) almost all the improvement immediately after training takes place at the institution which sponsored the trainee's stay at CIAT, with the exception of cassava trainees, and 2) improvement in position by the moment of the survey is occurring both within and out of those institutions, more frequently within institutions for rice and tropical pastures trainees, and out of institutions for beans and cassava trainees That four out of every five former cassava trainees improve their position out of their institution suggests that opportunities at sponsor institutions are scarce in this field, a fact which may stimulate migration of talent

Table 21 Changes in level of position occupied by former trainess after training, in comparison to those occupied immediately before (n=96)

	Level of positions							
	Immediately after				At the moment of the survey			
	Higher	Same	Lower	Unemployed	Higher	Same	Lower	Unemployed
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Beans	27	73	0	0	33	67	0	0
Rice	23	77	0	0	18	77	0	5
T pastures	35	65	0	0	48	52	0	0
Cassava	22	78	0	0	28	72	0	0
TOTAL	27	73	0	0	33	67	0	0

Table 22 Improvement in their position in and out of the institutions which sponsored their training

	Immediately after		At the moment of the survey	
	Same institution (%)	Other institution (%)	Same institution (%)	Other institution (%)
Beans	24	3	11	22
Rice	18	5	13	5
Tropical pastures	35	0	28	20
Cassava	11	16	5	23
TOTAL	23	4	17	16

D Performance ratings

Former trainees performance was rated by their supervisors Four sets of activities were evaluated performance when doing research, when training colleagues, when administering research, and when serving as consultant The following 1-5 scale was used for this purpose

5 = He (she) performed on these activities among the best professionals of the institutions at their position level
4 = Performed above the average
3 = Average performance
2 = Performed below the average
1 = Among the lowest

A zero was used to indicate non performance of the corresponding activity So this is not a part of the scale, and does not have appraisal meaning Former CIAT trainees perform above the average (above 3 0) in the four sets of activities appraised (Tables 23 and 24) Data partitioned by commodities and activities show above average ratings for all commodities when former trainees are appraised in their performance as researchers Above the average is also the performance of been trainees in all the activities appraised There are three instances in which the ratings are slighthly below the average rice trainees when doing administration of research, tropical pastures trainees when training colleagues, and cassava trainees when doing administration and consulting

Table 23 Average ratings of former CIAT trainees' performance as appraised by their supervisors, distributed by commodity and activity (n = 96)

	Beans	Rice	Pastures	Cassava	TOTAL
Research	3 89	3 52	3 40	3 46	3 70
Training	3 71	3 06	2 89	3 55	3 27
Administ	3 64	2 90	3 63	2 85	3 33
Consulting	3 56	3 44	3 27	2 97	3 39

Scale 5 = high performance, 4 = performed above the average,
3 = average performance, 2 = performed bellow the average,
1 = among the lowest

IV RETURN TO AND STAY IN THEIR INSTITUTIONS, RESEARCH AND FIELDS OF TRAINING

This chapter focuses on the return of former CIAT trainees to their organizations and their length of stay in the activity of research. It examines the question of, to what extent are the Latin American countries building inventories of human resources for agricultural research, based on CIAT's training?

The first section deals with the central question of inventory formation 1) CIAT's contribution for preparing agricultural researchers for the region, 2) effectiveness, and 3) efficiency of the region in forming researchers' inventories based on CIAT's training, 4) migration of researchers as a source of inefficiencies, 5) stay in institutions and in the activity of research, and 6) inventories of research experience.

The last portion of the chapter explores the presence of relationships between stay in research and two independent variables length of training, and facilities to do research in the fields of training at sponsor organizations.

A Inventory formation

1 CIAT's contribution. The contribution of CIAT to the formation of inventories of agricultural professionals in Latin America during the period 1969-79 is indicated by the number of persons trained. The review of training files shows that during the period a total of 1413 professionals from various parts of the world utilized the training opportunities provided by CIAT. Most of them (89.1%) are from Latin America. The rest are distributed almost evenly between Africa, Asia, and Australia (4.6%), and North America and Europe (6.3%).

Figures corresponding to Latin American professionals are arranged in Table 24 in terms of three types of training: a) production and extension, b) research support, and c) research. A segment of this last type of training (enclosed within discontinuous lines in Table 24) is the center of attention for this study. It comprises training in research in CIAT's present four commodity programs. A set of 783 persons, representing 62% of the total for the period 1969-79, constitute the study population.

2 Effectiveness. The source of data for the analysis of human resource inventories is a census conducted for this study in the 187 organizations which sent personnel to CIAT for research training. From the population of 783 professionals who completed their training in research between 1969 and 1979, data were obtained for 580 persons. The average rate of response for the total period was 74% (Table 25).

The extent to which former CIAT trainees have reentered their sponsor organizations and stayed active in research is analyzed here from the envisioned points of view of three different sets of people: a) directors of sponsor organizations, b) the training organization (CIAT), and c) country-based and international sponsors and science policy makers. For convenience of expression, these three perspectives will be respectively labeled, throughout the chapter, "sponsor organizations," "fields of training," and "research in general."

Table 24 Former CIAT trainees from Latin American distributed by training content

Training content	N	(%)
Production and extension	201	16 0
Crop production	57	4 5
Beef production*	46	3 7
Seed production	98	7 8
Research support	116	9 2
Biometrics and data processing	6	0 5
Communications	9	0 7
Documentation	41	3 3
Station operations	38	3 0
Others	22	1 7
Research	942	74 8
CIAT's commodities	783	62 2
Rice	173	13 7
Beans	245	19 5
Tropical pastures	172	13 7
Cassava	193	15 3
Other research	159	12 6
Economics**	12	1 0
Swine production***	85	6 7
Corn	20	1 6
Weed control	42	3 3
TOTAL	1259	100 0

* Actual number of participants in crop and beef production is larger because some trainees participated in both production and research training They are assigned to research in order to not double count the number of participants

** These are only the participants in training in economics who cannot be specifically classified within any of the other research categories The actual number of trainees in economics is larger

*** Swine training includes both research and production It was decided to classify this as research training

Study population

Table 25 Population and sample of former CIAT research trainees (1969-79), distributed by training content and year in which training was completed

Year	RICE			BEANS			T PASTURES			CASSAVA			TOTAL		
	n'_R	N_R	(%)	n'_B	N_B	(%)	n'_P	N_P	(%)	n'_C	N_C	(%)	n	N	(%)
1969	1	1	100	0	0	0	0	0	0	0	0	0	1	1	100
1970	3	8	38	0	0	0	0	0	0	2	2	100	13	21	62
1971	5	5	100	1	1	100	3	4	75	1	1	100	10	11	91
1972	17	34	50	3	3	100	8	9	89	3	3	100	31	49	63
1973	4	6	67	3	4	75	5	6	83	7	7	100	19	23	83
1974	8	15	53	2	5	40	8	12	67	25	29	86	43	61	70
1975	4	5	80	16	23	70	8	12	67	6	11	55	34	51	67
1976	7	10	70	20	22	91	12	19	63	25	40	63	64	91	70
1977	12	14	86	37	42	88	13	31	42	4	4	100	66	91	72
1978	13	26	50	55	66	83	23	31	74	38	48	79	129	171	75
1979	39	49	80	64	79	81	26	37	70	41	48	85	170	213	80
TOTAL	113	173	65	201	245	82	114	172	66	152	193	79	580	783	74

N_R= Rice population, N_B= Beans population, N_P= T pastures population, n'_C= Cassava population, N_R= Rice sample, n'_C = Beans sample, n'_P = T pastures sample, n'_C= Cassava sample

The formation of inventories has increased during the period analyzed (Table 26) Annual net balances are positive for each of the three perspectives examined, and in all of them, increase final inventories This process, however, has been more effective in the building of human resources for "research in general," and less effective for building inventories in specific "fields of training " The other perspective ("sponsor organizations") shows intermediate effectiveness (A similar analysis by commodities is presented in Appendix C, Tables 1,2,3,4)

3 Efficiency While final inventories show effectiveness in the process of forming resources for agricultural research, we can ask the further question How efficient have these processes been? To examine this question, efficiency is defined as the percentage which final inventories represent with respect to the cumulative number of trained personnel Efficiency is not calculated for the whole 11-year period because the personnel trained during the first years was relatively low in number Efficiency rates appear in Table 27 starting with the year 1972

Two tendencies are observed First, efficiency in the formation of inventories for "research in general" and for "sponsor organizations" has been over 70 percent, while efficiency in building a "critical mass" of professionals for establishing collaborative linkages with respect to CIAT commodities in particular "fields of training" has been much lower, oscillating between 50 and 60 percent Second, from the three perspectives--"organizations," "fields of training,' and "research in general"--there seems to be a slight tendency toward decreasing efficiency in formation of inventories

4 Migration Tables 28 and 29 present migration broken down in its non-return and drop-out components (raw data for preparing these tables appear in Appendix C, Tables 5 to 8) Examining the cumulative effects of migration up to 1979, two conditions are evidenced a) for the three perspectives, migration in the sample studied has been an extended phenomenon, ranging in magnitude between 19 percent, in "research in general," and 46 percent, in "fields of training," of the total trained personnel, and b) this process has eroded more heavily the human resources prepared for establishing collaborative research linkages among CIAT and counterpart organizations in the region ("fields of training"), than for preparing personnel for country-based "organizations" and "research in general" (Table 28)

Looking at how the phenomenon has grown over the years, some tendencies are observed migration is increasing from the perspectives of "sponsor organizations" and "research in general," while it seems to be stagnant--in spite of its high magnitude--for 'fields of training" (Table 29)

The disaggregation of migration into its two components helps one to gain some insights about the preceding findings Two immediate facts surface a) drop-out is an extended phenomenon for the three perspectives studied, its cumulative effect up to 1979 being higher than 14 percent of the total number of persons trained, and b) drop-out has its heaviest effects for "sponsor organizations" and "research in general," while non-return affects more the formation of inventories for "fields of training" (see absolute numbers and percentages of migration in Table 28) Is there any tendency over the years for the cumulative effects of drop-out and non-return? Percentages in Table

29, clearly suggest that, in general, drop-out is increasing, and non-return is decreasing or remaining stagnant, with the exception of "research in general," where non-return has slightly increased

Table 26 Inventory formation for the period 1969-79, showing initial inventories, annual net balances, and final inventories for three perspectives (n = 580)

	Years										
Perspectives	1969	70	71	72	73	74	75	76	77	78	79
Sponsor organizations											
Initial inventory	0	1	12	20	49	61	101	123	172	218	308
Annual net balance	1	11	8	29	12	40	22	49	46	90	121
Final inventory	1	12	20	49	61	101	123	172	218	308	429
Field of training											
Initial inventory	0	1	7	14	29	40	64	81	107	143	222
Annual net balance	1	6	7	15	11	24	17	26	36	79	89
Final inventory	1	7	14	29	40	64	81	107	143	222	311
Research in general											
Initial inventory	0	1	14	22	51	66	108	133	185	241	341
Annual net balance	1	13	8	29	15	42	25	52	56	100	129
Final inventory	1	14	22	51	66	108	133	185	241	341	470

Table 27 Efficiency in the formation of human resource inventories for agricultural research (n = 580)

Perspectives	YEARS							
	1972	1973	1974	1975	1976	1977	1978	1979
Sponsor organizations								
Cumulative trained personnel	55	74	117	151	215	281	410	580
Final inventories	49	61	101	123	172	218	308	429
Efficiency (%)	89 1	82 4	86 3	81 5	80 0	77 6	75 1	74 0
Fields of training								
Cumulative trained personnel	55	74	117	151	215	281	410	580
Final inventories	29	40	64	81	107	143	222	311
Efficiency (%)	52 7	54 0	54 7	53 6	49 8	50 9	54 1	53 6
Research in general								
Cumulative trained personnel	55	74	117	151	215	281	410	580
Final inventories	51	66	108	133	185	241	341	470
Efficiency (%)	92 7	89 2	92 3	88 1	86 0	85 8	83 8	81 0

Table 28 Cumulative effects of migration, drop-out, and non-return percentages of the total number of trained personnel (n = 580), and as percentages of migration within each perspective

Perspectives	Drop-out (No.)	Drop-out (%)	Non-return (No.)	Non-return (%)	Migration (No.)	Migration (%)
	Numbers and percentages of total trained personnel					
Sponsor organizations	102	17 6	49	8 4	151	26 0
Fields of training	86	14 8	183	31 6	269	46 4
Research in general	83	14 3	27	4 7	110	19 0
			Percentages of migration			
Sponsor organizatios		67 5		32 5		100 0
Fields of training		32 0		68 0		100 0
Research in general		75 5		24 5		100 0

Table 29 Cumulative migration, drop-out, and non-return expressed as percentages of cumulative trained personnel (n = 580)

	YEARS							
Perspectives	1972	1973	1974	1975	1976	1977	1978	1979
Sponsor organizations								
Migration	10 9	17 6	13 7	18 5	20 0	22 4	24 9	26 0
Drop-out	1 8	5 4	5 1	8 6	9 8	12 8	15 9	17 6
Non-return	9 1	12 2	8 6	9 9	10 2	9 6	9 0	8 4
Fields of training								
Migration	47 3	45 9	45 3	46 4	53 0	59 1	45 8	46 4
Drop-out	3 6	4 1	2 6	4 6	7 0	8 9	11 2	14 8
Non-return	43 7	41 8	42 7	41 7	46 0	40 2	34 6	31 6
Research in general								
Migration	7 3	10 8	7 7	11 9	14 0	14 2	16 8	19 0
Drop-out	5 5	8 1	5 1	7 3	8 4	8 9	11 2	14 3
Non-return	1 8	2 7	2 6	4 6	5 6	5 3	5 6	4 7

5 Stay Stay indicates the total number of persons who have not migrated up to a given year Rates of cumulative stay decrease until an interval of six years for "fields of training" and "CIAT commodities," and until the seventh year for "research in general" and "sponsor organizations " Beyond these intervals, rates of cumulative stay appear to increase (Table 30 and Figure 2) These tendencies seem to support propensities in both directions, to migrate and stay During the first six to seven years after training there is a propensity to migrate In the other direction data suggest that beyond six to seven years after training there is a propensity--among those professionals who still have not migrated--to stay in their organizations and fields of research

The question of length of stay does not have a single answer for each perspective, it depends on the size of the interval after training Rates of cumulative stay range between 95% and 34% for the different perspectives and intervals studied Nine out of every ten former CIAT trainees have stayed for at least one year doing research after training, but out of every three professionals who have had the opportunity to stay at least six years two have migrated from their fields of training However, for those who have had the chance to stay nine years, rates range between 38% and 75% according to the different perspectives (Table 30 and Figure 2) These results raise the question of the extent to which the region is building and retaining research experience with basis on the training carried out at CIAT The following section addresses this question

6 Research experience Retention and stay are closely related to one variable of much importance in scientific research experience in its essence, experience is generated cumulatively by doing An unrefined indicator of experience is the number of years that a person stays doing a given activity This is an oversimplification because it assumes that every person is devoting 100% of their work time to that activity, and because it also assumes that one year of experience of person A is equivalent to one year of experience of person B, which might not be the case However, for the purpose of getting a notion about what occurs in this sample with regard to experience formation and retention, this indicator is considered adequate

Cumulative figures for experience formation and retention are presented in Table 31 They show--more vividly than figures expressed in number of persons--the erosion that migration causes on the inventories of human resources for agricultural research which Latin American countries have been building with basis on CIAT's training

Efficiency in retention measured in person-years (experience) diminishes ten to fifteen percent in comparison to retention measured in number of persons The impact on retention of the two components of migration is visualized in Figure 1 by means of circles, each one representing 100 percent The percentages which appear inside the circles result from applying the following relationships The difference between efficiency in retention and 100 percent represents the lost efficiency corresponding to the cumulative effects of migration The difference between experience formation and experience retention gives the losses corresponding to drop-out And the difference between migration and drop-out is the loss of efficiency corresponding to non-return

Table 30 Cumulative stay distributed by number of years after training (n = 580)

Perspective	Number of years after training								
	1	2	3	4	5	6	7	8	9
Sponsor organizations									
Trained personnel*	580	410	281	215	151	117	74	55	24
Cumulative stay	531	345	210	146	98	70	41	32	15
Rates of cumulative stay	92%	84%	75%	68%	65%	60%	55%	58%	58%
Fields of training									
Trained personnel*	580	410	281	215	151	117	74	55	24
Cumulative stay	397	243	133	90	56	40	28	19	9
Rates of cumulative stay	68%	59%	47%	42%	37%	34%	38%	35%	38%
Research in general									
Trained personnel*	580	410	281	215	151	117	74	55	24
Cumulative stay	553	363	230	170	116	86	49	40	18
Rates of cumulative stay	95%	89%	82%	79%	77%	74%	66%	72%	75%

* Represent the number of persons who meet the criterion of having at least 1, 2, 9 years after training

Table 31 Number of person-years and efficiency in the formation and retention of research experience, up to 1980 (n = 580)

Perspectives	Experience formation		Experience retention	
	Person-years	Efficiency	Person-years	Efficiency
Sponsor organizations	1494	78%	1183	62%
Fields of training	1019	53%	764	40%
Research in general	1632	85%	1368	71%

Figure 1 indicates that approximately 45 percent of the professionals who left their fields of training and research on CIAT commodities account for a loss of about 60 percent of the research experience which would have been built during the 11-year training period And those who migrated from their sponsor organizations and research in general represent losses in research experience of about 40 percent and 30 percent, respectively

Drop-out accounts for 13 to 16 percent of such losses, and non-return losses have ranged between 15 and 47 percent The higher numbers for non-return do not mean that drop-out is a phenomenon of less importance It should be recalled that drop-out shows a tendency to increase, when non-return seems to decline

A condensation of these findings (Table 32) reveals that, during the 11-year period studied, five percent of former CIAT trainees never worked in research, representing a total loss of 16 percent of the potential experience which could have been accumulated Fourteen percent dropped out of research toward other activities, making up a loss of 13 percent of potential experience

Table 32 also presents condensed figures to answer two broad and central questions in relation to the formation of human inventories for agricultural research in Latin America and the Caribbean countries What proportion of former CIAT trainees were still doing research in 1980? What proportion still continued working in the four areas in which they carried out their training?

The number of persons who have stayed doing research reaches a total of 81 percent, representing 71 percent of the cumulative experience for the 11-year period This 81 percent is distributed in the following way 24

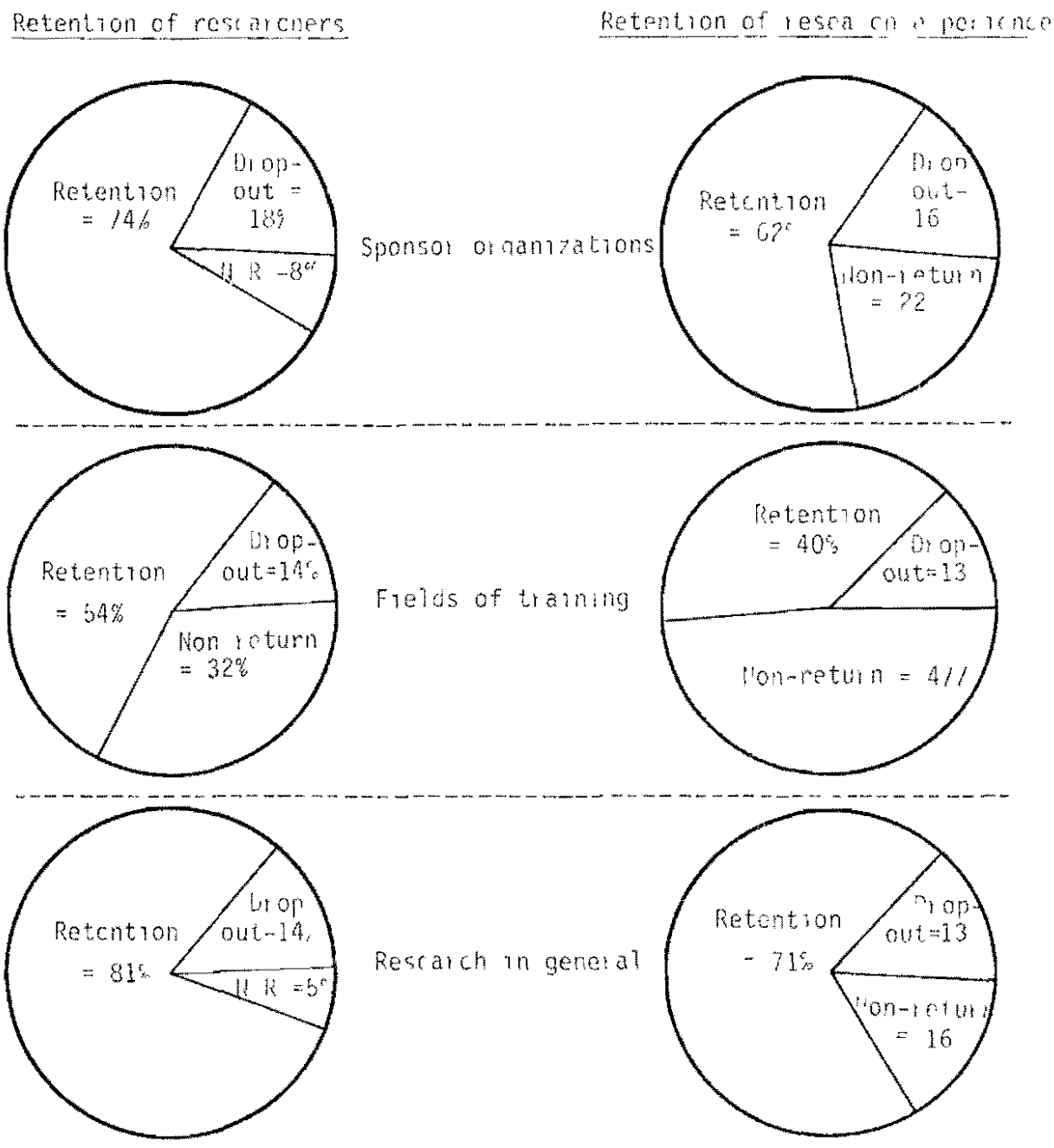


Figure 1 Cumulative retention, drop-out, and non-return for the eleven-year training period, measured as percentages of number of persons and number of person-years (experience)

percent have kept doing research in areas different than CIAT endeavors, three percent moved from their original training area toward others within CIAT research commodities, and finally, 54 percent of the trained personnel have remained working in their fields of training, accounting for only 40 percent of the total potential experience

Table 32 Cumulative non-return, drop-out, and retention with respect to research activities for the 11-year training period expressed as percentages of trained personnel and percentages of person-years (n = 580)

	Percentages of trained personnel	Percentages of person-years
Non-return	5	15
Drop-out	14	13
Research other than CIAT	24	29
Migration within CIAT commodities	3	2
Retention in fields of training	54	40
TOTALS	100	100

B Relationships between stay and the independent variables

The other two independent variables of interest for this study are analyzed in their relationships to stay These variables are length of training and facilities to do research at former trainees' home organizations

The same perspectives examined in the preceding analysis are also studied in this section Data have been processed through analysis of variance which were conducted within each perspective and training content They do not apply to comparisons between perspectives or between training contents

Stay of former CIAT trainees in their fields of training, research in general, and at their institutions is broken down by commodities in Table 33, and Figure 2 Stay in their training fields has been higher for beans and rice trainees than for tropical pastures and cassava trainees Stay in research in general and at their institutions has been similar for beans, rice and cassava trainees but lower for tropical pastures trainees

Table 33 Stay in training fields, research, and institutions, by commodities (n = 580)

Commodity	Stay in research		Stay at the institution
	Field of	In general	
	(%)	(%)	(%)
Beans	60	84	78
Rice	60	80	73
Tropical Pastures	45	72	61
Cassava	48	81	74
TOTAL	54	81	74

Length of training is defined as the time from physical arrival to CIAT to departure from CIAT, measured in number of months It is grouped in three categories a) short training, when the duration was up to two months, b) intermediate training, when it took more than two months up to six months and c) long training, for programs longer than six months

Results of analyses of variance (Table 34 and Figure 3) support the existence of a positive relationship between stay and length of training Most comparisons of means are statistically different at an alpha level of 5% However, the high heterogeneity of the data should be noticed, revealed by large standard deviations Such high variability may be tied to individual, organizational, and socio-economic-cultural factors which may affect average stay and are not controlled in this study

1 Stay and length of training An assumption in the design of training programs at CIAT with different durations has been that length of training is positively correlated with post-training performance The rationale is that not only with more time is it possible to acquire more information and develop new skills, but that an "enduring" effect of training occurs as length increases The intent of this study is not to examine in detail how length of training affects research performance, but to "check" in an exploratory way the presence or absence of the relationship with regard to stay as a single indicator of a dimension of research performance (stay)

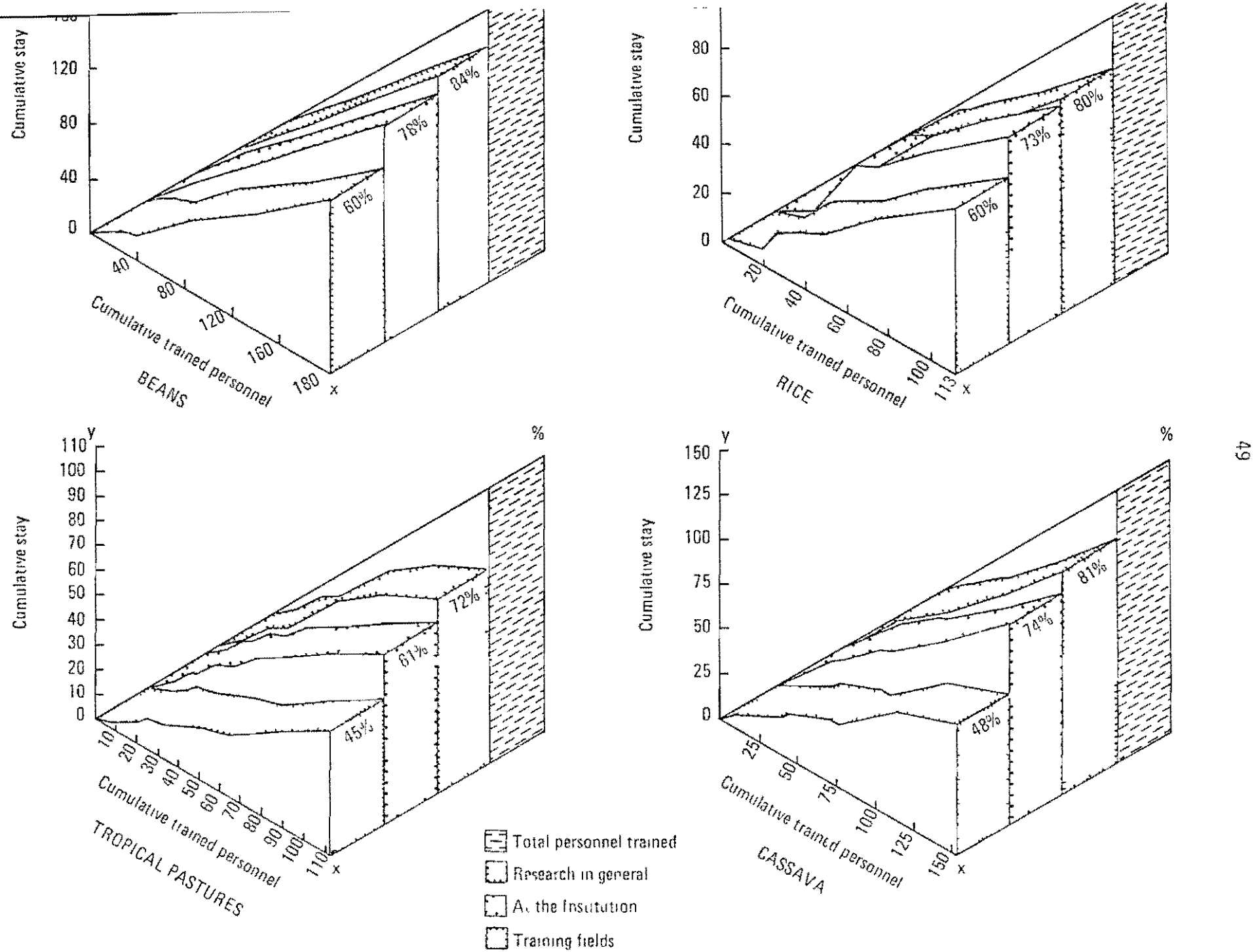


Figure 2 Stay in training fields research and institutions distributed by commodities (n = 580)

A closer look at the patterns of the relationship stay-length suggests some tendencies for the perspectives and commodities within which the analysis is carried out (Figure 3) In general, the relationship is clearer for "research in general" and "sponsor organizations " This is more evident in the cases of rice and beans For the perspective "fields of training" there are no statistical differences in the cases of beans and cassava, which indicates that the relationship does not exist or it is very weak This is also the case for the comparisons between short and intermediate training in tropical pastures, and between intermediate and longer training in rice However, for "fields of training" the positive relationship is very clear in the comparison between short and intermediate training, in the case of rice

2 Stay and facilities to do research The degree of facilities to do research in the fields in which former trainees carried out their training is a structural factor supposedly very influential in post-training research performance It is assumed that stimuli as well as constraints may arise from the degree of facilities available to a person for continuing to actively engage in research

In order to examine the presence or absence of a relationship between stay and research facilities, the Latin American and Caribbean countries which have sent professionals for training at CIAT were classified in eight groupings, two per commodity those with "more" facilities to do research in each commodity, and those with "less" facilities

None of the means compared exhibited statistical differences at an alpha level of 5% (Table 35) Therefore, data do not support the existence of a relationships between "stay" and "facilities to do research " Or, at least, such a relationship is very weak in these data, and consequently significant differences could not be detected Similar to the case of "length of training," the size of standard deviations for "research facilities" is large

In spite of the fact that differences are not statistically different, a sligth relationship seems to be suggested by the data Two thirds of the actual values of average stay are higher for trainees whose sponsor organizations are classified as having "more" research facilities than those with "less" facilities

A possible explanation for the lack of significant differences is that all members of this sample have the minimum level of research facilities, under which people are restricted from doing research This last explanation might be supported by the circumstance that agricultural research tends to be non-capital intensive Speaking in general terms, most agricultural research activities do not appear to require costly investments in labs and sophisticated equipment Even the ownership of land and buildings for experimental stations does not seem to be essential, as illustrated by the case od the Instituto de Ciencia y Tecnologia Agrícola (ICTA) of Guatemala, where researchers have been effectively conducting most of their research work off stations on farmer's land

Table 34 Summary of the analyses of variance for the dependent variable stay (number of years) as a function of the independent variable length of training (Comparisons are not between contents or perspectives)

Content/Perspective	Two months or less	More than two months, up to six	More than six months		T o t a l
Rice	(n" = 43) x"	(n" = 57) x"	(n" = 13) x"	x'	(n' = 113) Sx'
Sponsor organizations	2 58 B	3 46 B	5 69 A	3 88	2 88
Fields of training	1 49 B	3 11 A	2 62 AB	2 43	2 70
Research in general	2 67 B	3 67 B	6 08 A	3 57	2 86
Beans	(n" = 107) x"	(n" = 70) x"	(n" = 24) x"	x'	(n' = 201) Sx'
Sponsor organizations	1 65 B	2 33 A	2 79 A	2 02	1 38
Fields of training	1 25 A	1 79 A	1 88 A	1 51	1 47
Research in general	1 68 C	2 56 B	3 58 A	2 21	1 42
Tropical pastures	(n" = 22) x"	(n" = 46) x"	(n" = 46) x"	x'	(n' = 114) Sx'
Sponsor organizations	2 05 B	2 02 B	3 67 A	2 69	2 46
Fields of training	1 09 B	1 23 B	2 24 A	1 65	2 14
Research in general	3 05 A	2 13 B	4 17 A	3 13	2 51
Cassava	(n" = 114) x"	(n" = 14) x"	(n" = 24) x"	x'	(n' = 152) Sx'
Sponsor organizations	2 39 B	3 07 AB	3 42 A	2 62	1 96
Fields of training	1 60 A	2 21 A	1 63 A	1 66	1 78
Research in general	2 54 B	3 86 A	3 46 A	2 81	2 01

Note Means with the same letter are not significantly different Alpha level = 0 05

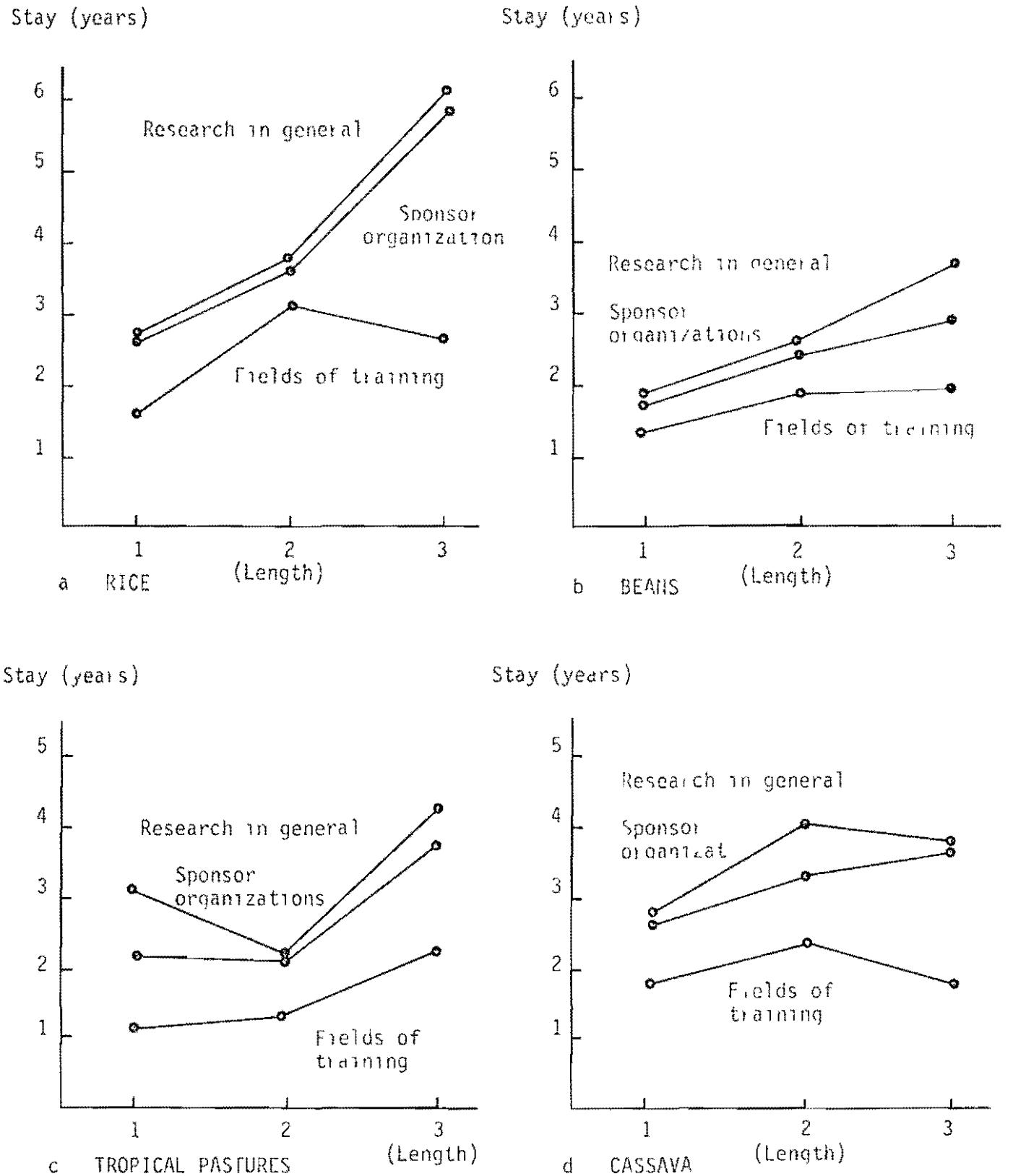


Figure 3 Average number of years of stay within sponsor organizations, fields of training, CIAT commodities, and research in general, for the training contents rice, beans, tropical pastures, and cassava. Stay is graphed as a function of length of training (1 = short training, 2 = intermediate training, and 3 = longer training)

Table 35 Summary of the analyses of variance for the dependent variable stay (number of years) as a function of the independent variable facilities to do research at sponsor organizations

Content/Perspective	Facilities: More	Facilities: Less	Total
Rice	(n" = 91) x"	(n" = 22) x"	(n' = 113) x' Sx'
Sponsor organizations	3 58	2 54	3 38 2 78
Fields of training	2 51	2 09	2 43 2 70
Research in general	3 81	2 54	3 57 2 86
Beans	(n" = 126) x"	(n" = 75) x"	(n' = 201) x' Sx'
Sponsor organizations	1 99	2 08	2 02 1 38
Fields of training	1 53	1 48	1 51 1 47
Research in general	2 21	2 23	2 21 1 41
Tropical pastures	(n" = 64) x"	(n" = 50) x"	(n' = 114) x' Sx'
Sponsor organizations	2 73	2 64	2 69 2 46
Fields of training	1 50	1 84	1 65 2 14
Research in general	3 27	2 96	3 13 2 51
Cassava	(n" = 110) x"	(n" = 42) x"	(n' = 152) x' Sx'
Sponsor organizations	2 61	2 64	2 62 1 96
Fields of training	1 72	1 50	1 66 1 78
Research in general	2 84	2 74	2 81 2 01

Note All means are not statistically different at alpha level = 0 05

V PARTICIPATING IN NETWORK OF RESEARCHERS

Interfaced with the building of formal research organizations, there is another substantive factor involved in the building of scientific capabilities of science in developing countries the building of formal and informal channels for the interchange of research findings and resources, e g scientific literature and germplasm

This chapter examines former CIAT trainees as practitioners who participate in networking processes among agricultural researchers It is presented in three sections A) characterizing the network by size, composition (regions, countries and institutions) and partipation, B) qualifying network content, channels, benefits and assessing the contribution of CIAT training to networking, and C) exploring the relationship between network participation and research performance

The population for this network study consists of researchers interested in doing collaborative research in beans, rice, tropical pastures and cassava The identification of the members of this population was approached by means of a snow-ball sampling technique, starting with the former CIAT trainees who did research after training, out of them a subsample of 207 were more in depth network analyzed For determining content of interchanges, network channels and benefits, a set of questions were included in the random sample survey to 96 former CIAT trainees

A Characterizing the network

The snow-ball sample started saturating at a size of 1810 researchers They work in 42 countries, most of them Latin American, but encompassing 15 countries outside the region (Table 36) This network includes researches from CIAT, other international and regional centers, national research programs, development organizations and universities, with the last two types accounting for more than fifty per cent of the network (Table 37)

Table 36 Network composition by regions and countries

	Countries (No)	(%)	Researchers (No)	(%)
Latin America and the Caribbean	27	64	1726	95
Asia	4	10	21	1
Africa	2	5	2	-
Europe	6	14	16	1
U S A and Canada	2	5	39	2
Australia	1	2	6	-
TOTAL	42	100	1810	100

Table 37 Network composition by type of institution

	(No)	(%)
CIAT	84	5
National research program	652	36
International and Regional Centers	30	2
Ag development organizations	660	21
Universities	384	36
TOTAL	1810	100

The multitude of interrelationships among the members of this community are classified by the direction and intensity of their interchanges Direction allows to establish the extent of connectedness within the network, and consequently to classify researchers as participants or non-participants Participation refers to connectedness to the bulk of the network, so, non-participation does not mean lack of interaction, but isolation from the activities of most network members and, as a consequence, isolation from the vital leadership processes which give orientation and dynamics to the network activities Out of the content and intensity of interactions emerge the social structures of the network, which are differentiated in terms of network roles Cognitive goals are at the core of research networks, and center around research problems Intensity of interactions, measured by frequency and depth of interchanges, allow to identify the network roles (group members, network leaders called "liaisons", others) which characterize the social structures existing within the network

Coordination and cooperation within a network is related to the degree of structure arising out of regular interactions among network members A highly structured network allows to differentiate specific research groups, network leaders, and researchers performing "other" roles as participants of the network

About two thirds of the persons network analyzed are participants, they form a totally interconnected net which trascends institutional and national boundaries Social structures have emerged out of their continued, regular interactions, allowing to differentiate network roles These social grouping tend to be organized by commodities, but interchanges occur also between network members of different commodity affiliations (Tables 38, 39 and 40)

The international character of this networks is specified in Table 38 Members of international networks are people who relate their societies to each other through continued interactions which, in essence, are personalized but do not require continuing face-to-face encounters These relation ships prevail among scientific researchers who do not have the same nationality or organizational affiliation, but are widely scattered throughout the world,

Table 38 Network participants and non-participants distributed by country where they work (n = 1810)

	Roles					
	Participant		Non-participant		TOTAL	
COUNTRY	(No)	(%)	(No)	(%)	(No)	(%)
Argentina	32	1 77	18	0 99	50	2 76
Antigua	0	0 00	1	0 06	1	0 06
Australia	5	0 27	1	0 06	6	0 33
Belize	0	0 00	1	0 39	7	0 39
Bolivia	20	1 11	22	1 21	42	2 32
Brazil	325	17 95	123	6 80	448	24 75
Chile	22	1 21	11	0 60	33	1 82
Colombia	241	13 31	130	7 18	371	20 50
Costa Rica	42	2 32	13	0 71	55	3 04
Cuba	7	0 38	18	1 00	25	1 38
Canada	4	0 22	1	0 05	5	0 27
Dominican Rep	14	0 77	31	1 71	45	2 49
Ecuador	73	4 03	28	1 54	101	5 57
England	3	0 17	0	0 00	3	0 17
El Salvador	11	0 61	14	0 77	25	1 38
France	1	0 06	0	0 00	1	0 06
Guatemala	22	1 21	31	1 71	53	2 93
Guayana	1	0 05	6	0 33	7	0 39
Haiti	1	0 06	5	0 27	6	0 33
Honduras	18	0 99	28	1 54	46	2 53
Holland	1	0 06	0	0 00	1	0 06
India	4	0 22	0	0 00	4	0 22
Jamaica	0	0 00	1	0 06	1	0 06
Japon	2	0 11	0	0 00	2	0 11
Kenya	1	0 06	0	0 00	1	0 06
Mexico	124	6 85	36	1 98	160	8 83
Nicaragua	9	0 49	6	0 33	15	0 82
Panama	14	0 77	11	0 61	25	1 38
Paraguay	4	0 22	3	0 16	7	0 39
Peru	69	3 81	38	2 10	107	5 91
Philippines	12	0 66	0	0 00	12	0 66
Pto Rico	2	0 11	1	0 05	3	0 16
Surinam	1	0 05	0	0 00	1	0 06
Syria	3	0 17	0	0 00	3	0 17
Scotland	3	0 17	0	0 00	3	0 17
Tanzania	1	0 06	0	0 00	1	0 06
Trinidad Tobago	1	0 05	1	0 05	2	0 11
Uruguay	10	0 54	11	0 06	11	0 60
U S A	31	1 71	3	0 17	34	1 88
Venezuela	47	2 60	32	1 77	79	4 37
West Germany	0	0 00	7	0 39	7	0 39

Table 39 Network participants and non-participants, by commodities (n = 1810)

	Roles					
	Participants		Non-participants		TOTAL	
	(No)	(%)	(No)	(%)	(No)	(%)
Beans	502	27 73	155	8 58	657	36 31
Rice	265	14 64	132	7 29	397	21 93
T pastures	203	11 21	194	10 72	397	21 93
Cassava	210	11 60	139	7 68	349	19 28
Other	2	0 11	8	0 44	10	0 55
TOTAL	1182	65 29	628	34 71	1810	100 00

Table 40 Network roles of participants, distributed by commodities (n=1810)

	Participants' roles							
	Group Members		Liaisons		Others		TOTAL	
	(No)	(%)	(No)	(%)	(No)	(%)	(No)	(%)
Beans	79	4 36	5	0 28	418	23 00	502	27 73
Rice	18	0 99	1	0 06	246	13 59	265	14 64
T pastures	35	1 93	1	0 06	167	9 23	203	11 11
Cassava	12	0 66	1	0 06	197	10 88	210	11 60
Other	0	0 00	1	0 06	1	0 06	2	0 11
TOTAL	144	7 96	9	0 52	1029	56 86	1182	65 24

world, working for different countries and organizations What keeps those interactions alive is not kinship or location ties, but the sharing of cognitive goals and experiences their research problems By means of these interchanges, researchers create new social groupings, they are members of small transnational communities Participants carry into these communities cultural elements of their respective indigenous societies, from the interaction between cultural elements of the interdependent societies, new cultural forms arise which are shared by network members and passed on to newcomers to these new social groupings In such ways bi-national, multi-national, and worldwide cultures of science and technology are created, maintained, and shared by participants in networks of researchers

To examine the nature of the networks in which former CIAT trainees participate, two dimensions of their linkages are analyzed locus of incidence and type of linkage Locus of incidence refers to the location of the interacting persons mentioned by respondents Type of linkage refers to the frequency and depth of the interactions

1 Locus of incidence

An aggregate of links are presented in Table 41 Participants in networks report a relatively high incidence of links with their significant others, on the average, 9 3 links per person Nearly three out of every four ties are with other researchers within their immediate organizations and home countries Within Latin America one in every five has personal ties with researchers working for organizations and countries other than their own Close to seven percent are linkages outside the Latin American region in some part of the rest of the world

Table 41 Locus of incidence of links reported by network participants

Locus of incidence	Number of links	Percentage of links	Links per individual
Own organization	4421	40 4	3 75
Home country	3589	32 8	3 05
Latin America (Outside their country)	2188	20 0	1 86
Worldwide (Beyond Latin America)	744	6 8	0 63
TOTAL	10942	100 0	9 28

These results indicate that the total linkages are primerily oriented toward their own work organization and home country However, these networks are not totally domestic To put it in the large international setting, over a fourth of participants have connections with fellow researchers beyond their home land

2 Type of linkage

Six out of every nine links are of an intensive nature Relationships of sub-type two (more intensive) are about twice as common as those of sub-type one The other three out of nine links constitute latent and nascent interactions, with the latent being approximately double the nascent ties (Table 42)

Table 42 Number of links reported by network participants, distributed by type of linkage

Type of linkage	Number of links	Percentage of links	Links per respondent
Latent	2386	21 8	2 02
Nascent	1258	11 5	1 07
Intensive, sub-type one	2374	21 7	2 01
Intensive, sub-type two	4924	45 0	4 17
TOTAL	10942	100 0	9 28

However, hypothetically it is possible that intensive ties concentrate within organizations and countries, and international relationships might be only of a nascent or latent character To check these possibilities, and explore in more detail the international nature of the networks in which former CIAT trainees participate, the relationships reported by participants are cross-tabulated according to "locus of incidence" and "type of linkage" (Table 43) This cross-tabulation shows that almost one third of the intensive relationships occur at the regional or world levels, that is to say with people from outside of respondents' own organization and country

Table 43 Linkages of network participants, distributed by locus of incidence and type of linkage

	Type of linkage				
Locus of incidence	Latent Links (%)	Nascent Links (%)	Intensive 1 Links (%)	Intensive 2 Links (%)	Total Links (%)
Organization	10 0	4 7	7 6	18 1	40 4
Home country	6 7	4 4	6 4	15 3	32 8
Latin America	4 5	1 7	5 0	8 8	20 0
World-wide	0 6	0 8	2 6	2 8	6 8
TOTAL	21 8	11 6	21 6	45 0	100 00

belong to universities, two of those are U S universities, and the rest are universities of seven Latin American countries Brazil, Colombia, Chile, Mexico, Peru, Puerto Rico, and Venezuela Researchers from four international centers CIAT, IRRI, ICRISAT, and ICARDA participate in these groups

Table 44 Members of the 22 reseach groups by type of organizational affiliation

Organization	(No	(%)
National research programs	74	51
International center	16	11
Ag development organizations	31	22
Universities	23	16
TOTAL	144	100

By relationship to the identities of group members, the relevant interplay of fields of research, countries where currently working, and organizational affiliation may be realized in describing one of these invisible colleges, e g group 11 (Figure 5) This group is integrated by five researchers Four are bean researchers The other one is a cassava trainee who has been studying the crop association bean-cassava The group includes four nationalities and four organizational affiliations two people are from the Universidad Tecnica del Piura, in Perú, one is from ICA, the Colombian institute of agricultural research, another from FONAIAP, the Venezuelan national organization for agricultural research, and the last one does research in a Japanese organization This invisible college is connected with groups 10 and 13 through person number 54, who plays the role of liaison This professional is a woman from Peru She was trained at CIAT in cassava research Group 11 is also bound to group 12 by person number 697, a bean research In addition, group 11 is connected by groups 20 and 7 by means of members of the corresponding groups who perform as bridges between these groups Group 11 is described here as matter of example, but not as typical of the reseach groups existing in this network, in fact, there are no typical groups, each one has its own characteristics

Participants in this research network are totally interconnected with each other An all-encompassing picture of these inter-dependencies is presented in Figure 4 With the purpose of simplifying the visual representation, only groups and liasions are shown in this map Some clusters of groups by field of research can be recognized Such is the case of groups 13, 18, 19, 20 and 21 composed of tropical pastures researchers Specialized group in rice, beans, and cassava are well interconnected with groups including researchers of two commodities in some cases cassava and beans, in others, rice and beans

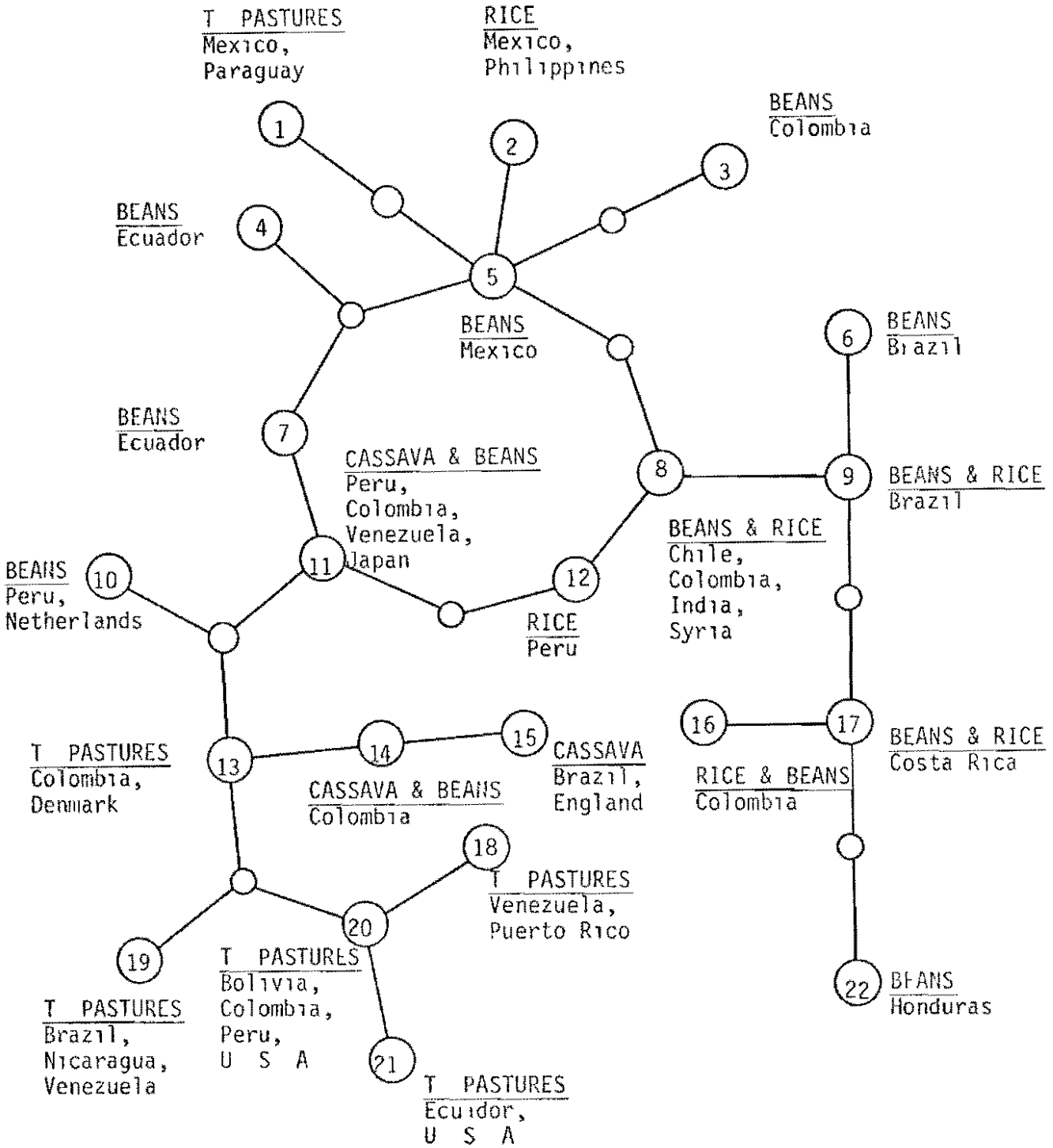


Figure 4 Research network mapped with base in the network analysis results To simplify the map, "others" and non-participants are not diagrammed Numbers within circles are labels to identify groups Small circles represent liaisons (research leaders)

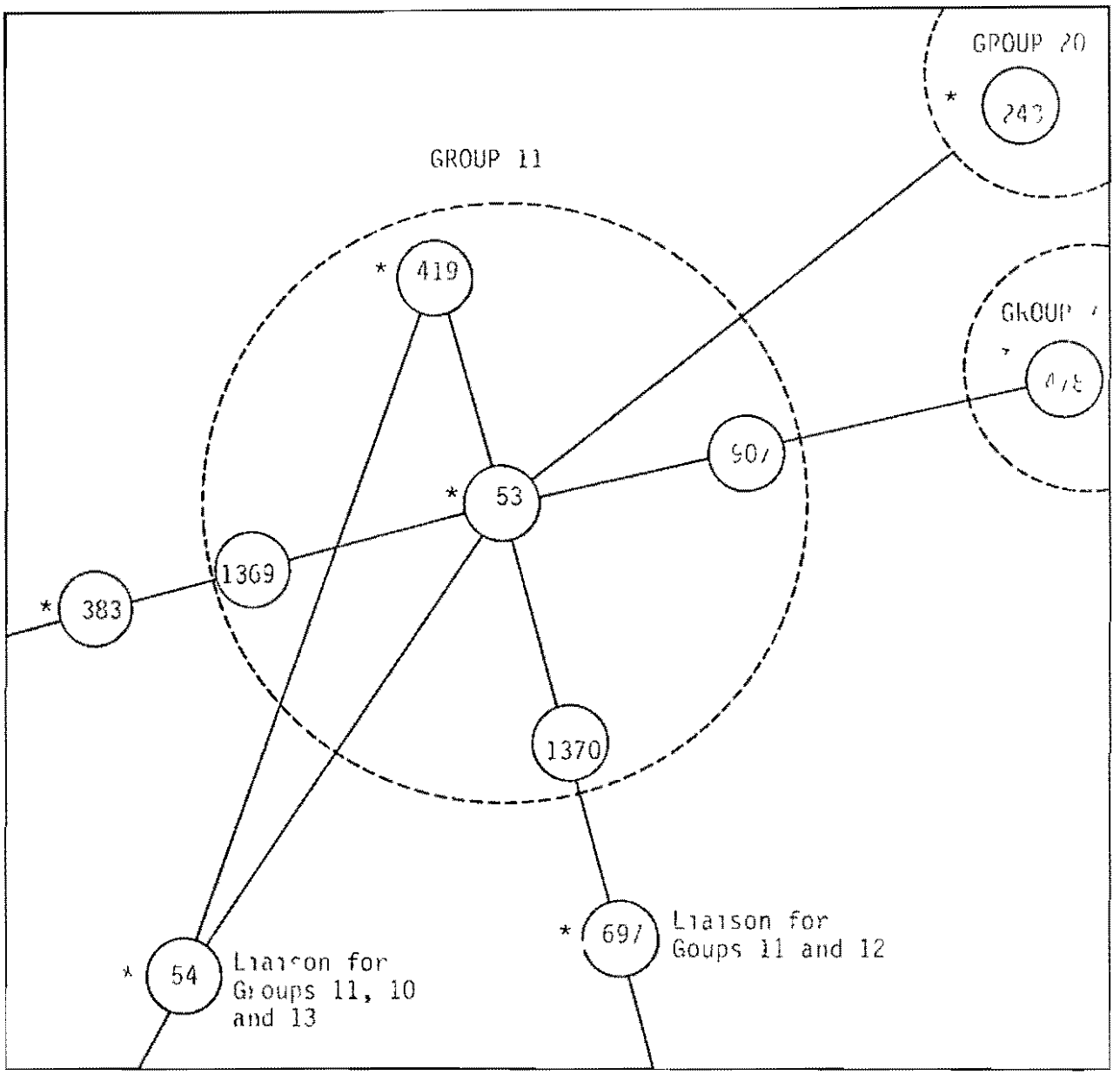


Figure 5 Group number 11, integrated by cassava and bean researchers
Organizational affiliations of group members are

*53 = U Tec Piura, Peru
*419 = FONAIAP, Venezuela
907 = JICA, Japan
1369 = ICA, Colombia
1370 = Universidad Nacional Technica de Piura, Peru

* = Former CIAT trainee

In summary, the analyses of locus of incidence and type of linkage of CIAT-trained researchers with relevant colleagues provides evidence that international networks of science and technology are being created, maintained, and shared in particular fields of agricultural research (beans, rice, tropical pastures and cassava)

3 Network structure

The specificities of network structure are more clearly visualized when results are discriminated and mapped in reference to particular research groups (Figure 4) Twenty-two research groups (invisible colleges) were identified Most of them are specialized seven in bean research, six in tropical pastures, two in rice, and one in cassava The other six groups combine researchers of different fields four groups are integrated by rice and bean researchers, and two are composed of cassava and bean researchers The size of research groups varies between three and fourteen persons, groups with three, four, or five people are most frequent (thirteen groups altogether) Most research groups include professionals with and without CIAT training, two exceptions occur one group in bean research and the other group in tropical pastures, which consists exclusively of former CIAT trainees Among the researchers in the twenty-two groups, about one half are CIAT alumni

As for the transnational identifies of group members, they split in two halves, eleven are entirely in-country groups, and eleven groups have members of various nationalities However, in all twenty-two groups there is within-country dominance in the proportionate number of group members The eleven groups with membership from various countries include five of the six tropical pastures groups, plus six groups integrated by rice researchers, rice and bean researchers, bean researchers, bean and cassava researchers, and cassava researchers There is only one specialized group in cassava

Twelve Latin American countries have representation in these twenty-two research groups Bolivia, Brazil, Colombia, Costa Rica, Chile, Ecuador, Honduras, México, Nicaragua, Paraguay, Perú, and Venezuela, there are no group members from the Caribbean countries Eight countries in the rest of the world, outside the region, also have participants in these twenty-two invisible colleges Japan, the Philippines, India, Syria, the Netherlands, Denmark, England, and the U S A

The eleven within-country groups are two in Brazil, three in Colombia, one in Costa Rica, two in Ecuador, one in Honduras, one in Mexico, and one in Venezuela

With the exception of three groups, invisible colleges normally include persons from differing research organizations These three groups are one in ICA, Colombia, one in INIAP, Ecuador, and one in the Ministry of Natural Resources of Honduras All members of these three groups are bean researchers

The distribution of organizational affiliation of the 144 persons who compose the 22 research groups identified by this study is presented in Table 44 About half of them work for national agricultural research institutes, and one fifth for agricultural development organizations Sixteen percent

The roles of liaisons are performed by four former CIAT trainees, four members of the staff of CIAT, and one member of the staff of INIA, in Mexico

A profile of some personal characteristics of the former CIAT trainees who are members of research groups follows (Table 45) They range between 24 and 55 years of age, similar to what occurs in the rest of the population, however, frequencies in the ages between 24 and 34 years are higher for group members than for the rest of the population These frequencies characterize sample group members as relatively young researchers Group members are, with one exception, males The proportions between single and married people are the same in this sub-sample as in the population As for educational, there is a slight tendency for practitioners holding higher formal degrees to be group members There is a group member whose education is under the B S level

Table 45 Former CIAT trainees who are members of research groups, distributed by age, gender, marital status, and education

Characteristic	(No)	(%)
Age (years)		
Less than 30	21	30 4
30 - 34	33	47 8
35 - 39	11	15 9
40 - 44	3	4 4
More than 44	1	1 5
	69	100 0
Gender		
Female	1	1 5
Male	68	98 5
	69	100 0
Marital status		
Single	25	36 2
Married	44	63 8
	69	100 0
Education		
Less than B S	1	1 5
B S or equivalent	59	85 5
M S or equivalent	7	10 1
PhD	2	2 9
	69	100 0

4 Relationships with three selected factors

a Participation and training content The selection of content as factor of interest for this study assumes that a researcher's performance is affected by the cognitive nature of his/her research tasks Another related assumption is that the nature of these tasks is tied to the differntial historical development of scientific fields and modes of production For instance, when cassava researchers perform differently from rice researchers, this is associated not only with the contrasting character structures of the persons who carry out research tasks in these specialized fields, and with particular conditions of the organizational environments in which they work, differential performance is associated also with the dissimilar characteristics and stage of development of research traditions and modes of production of rice and cassava This is not to say that doing research on cassava is more or less difficult than doing research on rice, but simply that the two differ

A chi-square test suggests that proportions of network participants and non-participants distributed by training content are different among the sample studied (Table 46) There is a higher rate of participation for beans and rice former trainees who are engaged in research (approximate ratios between participants and non-participants are 4 1 in beans and 3 1 in rice), and lower participation for cassava and tropical pastures trainees (ratios are 2 1 in cassava and 1 1 in tropical pastures)

Table 46 Former CIAT trainees' participation in networks of researchers, distributed by training content

Variable	Participants n'	Participants (%)	Non-participants n'	Non-participants (%)	TOTAL n	TOTAL (%)
Training content	141	68 1	66	31 9	207	100 0
Rice	24	75 0	8	25 0	32	100 0
Beans	71	78 9	19	21 1	90	100 0
T Pastures	19	45 2	23	54 8	42	100 0
Cassava	27	62 8	16	37 2	43	100 0

Chi-square = 32 17 Statistically significant at alpha level 0 05

A last examination of the relationship between participation in research networks and training content arises from disaggregating participation in terms of networks roles, and then focusing on the proportions of group members within each content This focus on group members is based on the high significance that "invisible colleges" have within research networks (Liaisons are also very important, but their reduced number does not allow one to make comparisons) The proportion of group members is higher in the fields of bean (44%) and tropical pastures (36%), intermediate for rice (28%), and lowest for cassava (12%) The high proportion of group members in tropical pastures sharply contrasts with the circunstance that this same field exhibits the highest proportion of non-participants (55%) in this sub-sample (Table 46)

b Participation and length of training Unexpectedly, length of training is inversely related to participation in networks of researchers (Table 47) This result is contrary to the general assumption made in the design of training programs at CIAT, and also contrary to the relationship observed formerly between length of training and number of years that practitioners stay doing research after training

Table 47 Former CIAT trainees' participation in networks of researchers, distributed by length of training

Variable	Participants n'	Participants (%)	Non-participants n'	Non-participants (%)	Total n	Total (%)
Length of training	141	68 1	66	31 9	207	100 0
Two months or less	76	73 1	28	26 9	104	100 0
More than two months up to six months	47	71 2	19	28 8	66	100 0
More than six months	18	48 7	19	51 3	37	100 0

Chi-square = 14 82 Statistically significant at alpha level 0 05

A clearer pattern emerges suggesting a curvi-linear relationship, in which intermediate training is correlated with the highest proportion of group members (Table 48)

Table 48 Group members, who are former CIAT trainees, distributed by length of training

Length of training	Group members	Percentage of sub-sample	Sub-sample size
Two months or less	32	31	104
More than two months, up to six months	30	45	66
More than six months	7	19	37

Finally, this relationship is examined within training contents, selecting again as a focus the number of group members, given the relevance of this role within a research network. The curvilinear pattern suggested in the preceding paragraph consistently emerges within all four training contents (Table 49 and Figure 6).

Table 49 Group members who are former CIAT trainees, distributed by content and length of training

Training content	Length of training: Short (No.)	Short (%)	Intermediate (No.)	Intermediate (%)	Longer (No.)	Longer (%)	Total (No.)	Total (%)
Rice	4	29	5	33	0	0	9	28
Bean	23	43	13	50	4	36	40	44
T. pastures	2	40	11	52	2	13	15	36
Cassava	3	9	1	25	1	14	5	12
TOTAL	32	31	30	45	7	19	69	33

c. Participation and facilities to do research. Data grouped in terms of more and less facilities to do research in the fields of training at home organizations do not show statistically significant differences (Table 50). This result conforms with what was observed before in the relationship between research facilities and number of years that practitioners stay doing research after training. In spite of the lack of statistically significant differences, a slight difference seems to exist in the data suggesting a possible positive correlation between participation in networks of researchers and facilities to conduct research at home organizations.

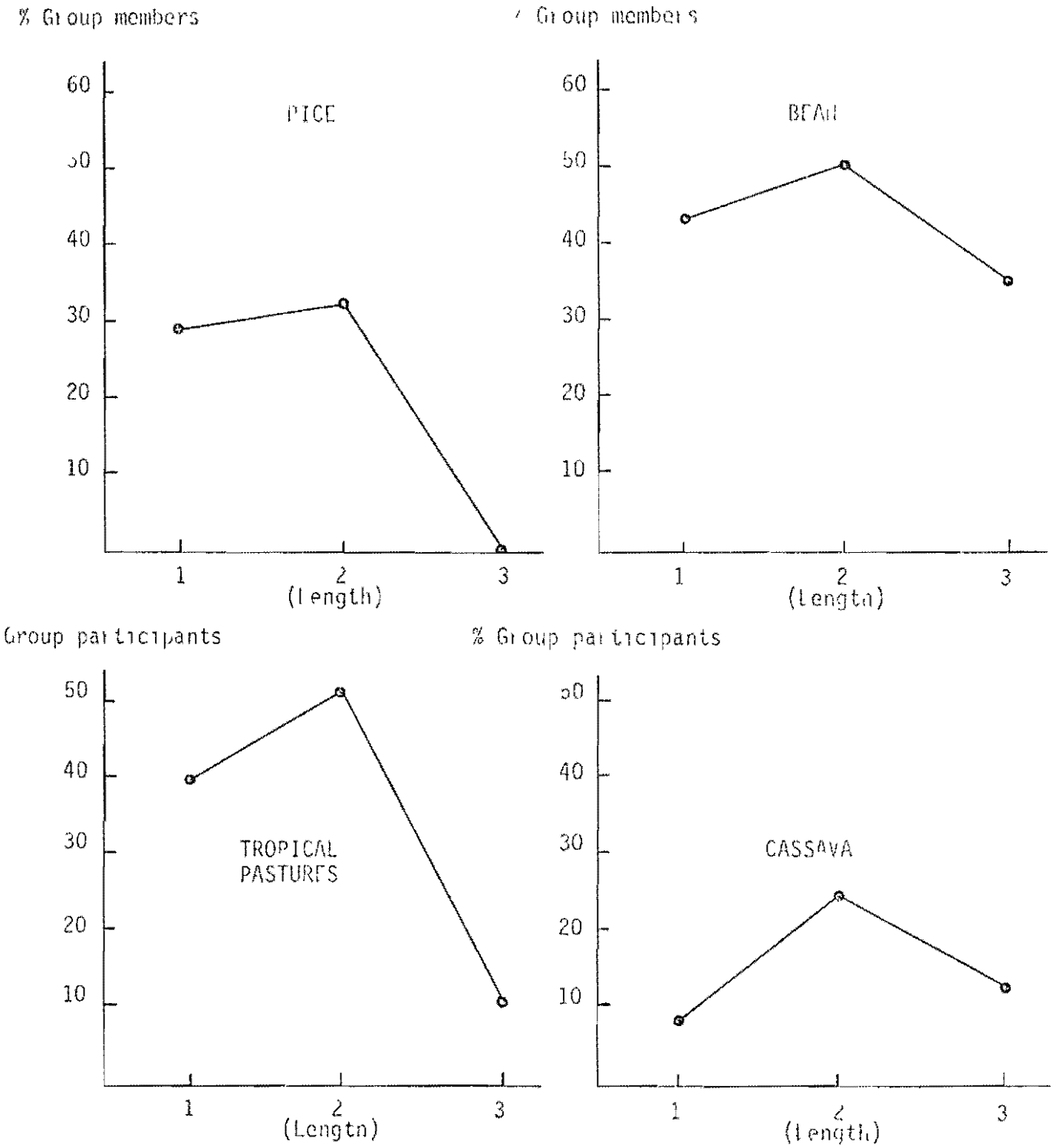


Figure 6 Percentages of former CIAT trainees who are group members represented in relation to length of training

Table 50 Former CIAT trainees' participation in networks of researchers distributed by facilities to do research at home organizations

Variable	Participants n'	Participants (%)	Non-participants n'	Non-participants (%)	Total n	Total (%)
Facilities to do research	141	68 1	66	31 9	207	100 0
More facilities	104	68 9	47	31 1	151	100 0
Less facilities	37	66 1	19	33 9	56	100 0

Chi-square = 0 23 Not statistically significant at alpha level 0 05

Summarizing the relationships with independent variables this study indicates that participation in research networks varies with training content and length of training, but not with facilities to do research at home organizations The highest proportions of participants are in the fields of rice and bean, and the lowest in tropical pastures and cassava However, when participants are disaggregated by network roles, bean and tropical pastures are the fields with highest proportion of group members, rice is intermediate and cassava is the lowest Linkages are more transnational in the fields of rice and tropical pastures, and more localized within organizations and countries for bean and cassava researchers These relationships reflect the structural character of the content factor In fact, there is more developed infrastructure in Latin America for entreprises related to rice and bean production and marketing, and a less developed infrastructure for cassava Tropical pastures are an intermediate input for beef production, which also has a more developed infrastructure than cassava Both cassava and tropical pastures are newer fields of research than rice and beans Rice and tropical pastures are more worldwide concerns which are reflected in the apparently more "cosmopolitan" linkages of researchers in these fields In contrast, bean and cassava research are more domestic concerns at present, and this appears to be reflected in a more "local" orientation of the professional linkages in these fields

There is a curvilinear relationship between length of training and participation of research networks with those persons who have an intermediate training presenting the highest proportion of participation This is a puzzling relationship whose understanding requires further investigation

B Network content, channels and benefits

1 Content What do people interchange in this network? First, ideas about their research problems, particularly with regard to establishing and selecting priorities (Table 51) Second, methodology, techniques, practical ways to surmount procedural obstacles when doing research Third,

scientific and technical literature already published, as well as manuscripts Fourth, germplasm Fifth, shared work as part of collaborative research Less frequent are interchanges to jointly prepare presentation for professional meetings, and circulation of information on employment opportunities It is noteceable the interchange of germplasm, because at network level this activity means horizontal transfer of technology and research capability

Table 51 Content of the interchanges (n = 96)

	Beans (%)	Rice (%)	T pastures (%)	Cassava (%)	Total (%)
Research problems	94	77	70	78	81
Research methodology	79	73	61	83	74
Scientific and technical literature	67	91	61	78	73
Manuscripts	61	68	43	83	67
Germplasm	58	82	48	50	59
Collaborative research work	67	55	43	56	56
Work to prepare presentations	58	36	39	50	47
Employment opportunities	18	41	22	11	23

2 Network channels There is a diversity of media through which interchanges take place in this network, but preferences seem to exist on personalized channels, such as personal letters, visits, and encounters at professional meetings (Table 52) Other network media include annual reports of institutions or research programs, the CIAT library and documentation centers, and publications Phone calls are the less frequent channels reported, a fact which may be related to the quality and cost of telephone services in most Latin American countries

Table 52 Network channels (n = 96)

	Beans (%)	Rice (%)	T pastures (%)	Cassava (%)	Total (%)
Personal letters	64	73	87	67	72
Visits	76	64	65	61	68
Annual reports	73	68	52	61	65
Regional meetings	76	64	48	50	61
National meetings	76	59	43	56	60
CIAT library and documentation centers	52	64	57	67	58
International meetings	67	59	39	44	54
Publications	48	45	43	72	51
Phone calls	42	36	30	61	40

3 Benefits derived from network participation One of the more positive assets of CIAT is its contribution to the establishment and maintenance of functional connections among agricultural researchers particularly by those young practitiones who comprise the majority of CIAT trained personal

The survey questionnaires and interviews show that before training former trainees had few opportunities for exchanging information, experiences and materials with significant colleagues who work at other institutions and in other countries (Table 53) They were almost not acquainted with other countries' people and research After training, as reported in the preceding section, they have been participating very actively in research networks A significant proportion of former trainees attribute to CIAT training a high degree of contribution to their integration into those networks (Table 54)

Table 53 Research links established through training by former CIAT trainees (n = 96)

	Proportion of links established		
	Most (%)	Some (%)	None (%)
Beans	39	52	9
Rice	50	41	9
T pastures	64	36	0
Cassava	33	61	6
TOTAL	46	47	7

Networking has been useful for keeping researchers up-date, getting recognition and socio-psychological rewards, facilitating research production by means of colleagues advice and collaboration, and stimulating advance of professional careers (Table 55) A former CIAT trainee pointed out the meaning of network participating for him with the following words

" Being part of a research network means to have access to a lot of collective experice having already been in a network, you realize this, particularly when you have to switch commodities, which means that you are changing your research area If in this new area there doesn't exist an already developed network or if an easy integration to the network has not been yet available to you you feel a big void, a lack of support, an isolation, a relative impotence, sometimes you feel that you efforts are sterile The morale might drop and the work may become fruitless"

Table 54 Degree in which CIAT training contributed to former trainees integration into research networks (n = 96)

	Degree of contribution		
	High (%)	Medium (%)	Low (%)
Beans	52	36	12
Rice	68	27	5
T pastures	27	64	9
Cassava	56	33	11
TOTAL	51	40	9

Table 55 Benefits derived from network participation (n = 96)

Benefits	Beans (%)	Rice (%)	T pastures (%)	Cassava (%)	TOTAL (%)
Access to scientific literature	73	77	70	78	74
Collaboration and advise	70	77	70	72	72
Up-dating	79	64	74	61	71
Links with other colleagues	64	68	65	61	65
Research recognition	48	59	61	50	54
Germplasm	52	77	52	33	54
Research visibility	42	55	48	56	49
Opportunities to publish	33	63	48	50	47
Labs and equipment services	39	55	43	28	42
Higher education	39	50	39	28	40
Logistic support to research	9	18	22	28	18
Employment	3	9	4	6	5

C Networking and research performance

The relationship between networking and research performance was explored by comparing time devoted to research and performance ratings of groups members versus those of isolated researchers It was hypothesized that group members perform higher than isolates in these two dimensions, and that there are no significant differences in both sets of people distributed by commodities

Data processed by an analysis of variance support the hypothesized relationships Means are presented in Tables 56 and 57 Group members devote about 20% more time to research than isolate researchers do, the differences being highest among cassava and rice researchers, and lowest among beans and tropical pastures researchers Performance ratings are significantly higher for group members than for isolates, the differences being higher for rice researchers From the other side, differences within group members and within isolates are not significant

These results support the conclusion that networking has a positive impact on research performance Such conclusion invites to consider networking as a new, fresh, open avenue for strengthening research in developing countries

Table 56 Average percentage of time devoted to research by former CIAT trainees who perform network roles as group members and isolates, distributed by commodities

Commodity	Average % time devoted to research	
	Group members	Isolates
Beans	68 82	59 29
Rice	72 50	45 00
T pastures	62 92	51 58
Cassava	70 83	42 00
TOTAL	68 36	50 90*

* Significantly different at $\alpha = 0\ 05$

Table 57 Average performance ratings (on a 1-5 scale, 1 = poor, 5 = excellent) of former CIAT trainees who play network roles as group members and isolates, distributed by commodities

Commodity	Average performance ratings	
	Group members	Isolates
Beans	4 17	3 78
Rice	4 13	2 86
T Pastures	4 08	3 37
Cassava	3 82	3 20
TOTAL	3 94*	3 38*

* Significantly different at = 0 05

VI STRENGTHENING RESEARCH PROGRAMS

Following is a summary of four case studies prepared to examine in depth the contribution made by CIAT in strengthening national programs dedicated to research in beans, rice, tropical pastures and cassava. Detailed versions of these studies are available in Spanish.

Interviews and group meetings with researchers and administrators from the respective programs, interviews with personnel from institutions related to these programs, discussions with CIAT scientists directly involved in the development of these national programs, trip reports prepared by CIAT personnel, and documents available in national institutions and libraries were used as sources of information to prepare these studies.

The four case studies are ICTA's (Instituto de Ciencia y Tecnología Agropecuaria) Bean Program, Guatemala, INIAP's (Instituto Nacional de Investigaciones Agropecuarias) Rice Program, Ecuador, INIPA's (Instituto Nacional de Investigación y Promoción Agropecuaria) and IVITA's (Instituto Veterinario de Investigaciones Tropicales y de Altura de la Universidad Nacional Mayor de San Marcos) Tropical Pastures Research Centers, Peru, and, finally, INIA's (Instituto Nacional de Investigaciones Agrícolas) Cassava Program, Mexico.

A ICTA's Bean Program, Guatemala

1 Establishment of the Program

The Bean Program was initiated as one of the plans included in reorganization of Guatemala's agricultural sector in 1970. A national agricultural development plan was defined, encompassing the need to generate technology on basic cereal production. In view of growing internal demand for cereals and the slow growth of technology development, the Ministry of Agriculture took the first steps to strengthen and accelerate research efforts.

These efforts were crystallized on 24 October, 1972 through Congress, decree 68-72, by means of which ICTA was created as the institution responsible for agricultural research in Guatemala. The structure and development of ICTA's programs were based on existing relationships with CIAT, whose research would serve as back-up for the new institution. In accordance with the Ministry of Agriculture, CIAT staff participated during March, April, and May, 1973, in the revision of organic structure, administrative procedures, and work plans aimed at starting initial research activities. On 10 May, 1973, ICTA was formally inaugurated and on 1 June, 1973 the institution officially started operations.

The following criteria were defined in formulating an operational strategy: a) a necessary condition for the success of the task ahead was the permanent interaction among researchers, as well as among researchers and farmers, b) the quality and efficiency of the work conducted depends on the capacity, training, and dedication of professionals, as well as on the logistical support offered to them, and c) before starting activities it would be necessary to identify and define main working targets.

2 Highlights in development of know-how to conduct bean research

a Human resources for research During its ten years of activities, the number and quality of Program professionals has gradually strengthened The team has been made up of 7-11 researchers (Figure /, Table 58) Directly through their work and in specialized courses and university programs, these researchers have gained experience and improved their technical abilities

As of 1981, CIAT had contributed by training the greatest number of professionals from ICTA CIAT has trained two thirds of the ICTA's Bean Production Program staff during ten years of existence (Figure /) Of the proffessionals still working for the Program, 63 6% have been trained at CIAT Currently, two of the researchers assisting short courses at CIAT are now studying to obtain their Master degree

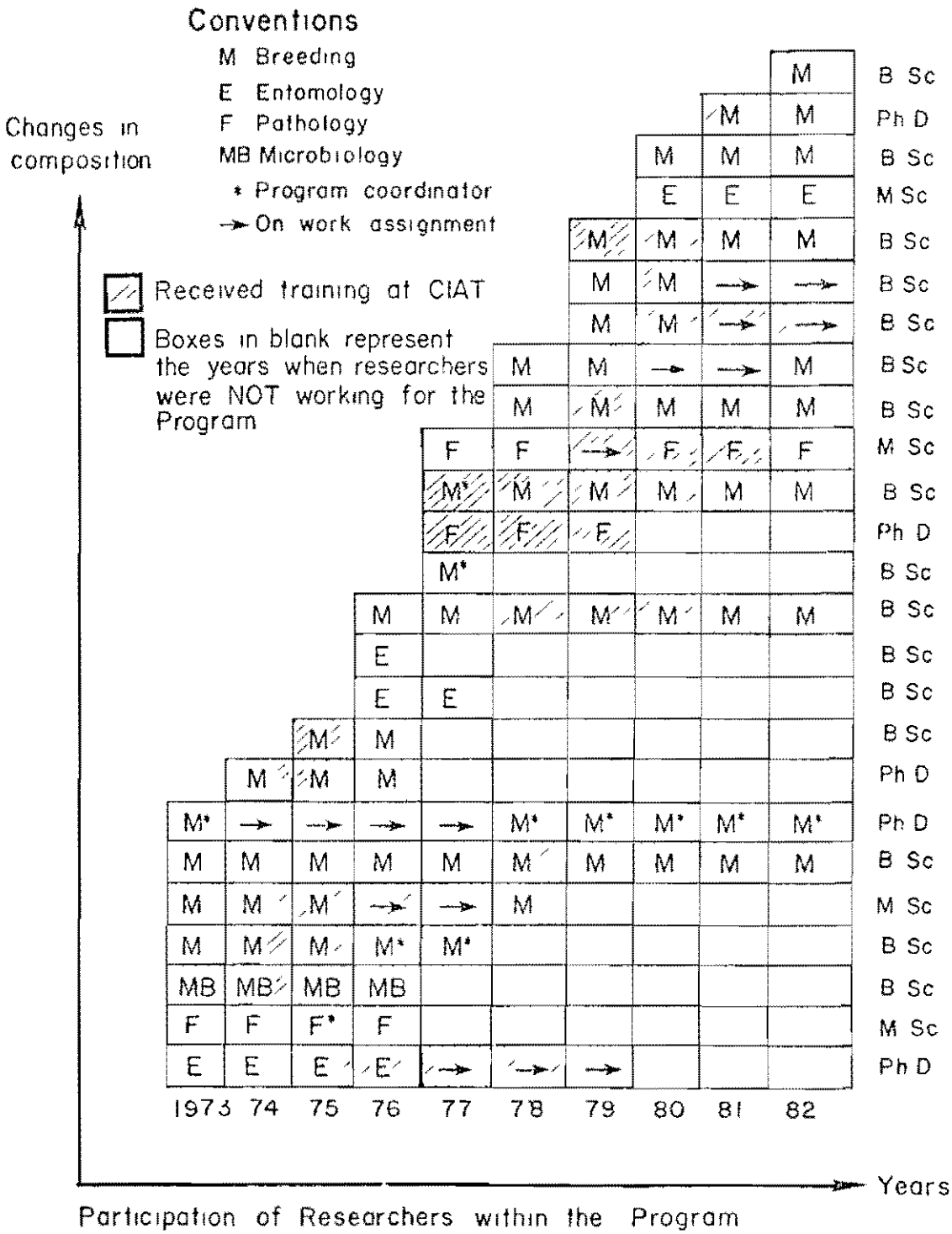
In regard to academic level, large part of the team has been made up of Agronomists, the Program has been strengthened by the participation of researchers who had already received their Master or Ph D degrees (Table 59) Only one out of the nationally recruited professionals already had his Master degree when starting to work for the Program The rest have been raising their academic level as members of the team (observe study assignments in Figure 7)

As the Program has matured and oriented itself more clearly toward the obtention of improved varieties, the staff has reorganized to center itself on breeding activities, with the support of personnel trained in pathology and entomology (Figure 7 and Table 60)

As seems to be typical in national agricultural research programs in Latin America, ICTA's Bean Program also presents a high level of personnel rotation What is not typical is the fact that changes in personnel were concentrated almost completely during the same year, in this case, the majority of professionals left during 1977 In this sense, 1977 divides in two the history of the Program From 1973 to 1976, 100% of the qualified staff kept their jobs For personnel recruited nationally after 1977, retention was also 100% It is worth mentioning that research continuity has been possible thanks to the current coordinator, who was named at the start of the Program, and, in addition, had been conducting research in beans even before ICTA was established

b Research facilities Due to technical reasons, the Production Center of Monjas was closed during the agricultural year 1974-75, land was acquired in Jutiapa to locate the new Production Center for the East This production center, as well as the other centers, in ICTA, count with minimum facilities (equipment, area, and offices) for their researchers to carry out part of their activities, considering that part of the work has to be developed in farms or plots rented from the farmers If the farmer is the client, technology must be generated and evaluated in his own farm Under this general objective, the Program elaborated its First Work Plan and the budget requested was assigned During the first three years, the Program's main headquarters were located in Jutiapa (East), this was the only region assigned a budget, until 1976,when Chimaltenango (Altiplano) was financed

Figure 7 Dynamics of the composition and participation of researchers from ICTA's bean production Program



Not too many facilities are available for writing and printing research results, but there are sufficient resources to conduct field work Other items such as research outside the station, documentation and training, in addition to facilities shared by all of ICTA's programs, also count with international support

The exchange of information and experience among colleagues from other national bean programs in Latin America is done through the international institutions, primarily CIAT and PCCMCA Researchers in the Program pointed out that if these international relationships did not exist, they would find themselves isolated from similar work being conducted in other similar programs in the region

Also mentioned was the need to start publishing research results and reinforcing research planning in order to generate new technology and advances that satisfy current farmer needs and expectations from technicians as to development of new varieties

3 Program Results

The Program at ICTA has developed a research capacity during its ten years of existence far superior to that existing in Guatemala in 1972, as evidenced by the number and quality of researchers formed, by the philosophical evolution and objectives of the Program, its research methodology, and by the technology made available to farmers and development institutions in Guatemala's agricultural sector

The initial Program mandate had identified Yellow Mosaic Virus as one of the most serious restraints to bean production in eastern Guatemala Three varieties were released in 1979 as alternative solutions to this problem

Technology released by the Program has been transferred to farmers in three ways a) directly through the research process itself, b) through activities carried out by other institutions in the agricultural sector, and c) from farmer to farmer by means of the social system of bean production Studies carried out in eastern Guatemala, the mayor bean production region, show that close to 30% of the farmers are planting improved varieties in 25% of the total production area There is awareness of the present need for the Program to adopt a more agressive technology transfer strategy

An overview of the impact generated by improved bean varieties indicates a) a group of 17 farmers from eastern Guatemala, whose activities were followed up on during 1981, received an average net income of US$438/ha, b) based on ICTA estimates, close to 8000 ha were planted to improved varieties during 1981 in eastern Guatemala, meaning a possible additional income for the region superior to US$3 000 000 (at current prices), c) taking into account only the benefits obtained in the eastern region due to the use of improved varieties, it is estimated that the Program has had an internal rate of return of 200%, and a cost/benefit relationship of 5 1 calculated on the basis of a 10% rate of discount

Program proyections are oriented toward three main objectives a) emphasis on technology transfer directly to farmers, b) technology development for new

geographical areas (west and southern coast), and c) horizontal cooperation with other bean programs in the region (Central America and the Caribbean)

TABLE 58 Researchers trained at CIAT working for ICTA's Bean Research Program (CIAT advisors have been included)

Year	Total no of researchers	Training at CIAT	
		Number	Percentage
1973	7	2	28
1974	7	4	56
1975	8	6	75
1976	10	5	50
1977	8	3	38
1978	9	5	56
1979	10	6	60
1980	10	7	70
1981	9	6	67
1982	11	7	64

TABLE 59 Program staff by academic level

YEAR	Ph D	M S	B Sc	TOTAL
1973	0	1	6	7
1974	1	1	5	7
1975	1	1	6	8
1976	1	1	8	10
1977	1	0	7	8
1978	2	1	6	9
1979	2	0	8	10
1980	1	2	7	10
1981	2	2	5	9
1982	2	2	7	11
TOTAL	13	11	65	89

TABLE 60 Program staff by work area

YEAR	M	F	E	MB	TOTAL
1973	4	1	1	1	7
1974	4	1	1	1	7
1975	5	1	1	1	8
1976	5	1	3	1	10
1977	5	2	1	0	8
1978	7	2	0	0	9
1979	9	1	0	0	10
1980	8	1	1	0	10
1981	7	1	1	0	9
1982	9	1	1	0	11
TOTAL	63	12	10	4	89

Conventions

M = Breeding
F = Pathology
E = Entomology
MB= Microbiology

B INIAP's Rice Program Ecuador

1 Program Background and Establishment

Rice has been traditionally produced and consumed in Ecuador for many years Production is located in the coastal area, where ecological conditions favor this crop During the last two decades approximately 120,000 hectares have been planted to rice

Even before 1969 demand for rice production technology in Ecuador was evident This demand was satisfied by importing seed, chemical agricultural products, equipment, and information To a certain extent, these products are still imported primarily by large landowners, with the help of multinational enterprises An institutional infrastructure did not exist in Ecuador before 1969 to confront rice production problems Only certain isolated aspects were studied by university students in preparing their graduate thesis

In 1969 INIAP established its Rice Research Program, with headquarters in the Boliche Experimental Station The Program started activities with two professionals who had participated in CIAT's training program during 1968 as rice researchers

2 Development of know-how in rice research

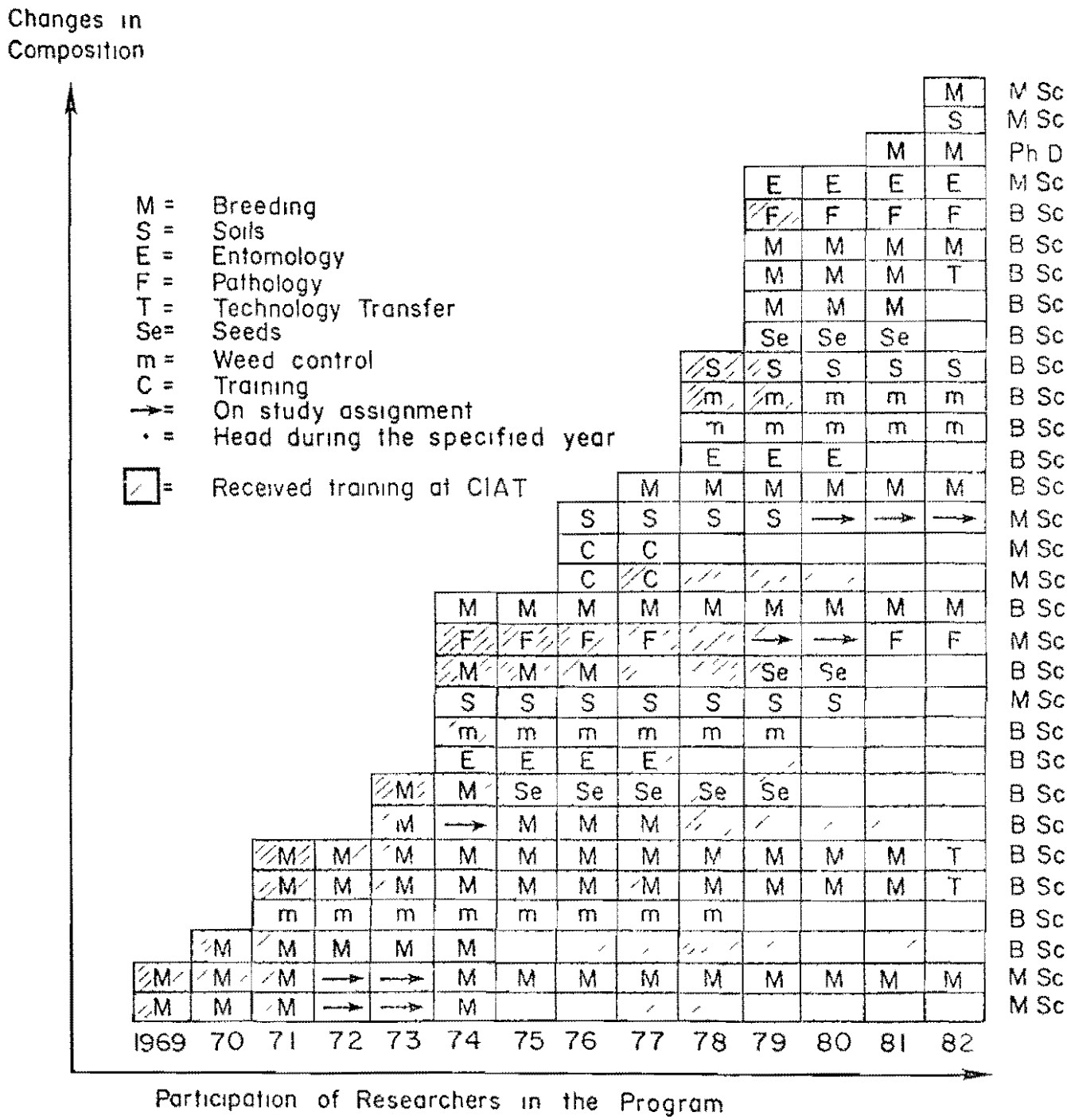
a Human resources The Program's achievements in establishing its team of researchers (Figure 8) has been outstanding From two professionals in 1969, the team grew to six in 1973, increased to 13 in 19/4, and continued expanding to a total of 20 researchers in 1979, there was a small decline from 1980 to 1982, reaching an average since then of 16 researchers in the Program (Table 61)

Right from the start until today, the Program has continued to stregthen its technical quality based on training offered at CIAT Out of the 31 researchers participating in the Program, 19 (61%) have come to CIAT (Figure 8) As the team has grown in size, the proportion of Program researchers having received training at CIAT has decreased year by year, but this proportion has never been lower than 50% (Table 61)

Until 1974, professional personnel retention was 100% (Figure 8) Currently, out of the 16 researchers remaining in the Program, 10 (62 5%) have received training at CIAT Eight of them have worked for the Program at least five years, two have worked with INIAP during 12 years, and the Program head has been working for the Program since its establishment in 1969 (Figure 8)

Since 1974, departure of professionals has been greater among those having received training at CIAT of the 14 researchers who have left during the existence of the Program, 9 had received training at CIAT (Figure 8) However, it must be emphasized that all of these nine professionals are still related to the rice sector, they contribute to the Rice Program from other sections in INIAP, from other public or private institutions, or as private technical advisors

Figure 8 Dynamics of the composition and participation of researchers from INIAP'S rice program



The team is made up of professionals with a B Sc degree in Agronomy During its 14 years of operations, two thirds of the professional labor force (researcher-years) has been made up of agronomists (Table 62)

The academic level of the team has been improving as the Program achieves maturity It is frequent to find professionals joining the Program as soon as they finish their B Sc studies Here they give their first steps in research, guided by their more experienced colleagues In many cases, these initial jobs serve as the basis for their B Sc thesis Afterwards, some of them have the opportunity to continue studying for their Master degree (see study assignments in Figure 8) Not one of these researchers has obtained his Ph D degree, and it seems that this is not an objective shared by either the Rice Program or INIAP in general

Breeding activities have counted with 50% of the professional labor force (Table 63) Emphasis has been on introduction, evaluation, and selection of varieties, especially those adapted to irrigated rice conditions However, breeding has not been the exclusive activity, research has also been conducted on cultural practices, characterizing INIAP's Rice Program as an agronomy program The emphasis on breeding as the main team work was started in 1981 Since then, activities have been centered to make this new focus operational

b Research facilities Field work is conducted both in the Boliche Experimental Station and in private farms Part of Boliche's 200 ha have been adequated for irrigation and drainage Offices and storehouses are located here Pathology, entomology, and soil laboratories located in this station are used more by professionals from support units than by the members of the Program A small documentation center, not very well equipped, has been organized

Professionals in the Program have maintained close relationships with IRRI and CIAT, through which a flow of current technology from the rest of the world is received However, they have not participated, moved by their own initiative, in any international research network Locally, Program professionals have developed means by which to be continuously involved in learning activities, thus, they are continuously involved with universities as thesis advisors, as short course participants or instructors, organizing professional events, and/or participating in activities organized by the agricultural sector Within the institution, researchers prepare brochures, technical reports, and the obliged annual report

As evidence of the Program's ever increasing maturity, is its conceptualization of how to focus research on the basis of Ecuadorian ecological and socio-economic conditions Main emphasis continues to be given to irrigated rice, but upland rice is each time receiving more attention since 1976 This conceptual frame includes a diagnosis of each of the four production systems

3 The Program's Impact

In terms of yield increase during the 1970-80 decade, the Ecuadorian rice sector has had an annual growth rate of 1 77', lower than the 3% rate of population increase

However, evaluating other changes occurred in the rice sector, additional benefits can be observed Area planted to rice increased at a 5 68% annual rate, and this increase was not related to an increase in rice prices On the contrary, these have shown a tendency to decrease These increases in area planted to rice can be associated with the presence of trained professionals who have made available to the sector new technology through research, extension, and technical assistance serv ces

Due to increases in yield and in area planted, production grew during the past decade at an annual rate of 7 45%, this rate exceeds by 1 35' the annual rate of demand (6 1%)

These conditions suggest that during the past decade, supply was the motor behind the growth of the Ecuadorian rice sector It was possible to satisfy the additional demand generated by the population increase (3%), and even to stimulate a 3 1% annual increase in rice consumption, which went from 17 to 20 kg/person/year This increase in consumption is explained both by the increase in income per capita and by the decrease in rice prices

During the 1970-80 decade, rice prices had decreased by 5% in relation to maize, by 74" in relation to potatoes, and by 58/ in relation to beans The price rate between meat and rice had remained constant

An additional benefit, difficult to quantify in economic terms is the impact that technological change (new varieties and their complementary technology), based on a team of well trained professionals, can have on the stability of rice production and therefore on prices The yield variation which in 1956-60 was 478 kg, was reduced to 112 kg in 1976-80

It has been estimated that additional production due to the impact of research and training has ben 209 340 tons paddy rice, which at an international price of US$250/ton, would result in a total cost of US$52 3 million

Finally, if the current situation is projected toward the future, the need to continue and if possible increase financial support for research and training is accentuated Only to maintain the current levels of rice consumption, Ecuador would require for the year 2 000 50° more production than current figures It is expected that this increase come from an expansion in yield and area planted In both cases the system must receive the impulse of technological innovations, whose generation and extension in turn require a highly trained professional work force

TABLE 61 Number of professionals having received training at CIAT who have worked with INIAP's Rice Program, Ecuador

Year	Total No of researchers	Professionals trained at CIAT	
		Number	Percentage
1969	2	2	100
1970	3	3	100
1971	6	5	83
1972	4	3	75
1973	6	5	83
1974	13	10	84
1975	12	9	75
1976	15	9	60
1977	14	8	57
1978	14	7	50
1979	20	10	50
1980	17	9	55
1981	16	8	50
1982	16	10	62

TABLE 62 Program staff by academic level, expressed in number of research-years

Year	Ph D	M S	B Sc	Total
1969	0	0	2	2
1970	0	0	3	3
1971	0	0	6	6
1972	0	0	4	4
1973	0	0	6	6
1974	0	3	10	13
1975	0	2	10	12
1976	0	3	12	15
1977	0	3	11	14
1978	0	2	12	14
1979	0	3	17	20
1980	0	3	14	17
1981	1	3	12	16
1982	1	5	10	16
TOTAL	2	27	129	158

TABLE 63 Program staff by work area, expressed in number of researcher-years

Year	M	F	E	S	m	Se	T	C	TOTAL
1969	2	0	0	0	0	0	0	0	2
1970	3	0	0	0	0	0	0	0	3
1971	5	0	0	0	0	0	0	0	6
1972	3	0	0	0	1	0	0	0	4
1973	5	0	0	0	1	0	0	0	6
1974	8	1	1	1	2	0	0	0	13
1975	6	1	1	1	2	1	0	0	12
1976	6	1	1	2	2	1	0	2	15
1977	6	0	1	2	2	1	0	2	14
1978	5	0	1	3	4	1	0	0	14
1979	8	1	2	3	3	3	0	0	20
1980	8	1	2	2	2	2	0	0	17
1981	9	2	1	1	2	1	0	0	16
1982	6	2	1	2	2	0	3	0	16
TOTAL	80	9	11	17	24	10	3	4	158

Conventions

M = Breeding

F = Pathology

E = Entomology

S = Soils

m = Weed control

Se = Seeds

T = Technology Transfer

C = Training

C Tropical Pastures in Peru

Peru does not have a national tropical pastures program Two nuclei exist, working quite independently one from the other (IVITA in Pucallpa and INIPA in Yurimaguas and Tarapoto) Lately these research centers have come closer together and work coordination has been initiated through cooperative trials Former CIAT trainees have promoted this coordination CIAT scientists have helped as advisors and by sending germplasm and information

1 IVITA (Instituto Veterinario de Irvestigaciores Tropicales y de Altura de la Universidad Mayor de San Marcos)

IVITA's present tropical pastures research nucleus (Figure 9)was started in 1966 as a result of an agreement signed between the Universidad Mayor de San Marcos and FAO

The first professional arrived in 1966 and started by constructing the experimental station's infrastructure, by clearing-up and sowing the first pastures, and setting the bases for the first buildings The next year another professional joined his work From the difficulties encountered in converting forests into pastures, arose the need to find better grasses than those native to the region

The team started by introducing grass species mentioned in the literature as having potential under grazing in forest ecoystems At the same time that these grasses were being evaluated, work was initiated on agronomic aspects related to pasture establishment using promising cultivars to determine the response to fertilizer sources and levels Land preparation methods were also evaluated, using only manual labor and using machinery Consideration of other agronomi aspects such as advisable planting densities for pasture establishment and disease evaluation came years later

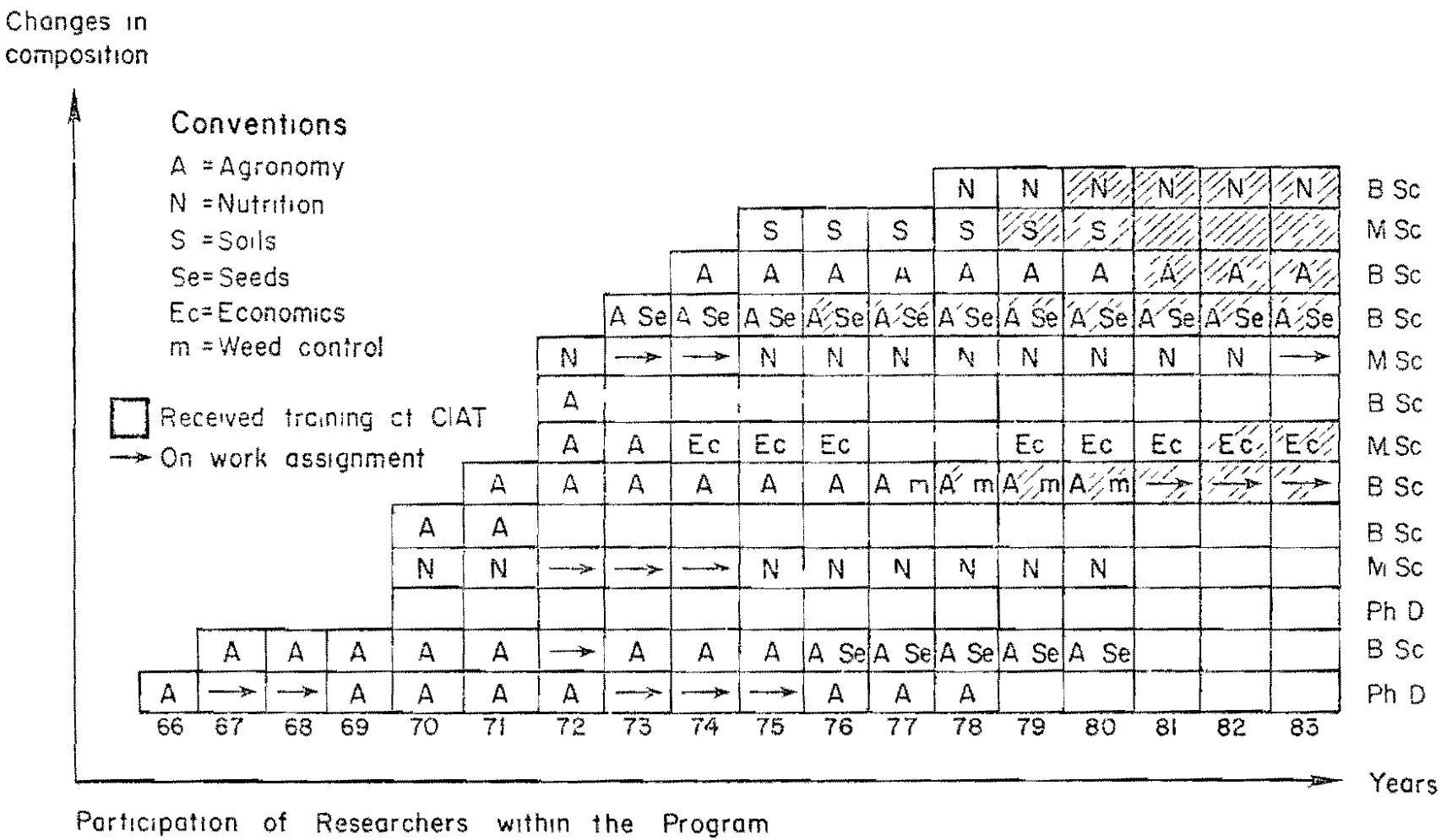
By 1970 this nucleus already had five members in its staff Their work had a broader vision The team defined as a basic element to establish cattle production in the Peruvian Jungle, the development of an appropriate pasture production technology, thus, this became IVITA's first research priority in Pucallpa

In 1972 a technology package was available for the Station, the professional team expected this package to be functional when used by farmers, but did not take direct actions to achieve diffusion and utilization by farmers of this technology

By the time, professionals at IVITA were divided by two ways of focusing the problem to center attention on the animals, or to focus on forage production The first group, derived their opinion from their formation as veterinary doctors, the second, from their background as agronomists

The agreement with FAO expired in 1976 and, therefore, their professional and economic contribution ended At that time there were nine professionals in the team

Figure 9 Dynamics of the composition of the nucleus of IVITA's Tropical pastures researchers at Pucallpa, Peru



After 1978, personnel from IVITA started training at CIAT, a total of seven professionals have now been trained, five of which still belong to the program The other two are studying to obtain their M S degree

2 INIPA's nuclei in Tarapoto and Yurimaguas (Figure 10)

Work in Tarapoto also started in1965 and included basic aspects of pasture selection and management The method gradually adopted by researchers in Tarapoto was to deliver promising materials directly to farmers

During the first decade (1965-75), the use of Brachiaria and forage soybean was promoted among cattle raisers for the fertile soil conditions existing in Central Huallaga

Research during these first years was centered primarily on breeding, evaluation of introductions, and search for pasture varieties resistant to the Acromyrmex landotti ant that was causing serious damage to native pastures In 1972 evaluation of the compatibility of the most common grass in the region (Brachiaria decumbens) and forage soybean was studied Beginning in 1973, technology transfer was initiated and was afterwards intensified in 1976-77

In 1978 the team established contact with work at CIAT Regional trials were started in the region and two professionals came to CIAT for training

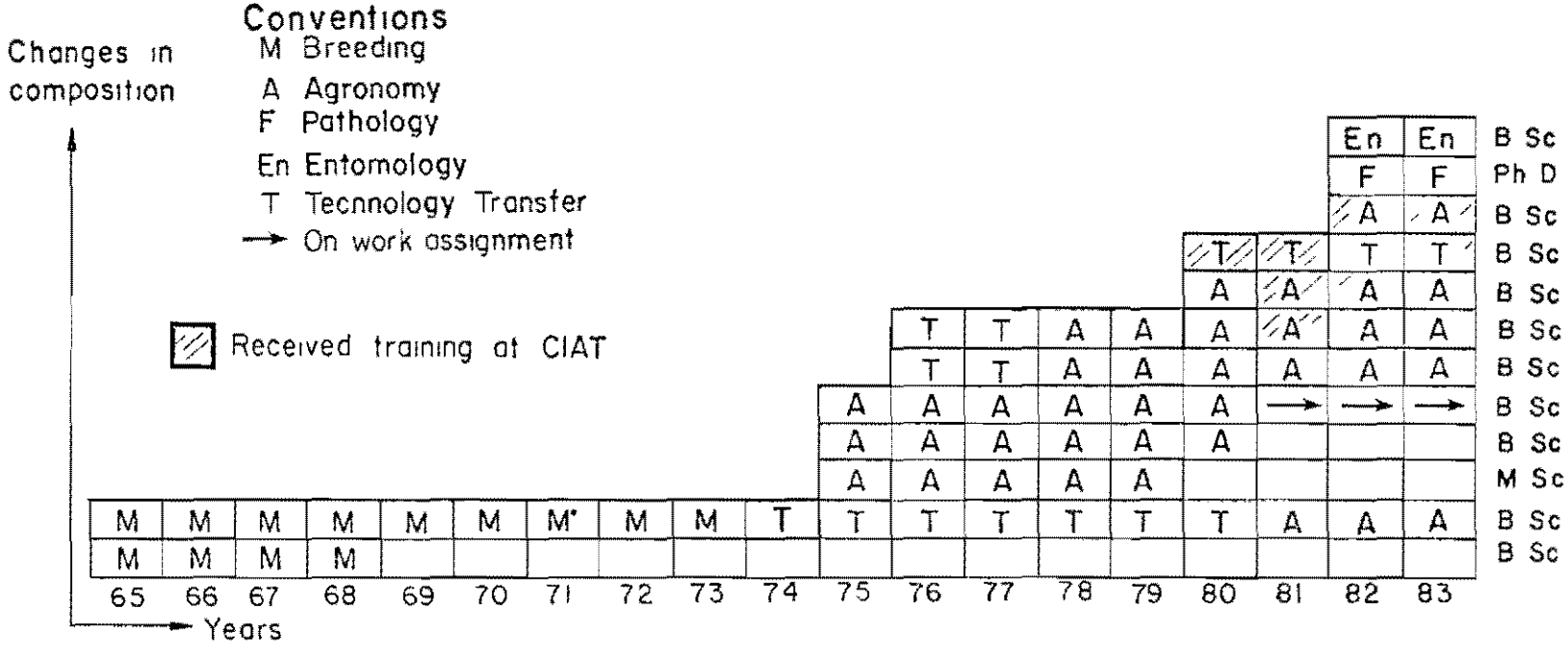
In 1980 two more professionals received training at CIAT One of them came from Tingo Maria, where he works in close relationship with Tarapoto and Yurimaguas, even though this research has not been officially coordinated In 1982 and 1983, each, one professional was trained at CIAT, afterwards they integrated INIPA's tropical pastures teams in Yurimaguas and Tarapoto

These professionals have left CIAT aware that forage species tend to adapt themselves to soil conditions, instead of trying to change the soil to adapt it to the species grown, which is a costly and nonprofitable practice for the farmer They have therefore adopted a low cost and low input philosophy

Today in many sites in the Jungle, trials are being conducted in direct relationship with the Tropical Pastures Program at CIAT This relationship has also been strengthened by visits made by CIAT staff Among the many important results of this relationship was the initiation of a line of work on control of diseases affecting pastures Thus, in 1982, two more team members dedicated their efforts to this aspect

A technology package is not yet available to be recommended to farmers, but various components of this package have been defined compatibility, persistence, and productivity of certain grass/legume associations, and promising grass and legume ecotypes

Figura 10 Dynamics of the composition and participation of researchers from INIPA'S Tropical pastures research team



3 Future research in tropical pastures

There is great interest in Perú for research in tropical pastures which can generate low input alternatives for the Jungle and which at the same time to do not cause ecological damage The most immediate perspective consists in the creation of a national program that integrates resources of various institutions with common interests, such as INIPA, the North Carolina University Mission, IVITA (Pucallpa), and the Universidad Nacional Agraria de la Selva (Tingo María)

D INIA's Cassava Program, Mexico

1 Background

The current Cassava Research Program in INIA is the result more of the perception of an opportunity than of the reaction to existing problems in cassava production or consumption in Mexico Various persons, who carried out their professional or commercial activities in the southeast of Mexico, had been aware for many years of this opportunity

In 1975, the Rural Credit National Bank and INIA sent eight professionals to CIAT to receive training in various areas of cassava research, production, and utilization Upon returning to Mexico, these professionals continued working in the same sections of their institutions, where they had been assigned before Their effort was dispersed and the development of a Mexican cassava program, integrating financial support, research, and extension, did not take place

2 Establishment of the Cassava Research Program

This first group trained at CIAT carried out activities in their respective institutions which influenced positively the creation of the future Cassava Research Program In 1976, these researchers started planting native material and germplasm from CIAT's collection, studied pests and diseases and production systems, made economic analysis, and conducted research on cassava utilization for swine feed Their scattered efforts were not part of a joint strategy, but did however serve as a continuum for their interest, knowledge, and techniques developed at CIAT during their training period

In 1976 another group of 8 Mexican professionals received training in cassava at CIAT This group, as did the previous one, carried out research in cassava even though not belonging to a formally organized cassava program Thus, 16 professionals had completed their specialized training without succeeding in the establishment of a cassava program (Figure 11)

The creation of this program received a decisive impulse in February, 1977 Five institutions decided to participate in an inter-institutional effort Agricultural Extension, the Plant Health Department, the FIRA, the Graduate College of Tropical Agriculture, and INIA commissioned eight members of their professional staff to work for the new program, headquartered in Huimanguillo, Tabasco Six of the 16 professionals trained at CIAT joined the team (Figure 11)

3 Highlights in the development of know-how to conduct cassava research

a Human resources A total of 33 professionals had been trained as of 1982 to strenghten cassava research in Mexico (Table 64) The Mexican program initiated in 1976 has gone through two phases an inter and an intra-institutional phase, which show "ups and downs" directly related with its researchers joining and then leaving the team afterwards (Figure 7) The first phase ended after three years of operations, when all

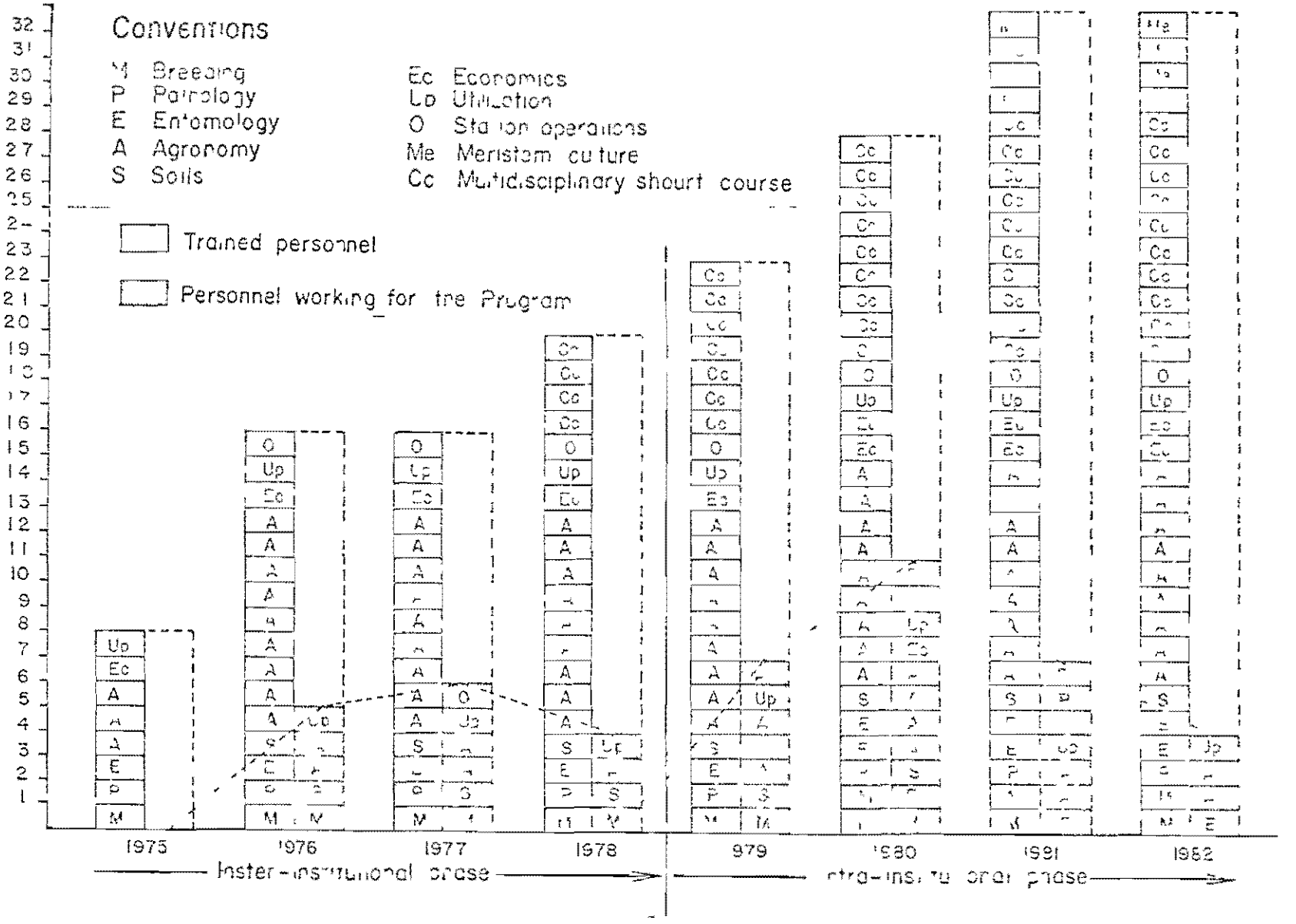


Figure 11 Personnel trained at CIAT, year by year, and participation of trainees in the Mexican Cassava Research Program

activities were practically handle by two professionals The second phase started when INIA gave new life to the program by hiring additional researchers, and simultaneously accelerating the development of research facilities However, three years later, early in 1982, the program experienced a second personnel crisis reaching a point where all research was handled by four professionals This crisis seems to be on its way to being solved through more training at CIAT and now that two researchers, program founders, who have received their M S and Ph D degrees are working for the Program again

b Research facilities Since its early years, the Program has progressively received more help from the agricultural sector In 1977 cooperating institutions absorbed personnel costs by assigning their own staff to work in cassava in 1981 20 million Mexican pesos were budgeted exclusively for the Program To start out, the team did not have its own offices or experimental stations In 1982, the Centro Integral de Investigación Agrícola, Pecuaria and Forestal was inaugurated, and specific facilities were alloted to cassava research

4 Results

From the point of view of achievements, cassava research at INIA has consolidated to some extent and a more productive technology than that traditionally used in cassava production and utilization is now available This technology, however, has not yet resulted in social benefits because of the weakness of the cassava development and utilization program in Mexico

The creation of a community of cassava researchers in Mexico is still incipient Survival of cassava research is therefore very fragile, unless a high degree of institutional protection is maintained and unless researchers in Mexico find the continuous support of an international network of colleagues Without the institutional protection of INIA, cassava research in Mexico would again become practically inexistant Without the support of an international network of cassava researchers, the incipient Mexican research community in this field would stay behind in relation to scientific, and methodology and technology developments taking place in the rest of the world

Table 64 Disciplines of training receive at CIAT's cassava Program by Mexican professionals

	No	%
Multidisciplinary short course	10	31
Agronomy	9	27
Meristem culture	4	12
Breeding	2	6
Entomology	2	6
Economics	2	6
Plant pathology	1	3
Soils	1	3
Utilization-swine	1	3
Stations operations	1	3
	33	100

VII INTERPRETATION

This interpretive section selectively takes some of the most salient findings, advances one step beyond the empirical data, and looks for additional meanings about the main aspects of these studies

A Assessing the inventory formation process

How does one assess this inventory formation process? Are figures too high or too low? Are there some findings to be concerned with? First of all, most former CIAT research trainees had had no trouble finding a job after training This is remarkable in a region where unemployment exists among agricultural professionals The contrary has occurred immediately after training, they have not only had the option of returning to their research duties in their sponsoring organizations, but have found opportunities to engage in activities other than research and with organizations other than those which spondored their training

CIAT's training is highly regarded, not only for preparing personnel for research, but for other professional work in agriculture, e g , extension, teaching, commercialization of agro-chemicals, credit, technical assistance to and administration of commercial farms, among others From positions like those, the 19% of former CIAT research trainnes who left the practice of research are contributing to food production and economic growth

Second, from the perspective of preparing research workers for the region, the accomplishments seem very good Four fifths of the people prepared during the 11-year period still participated in research activities in 1980, including those who were working on research areas different than their training fields Specialized training is useful for working with a variety of species (commodities) and research approaches The research techniques, the attitudes toward the conduct of research, the organizational frameworks of research, and other learnings acquired by professionals during their training at CIAT, as well as the contacts they made there with significant colleagues from other organizations and countries, have enabled CIAT trainees to do research in fields other than those of their specialized training Therefore, these persons--24% of whom have engaged in research with other than CIAT commodities are also contributing to increased food production and economic growth in their countries

Third, from the perspective of the sponsor organizations, there are accomplisments and concerns The entering, stay, and retention of former CIAT trainees offer an encouriging picture for human resource development three-fourths of the persons trained between 1969 and 1979 were still in their sponsor organizations in 1980 This does not suggest that a loss of twenty-six percent has no significance for sponsor organizations It does constitute a serious source of concern, studies of the reasons why people leave their organizations should be continuosly pursued, and corrective actions, when feasible, should be taken

Fourth, from the perspective of CIAT efforts to prepare skilled researchers in the focus of its mission and with the purpose of solidly establishing collaborative linkages in CIAT's four specific commodities, the

findings of this study on inventories constitute a concern About half of the persons trained during the period have migrated toward activities different than their fields of training and CIAT commodities

1 Reasons for migration

Why do people leave their organizations, the activity of research, or the specific fields in which they were trained? Based on the insigths gained through interviews and case studies several comments are advanced in the following paragraphs about this complex issue It should be emphasized that these comments do not refer to the majority of former CIAT trainees Most of them as pointed out in the preceding paragraphs, remain in their sponsoring organizations and in the activity of agricultural research

From the perspective of social systems which underlies the whole conception of these studies, human behavior is determined by the inter-action between the desires, expectations, and characteristics of persons, and the structures and cultures of the social systems in which these persons are embedded Although systems overlap and interact with each other, they are not necessarily convergent in the demands made upon their members In addition, social systems are not equally responsive to and do not equally fulfill the particular desires and expectations of each of their members These circumstances generate conflicts within individuals, among individuals, and between individuals and social systems

How are these conflicts resolved? This is an empirical question for particular settings and persons With respect to agricultural research, the complexities of the situation may be simplified by reducing the more relevant social systems to three categories a) the research organization, b) the profession of agricultural research, and c) the primary systems in which the individual's socialization originally tool place, e g , his/her country, local communities, and family

a Divergent systems' demands When the demands of the organization, the profession, and the primary systems are not convergent, agricultural researchers need to make compromises between their loyalties to these systems They may even have to break their ties with a particular system For instance, if a professional perceives that the research goals of the organization are irrelevant to the needs of local communities to which he or she expects to make contributions with improved technologies, this researcher may resolve the conflict by leaving the organization and/or the profession, or by lessening his/her ties with local communities

Conflicts of this nature may be frequent in Latin America, where agricultural research must respond to contradictory demands of dual economies Conflicting developmental goals often alternate in relative short intervals within the same organization, e g , the goals of generating technologies to implement national policies of import substitution, exportation of agricultural products, feeding increasing urban populations, or making available technological options for subsistence farms Some agricultural researchers may have kinship or economic ties to either commercial or subsistence agriculture which bring these conflicts to critical points Crises may be resolved by leaving the organization or the profession An alternative route in the resolution of this type of conflict is to strengthen the loyalties to the organization or the profesion, and to decrease the

importance of developmental goals This option may imply, for instance, dwindling researchers' ties with local communities A consequence may be diminished relevance of researchers' technological outcomes to the problems of the compromised social system, e g , communities of farmers who practice subsistence agriculture

The demands of different social systems upon agricultural researchers may act as counterveiling forces What may be dysfunctional for researchers' role performance is the total orientation toward a given social system with exclusion of the others For instance, a total orientation toward the profession may result in research outcomes lacking relevance to organizational goals and agricultural development needs, a total orientation toward the organization may lead researcher to concentrate on the goal of getting the highest positions of the bureaucratic hierachies with the result of losing continuity in their research work, and, a total orientation toward the farmer without taking into consideration the needed loyalties to the organization and the profession may result in researchers who understand very well their clientele needs but do not have the research support provided by the organization, and the knowledge basis generated by other colleagues

b Difficulties in making a living From the personal side, researchers have their own needs, aspirations, and expectations, in the whole range from physiological primary requirements to social psychological and cultural needs, such as belonging, identity, self-esteem, and creativity

In reciprocity for their work, researchers expect to make a decent living from the practice of their profession and their loyalty to a given organization When agricultural researchers realize that by staying in their organizations and professions they cannot afford to have adequate housing food, clothing, medical services, education, and recreation for themselves and their families, they are compelled to move toward other activities and organizations Sometimes what makes a researcher leave his/her organization or profession is a prospect of a better education for his/her children, or a minimum additional facility, e g , the opportunity to have a vehicle for personal and family use

Salaries and other economic compensations for agricultural researchers in Latin America are very restricted One reason for this is the general stage of development of national economies Another is the relatively low status in any country of agricultural activities Other factors relate to organizational constraints, such as very limited budgets and rigid administrative procedures Many administrators of Latin American agricultural research organizations are conscious of the need of improving the economic conditions of researchers Administrators may be willing to take these actions, yet find obstacles in doing it Most agricultural research in Latin America takes place in governmental agencies ministries, research institutes--where bureaucratic practices usually do not permit compensation to a creative person for their work in correspondence with their contributions and accomplishments, but on the basis of narrowly fixed criteria which apply uniformly to all public servants in a specific status position within the hierarchy When a given researcher finds better job conditions than those of the organization or the activity of research, administrators do not usually have a realistic option but to accept with regret the departure of qualified and talented members of the organization

c Personal professional development It is entirely legitimate for a person to seek personal development as a member of a given profession The population of this study is composed of relatively young persons, many of them in their first job and just starting careers as agricultural researchers They need opportunities to pursue their training and formal education at higher levels, e g , participation in workshops, seminars, conferences, and other professional meetings, M S and Ph D studies, postdoctoral appointments, sabbatical leaves, and so on When researchers perceive that in other organizations they will have better training and educational opportunities, it is not surprising that more venturesome researchers try to move there

2 Research career a factor to reduce migration

Open opportunities to professionals for developing their careers as researchers constitute a factor to reduce migration The vigorous pursuit of a productive professional career requires not only training, formal education, and degrees It requires the recurrent engaging in research on problems which are significant for oneself and for others to whom one regards as significant colleagues Implicit in this fulfilling of a research career are a) the opportunities to develop a long term commitment to specific fields of research, b) the availability of a minimum level of resources and support for carrying out research in those fields, and c) open possibilities for acquiring an identity as a member of a self-generating community of researchers

a Long-term commitments Opportunities for developing long term commitments to specific research fields may be restrained in the environments of Latin American agricultural research, because of compounded effects of the conceptions and values held at the societal level with respect to scientific activities, and interferences of bureaucratic mandates

On an abstract level, it is very likely that S&T endeavors are highly valued by most sectors of Latin American societies Nevertheless these abstract valuations may result in mainly idealized conceptions of scientific activities without sensitivity to the conditions that enable them to occur Perhaps the more concrete images of S&T in Latin America are associated with labs, sophisticated equipment, computers, journals, books and libraries, surrounding eminent scholars What is observable by outsiders about the actual work of an agricultural research is not the creative individual and the collective intellectual processes, but the physical activities inherent in agricultural research The daily routines of a middle level agricultural researcher who spends most of his time planting, growing and harvesting crops might be regarded as too prosaic a set of tasks to fit in the idealized conception of science Consequently, people--particularly decision makers at the national level--could wonder why they should give much thought and attention to the long-term commitments of a professional career of a number of public sevants whose more visible activities are traveling in a jeep and making visits to crop fields Ironically, the idealized conception of science may lead to very simplistic understandings of research work Continuity of research may be considered as identical to continuity in a job, ignoring that what matters in scientific research is not the inherent physical activities, but a set of cognitive and social processes These are the

processes by which a person internalizes specific research concerns keeps aware of past and current work done in the field, creates and tests images about empirical relationships, elaborates conceptual frameworks, engages in collaborative work with others interested in similar or related cognitive goals, shares approaches, findings, interpretations, assessments, and accomplishments with significant colleagues, and, in so doing, contributes to the building of social development for their people These cognitive and social processes take time Without open opportunities for researchers to engage in long-term commitments to specific fields of research, these cognitive and social processes are not likely to develop

Long-term commitments may be hampered by bureaucratic mandates which obligate researchers to switch from one research problem or field to another, there are occasions when those problems and/or fields are totally unconnected The emphasis here is not with autonomy of professionals in the selection of research problems, although ntellectual freedom is also an important factor in the pursuing of a scientific career By its very nature, agricultural research is expected to make important contributions to socio-economic development in LDC's, this reality implies that, in self-conscious selecting of cognitive goals, researchers need to make compromises with their personal preferences and with the dominant concerns within their professions However, what cannot be compromised, if research effectiveness is desired, is continuity in the pursuit of a research goal Managerial mandates which obstruct continuity frenquently emerge not as purposive will to interfere with research, but as the result of diversity of political and economic pressures from inter-related social systems There are cases in which researchers seem to be equated with computers which are fed instructions and data, and are expected to immediately give out the desired information This "computerized" image of a researcher does not take into account the social-psychological and cultural forces involved in becoming a creative researcher Unfortunately, continuity of research--which is one of the main fuctions a formal organization of research is expected to maintain--is sometimes disrupted by managerial practices Perceived lack of opportunities for having continuity in research may induce professionals to abandon their organizations and/or the activity of research

b Research resources and support Here is where research organizations are expected to play a substantive role for the activity of research They provide a home, a collective identity, and resources, so researchers can work with support, security, and continuity

There is much heterogeneity in the level of development of research organizations in Latin America The range goes from no existence of organizations expressly designed for research in some countries to complex systems of local, state, and national research centers (such as EMBRAPA in Brazil)

This heterigeneity makes one expect that there is a relationship between researcher's behaviour and the level of research facilities In contrast to this expectation, this study disclosed no statistically significant difference to support this belief The consideration that most agricultural research is a non-capital intensive activity, and that most

members of the sample studied have at their disposal at least the minimum requirements of resources for conducting research may explain tha lack of statistical differences in the variable research support facilities

There are more subtle aspects of research support that stimulate migration a) unrealistic expectations from research administrators and segments of a society about project detelines, or about the quality and quantity of research outcomes, these expectations may reflect lack of understanding of the uncertainties inherent in research and can take the form of very short-term planning and/or inadequate research implementation, b) hidden organizational policies against the building of professional careers in agriculture, c) perception by researchers that they and their work are not held in esteem in their organizations, profession, countries, or local communities, d) political influences over professional appointments and promotions, e) lack of identity of researchers with the product of their work and/or loss of intellectual property, f) lack of a communication environment which facilitates interaction among collegues, and g) perception by agricultural researchers that they lack a feeling of self-confidence and security as members of their organizations and professions

c Self-supporting communities of researchers A factor which appears not to be well recognized for facilitating the building of research careers is the existence and possibility of participation in self-supporting communities of researchers This topic refers to the researchers' networks Interpretations of the findings on networks are the substance of the following section

B Interpreting findings on research networks

Three questions of the social structures created, maintained, and shared by this segments of Latin American agriculturists are especially noteworthy a) how do these linkages arise, grow, and develop?, b) what are the uses and purposes of these networks", and c) why do these research communities arise, grow, and develop?

1 How do linkages emerge and evolve?

The arousal of nascent linkages begin in a diversity of occasions For instance, some links are established very early in the life of a person as member of primary systems, these include kinship, religious, local community, first schooling, and other kind of ties A substartive number of interpersonal links among middle level agricultural researchers in Latin America are created during the B S studies with teachers and peers However, many of these connections do not evolve, they remain latent or eventually fall apart This, in particular, is the case of latent or no significant ties with former B S teachers, who in most Latin American organizations of agricultural educational do not have adequate opportunities and rewards for pursuing research endeavors

A high proportion of ties which become intensive are created when practioners are in the process of entering specialized fields of research, and when they are trying to keep themselves up-to-date on the developments of their current fields of specialized work This often occur during postgraduate studies, but for this particular sample, many of what eventually evolved as intensive ties are relationships that were initiated with

instructors and fellow students during training programs at CIAT for entering specialized fields of research Ties established with former professors at the Master and PhD level are highly influential, often resulting in deep interchanges, but are low in the frequency of interactions (intensive sub-type one) and in the number of persons engaged The low frequency might be attributed to lack of a facilitative communication environment for making interchanges feasible, but the evidence gained in this study in this respect is mixed The low number of people engaged in intensive interchanges with former professors at the Master of PhD level is explained by the fact that most members of this study population do not undertake postgraduate studies

Some links emerge from literature reviews when a professional becomes aware of the existence of persons conducting significant work in his/her field of interest, makes the decision of trying to contact those colleagues, has the opportunity to do it, and finds reciprocity in some of them Other connections are established at the moment of entering a new organization of research, in the planning and executing of inter-organizational formal contracts for conducting coordinated research, during the interaction with consultants, and at professional meetings

The number of research groups, identified in this study, and the fact that most of them are specialized, supports the conception that what brings these people together is the sharing of their cognitive goals and experiences, that is, their research problems and findings The point of departure for starting the building of functional linkages with significant colleagues is, then, the awareness by practitioners of the existence of other researchers who have similar cognitive interest to theirs

A second step is the acquaintance with the researchers personally and with the work they have completed or that is in progress This is done through face-to-face encounters, by correspondence, or by studying published work At the level of acquaintance, in addition to knowing work characteristics, practitioners learn about each other's national, organizational, and professional identities Availability of directories of researchers with names, organizational affiliations, current addresses, and indications about work interests facilitate these processed of awareness and acquaintance Nascent ties are typically at this level

Additional and continued interactions allow researchers not only to learn more about each other's work activities and interests, but to get insights about each other's personalities Then relationships become established at a more psychological level Nascent ties start transforming into intensive linkages Functional interchanges for work activities and for personal support begin to appear

As interchanges gain frequency and depth, inconsistencies among practitioners' conceptions of research work may emerge These inconsistencies are frequently identified with communication barriers, such a problems in terminology, incompatible personalities, lack of communication skills, negative attitudes toward team work, or excessive individualism on the part of some researchers However, communication difficulties are only symptoms, these inconsistencies reflect deeper philosophical disagreements about the

whole conception and practice of scientific research, disagreements which often materialize as conflicting views on research priorities approaches, and techniques As a result, at this stage ties may decay and extinguish or stay at a latent level

These disagreements are not mere confrontations of personalized views and individualized patterns of behavior They arise from differing views predominant in segments of the larger social structures and cultures in which researchers are embedded, and with which they identify themselves, e g , the profession, the organization, sectors of the economy, political parties, nationalistic views, and so on

An intense and open debate or submission on the part of maintainers of the conflicting views is required so a minimum of consensus can begin to emerge among members of the research network An example of these types of conflicts has existed for several years among sectors of this study sample in the fields of rice and beans In rice the central issue has been the generation of appropriate technologies for farmers who produce rice under non-irrigated conditions, in beans a recurrent debate is the generation of appropriate technologies for small farming, particularly in reference to crop associations between beans and other compatible species

Interpersonal relationships which survive these confrontations and continue to be intensive gain endurance and functionality "Invisible colleges" begin to be structured by those practitioners who have not only a common cognitive focus in their research interests but who share views about the relevant priorities and the appropriate ways of conducting research in their specialized fields

At this stage, collaboration in research ceases to be an abstract aim, and starts to be translated into concrete sets of concerted activities Well structured research groups come to exert leadership and influence within their fields Up to this point, a community of researchers is no longer a metaphor, but a viable, concrete, self-supporting entity whose existence and continuity of operation represents a solid step in the building of research capabilities in a given society or in a set of inter-dependent societies

At all stages in the devolpment of a research network links continue to emerge and transform Some of them become intensive, other decay and stay latent or even disappear In turn some latent links may be activated by new research opportunities and events among members of the research network A high proportion of extinction of intensive ties may indicate the decline of the entire research paradigm as a consequence of drastic internal and/or external changes

2 The uses and purposes of research networks

These studies' findings consistently show higher research performance of network participants in comparison to those who do not participate The content of research interchanges mentioned by the sample members interviewed give origin to a long list from which the uses and purposes of these networks can be inferred These uses and purposes are summarized in two sets practitioners engage in network interchanges to obtain a) research resources, and b) socio-psychological support

a Resources There is a variety of research resources that practitioners with nascent and intensive ties interchange materials, particularly plant germ plasm, services, especially lab analyses and data processing, information about research sponsors, names and addresses of other colleagues in the field, and published research literature (it seems that many people get access to the relevant literature more by personal contacts than through libraries)

Other resources are interchanged mainly by members of invisible colleges pre-prints, most of the time asking for comments and suggestions raw data about experiments and field observations which are just finished, but for which analysis and interpretations has not been completed by the investigator, interpretation and aseessment of findings, and views about research priorities and approaches

An item of particular importance in the more intensive interchanges among members of research group is what may be designated as interchange of work More active members of these research networks sometimes engage in collaborative personal research agreements in which an experiment is replicated by different practitioners with differing organizational affiliations and, on occasions, working in different countries

b Social psychological support The category called here social-psychological support is perhaps what keeps these sets of people together and makes possible the development of social structures and cultures which eventually emerge as identifiable communities of researchers Social-psychological support at the beginning of a relationship--when links are still at a nascent stage or starting to gain intensity--consists of help provided by more mature researchers to new entrants In many cases this type of support is given by helping new practitioners identify training, educationl, and career opportunities, providing letters of recommendation for entering graduate schools, helping secure funds and invitations for participation in professional meetings, local, national, and international, instructing about where and how to apply for scholarships and assistantships, and helping newcomers develop their own personal identities as practitioners of particular fields of research

At subsequent stages of development of these interpersonal relationships, social-psychological support implies some degree of mutual reliance, more mature researchers take the risks involved in recommending fellow researchers for job appointments in places where those more mature persons have achieved prestige A recommendation for a research position means much more to a practitioner than an employment opportunity, it means that the one who is recommending him/her is showing a signal of respect and appreciation, recipients of this type of social-psychological support feel that they are held in esteem by people in what they start to consider "their" fields of research

Finally, more developed linkages--typical of invisible colleges--are both highly professional and highly personalized At this stage the interpesonal support implies high reciprocity, and it is characterized by the presence of a strong social-psychological factor, which in Spanish is well described by the word "confianza" "Confianza" implies more than reliance and confidence, perhaps "trust" is its equivalent in the English language

Trust among fellow researchers opens opportunities for them for interchanging specifics about research approaches and techniques that they use, although these techniques and approaches are still not widely accepted or standardized, opportunities arise for interchanging details of projects which failed, details about what would be considered "negative" results if published, about problems and forthcoming opportunities perceived as promising in the field or in neighboring fields, about projects in the fields perceived as very risky undertakings, and, particularly, about philosophical views on what should and should not be research priorities in their specialized fields However trust in the interpersonal relationships among members of research networks does not imply a blind loyalty which avoids objectivity in pointing out the professional concerns with each other's research activities and outcomes Researchers who trust each other openly analyze their work and make competent criticisms about it, but those interchanges are personalized, and remain among the interactants who trust in each other's loyalties, so this type of information will not be used against any one of them in the profession, in their organization, or in their other social milieus

3 Why do these research communities arise and develop?

Four sources of explanations are presented in the following paragraphs in relation to the emergence and development of research networks a) dysfunctionalities in the formal structures, b) the nature of some research goals which are inherently transorganizational and transnational, c) costs and economies of scale and size, and d) risks and uncertainties inherent to scientific research

a Dysfunctionalities At the intra-organizational level, the emergence of non-formalized structures may be associated with dysfunctionalities in the distribution of power, influence, and resources through the formal organization chart, or the organigram may seem adequate but for some reason it simply does not work This seems to be the case in some Latin American organizations of agricultural research having a highly structured distribution of positions from the national to the local level These structures usually establish as "link pins" between the central hierarchy and the research teams at the local level a set of "national coordinators" (the equivalent of "liaisons" in the research networks) who are not always adequately equipped with the necessary budgetary flexibility to operate, or lack formal authority to "coordinate" research activities and projects

Dysfunctionalities of the formal structures in research organizations are a complex difficulty, which involve more than simply systematic arrangements of positions and job descriptions Theodore W Schultz (1979) has pointed out how the entrepreneurial function, which is responsible for the dynamics of innovation and progress in society, operates differently in businesses and research organizations In business enterprises, the centralized body of high level executive officers performs the entrepreneurial function, while the skilled factory workers do the unchanging, routine tasks But research is otherwise Administrators may be entrepreneurs in fostering the organizational infrastructure for research activities but the dynamics of innovation and progress in the specialized fields of research is beyond administrators' possibilities Research entrepreneurship is the function of the research worker A critical question

concerning the design of formal organizations of research, then, is To what extent is it viable and advisable to "coordinate" by mandatory acts? In the words of Professor Schultz

> "The convenient assumption is that a highly organized research institution firmly controlled by an administrator will perform this important function But in fact a large organization that is tightly controlled is the death of creative research, regardless of whether it be the National Science Foundation, a government agency, a large private foundation, or a large, research-oriented university (Schultz 1979, p 7)

Dysfunctionalities in formal structures of research, in addition, may relate to lack of or weak mechanisms for providing adequate recompesations to researchers for their work and accomplishments Another important component of this problematic situation is related to the extent to which the formal organization has adequate mechanisms for the allocation of professional recognition and rewards to its research workers On occasions researchers in Latin American organizations of agricultural research lose their identities in their work This loss of identity sometime occurs as the result of very limited availability of channels for publishing research findings There are organizations in which the annual report constitutes almost the only channel available As a general practice, most annual reports do not associate the work reported with any person in particular Practitioners involved in these situations feel that they are not held in esteem by their organizations Interpersonal relationships with significant colleagues may be regarded as a substitute for the social-psychological support that their organizations are failing to provide them

Beyond the boundaries of organizations, at the country, region, and worldwide levels, dysfunctionalities in formal structures which stimulate the emergence of research networks may be related particularly to lack of active professional associations, lack of or weak formal communication systems of science, and lack of accessibility of these sample researchers to the international journals of the world epicenters of science These journals may have very low priority for publishing the type of outcomes generated by these practitioners, which are for the most part adaptations of previously generated technologies

b The nature of research goals This is another explanation for high networking activity There are research concerns which transcend the boundaries of a particular organization, local community, country, and even region This seems to be the case of practitioners engaged in research in rice and tropical pastures

c Costs Related to the above-mentioned factor is the issue of research projects which may be extremely costly if performed by a single

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Schultz, T W (1979) "What are we doing to reseach entrepreneurship?", in Hueg, W F , Jr and C A Gannon (eds), Transforming knowledge into Food in a Wodwide contest Minneapolis, Miller Publishing Company, pp 96-105

organization or country, but may be jointly pursued by members of different organizations who are already scattered through wide geographical regions and in a diversity of ecological conditions

d Risk and uncertainty In its own essence research is a human enterprise conducted under conditions of high risk and uncertainty As pointed out elsewhere, researchers may not be willing to share their uncertainties with formally appointed research leaders in their organizations, because this information could be used against researchers' professional and bureaucratic careers So they do not trust in the formal structures to reduce the psychological stresses and tensions induced by the inherent uncertainties and risks of their research projects Consequently, they develop interpersonal relationships deep enough so they can trust and receive personalized understanding and support from others who have experienced similar risks and uncertainties

4 Non-participation This last part of the section turns the attention to the phenomenon of non-participation Two aspects are interpreted a) why a proportion of research practitioners do not participate in these communities, and b) what may be some consequences of non-participation?

a Why people do not participate The first reason may be lack of a facilitative communication environment This includes lack of actualized directories of persons in the research fields surveyed, low activity of professional associations within countries and in the region, organizational policies consciously or unconsciously militating against research interchanges among colleagues lack of funds for traveling or using telephone and mail systems difficulties, and visa problems, among others

Additional reasons for non-participation in networks of researchers may include personality characteristics of some researchers who prefer work and stay in relative isolation, excessive nationalism of some researchers who regard with suspicion the international activities involved in networking, ideologies in conflict with international collaboration and with a view of inter-dependence among nations, patterns of authoritarianism and dogmatism perceived by some non-participant researchers as predominating among groups of very active colleagues, excessive competence in some fields (which may result in patterns of secrecy), excessive bureaucratization which frustrates any attempt to participate in professional meetings, and fields composed of "one-of-a-kind" researchers (that is, fields where a "critical mass" of colleagues still has not developed)

b Consequences of non-participation The main consequence suggested by these studies' empirical data is lowest research performance Other consequences are

1 First, lack of contribution to the research community Non-participants, as defined in this study, are not transmitting by personalized interchanges the research findings to the mainstream of colleagues Accordingly, unless non-participants publish their findings in the formal system of communication--journals, books, etc --their isolation deprives their scientific communities of their contributions Given that most members of this study population are young professionals in the first stages

of their research careers, and given the limited number of journals and scientific publications available in Latin America, it is very likely that the research findings of non-participants are not accessible to their colleagues

Second, training obsolescene Non-participation in networks of relevant researchers is also interpreted as suggesting that a segment of former CIAT trainees may be unaware of the technical progress that their research associates are achieving in research endeavors pertinent to theirs Such isolation results in rapid obsolescence of previous training

Third, technological lag Non-participants may be getting access to the technology progress through the formal communication system, via printed and other media This system is not consistently characterized by speed While its better peformed functions are giving professional recognition, assessment, and permanence to scientific advances, the last issue of a scientific journal often reports research carried out and findings obtained several years ago In addition, the formal system is not commonly the best way to get full access to the specifics of research technology Fine descriptions of research instruments, techniques, and procedures are usually not published in scientifi journals, but typically diffuse via personalized interchanges among colleagues This is particularly the case in applied agricultural sciences In most applied fields much of the flow of knowledge comes not through formally published books and journals, but through correspondence, pre-prints, mimeographs, findings, and data, which circulate by personalized inter-changes Researchers in rapidly growing fields, who rely entirely on journals and books for their information may confine themselves by continually lagging behind in scientific knowledge

Fourth, cultural dependenc One consequence of over-relying on established international journals and books published in the world epicenters of science is cultural dependence Latin America still has not developed an adequate formal system of scientific communication Consequently, most literature comes from other cultures A mere consumerism of foreign scientific literature does not provide a full opportunity for entering in the creative process of interaction between people, which results in the development of international research communities An over-dependency on the foreign scientific literature can impede the generation of indigenous capabilities for technological innovation in the agriculture of the region

Fifth, lack of identity as practitioners of research Non-participants who cannot get recognition and rewards through the formal communication system, and who- by definition of non-participation--do not receive personalized social-psychological support, respect and esteem, are open to disillusionment in their research activities which, added to other consequences of isolation, might precipitate migration of non-participants toward activities other than research Non-participation and propensity to migrate from research might be two inter-dependent factors which reinforce each other through time

In summary, non-participation in networks of researchers is regarded in these studies as a symptom of scientific isolation And isolation might be impinging on the broader aims of encouraging task forces of researchers to contribute to agricultural development in particular, and to the institutionalization of S&T in general

VIII CONCLUSIONS

A Findings

1 Most former trainees surveyed and their supervisors interviewed for these studies assessed CIAT training as highly valuable for their work at national institutions as well as for trainees' personal professional development

a The majority of former trainees assessed CIAT training as appropriate in terms of training duration, content level, amount of information delivered and training structure

b Over four out of every five former CIAT trainees regard their training as having high relevance and applicability to the conditions of their institutions and countries

c Most former CIAT trainees report to have utilized what they have learned at CIAT in a high degree

d In general, there is a close balance between the research skills developed during training at CIAT and their utilization when trainees were back at their work However, research report is a type in which skills developed at training are relatively low if compared to its corresponding high level of utilization by former trainees at work

e Former trainees report to have received effective backing support from CIAT after training One out of every three report to have received support by means of germplasm materials and scientific advise from CIAT staff A half receive CIAT publications and annual reports

f CIAT training has been instrumental for achieving greater individual satisfaction and professional development Six are the most significant sources of satisfaction reported by more than 50% of former CIAT trainees Self-confidence in their personal capabilities to carry out research as a profession, positive motivation toward research, access to and utilization of scientific literature, research methodology, technical competence, and communication skills

g By far the most positive consequences of CIAT training reported by former trainees consist on the higher credibility as researchers that they gained among their colleagues, and the higher appreciation for their work by the institutions they have worked for after training

2 After training, former CIAT trainees are more oriented toward serving agricultural development goals, than to their profession and organization This shows a strong value put in solving practical, socio-economic pressing problems, with basis on scientific production technology

3 Former trainees distribute their work time in a set of research and non-research related activities, with enfasis on doing research (63%)

They also spend some work time on training colleagues (6%), doing research administration (6%), and consulting (4%) About one fifth (21%) of their work time is devoted to activities not directly to research

4 One out of every three former CIAT trainees have improved in the level of their positions at their institutions after training No one occupied a lower position No one was without a job immediately after training

5 The forming of inventories of human resources for staffing the intermediate level of agricultural research organizations in Latin America through CIAT's training has been an effective process It exhibits inefficiencies in regard to the ability to retain trained persons in the sponsoring organizations and in the activity of research However, beneath the surface of obvious loss are more complex and unexamined consequences of the internal brain drain Individuals who have left their sponsoring organizations may nevertheless perform significant roles in other positions tied to agricultural research and development Specific findings on human resource development for agricultural research are

a Effectiveness of the process is supported by annual net balances and final inventories which during the entire period are positive and increasing

b Inefficiencies are due to a growing process of migration of trained persons towards sites and tasks other than those of their sponsoring organizations, fields of training, and the activity of research

c This migration has directly constrained in particular the forming of a "critical mass" of qualified professional to establish collaborative reseach linkages between CIAT and counterpart organizations in the region

d Four out of every five are still agricultural researchers, and over half (54%) of them work in those training commodities (rice, bean, tropical pastures, and cassava) Another fourth (24%) shifted to other types of research, either within their sponsoring organizations or else-where Slightly one fifth (19%) have left research activities

e Put in a time frame, efficiency in retaining trained persons and research experience was low during the first years of CIAT's training, but since 1975 has shown a consistent tendency to increase

f The length of stay in sponsoring organizations, specialized fields of training, and in research activities manifest a decreasing trend throughout the first five to six years after training, but beyond this interval there is a slight increasing tendency for staying in the same organizations and fields among those practitioners who still have not left research

g The total span of years that members of the sample continue in their sponsoring organizations, fields of training, and activity of

research, is positively related to the length of their CIAT training experiences It is not related to the facilities available in their work organizations in their specialized fields of training

6 A substantive proportion of former CIAT trainees participate in research interchanges with relevant colleagues and form networks which have an international character There is solid evidence that identifiable social structures have emerged out of the research interactions in which these agricultural researchers participate However, not all former CIAT trainees are well connected to these networks among the proportion who are non-participants there are different degrees of isolation Specific findings are

a About two thirds of the persons in the sample network analyzed participate in communities of researchers

b These networks have and international character Slightly over one out of every four (27%) of the participants linkages extend beyond their home country, with most of these ties being with their counterpart researchers working in Latin America (20%) Among the participants in transnational networks, seven percent have personal professional ties beyond the region with colleagues working in some part of the rest of the world Two thirds of all their linkages are of an intensive nature, and about one third of the intensive relationships occur at the region or worldwide level

c The networks generated through the recurrent interaction of participants with professional colleagues are highly structured Twenty-two research group ("invisible colleges") were identified, most of them are specialized seven in bean research, six in tropical pastures, two in rice, and one in cassava The size of the groups varies between three and fourteen persons Most groupings are interorganizational and half of them are international The transnational linkages include researchers of international centers

d Participation in research networks varies with training content and length of training, but not with facilities to do research at home organizations

e There is a curvilinear relationship between length of training and participation in research networks, with those persons who have an intermediate training presenting the highest proportion of participation The is a puzzling relationship whose understanding requires further investigation

7 One third of this study's sample do not participate in networks of researchers The highest number and proportion of non-participants are in the field of tropical pastures

B Implications

1 Implications for CIAT A selective aspect of the research questions examined in these studies can be pursued further in relationship to these findings On one side, a heavy migration outside the commodities of training was clearly evident in the study's data, on the other an intensive

process of networking emerged The facts about migration suggest a strategy of continuously training twice the number of persons required Findings on networks indicate that numerous research groups have emerged across the region in relationship to CIAT's training and communication strategies The existence of these professional structures among Latin American agricultural researchers opens a new option to CIAT for policy-making and resource allocation with regard to training An appropriate route for strengthening agricultural research in Latin America seems to be to invest more in networking CIAT already has developed a set of international cooperation activities for stimulating the emergence and functions of these social structures documentation centers, publications, training and conferences facilities, as well as an active component for interchanges of materials and expertise A series of newsletters have been published and distributed in recent years by each commodity program Although some directories of researchers have been prepared and distributed, this might be an area which invites more recurrent attention in the future All these components might be explicitly and formally integrated in a systematic strategy for encouraging and sustaining research network development

With regard to the issue of the length of training, the duration of training experiences relates to the content of learning objectives formulated for particular training programs Perhaps, allocation of resources to longer durations should be considered only after conducting further analysis of instructional design

Finally, major potential sources of improvement in the length that practitioners stay in the activity of research must be discerned and managed from a better understanding of the complex of reasons that professinals have for leaving their organizations and the research activity

2 Implications for international sponsors of agricultural research What emerged out of the study of interpersonal professional linkages among former CIAT trainees were findings about a new and distinctive type of network which is role-related and professionally meaningful for these researchers at work These networks are not simply sets of friends who occasionally meet to politely reaffirm their interpersonal ties with one another These networks are structured communities of working scholars, which positively influence research performance Research networks regularly provide to their members important resources and social-psychological support in their work roles

This finding on the existence of active professional structures among agricultural researchers in Latin America allows to make the following suggestion to research an development sponsors the encouraging and supporting of networks of intermediate level agricultural researchers across the region may be as important for agricultural development and food production as is the more specialized and planned building of formal organizations or the transfer of finished technologies for the same purposes

The findings of the study of these professional structures imply that opportunities now exist for selectively allocating resources for a better understanding by administrative leadership of the process of research networ

development (RND), and a comprehension of how these networking processes function to complement other organizational procedures for creating realistic supportive systems for the generating and sustaining of these communities of researchers These efforts would constitute complementary strategies for international agricultural development, and might result in mutually supportive coexistence of both the formal organizations of research and the communities of researchers

3 Implications for country-based science policy makers The outcome of this study on inventories of researchers show an increasing migration of trained persons out of the sponsoring organizations and out of the activity of research From another side, the findings of this study on research networks allow to have an alternative view of the process of science development A perspective on research networks opens fresh ways of looking more closely at some of the pervasive macro-level concerns of many science policy makers throughout the region on the phenomenon of "brain drain" From a network perspective, the horizontal mobility of researchers from organization to organization, or from country to country within the region does not necessarily need to be assumed to constitute a total loss of skilled persons Researchers in general are mobile persons, their continued intechanges with colleagues in other societies and cultures enables them to elicit reactions to their own thinking and cope reciprocally to keep abreast of the new achievements in other parts of the world As long as researchers continue actively intechanging their findings, paradigms, and methodological breakthroughs with other members of their research networks the circumstance of the specific location where they are working may be of secondary importance, and calls for a more sophisticated search for understanding the cross-cultural transfer of technology

APPENDIX A

DISTRIBUTIONS OF THE STUDIES' POPULATION

Table 1 Total number of former CIAT trainees distributed by geographical regions of the world *

Region	N	%
Africa, Asia and Australia	65	4 6
North America and Europe	89	6 3
Latin America	1259	89 1
TOTAL	1413	100 0

Table 2 Former CIAT trainees from Latin American distributed by type of training

Type of training	N	%
Production and extension	201	16 0
Research support	116	9 2
Research	942	74 8
TOTAL	1259	100 0

* This does not include postdoctoral fellows, nor other students whose training was financially supported by CIAT but carried out at other educational organizations

Table 3 Former CIAT research trainees, distributed by number of trainees per sponsor organization (n = 783) *

Number of trainees per organization	Organizations		Trainees	
	Number	%	Number	%
1 - 3	130	71 4	204	26 0
4 - 8	31	17 1	172	22 0
9 - 23	15	8 2	206	26 3
24 - 48	6	3 3	201	25 7
	182	100 0	783	100 0

* This distribution indicates the organizational origins of trainees, and not their present locations

Table 4 Number of research trainees from Latin America, distributed by country and year of training completion

Country	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	TOTAL
Antigua	0	0	0	0	0	0	0	0	0	0	1	1
Argentina	0	1	0	0	0	0	0	0	1	3	5	10
Belize	0	0	0	0	0	0	0	0	0	3	5	6
Bolivia	0	0	0	1	0	1	2	3	7	6	7	27
Brasil	0	1	0	26	3	21	7	17	14	46	50	185
Colombia	0	14	5	9	9	14	9	18	13	24	32	147
Costa Rica	1	0	0	3	0	0	1	0	2	8	12	27
Cuba	0	0	0	0	0	0	0	0	0	7	14	21
Chile	0	0	0	0	0	0	7	2	1	5	1	16
Ecuador	0	2	4	5	2	9	1	1	5	10	13	52
El Salvador	0	0	0	0	0	3	4	2	3	2	5	19
Guatemala	0	0	0	0	1	3	4	3	15	4	6	36
Guayana	0	0	0	0	0	2	0	1	1	2	1	7
Haiti	0	0	0	0	0	0	0	0	0	0	5	5
Honduras	0	0	1	1	3	0	1	7	8	8	6	35
Jamaica	0	0	0	1	0	0	0	0	0	0	0	1
Mexico	0	0	0	0	3	0	6	12	5	8	13	47
Nicaragua	0	0	0	0	0	0	0	0	1	4	2	7
Panama	0	0	0	1	0	0	0	3	2	5	2	13
Paraguay	0	0	0	0	1	0	2	1	0	0	0	4
Perú	0	1	0	0	1	7	1	8	6	13	12	44
Puerto Rico	0	0	0	0	0	0	0	1	0	0	0	1
República Dominicana	0	2	0	1	0	2	1	4	5	4	14	33
Trinidad	0	0	0	0	0	0	0	0	0	0	1	1
Uruguay	0	0	0	0	0	0	1	0	0	0	1	2
Venezuela	0	0	1	1	0	4	4	8	2	8	8	36
TOTAL	1	21	11	49	23	61	51	91	91	171	213	783

A P P E N D I X B

DELINEATING THE POPULATION

DELINEATING THE POPULATION

1 Definition The study population is defined as composed of all former research trainees from Latin America who completed their training between December 31, 1969, and December 31, 1979, in any of the four CIAT commodity programs, and for whom there were records in the CIAT training files

2 Data gathering Data for delineating the population were obtained form both the files and staff of CIAT The local data collected from these two sources made it possible to a) determine the size of the population, b) describe its distribution by the three independent variables of interest, and c) characterize it in relationship to age, gender marital status, formal education, country of origin, and year of training completion In addition, organizational reports obtained during this phase of the study provided the basic materials for writing a description of the training setting

3 Population size The determination of the population size consists of identifying and counting those professionals who fit the population definition Two types of persons are excluded a) all students whose names are in the files because they were financially supported by CIAT, but whose actual training was carried out at educational organizations other than CIAT, and b) all postdoctoral fellows because they differ from the study population in status and activity at CIAT The size of the population so determined consists of 783 Latin American agriculturists It represents 62 2% of the total number of 1259 persons who had completed their training at CIAT between December 31, 1969, and December 31, 1979

4 Strata for independent variables The following strata were constructed in order to classify the population according to training content, length of training, and facilities to do research in the fields of training at sponsor organizations

a Strata for training content were readily available in the records They constitute the four CIAT commodity programs rice, beans, tropical pastures, and cassava

b Strata for length of training were constructed on the basis of the following patterns which have emerged over time in the CIAT training programs i) In general, periods of training up to two months correspond to structured short intensive courses, mainly carried out within classrooms, and usually focused on a commodity, e g , rice, or field of research within a commodity, e g , multiplication of cassava germ plasm by means of meristems ii) Training periods from two months to six months usually are less structured than short courses, take place almost totally at labs, greenhouses, and research field, and are designed for gaining specialization in a discipline or field of research within a commodity, e g , cassava phytopathology, rice plant breeding iii) Periods longer than six months commonly involve the pursuit of a research project under the guidance and supervision of a researcher of the staff of CIAT, and sometimes the projects are connected with fieldwork for M Sc and PhD theses

c Strata for support facilities to do research at home organizations were more difficult to construct and apply to this population Several possibilities were examined for macro-data, for instance, investment in agricultural research in each Latin American country, or resources available for agricultural research at Latin American organizations The data found were insufficient to construct a comprehensive set of strata inclusive enough to classify all members of this population In addition, those data were not directly related to the commodities around which research training is organized at CIAT Hence, the decision was made to try using the judgement of competent researchers who know the research facilities available at agricultural organizations in Latin America Two researchers from the staff of each CIAT commodity program were asked to classify all countries of the region according to two categories those having more facilities to do research in the fields in which CIAT has had training programs, and those with less facilities These two categories are referred to below as the "more" and the "less" facilities The category "less" does not mean inadequate facilities Experts who were asked to make appraisals were selected with the criterion that they had been personally involved in CIAT international cooperation activities, so they would have first-hand knowledge about the research facilities available at national organizations in their specialized field

There was little disagreement among the two separate sets of appraisals about the classification When it appeared, disagreement was resolved by contacting other experts and discussing with them the issues until an acceptable level of consensus was reached Experts did not judge other fields of research but only their own For example, cassava researchers classified the countries according to their judgement on the facilities available to carry out cassava research, but did not judge research facilities for other commodities

The resultant classification is in Table 1 Twelve countries of the region were classified as having "more" facilities for at least one of the four CIAT research commodities These 12 countries are Brazil and Colombia, which have "more" research facilities for all four commodities, Argentina and Mexico, for three commodities, Guatemala, Peru, and the Dominican Republic, for two commodities, and for only one commodity, Cuba, Costa Rica, Chile, Ecuador, and Venezuela All other Latin American countries were classified as having "less" facilities to carry out research in the fields in which CIAT offers research training

Table 1 Classification of Latin American countries by availability of facilities to do research in areas in which training was carried out at CIAT

Country	Research facilities							
	Rice		Beans		T pastures		Cassava	
	More	Less	More	Less	More	Less	More	Less
Antigua		X		X		X		X
Argentina	X		X		X			X
Belize		X		X		X		X
Bolivia		X		X		X		X
Brazil	X		X		X		X	
Colombia	X		X		X		X	
Costa Rica	X			X		X		X
Cuba		X		X		X	X	
Chile		X	X			X		X
Ecuador	X			X		X		X
El Salvador		X		X		X		X
Guatemala	X		X			X		X
Guiana		X		X		X		X
Haiti		X		X		X		X
Honduras		X		X		X		X
Jamaica		X		X		X		X
Mexico	X		X			X	X	
Nicaragua		X		X		X		X
Panama		X		X		X		X
Paraguay		X		X		X		X
Peru	X		X			X		X
Puerto Rico		X		X		X		X
Dominican Republic	X			X		X	X	
Trinidad		X		X		X		X
Uruguay		X		X		X		X
Venezuela		X		X	X			X

A P P E N D I X C

Additional tables on the formation of human resource inventories for agricultural research in Latin America and the Caribbean countries

Table 1 Inventory of trained persons at CIAT in Bean research (1969 - 79, n = 201)

	Years	69	70	71	72	73	74	75	76	77	78	79
Research in general	Initial inv	0	0	0	1	4	7	9	24	41	71	119
	Net balances	0	0	1	3	3	2	15	17	30	48	50
	Final inv	0	0	1	4	7	9	24	41	71	119	169
At the institution	Initial inv	0	0	0	1	3	5	6	21	38	65	110
	Net balances	0	0	1	2	2	1	15	17	27	45	48
	Final inv	0	0	1	3	5	6	21	38	65	110	158
Research in Beans	Initial inv	0	0	0	1	2	5	6	15	24	48	82
	Net balances	0	0	1	1	3	1	9	9	24	34	39
	Final inv	0	0	1	2	5	6	15	24	48	82	121

Table 2 Inventory of trained persons at CIAT in rice research (1969 - 79, n = 113)

	Years	69	70	71	72	73	74	75	76	77	78	79
Research in general	Initial inv	0	1	4	9	26	29	37	40	41	50	59
	Net balance	1	3	5	17	3	8	3	1	9	9	24
	Final inv	1	4	9	26	29	37	40	41	50	59	83
At the institution	Initial inv	0	1	4	9	26	29	36	37	41	50	59
	Net balance	1	3	5	17	3	7	1	4	9	9	31
	Final inv	1	4	9	26	29	36	37	41	50	59	90
Research in rice	Initial inv	0	1	4	7	17	20	24	26	27	36	45
	Net balance	1	3	3	10	3	4	2	1	9	9	23
	Final inv	1	4	7	17	20	24	26	27	36	45	68

Table 3 Inventory of trained persons at CIAT in Tropical Pastures Research (1969-79, n = 114)

Stay	Years	69	70	71	72	73	74	75	76	77	78	79
Research in general	Initial Inv	0	0	8	10	16	19	27	31	42	54	68
	Net Balances	0	8	2	6	3	8	4	11	12	14	14
	Final Inv	0	8	10	16	19	27	31	42	54	68	82
At the Institution	Initial Inv	0	0	6	8	15	17	25	28	37	45	56
	Net Balances	0	0	6	7	2	8	3	9	8	11	14
	Final Inv	0	6	8	15	17	25	28	37	45	56	70
Research in Tropical Pastures Research	Initial Inv.	0	0	2	4	8	10	13	17	21	25	37
	Net Balances	0	2	2	4	2	3	4	4	4	12	14
	Final Inv	0	2	4	8	10	13	17	21	25	37	51

Table 4 Inventory of trained persons at CIAT in Cassava Research (1969-79, n = 152)

	Years	69	70	71	72	73	74	75	76	77	78	79
Research in general	Initial Inv	0	0	2	2	5	11	35	38	61	66	95
	Net balances	0	2	0	3	6	24	3	23	5	29	41
	Final Inv	0	2	2	5	11	35	38	61	66	95	136
At the Institution	Initial Inv	0	0	2	2	5	10	34	37	56	58	83
	Net balances	0	2	0	3	5	24	3	19	2	25	28
	Final Inv	0	2	2	5	10	34	37	56	58	83	111
Research in Cassava	Initial Inv.	0	0	1	2	2	5	21	23	35	34	58
	Net balances	0	1	1	0	3	16	2	12	-1	24	13
	Final Inv.	0	1	2	2	5	21	23	35	34	58	71

Table 5. Number of former CIAT research trainees from Latin America who stayed at sponsor organizations up to a given number of years, distributed by year of training completion

Training year	Completed training	Number of years staying at sponsor organizations												Data for total of	Don't know, about
		11	10	9	8	7	6	5	4	3	2	1	0		
1969	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0
1970	21	0	4	3	0	0	1	1	0	1	0	1	2	13	8
1971	11	0	0	7	0	1	0	0	0	1	0	0	1	10	1
1972	49	0	0	0	17	3	1	2	2	1	1	2	2	31	18
1973	23	0	0	0	0	5	5	1	0	2	2	0	4	19	4
1974	61	0	0	0	0	0	22	5	7	4	1	3	1	43	18
1975	51	0	0	0	0	0	0	19	2	1	5	2	5	34	17
1976	91	0	0	0	0	0	0	0	37	7	9	4	7	64	27
1977	91	0	0	0	0	0	0	0	0	47	5	9	5	66	25
1978	171	0	0	0	0	0	0	0	0	0	112	7	10	129	42
1979	213	0	0	0	0	0	0	0	0	0	0	158	12	170	43
TOTAL	783	1	4	10	17	9	29	28	48	64	135	186	49	580	203

Table 6 Number of former CIAT research trainees from Latin America who stayed working in their training fields up to a given number of years, distributed by year of training completion

Training year	Completed training	Number of years working in fields of training												Data for a total of	Don't know about
		11	10	9	8	7	6	5	4	3	2	1	0		
1969	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0
1970	21	0	2	1	0	0	1	1	0	0	0	1	7	13	8
1971	11	0	0	5	0	2	0	0	0	0	0	1	2	10	1
1972	49	0	0	0	10	3	0	0	1	1	0	1	15	31	18
1973	23	0	0	0	0	4	2	2	2	0	2	0	7	19	4
1974	61	0	0	0	0	0	9	7	4	2	2	0	19	43	18
1975	51	0	0	0	0	0	0	6	5	2	4	4	13	34	17
1976	91	0	0	0	0	0	0	0	22	5	5	2	30	64	27
1977	91	0	0	0	0	0	0	0	0	33	7	6	20	66	25
1978	171	0	0	0	0	0	0	0	0	0	90	10	29	129	42
1979	213	0	0	0	0	0	0	0	0	0	0	129	41	170	43
TOTAL	783	1	2	6	10	9	12	16	34	43	110	154	183	580	203

Table 7 Number of former CIAT research trainees from Latin America who stayed doing research in a commodity of CIAT's mandate up to a given number of years, distributed by year of training completion

Training year	Completed training	Years doing research in a commodity of CIAT's mandate												Data for a total of	Don't know about
		11	10	9	8	7	6	5	4	3	2	1	0		
1969	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0
1970	21	0	2	1	1	0	1	0	0	0	0	1	7	13	8
1971	11	0	0	5	0	2	0	0	0	0	0	1	2	10	1
1972	49	0	0	0	11	4	0	0	2	1	0	1	12	31	18
1973	23	0	0	0	0	4	3	2	2	0	2	0	6	19	4
1974	61	0	0	0	0	0	10	7	4	2	2	0	18	43	18
1975	51	0	0	0	0	0	0	7	5	4	3	3	12	34	17
1976	91	0	0	0	0	0	0	0	24	4	6	1	29	64	27
1977	91	0	0	0	0	0	0	0	0	37	7	7	15	66	25
1978	171	0	0	0	0	0	0	0	0	0	92	11	26	129	42
1979	213	0	0	0	0	0	0	0	0	0	0	136	34	170	43
TOTAL	783	1	2	5	12	10	14	16	37	48	112	161	161	580	203

Table 8 Number of former CIAT trainees from Latin America who stayed doing research in any field up to a given number of years, distributed by year of training completion

Training year	Completed training	Number of years doing research in any field												Data for a total of	Don't know about
		11	10	9	8	7	6	5	4	3	2	1	0		
1969	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0
1970	21	0	5	4	0	0	1	0	0	1	0	2	0	13	8
1971	11	0	0	8	0	1	0	0	0	0	0	1	0	10	1
1972	49	0	0	0	22	3	0	1	2	0	0	2	1	31	18
1973	23	0	0	0	0	5	6	1	1	3	2	0	1	19	4
1974	61	0	0	0	0	0	30	4	4	1	0	3	1	43	18
1975	51	0	0	0	0	0	0	24	2	0	3	1	4	34	17
1976	91	0	0	0	0	0	0	0	45	5	8	1	5	64	27
1977	91	0	0	0	0	0	0	0	0	50	6	7	3	66	25
1978	171	0	0	0	0	0	0	0	0	0	114	7	8	129	42
1979	213	0	0	0	0	0	0	0	0	0	0	166	4	170	43
TOTAL	783	1	5	12	22	9	37	30	54	60	133	190	27	580	203