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Guatemala and the CGIAR Centers

A Study of Their Collaboration in Agricultural Research

Rigoberto Stewart

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At its annual meeting in November 1983 the Consultative Group on International Agricultural Research (CGIAR) commissioned a wide-ranging impact study of the results of the activities of the international agricultural research oganizations under its sponsorship. An Advisory Committee was appointed to oversee the study and to present the principal findings at the annual meeetings of the CGIAR in October 1985. The impact study director was given responsibility for preparing the main report and commissioning a series of papers on particular research issues and on the work of the centers in selected countries. This paper is one of that series.

The judgments expressed herein are those of the author(s). They do not necessarily reflect the views of the World Bank, of affiliated organizations, including the CGIAR Secretariat, of the international agricultural research centers supported by the CGIAR, of the donors to the CGIAR, or of any individual acting on their behalf. Staff of many national and international organizations provided valued information, but neither they nor their institutions are responsible for the views expressed in this paper. Neither are the views necessarily consistent with those expressed in the main and summary reports, and they should not be attributed to the Advisory Committee or the study director.

This paper has been prepared and published informally in order to share the information with the least possible delay.

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SUMMARY

The National Agricultural Research System of Guatemala appears to be well-organized, with the responsibility of developing appropriate agricultural technology for small and medium size farmers entrusted to the Institute of Agricultural Science and Technology (ICTA).

Along with ICTA, the Public Agricultural Sector is made up of complementing agencies such as BANDESA which gives agricultural credit, DIGESA which provides agricultural extension services, INDECA which sets the prices of basic agricultural products and aids the marketing process, INAFOR which deals with forestry, and INTA which is charged with implementing land reform. All of these institutions together form the Ministry of Agriculture.

Mutual visits, with more coming from the centers, and regional or international nurseries appear to be the main means by which the international centers learn of and attend to the NARS needs. They appear to be working rather well. IARCs which have programs with regional representatives located in the area seem to be the most successful, with the NARS scientists most content with the cooperation.

The centers are doing the basic breeding research and crosses, complemented with adaptation trials and further selection by the NARS. ICTA's beans program is well developed; it is making crosses in Guatemala and cooperating with CIAT as a partner.

The NARS scientists, in general, believe that the flow of information from the centers is good and useful. The exchange of genetic material with the centers constitutes the backbone of their programs. The work of the centers in enhancing the human capital of the NARS scientists has been rated as invaluable.

Without the training most received from the centers they could not have undertaken the research that is now their responsibility. During this training they learned research methodologies on which their work is based. However, the scientists from the technology validation groups and the socio-economic unit in ICTA complained that they are ignored when training opportunities are presented.

ICTA appreciates the aid it gets from the centers in the form of equipment, supplies, etc. and acknowledges that without this aid many programs would have failed or years of work would have been lost.

Hard data on the spread and impact of innovations do not exist. Many varieties of grain crops have been released which are high yielding and disease/insect resistant. The adoption rates of these have been estimated to be from 40 to 50 percent for corn to 100 percent for rice. Most of the rice varieties planted, however, are of the traditionally planted American type (Blue Bonnet, etc.).

Many potentially significant innovations are planned for the next two years. Most are in the form of varieties. ICTA released the wheat varieties ICTA Patzun and ICTA Comalapa in 1984 which is expected to increase yields by 15-25 percent. In 1985 it will release three new varieties of beans and two of rice which are also expected to have great impact. It plans to release the sorghum variety ICTA C-21 with a yield potential of 4 tons/ha. In corn, the release of RM-1 and HE-1 is planned for 1985 and HE-2 and Sutuj in 1986.

There are some problems or limitations of the NARS that may affect the potential impact of its collaboration with the IARCs. ICTA has a serious budgetary problem that is damaging the performance of the commodity programs. There seems to be need for more economic studies and more collaboration of ICTA

socio-economics with the commodity programs. The current participation of private seed producers is good, but some thought must be given to the future direction of this arrangement. The technology validation team, despite the important work it does, is the least prestigious within the institution and receives the least backing, not even having a national coordinator. High attrition of personnel with graduate degrees seems to be a problem that cannot be solved without improving the salary structure.

The structure of land distribution, with "minifundia" dominant in the highlands, makes the development and transfer of appropriate technology rather diffcult and little progress has been made in these areas. The consumption habits and preferences of the Guatemalans, i. e. low per capita consumption of rice and potatoes and preference for longated potatoes also limit the domestic demand for new technology. Insufficient and misallocated credit, poor organization of grain marketing and the divorce between research and extension are other factors that work against the demand for new technology.

The support the NARS receives from non-CGIAR institutions has played an important role in the system's development and is mostly complementary to that received from the IARCs. The most notable is the current IDB project to strength the national research and extension system through training personnel, providing plant, equipment and vehicles, and improving institutional cooperation between the agencies in the public agricultural sector.

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TABLE OF CONTENTS

CHAPTER 1. BACKGROUND 1

1.1 The Country 1

1.1.1 Natural and Political Setting 1

1.1.2 Population 4

1.1.3 Economy 4

1.2 The Agricultural Sector 5

1.2.1 Structure 5

1.2.2 Infrastructure and Institutional Support 6

1.2.3 Pricing 10

1.2.4 Past and Present Performance 10

1.2.5 Policy Issues 13

CHAPTER 2. THE NATIONAL AGRICULTURAL RESEARCH SYSTEM 17

2.1 Overview 17

2.2 Institutional Structure 19

2.3 Allocated Resources 21

2.4 Staff 24

2.5 External Influences 26

2.6 Effectiveness and Problems 37

2.6.1 Effectiveness 37

2.6.2 Limitations 37

CHAPTER 3. IMPACT OF INTERNATIONAL AGRICULTURAL RESEARCH CENTERS ON THE NATIONAL AGRICULTURAL RESEARCH SYSTEM 39

3.1 General Issues 39

3.2 Biological Materials 39

3.3 Research Techniques and Methods 40

3.4 Research Organization 41

3.5 Information and Training 42

3.6 Relationship between the IARCs and the NARS 43

CHAPTER 4. RESEARCH IMPACTS ON AGRICULTURAL PRODUCTION 45
4.1 Important Innovations 45
4.2 Adoption of Innovations 47
4.2.1 Transmission Organization 47
4.2.2 Adoption 47
4.3 Production Effects 49
4.4 Other Effects 51
4.5 Innovations with Potential Impact 52
CHAPTER 5. CONCLUSIONS 55
REFERENCES 59

ACRONYMS

BANDESA	=	National Agricultural Development Bank
BID	=	Inter-American Development Bank
CATIE	=	Tropical Agronomic Center for Research and Teaching
DIGESA	=	Directorate General of Agricultural Services
FAO	=	Food and Agricultural Organization of the United Nations
ICTA	=	Institute of Agricultural Science and Technology
IICA	=	Inter-American Institute for Agricultural Cooperation
INAFOR	=	National Forestry Institute
INCAP	=	Nutritional Institute for Central America and Panama
INDECA	=	National Agricultural Commercializaton Institute (Guatemala)
INTA	=	National Institute for Agrarian Transformation (Guatemala)
PRECODEPA	=	Regional Cooperative Potato Program
ROCAP	=	Regional Office for Central America and Panama (USAID)
USAC	=	University of San Carlos (Guatemala)
PAS	=	Public Agricultural Sector
COREDA	=	Regional Committee for Agricultural Development. It is formed in each region by representatives of the agencies that form the PAS.

MEASUREMENTS AND CURRENCY

1 hectare (ha)	=	10,000 square meters
1 manzana (mz)	=	7,449 square meters
1 quintal (q)	=	100 lb
1 kilo	=	2.2 lb
1 ton	=	1000 kilos
Currency	=	Quetzal (Q)
Exchange rate		1 Q = $1

CHAPTER 1. BACKGROUND

1.1 The Country

1.1.1 Natural and Political Setting

(a) Natural. Guatemala is one of the largest Central American countries. Its land area of 108,780 square kilometers is 57 percent forest, 14 percent cultivated, 10 percent pasture and 19 percent in other uses. It is located in the tropics between 14 and 18 degrees north of the equator, with altitues varying from sea level to 4000 meters in the volcanic highlands. The climtic ranges from tropical in the lowlands to subtropical to temperate in the highlands. Rainfall ranges from 2,000 mm per year in certain lowlands to less than 500 mm per year in some semi-arid valleys. There are distinct wet and dry seasons in major crop-producing areas, with the rainy season usually going from May through November.

The government of Guatemala through its Sector Público Agropecuario y de Alimentacion (SPADA) adopted a regionalization of the country, based on the results of a study done by SIECA/IICA, in order to apply its development policies. Table 1 lists those regions and their major characteristics; the regions are also depicted in Figure 1.

(b) Political. Guatemala is a republic. The branches of government are the traditionally dominant executive, a unimerical legislature (National Congress) abolished in 1982 and re-elected July 1984, and a seven-member (minimum) Supreme Court. The last constitution, which came into effect in 1966 was suspended following the March 1982 coup. A National Congress was elected in 1984 to draft a new constitution.

Table 1. Agroecological regions of Guatemala

Characteristics	Regions							
	I	II	III	IV	V	VI	VII	VIII
Land Area (km^2)	14960	10268	35854	12921	9057	8237	9268	8809
Percent of total	13.7	9.4	32.8	11.8	8.3	7.5	8.5	8.0
Medium altitude (m above sea level)	1500-3000	1100-2700	50-275	0-1000	300-2000	0-1500	200-1000	1000-2700
Topography	Irregular; some valleys	Rugged mountains	Soft	Valleys to irregular mountains	Rugged mountains, some small valleys	Rugged mountains small valleys	Flat to irregular	Undulating to rugged
Rainfall (mm/yr)	1344-2500	2284-4100	1700	2000-4300	1000-2000	500-1500	1000-2500	2000-6000
Temperature (C)	11-26	16-23	22	22-38	16-26	25-35	28-40	15-25
Predominant Crops	corn, wheat, vegetables fruits, beef, dairy, sheep, goats	coffee, banana, corn, beans, beef, pork	forest woods	coffee, cotton, sugarcane tea, beef	coffee, corn, beans, tobacco, vegetables	coffee, corn, beans, sorghum. tobacco, sugarcane, vegetables, beef, pork	rice, corn, sorghum, tobacco, banana, beef	coffee, cocoa, rubber, citrus, nuts

Source: Censo Agropecuario 1979 and 1981

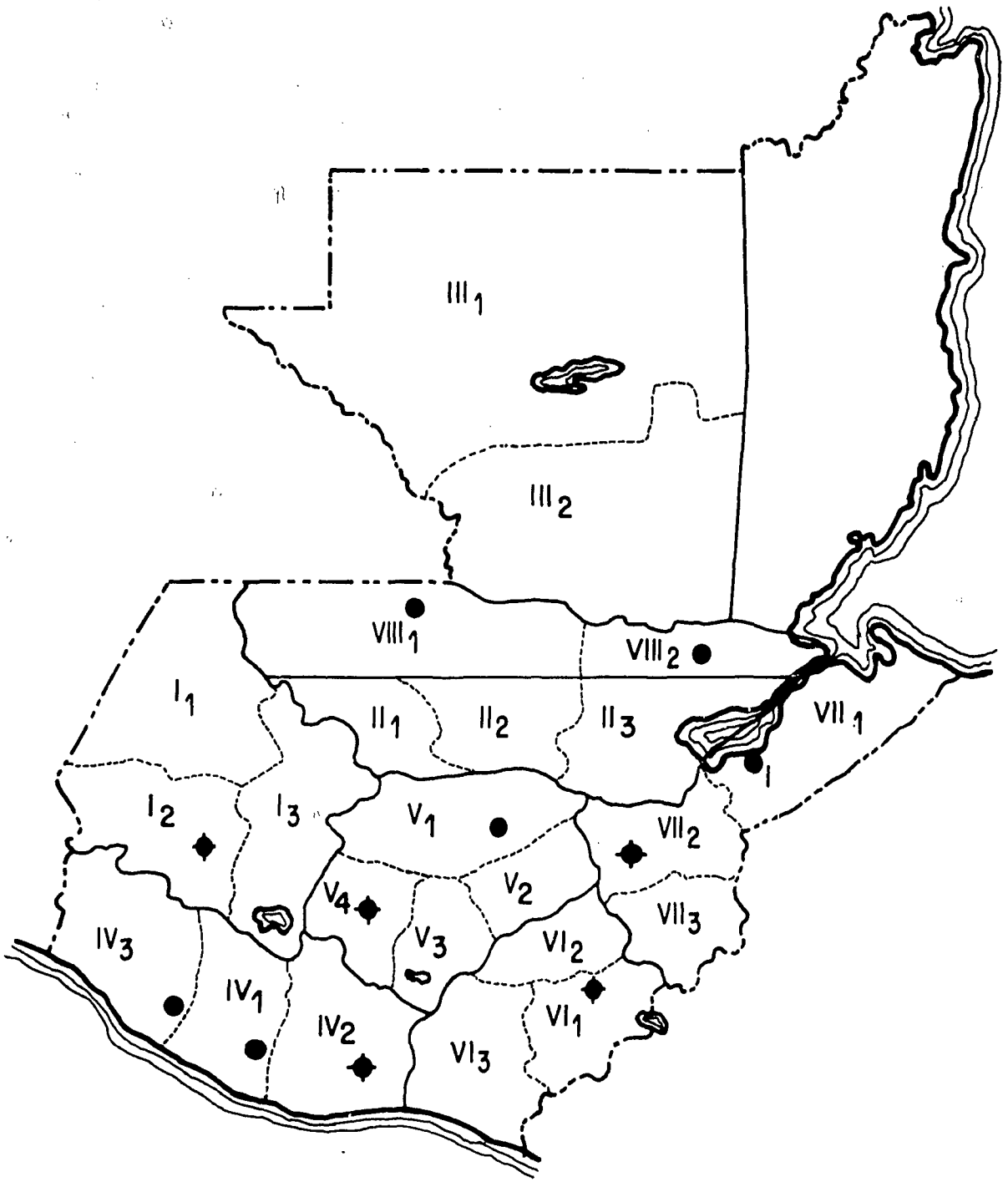

Figure 1. Agroecological regions and subregions of Guatemala

Since the damaging earthquake of 1976, Guatemala has been politically unstable, with a very active "guerrilla." The country, which has been ruled by the military constitutionally since 1970 and unconstitutionally since the coup of 1982, expects to return to constitutionality and a civilian government after the upcoming 1985 elections.

1.1.2 Population

In July 1984 the population was estimated at 7,956,000, with a growth rate of 3.1 percent (CIA, 1984). This gives a population density of 73 per km^2. In 1981, 76 percent of the population lived in rural areas. Ethnically the population is composed of 58.6 percent Ladino (Mestizo and westernized Indian) and 41.4 percent Indian.

The official language in Guatemala is Spanish, but over 40 percent of the population speaks an Indian language as a primary tonge (18 Indian dialects, including Quiche, Cakchiquel, Kekchi). The literacy rate is 50 percent.

1.1.3 Economy

Guatemala's natural resources are nickel, timber, shrimp and, perhaps, some petroleum. In 1982 its gross domestic product was estimated to be $8.6 billion, with a per capita income of $1114 (CIA, 1984). Between 1975 and 1980 the economy grew at an average annual rate of 5.7 percent, but in 1982 the real growth rate was a negative 3.5 percent.

Of the 1980 labor force of 2.2 million, 53.3 percent were employed in agriculture, 14.3 percent in services, 14.1 percent in manufacturing, 8.3 percent in commerce, 5.9 percent in construction, 3.2 percent in transportation, 0.5 percent in mining, 0.4 percent in utilities, and 15 percent were unemployed.

In 1983 Guatemala's export of $1.1 billion (f.o.b.) were mainly coffee, cotton, sugar, bananas and meat. Its imports of $1.12 billion (c.i.f.) were mainly manufactured products, machinery, transportation equipment, chemicals and fuels.

Guatemala was one of the countries negotiating in 1984 and 1985 with the International Monetary Fund for loans. The Fund has requested austerity and tighter fiscal policy.

The official exchange rate of the Quetzal is 1 to 1, but in May 1985 banks were changing at Q 2 per dollar, while the black market was paying up to Q 2.50.

1.2 The Agricultural Sector

1.2.1 Structure

The structure of land distribution has been the most important factor determining the pattern of development of Guatemala's agricultural sector (USAC, 1980). Local experts characterize the sector as having a well-defined dual structure, composed of a modern segment with large land holdings (latifundios) producing export crops--coffee, cotton, sugar cane, banana, beef and cardamomo--with the most advanced and sophisticated technology, and of a traditional segment with very small farms (minifundio) practicing subsistence agriculture. The modern export segment of the sector has always had easy access to credit and has the best agricultural land whereas the small traditional farmers utilize land in the highlands that is poor, steeply sloped and ill-suited for agriculture. They have also had little access to credit and other services. This segment of the sector produces most of the food for domestic consumption, the main crops being basic grains, vegetables and some fruits. Basic grains production is the greatest source of employment in the agricultural

sector.

The 1979 distribution of land by farm size, presented in Table 2, tends to confirm the duality of the structure, although medium-sized farms (0.7 to 45 ha) grew fastest between 1964 and 1979. The table shows that in 1979 farms of 45 ha and larger represented only 2.1 percent of the farms but 64.5 percent of the land.

1.2.2 Infrastructure and Institutional Support

(a) Infrastructure. The road system is Guatemala seems to be more than adequate for an even flow of agricultural products to central markets. The necessary infrastructure for the marketing of perishable crops, like vegetables, however, seems to be lacking.

(b) Institutional support. In 1971 the Guatemalan government initiated its firts National Rural Development Plan (1971-75), in which the actions of the public sector were reoriented in order to bring about drastic changes in the rural areas. Within this plan, the Ministry of Agriculture was restructured so as to institutionalize what is called the Public Agricultural Sector (PAS). This restructuring called for the creation of several specialized institutions, all of which form the PAS and are part of the Ministry of Agriculture. Some of them are semi-autonomous and others are centralized and more dependent on the Ministry of Agriculture. The PAS institutions, presented in Figure 2, are the following:

1. ICTA -- Instituto de Ciencias y Tecnologías Agropecuarias (Institute of Agricultural Science and Technology). The official agricultural research institution.

Table 2. Guatemala: Size distribution of farms in 1964 and 1979

Size and Class of farm	Number and area							
	Farms				Area			
	1964		1979		1964		1979	
	No.	%	No.	%	Has.	%	Has	%
	417,344	100.0	531.623	100.0	3,422.528	100.0	4,105,319	100.0
Less than 0.7 ha	85,083	20.4	167,240	31.4	32,619	0.9	55,331	1.3
0.7-7 ha	279,796	67.0	301,736	56.7	607,857	17.7	622,039	15.2
7-45 ha	43,656	10.5	49,509	9.3	648,902	18.8	779,611	19.0
45-902 ha	8,420	2.0	13,176	2.5	1,258,548	36.6	1,814,314	44.2
902-9025 ha	389	0.1	478	0.1	849,602	26.0	834,024	20.3

Source: Dirección General de Estadística. III Censo Nacional Agropecuario 1979; Vol. 1, Tomo 1. Guatemala, December 1982.

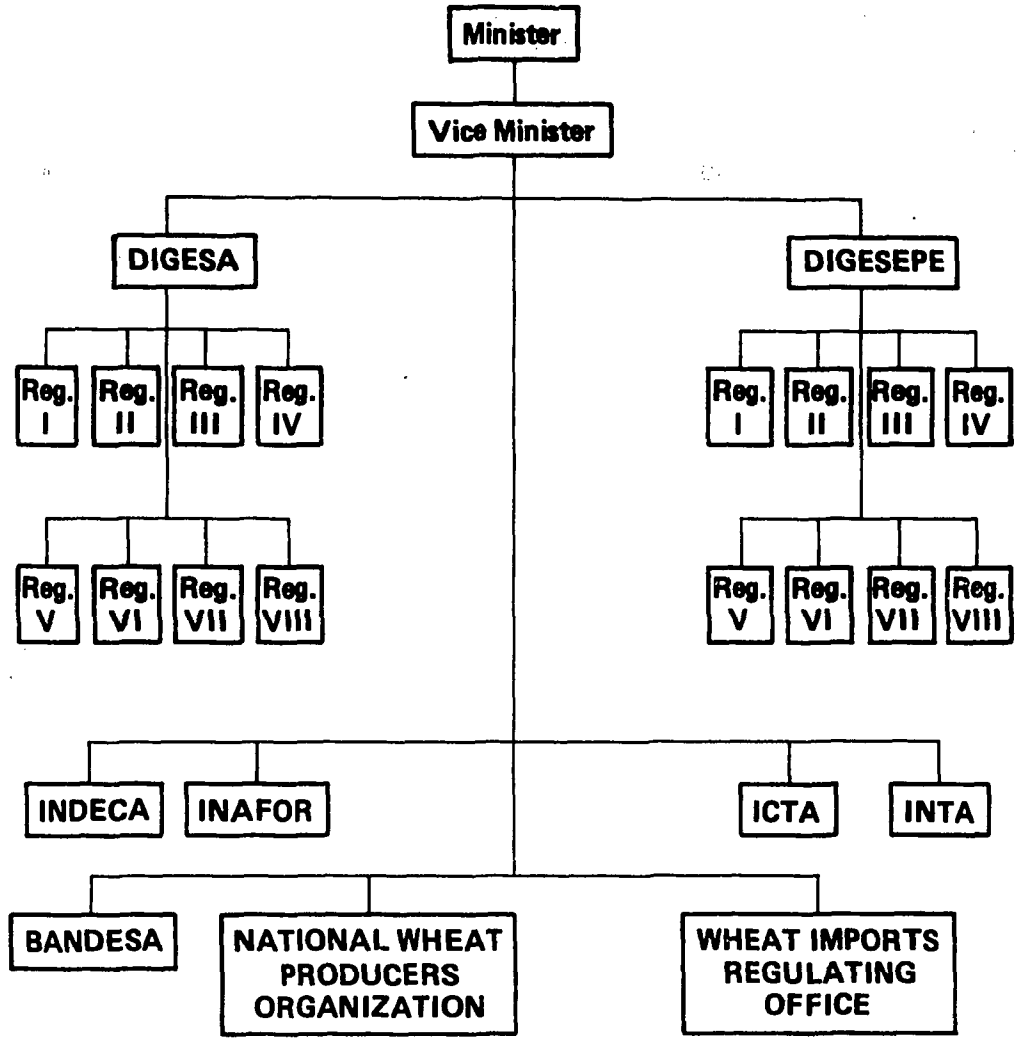

Figure 2. The Ministry of Agriculture and the public agricultural sector

2. DIGESA -- (Dirección General de Servicios Agrícolas) General Agricultural Service Bureau. The official agricultural extension institution.

3. BANDESA -- Banco Nacional de Desarrollo, S.A. (National Bank for Agricultural Development). The official agricultural lending institution.

4. INDECA -- Instituto Nacional de Comercialización Agrícola (The Agricultural Commercialization Institute). Sets grain prices and aids in the commercialization process.

5. INTA -- Instituto Nacional de Transformación Agraria. (The Agrarian Transformation Institute). Is charged with procuring land for peasants and instituting land reform.

6. DIGESEPE -- Dirección General de Servicios Pecuarios (General Animal Services Bureau). The official extension agency for animal producers.

7. INAFOR -- Instituto Nacional Forestal (National Forestry Institute)

8. Gremial de Trigueros: a semi-autonomous (paraestatal) institution created to assist wheat farmers with machinery, inputs and technical advice. Each wheat producer is a member of the Gremial and must pay a membership fee. It doesn't actually do research but instead is supposed to coordinate with ICTA.

Through the laws creating the PAS, ICTA is linked to the other institutions in many ways; for example, the Minister of Agriculture is the chairman of the Board of Directors of each of the PAS institutions.

ICTA should cooperate and coordinate extensively with DIGESA and DIGESEPE, but this has not been happening. There is a new project of technology development and transfer (financed by IDB) that contemplates this coordination.

The regional directors of each agency form what are called Regional Development Committees (COREDAS). They are supposed to coordinate the actions of all the agencies of the PAS at the regional level, but so far have not been able to do so.

The agricultural sector is supported by a well-organized and growing association of private seed producers as well as by a dynamic agricultural inputs industry.

1.2.3 Pricing

INDECA's mandate is to stabilize the prices of grains (rice, beans, corn and sorghum) by setting the prices before harvest and by buying or selling enought of each to maintain those prices. Due to the lack of resources, this institution has not been able to perform its duties, and all prices have differed from those set.

The Wheat Imports Regulating Office sets the price of wheat which the mills must pay farmes. These prices are usually set at levels higher than the import price, and to maintain them the government forces the mills to buy all the domestic production before they can import. This wheat pricing policy constitutes a stimulus to wheat production and demand for technology.

1.2.4 Past and Present Performance

The agricultural sectos has always been very important in Guatemala. In 1984 it contributed roughly 25 percent of

gross domestic product and generated about 60 percent of total exports. In recent years however the contribution of this sector to gross domestic product has been declining, going from 28 percent in 1970-75 to 25 percent in 1978-83. Its growth rate of about 5 percent during the 1970's fell to 1.4 percent in 1981 and has been roughly 2 percent since.

Tables 3 and 4, taken from Waugh (1977), show the behavior of rice and corn over the 10 year period prior to the creation of ICTA.

Table 3. Rice production statistics in Guatemala, 1961-72

Crop year	Area 1000 ha	Production 1000 tons	Yields tons/ha
1961-62	9.5	12.5	1.3
1962-63	11.0	16.3	1.5
1963-64	9.2	13.0	1.4
1964-65	12.1	24.3	2.0
1965-66	6.5	13.1	2.0
1966-67	6.5	14.7	2.3
1967-68	14.7	28.4	1.9
1968-69	14.5	25.0	1.7
1969-70	10.0	14.5	1.4
1970-71	12.0	22.7	1.9
1971-72	21.1	58.6	2.7

Source: Dirección General de Estadística

Table 4. Corn production statistics in Guatemala, 1961-72

Crop year	Area 1000 ha	Production 1000 tons	Yields tons/ha
1961-62	667	524	0.78
1962-63	791	673	0.85
1963-64	391	461	1.18
1964-65	678	648	0.95
1965-66	721	654	0.91
1966-67	703	601	0.85
1967-68	705	643	0.91
1968-69	736	697	0.95
1969-70	739	728	0.98
1970-71	706	524	0.74
1971-72	702	756	1.07

Source: Dirección General de Estadística

Table 5 shows the behavior of beans yields before and after ICTA's creation. The table shows beans yields falling between 1961-62 and 1977, and rising thereafter, while the area devoted to beans rose between 1961-62 and 1971-72 and trended downward thereafter.

Table 5. Beans crop production statistics in Guatemala, 1961-72 and 1976-83

Crop year	Period	Area 1000 ha	Production 1000 tons	Yields tons/ha
1961-62	Before ICTA	54.0	32.0	0.59
1962-63		75.0	33.0	0.44
1963-64		62.0	31.0	0.50
1964-65		129.0	52.0	0.40
1965-66		152.0	50.0	0.33
1966-67		134.0	44.0	0.33
1967-68		138.0	42.0	0.30
1968-69		162.0	66.0	0.41
1969-70		198.0	63.0	0.32
1970-71		160.0	65.0	0.41
1971-72		188.0	65.0	0.34
1976	After ICTA	138.6	40.1	0.29
1977		134.4	35.1	0.26
1978		94.8	79.6	0.84
1979		87.9	84.6	0.97
1980		64.6	57.2	0.89
1981		82.4	91.8	1.13
1982		100.6	100.5	1.01
1983		105.7	104.2	0.98

Note: Beans statistic for 1973-5 were not available.

Source: Dirección General de Estadística for 1961-62 to 1971-72. Banco Nacional de Guatemala for 1976-1983.

In 1984 Guatemala was self-sufficient in beans.

Maize: Approximately 500,000 ha are grown as a single crop and another 165,000 ha are grown with beans, sorghum or other crops. The bulk of production takes place on farms of less than 7 ha. Maize production grew at an annual rate of 3.2 percent during the period 1970-83, rising from 791,000 tons to 1,085,200 tons. Guatemala is currently self-sufficient in maize and may soon become an exporter.

Rice: This crop is grown on a few large farms and on many small farms. In 1983 production was up to 47,000 tons from 10,000 tons in 1977.

Wheat: The 45,000 tons of wheat produced in 1983 met only about 30 percent of the domestic demand; importation of the rest was at a cost of $20 million. Ideal wheat producing conditions are limited in Guatemala.

Potatoes: FAO data shows potato yields falling from 4 tons in 1974-76 to 3.5 tons in 1982. The yearly production of 50 thousand tons surpasses the domestic demand, and Guatemala has been exporting potatoes to other Central American countries.

Table 6 summarizes the performance of the grains producing sector in Guatemala over the periods 1974-76 and 1980-83.

1.2.5 Policy Issues

The allocation of agricultural credit has been an important issue in Guatemala. It is argued that most of the agricultural credit goes to export crops and not enough to the production of basic food stuffs. Table 7 presents a history of the allocation of credit (both private and government) over the period 1978-83.

Table 6. Guatemala agricultural production and trade 1974-76 and 1980-83

Crop	Year	Area 1000 ha	Yields kg/ha	Production 1000 tons	Tons
					Imports
Wheat	1974-76	40	1216	48	96,423[a]
	1980	50	896	45	108,020
	1981	64	712	45	107,917
	1982	65	769	50	nd
Rice	1974-76	16	1505	24	9,956[a]
	1980	16	3360	42	4,136
	1981	15	2973	46	4,200
	1982	15	3200	48	147
	1983	15	2850	43	nd
Corn	1974-76	585	1470	860	54,986[a]
	1980	655	1378	902	81,032
	1981	681	1464	997	74,000
	1982	876	1389	1217	nd
	1983	639	1636	1045	2,470
Sorghum	1974-76	38	1520	57	nd
	1980	47	1666	78	nd
	1981	41	2120	86	nd
	1982	45	1800	81	nd
	1983	48	2080	100	161
					Exports
Potato	1974-76	11[b]	4092	46	29,031[a]
	1980	16[b]	3750	60[b]	34,000
	1981	14[b]	3571	50[b]	30,000
	1982	14[b]	3571	50[b]	nd
Cotton	1974-76	100	3131	312	146,562[a]
	1980	123	3771	464	136,770
	1981	100	3980	399	110,000
	1982	81	3037	246	nd
Sugar Cane	1974-76	73	74676	5454	156,759[a]
	1980	79	68811	5409	198,612
	1981	83	68811	5680	228,124
	1982	81	76398	6150	nd
Coffee	1974-76	256	593	152	142,612[a]
	1980	250	654	163	124,508
	1981	253	682	173	132,000
	1982	250	648	162	nd

Source: FAO Trade Yearbook, 1981. FAO Production Yearbook, 1982.

Note: Beans Data are included in Table 5.

[a]Year 1979.

[b]FAO estimates.

nd = no data available.

Table 7. Guatemala agricultural credit 1978-83 (millions of U.S. dollars)

	1978	1979	1980	1981	1982	1983
Ag sector	112.4	119.4	178.7	189.4	176.4	206.9
Agriculture	92.6	88.4	150.5	161.5	153.4	179.6
Coffee	37.4	34.8	64.7	52.2	48.1	48.4
Cotton	29.1	23.9	47.9	50.4	44.3	52.3
Sugar cane	5.5	3.1	11.3	27.4	19.6	20.2
Basic grains[a]	11.5	14.6	13.7	18.0	20.2	21.7
Others	9.1	12.0	12.9	13.5	21.2	37.0
Animal husbandry	19.8	31.0	28.2	27.9	23.0	27.3
Beef and dairy	15.8	24.8	23.6	20.6	17.3	18.6
Others	4.0	6.2	4.6	7.3	5.7	8.7
Other sectors	467.0	544.1	598.5	621.3	652.3	768.0
Total credit	579.4	663.5	777.2	810.7	828.7	974.9

Source: 108, 1984.

[a] Includes corn, beans, rice and wheat.

CHAPTER 2. THE NATIONAL AGRICULTURAL RESEARCH SYSTEM

2.1 Overview

The following overview is taken from McDermott (1982) and Waugh (1974). Comprehensive assessment of Guatemalan rural areas in the late 1960s indicated that food production was just barely keeping pace with growing demand and that rural incomes and farmer productivity were stagnating. Almost all the increase in production was due to expansion of land devoted to agriculture. Staple foods, like beans and maize, were particularly affected. Although the total acreage devoted to beans tripled between 1960 and 1970, beans production only doubled and maize yields hardly increased at all. In 1972, the country was still importing maize and beans, and the availability of land was becoming a major constraint in maintaining production levels.

In 1970, a five-year development plan was issued to correct this situation. The plan initiated fundamental changes in the structure of the public agricultural sector (PAS). Measures were taken to improve small farmer productivity. Semi-autonomous institutes were created within PAS to serve the small-farm food-producing sector. INDECA, the national agricultural marketing agency and BANDESA, the national agricultural development bank, were the first two institutes formed. Initially research and extension functions were retained within the Ministry of Agriculture in the Directorate General of Agricultural Services (DIGESA), a centralized agency.

In 1973 agricultural research responsibilities were assigned to the Institute of Agricultural Science and Technology (ICTA). ICTA, like the other semi-autonomous institutes, was organized outside the Ministry of Agriculture, but with a board of directors chaired by the Minister of Agriculture. The semi-autonomous status of the institutes provided them with

Agriculture. The semi-autonomous status of the institutes provided them with flexibility to plan and implement new programs, hire personnel, and make independent contractual agreements. Some of DIGESA's most talented people accepted positions in the new institute. ICTA personnel were better paid and were free of some of the Ministry of Agriculture regulations that constrained DIGESA's personnel.

The planning for the development of ICTA, which took two years, involved scientists from other Latin American countries and personnel of both AID and the Rockefeller Foundation. The idea was to bring research into closer contact with both farmers and extension agents; Guatemalan scientists from the research education tradition of the Ministry of Agriculture played a major role.

ICTA was carefully designed to address four specific problems identified in the rural sector assessment: (1) the lack of adequate technology for the small farmer, (2) inadeaquate farm testing of the technology being recommended, (3) lack of evaluation of farmer acceptance of a recommended technology, and (4) the researchers' lack of knowledge of farmer problems and their insufficient contact with the extension agent.

ICTA was organized around an innovative concept and style of operation that has come to be called Farming Systems Research. Unlike the traditional research methodology, this approach brings the researchers in closer contact with the farmer-client. This helps the researchers to know and understand the farmer, thus enabling them to direct their research efforts toward seeking technology improvements that are relevant to his system. Innovations are tested by small farmers in their system before being released or recommended for use. This style involves on-farm research, with minimal experimental station research. ICTA has no central research station. It has

regional stations called production centers, which are neither large nor elaborate. Approximately 75 percent of research is done on individual farms.

Farmers' confidence in the use of new technologies results in considerable informal dissemination to other farmers even before information is released to extension workers and officially promoted. Accordingly, the traditional gap separating agricultural research and extension is significantly reduced.

In the ICTA model, research is directed toward specific agro-ecological areas and the focus is on technologies that can be implemented by and are profitable to small farmers.

Research is conducted by interdisciplinary teams consisting of both social and biological scientists. The focus is on a particular crop or a relevant mix of crops similar to those of the farming enterprise. Social scientists contribute by analyzing the socio-economic factors affecting farmers' management decisions and by evaluating innovations in terms of their compatibility with family labor constraints, traditional behavior patterns and cultural prices. The profitability of each innovation is carefully analyzed and assessed before recommendation.

2.2 Institutional Structure

ICTA is governed by a board of directors, which is formed by the Ministers of Agriculture, Economics and Public Finance, the Secretary of the National Council of Economic Planning, and the Dean of the College of Agriculture of the University of San Carlos. Figure 3 presents a sketch of the organization of ICTA. Operationally, it is run by the general manager who responds to the board of directors. The technical director heads the

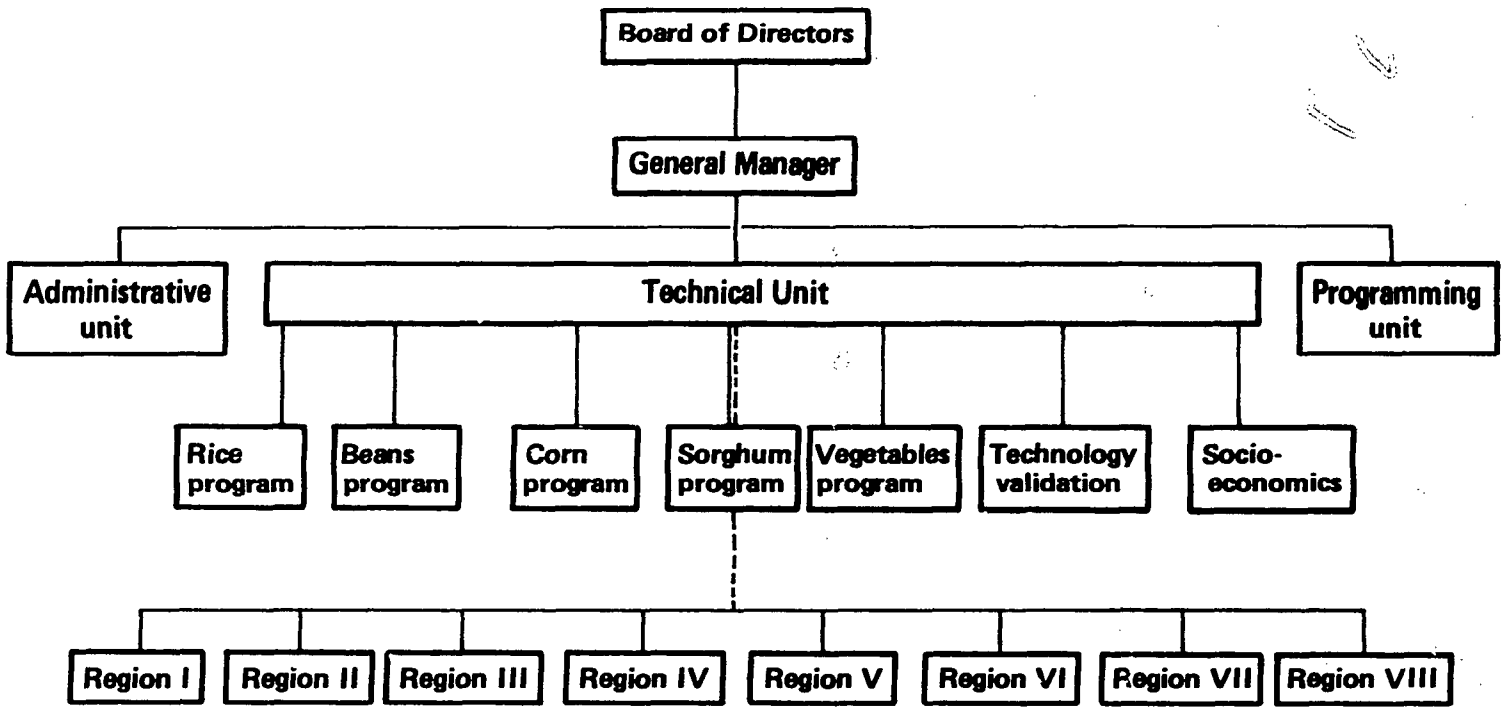

Figure 3. ICTA's organization

technical unit and is responsible for all technical matters.

The Technical Unit of ICTA carries out ICTA's mandate of developing, testing, validating and transferring appropriate technology to medium and small farmers through what is called the ICTA's Research System. This system is illustrated in Figure 4.

The technology validation teams and the socio-economic teams of each region are two important features of this process. The work of the technology validation team begins where the crop programs stop. It tests the crop program's output and then goes on to validate the selected technologies with the farmers (third box from the left in Fig. 4). If the technology developed passes this stage, the team will go even one step further to what is called "Technology Transfer Plots," in which the extension agents of DIGESA are supposed to participate actively (fourth box from the left in Fig. 4). If the technology developed fails at any stage, ICTA has a feedback system to the crop programs that facilitates any necessary adjustment.

The socioeconomics team do exploratory surveys whenever ICTA goes into a new area; they also do agroeconomic evaluations and constantly give the crop programs feedback.

This interdisciplinary apporach to the farmers' problem is very similar to the approach CIMMYT's Economics Program has been encouraging.

2.3 Allocated Resources

At the time this report was written the historical data requested pertaining to ICTA's budget and personnel had not yet

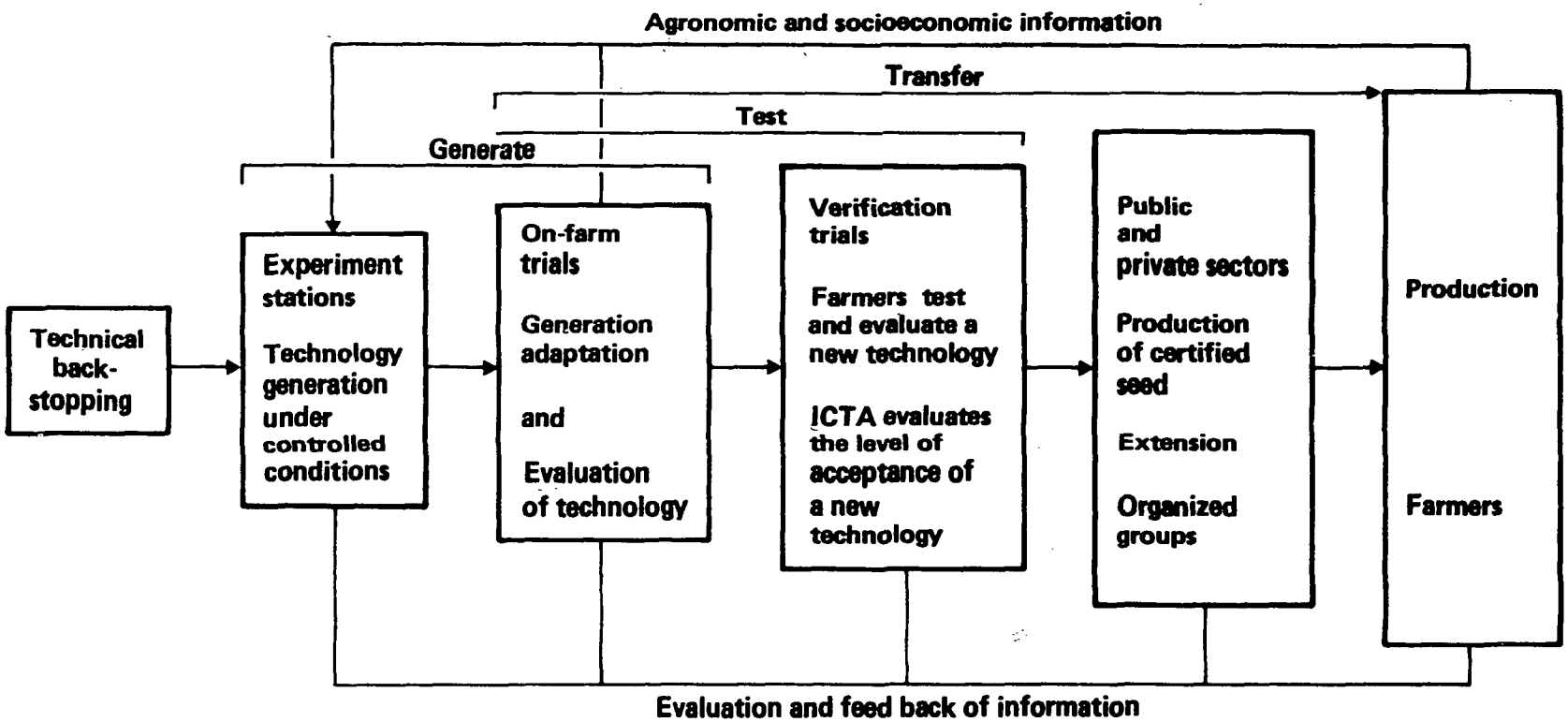

Figure 4. ICTA's research system--operational sequence

been delivered. The figures presented below were taken from secondary sources.

Nestel and Trigo (1984) reported that Guatemala spent 0.27 percent of its Gross Domestic Product on agricultural research. ICTA's budget for the years 1973-75 and 1980-84 is presented in Table 8.

Table 8. ICTA's budget for the periods 1973-75 and 1980-84 (in thousands of dollars)

	Years								
	Executed budget						Recommended budget		
Spending	1973[a]	1974[a]	1975[a]	1980	1981	1982	1983	1984	%[b]
Administration	--	--	--	655.1	682.6	661.5	665.2	663.4	13.9
Agricultural research	--	--	--	2597.8	3347.1	3033.7	3274.5	3538.9	74.1
Seed research	--	--	--	284.7	298.2	246.5	278.0	312.1	6.5
Other research Investments	--	--	--	233.8	242.2	208.2	236.4	257.0	5.4
Vehicles and machinery	--	--	--	278.0	398.8	45.0	264.3	7.0	0.1
Construction	--	--	--	205.0	--	173.0	159.3	--	--
Total	697.5	1560.6	2595.2	4254.4	4968.9	4367.9	4877.7	4778.4	100.0

Source: 1973-75 (Waugh, 1976) and 1980-84 (ICTA).

[a] Only totals were reported
[b] Percent of 1984 budget.

In Table 9, ICTA's budget by crops is reported for the years 1980, 1981 and 1982.

Table 9. Uses of ICTA's budget in 1980-82 (in thousands of dollars)

	1980	%	1981	%	1982	%
Administration	1779.8	41.8	2323.5	51.6	1894.9	43.4
Production Centers	547.6	12.9	655.4	18.1	436.2	10.0
Technical Services & Coordination	899.6	21.1	951.3	19.1	866.3	19.8
Central Administration	332.6	7.8	716.8	14.4	592.4	13.5
Agricultural Research	1882.8	44.2	2108.5	37.6	2012.6	46.1
Corn	203.7	4.8	241.5	0.1	229.2	5.2
Beans	116.0	2.7	101.3	2.0	124.4	2.8
Rice	81.7	1.9	94.8	1.9	75.0	1.7
Wheat	109.6	2.6	124.0	2.5	119.6	2.7
Sorghum	81.5	1.9	96.5	1.9	88.3	2.0
Vegetables	210.6	5.0	48.5	5.0	267.3	6.1
Fruits	13.3	0.3	23.1	0.5	22.5	0.5
Ajonjoli	30.7	0.7	35.2	0.7	34.5	0.8
Grapes	--	--	--	--	54.8	1.3
Animal Science	59.7	1.4	68.1	1.4	56.5	1.3
Technology Validation	976.0	22.9	1075.5	21.6	940.5	21.5
Seed Production and Management	334.7	7.9	298.2	6.0	246.5	5.6
Other Research	257.1	6.1	238.7	4.8	213.9	4.9
Chinese-Guatemalan project	73.0	1.7	64.6	1.3	62.2	1.4
Soils Management	20.0	0.5	24.6	0.5	127.5	0.6
Water Management	164.1	3.9	149.5	3.0	24.2	2.9
Total	4254.4	100.0	4968.9	100.0	4367.9	100.0

Source: Financial and Administrative Unit, ICTA.

2.4 Staff

The strengthening of ICTA's institutional capacity is reflected in the improved qualifications of ICTA staff. In 1970, 50 technicians were responsible for agricultural research

throughout Guatemala. Most were peritos agrónomos, high school graduates with some agricultural trade school preparation. Only 38 percent had B.S., M.S., or Ph.D. degrees.

By 1976, ICTA staff had increased to 145 technicians, 65 percent of whom had earned B.S., M.S., or Ph.D. degrees. In 1979, 76 percent of ICTA's 159 technicians had B.S. or higher degrees and by 1984 this figure had grown to 82 percent. This strengthening of the qualifications of ICTA personnel occurred in all technical and support units except the socioeconomic unit. The distribution of ICTA professional staff during 1975 and 1984 is presented in Table 10.

Table 10. ICTA professional staff for the years 1975 and 1984

Staff	1975	1984
National		
Ph.D.	2	2
M.S.	12	21
Ing. Agr.	55	147
Peritos Agrónomos	44	38
Foreign		
Ph.D.	4	1
M.S.	-	-
Ing. Agr.	3	1
	120	210

Source: 1975 (Waugh), 1984 (ICTA).

The distribution of DIGESA's 1983 professional staff is as follows:

158 Ingenieros Agrónomos
14 Economists--at B.S. level
526 Peritos Agrónomos
698 Total

High attrition rates among personnel with advanced degrees has become a serious problem for ICTA (McDermott, 1982). Rigid salary schedules are apparently responsible, but there is little the managers can do about that.

2.5 External Influences

Most of ICTA's budget comes directly from the government as part of the overall budget of the Ministry of Agriculture. Over the period 1980-82, 97 percent of ICTA's budget was financed by the government, the rest being financed through cooperative projects. It represented roughly 6.5 percent of the Ministry's budget. Table 11 contains a list of some of the projects under execution in 1984 and the amount budgeted; other projects and form of assistance are discussed below:

Table 11. Some of ICTA projects which are financed externally (in U.S. dollars)

Year	IDB [a]	AID (520 T 34) [b]		PRECODEPA [c]		ICTA/Cornell [d]	
	Budgeted	Budgeted	Used	Budgeted	Used	Budgeted	Used
1980		-	-	-	-	-	-
1982		-	-	256,800	139,000	-	-
1983		538,000	28,400	52,500	44,900	34,700	4,900
1984	24.200,000	311,500	391,000	48,000	-	40,000	-
1985		131,500	282,000	-	-	-	-
1986		89,500	-	-	-	-	-
1987		94,600	-	-	-	-	-

a Agricultural technology generation and transfer and seed production project.
b Crop diversification for small farmer in highlands.
c SDC through CIP.
d Technical assistance through the donation of a computer.

Source: Unit of Administration Services: ICTA.

A large number of non-CGIAR institutions or agencies were found supporting or collaborating with the NARS in one way or another. An outline of their major supporting activities follows:

The Inter-American Development Bank

a. The most important IDB support at the moment is through the "Agricultural Technology Generation and Transfer and Seed Production Project." the objective of this project is to strengthen research in areas of basic grains, vegetable oils and animal products. The total budget of the project is $24.2 million, of which $11.3 will go directly to ICTA for technology generation and some transfer, 6.9 to DIGESA for agricultural technology transfer, 3.3. to DIGESEPE for technology transfer in the area of animal production, and 2.6 million will go to the development of seed technology. Within technology generation and transfer, the project calls for training of 22 Ph.D's and 20 M.S. in the areas of plant breeding, entomology, plant pathology, soils, animal science, communication and cropping systems. This project will improve the system's capacity to take advantage of the cooperation they receive from the IARCs. As late as June 1985 no funds from this project were released because of the government's inability to finance the national portion.

b. IDB is also lending $40 million to BANDESA for loans to grain farmers. This should aid the technology adoption process.

c. IDB wants to finance private seed producers, who claim to need this kind of help. It should be noted that when ICTA was first organized IDB was the agency that helped set up the seed service to process and maintain genetic quality.

d. Two other projects are the "mini riego" (small irrigation) and the commercialization of agricultural products, which were approved in September 1983.

U.S. Agency for International Development

a. At the time of ICTA's creation, USAID played an important role in supporting its development. In 1975 AID approved the Food Productivity and Nutrition Project, which called for the strengthening and development of ICTA as an institution. Of the $1.73 million allocated for the project, $1.2 million was for expatriate technical assistance, including plant breeding experts and other technicians who staffed ICTA while project-sponsored Guatemalans were being trained to assume positions within the new institute.

b. At present, AID feels that ICTA is well supported by the IARCs and other agencies and that it should support others like DIGESA in order to strengthen the system. Nonetheless, they had a project in an area called "La Franja Transversal del Norte" to strengthen the research station there; now they want to place a two-man technical assistance team for tree crops and pasture.

c. There is an AID-520 credit for crop diversification in the highlands which calls for providing a four-man USDA technical assistance team.

d. There is a new Agribusiness Project conceived to improve the marketing of fruits and vegetables. The project contemplates the processing, freezing and dehidration of fruits and vegetables. A marketing expert is to come in and examine the whole process, working closely with ICTA, DIGESA and BANDESA. The objective of this project is to provide the small farmers in the highlands the opportunity to switch to crops better suited to the region.

Regional Office for Central America and Panamá (USAID ROCAP)

This office supports the NARS in indirect ways, usually through projects involving CATIE (item 9 below).

a. It supported small farming system and multiple cropping research through CATIE or IICA, which reached out to ICTA.

b. It supports coffee rust research at CATIE and in Guatemala.

c. It has started an Agricultural Pest Control Project with an IPM apporach which includes training local people, some at the M.S. level, at CATIE.

d. It also provides a pool of funds to ease the mobility of scientists to countries where they are requested for assistance.

e. It wants to strengthen the research and education capacity of CATIE.

The Rockefeller Foundation

The Rockefeller Foundation has provided graduate degree assistance. For example, in 1979 14 ICTA professionals were being sponsored for degrees (2 Ph.D.'s and 12 M.S.'s).

Government of Holland

In 1981, the government of Holland financed a program for the evaluation and reduction of post-harvest losses which was carried out by FAO. It also financed a wheat workshop.

Food and Agriculture Organization and UNDP

a. FAO/ICTA/USAC work together in the collection and exchange

with IARCs genetic materials of cassava, sweet potato, etc. They are part of the Interregional Committee on Phytogenetic Resources (CIRF) which is financed by FAO.

b. In their Agricultural Planning Project, lots of information is gathered.

c. Through the "Project for the Comprehensive Development of Izabel Area", they provide financing (through BANDESA), technical assistance, etc.

d. A new project is being developed to aid in the diffusion of the high quality protein maize variety, Natrica (UNDP).

Inter-American Institute for Agricultural Cooperation (IICA)

IICA indirectly supports or has supported the NARS through the following projects:

a. A "Production Models" project through DIGESA, which characterizes production processes (dates of planting and fertilizing, quantities of inputs, etc.). This is used by the extension agent as a checklist during his technical assistance.

b. A "Project of Coordination of the Public Agricultural Sector" which coordinates the efforts of all the agencies in each region as provided by the law that created the PAS. Apparently, in this region the COREDA is doing a better job because of this project.

c. IICA has received funds from CIDA (Canada) to strengthen animal research in Guatemala, through cooperation with DIGESEPE and other organizations involved with animal production.

d. A project with INTA where IICA will cooperate aiding Guatemalan peasants.

e. Help with courses at the National Cooperatives Institute and provision of a marketing course at INDECA.

f. Assisting the National Service for Agricultural Information (SNIAG) with work and resources, trying to prevent its disappearance.

PRECODEPA (Regional Cooperative Potato Program)

PRECODEPA, which became operative in 1978, is a regional potato program financed by the Swiss Development Corporation. The founding member countries are Costa Rica, Dominican Republic, Guatemala, Honduras, México, and Panamá. The International Potato Center (CIP) is also a founding member.

This program was conceived to take advantage of each member country's speciality. The network required each country to specialize in certain research areas and rely on other national programs for research in other areas. Research results and other technological developments are shared through regional seminars, workshops and production courses. Guatemala is the current leader in rustic storage and potato processing research.

Swiss Development Corporation

The SDC supports the NARS in Guatemala through its support of PRECODEPA and the regional beans program.

Tropical Agronomic Center for Research and Education (CATIE)

Located in Turrialba, Costa Rica, CATIE has not directly supported or worked with the NARS in Guatemala. The little indirect support has come through specific projects. Two of the

most important ones were:

a. A research project on the farming systems of small producers. This started in the mid-1970's with cropping systems alone and then, in 1980, went to mixed systems. An important achievement was the improvement of the research methodology. The technology generated with this project will now be validated and hopefully transferred to farmers through ICTA/DIGESA/BANDESA.

b. A project seeking systems of production in the highlands where farmers would grow vegetables along with their corn.

c. CATIE provides some in-country training of scientists in various fields from different instiutions.

Cornell University

Cornell University is the leader institution in agronomic, sociological and genetic aspects of research in beans yield and adaptaton of the Bean/Cowpea Collaborative Research Support Program (CRSP). This is a program of coordinated projects in Africa and Latin America addressing hunger and malnutrition through research on the production and utilization of beans and cowpeas. These international research partnerships directly involve research institutions in 13 host countries, two IARCs and 14 U.S. agricultural research institutions. With ICTA they are investigating the socioagronomic bases for the bean farming systems of the Indians in the highlands. In 1983 the project sponsored graduate work for one Guatemalan student. A great deal of the help to ICTA is financial, to pay for gas, wages, computer work, etc.

Chinese Agricultural Mission to Guatemala

The mission does not have an established program with ICTA. It mainly conducts occasional trials of genetic materials of crops which are usually not grown in the area. It works mainly on army farms and with other small farmers trying to get them to grow crops such as chinese cabbage, cauliflower, carrots, raddish, sweet pepper, rice and some fruit trees. It also provides services like rice threshing on farms, and has been testing the adaptation to Guatemala of Chinese rice varieties.

Regional Associates of Seed Technologists of Central America and the Caribbean (ARTES)

Has imparted regional courses in seed technology with assistance from CIAT, CIMMYT and the GTZ.

Latin American Sorghum Research Coordinator (CLIS)

CLIS financed by ICRISAT, includes all of the Central American and Caribbean countries. CLIS facilitates the exchange of valuable genetic material within the area.

University of Florida

ICTA is being considered for a farming systems project and will receive help from the UF Farming Systems Support Project. Florida wants to use ICTA in the future as a center for training in farming systems, although there is not yet any formal agreement. University of Florida has also helped PRECODEPA with materials and seminars on farming systems.

Asian Vegetable Research and Development Center (AVRDC)

So far, the NARS in Guatemala has not received much support from AVRDC. One scientist from ICTA has received training in

Taiwan, and there has also been exchange of some lines of tomato and sweet potato. ICTA is trying to reach agreement with AVRDC to establish a regional center in the area, which AVRDC seems to favor. The AVRDC currently works with tomato, sweet potato, chinese cabbage, mung beans, soybeans and NEM (nutrition, environment and management).

Institute of Nutrition for Central America and Panamá (INCAP)

The institute's program is dividded into three parts: agricultural food sciences, nutrition and health, and food intake planning.

In each of these areas, they carry out three activities: research, training and technical cooperation.

Within its technical cooperation activities, it is trying to improve overall agricultural research, and is actively collaborating with the IARCs. It works with CIAT on improving the methionine content of beans; CIAT sends the material to INCAP for proper evaluation. It also works with CIMMYT through CIMMYT's food analysis laboratory. In Guatemala with ICTA it has:

a. A project to establish the criteria used by consumers to determine the acceptability of a given product; i.e., in beans it would be the form, color, cooking quality, etc.

b. Worked together, through an ICTA/INCAP agreement, in the development of the quality protein maize variety "Nutricta," overcoming the problems of low consumer acceptance and low yields. INCAP is now a member of the Nutricta promotion commission.

c. Worked with ICTA trying to improve the digestibility of red grain sorghum.

d. Worked with CIGRAS (Costa Rica) on seed quality of basic grains (rice, beans, corn, sorghum) and cooking time.

INCAP feels there is ample room for cooperation with the IARCs and the NARS in terms of food storing and processing research. It is their belief that the IARCs on this continent should use its facilities instead of creating their own laboratories, and should probably place more emphasis on nutritional value in their breeding programs. It has suggested that the IARCs accept its productivity concept; productivity = yield/unit area * nutritional value * technological value (technological value is a measure of the degree of acceptance by consumers). With this approach, they said, there is potential to solve not only world hunger but also world malnutrition.

University of San Carlos College of Agriculture

Although the College of Agriculture has an Agricultural Research Institute, its leaders have complained about the lack of coordination and purpose of their research activities (USAC, 1980). There is also a lack of coordination with the public institutions of the agricultural sector. It does no grain research except for theses done with ICTA, but does have cooperative agreements with ICTA and INAFOR. Although most of its work is basic research (i.e., the use of cobalt 60 to modify beans to increase nutritional quality), they currently have a project called "Characterization of the Agricultural Production Systems of Guatemala." The objective of this project is to gather enough information to help change the way research is done. They are not working with ICTA on this project.

Texas A&M University

Its cooperation, now ended, with the NARS (ICTA) consisted of the exchange and evaluation of sorghum genetic materials, mainly hybrids, in search of resistance to an insect (MIGE) and

diseases. From 1974 to 1978, Texas A&M University supported ICTA's vegetable program through technical assistance financed by USAID. Texas A&M also provided seed for ICTA's evaluation. Through this cooperation, the melon export program was developed.

The Pan-American Agricultural School (EAP) in Honduras gave a seed course.

INIA (Mexico) supports ICTA with seed, especially potato seed.

Pioneer, CIBA-GEIGY and FMC supported ICTA by donating equipment.

Louisiana State University and University of Mississippi have both provided technical assistance to ICTA.

UCLA gave a course on methods of reproduction of the "polilla de la papa" (potato tuber moth).

Private Seed Producers Association

The private seed producers have contributed and supported the NARS by promoting the materials (varieties) and technologies developed through field days, publications and audio-visuals.

The Griffin Company

This was the company that showed most interest when the Guatemalan government invited several companies to participate in the vegetable export business. The company will grow a kind of canteloupe not currently grown, providing the farmers with equipment, credit, inputs and technological assistance. ICTA will contribute by evaluating new materials.

The International Board for Plant Genetic Resources (IBPGR), a CGIAR center, has collaborated with the Guatemalan NARS through ICTA and USAC in the collection, multiplication and evaluation of some national crops like cocoa and cassava.

2.6 Effectiveness and Problems

2.6.1 Effectiveness

The NARS in Guatemala has been very effective in terms of carrying out its mandate. The success of ICTA is based, according to experts, on its multidisciplinaary approach to agricultural research, backed by a well qualified and motivated staff. In only 10 years of operation, ICTA has developed a great number of varieties and methodologies for each of the different regions of Guatemala, has published numerous bulletins and technical reports, has trained hundreds of technicians, and has made many important regional contributions, all of which is testimony to its effectiveness.

2.6.2 Limitations

The following are some of the problems of the NARS that are limiting its effectiveness. Because of serious budget limitations, ICTA does not cover the whole country and most of the programs suffer from lack of personnel, equipment, materials, etc. Most regions don't have adequate facilities to store and maintain valuable germplasm. Seed quality and disease research cannot be carried out because of the lack of equipment. The seed program also needs better equipment to handle and care for the basic and foundation seed it produces.

There is some need for more promotion of the technology ICTA develops. Also, because ICTA's approach to research draws on some techniques of traditional extension methodology, there is some confusion regarding the respective roles of ICTA and DIGESA.

CHAPTER 3. IMPACT OF INTERNATIONAL AGRICULTURAL RESEARCH CENTERS ON THE NATIONAL AGRICULTURAL RESEARCH SYSTEM

3.1 General Issues

The three CGIAR centers in Latin America in general and CIMMYT in particular have played a very important role in the creation and subsequent development of ICTA. The two scientists that CIMMYT placed in ICTA for several years after its creation are credited by ICTA with the establishment of the maize and wheat research programs in Guatemala. They developed and passed on research methodologies that are still being used. The provision of genetic materials and training of ICTA's personnel have contributed to making ICTA one of the strongest agricultural research institutions in the area. Scientists and managers at ICTA emphasized the importance of the support they received from the IARCs, especially during the period of political instability when many other international agencies dropped their support.

Because ICTA has been so strong, it has been able to collaborate with the IARCs as partners, developing important technologies. The system, however, has not been free of problems that have limited impact. Within the NARS the technology validation teams are not given the importance they deserve; they are the only group without a national coordinator. The need for more economic evaluation of technological packages and for more support to the commodity programs by the socio-economic discipline was vividly expressed, not only by scientists in the commodity programs, but also by scientists from supporting disciplines.

3.2 Biological Materials

During the interviewes, NARS scientists were asked to

rate the quality of the IARCs collaboration. The answers were tabulated and the ratings of the provison of genetic materials are summarized in Table 12.

Table 12. Guatemala: Rating of the collaboration of the IARCs in terms of their provision of genetic materials

Centers	Program	Evaluation			
		Bad	Fair	Good	Excellent
CIMMYT	Maize				X
	Wheat				X
CIMMYT/ICRISAT	Sorghum			X	
CIAT	Rice				X
	Beans				X
CIP/PRECODEPA	Potato				X

Note: Programs not included were not rated.

3.3 Research Techniques and Methods

In terms of research methodologies, the contributions of the IARCs have been vital to the programs. The methodologies used in the programs were learned by NARS scientists mostly during training at the centers.

ICTA's scientists claim that CIMMYT made an invaluable contribution when they placed two scientists within ICTA. They claim that these two scientists left a base on which to build the corn and wheat programs. The methodology they developed was easily transmitted to NARS scientists because they were working side by side on a daily basis. The current arrangement, they claim, is less effective, since CIMMYT's regional people visit only periodically to assist, whereas the others used to execute. The wheat, sorghum, rice and seed programs feel that visits by IARCs scientists are too infrequent to meet their technical assistance needs. ICTA's technology validation and

socioeconomics teams complained that they get no assistance from IARCs in terms of methodologies.

3.4 Research Organization

Besides the international nurseries and testing programs, each of the three centers has a regional program in Central America.

a) CIMMYT. This center's regional programs operate through periodic visits to the NARS by scientists based in Mexico and through the coordination and support of regional trials. CIMMYT supports and participates actively in the Central American Cooperative Project for the Improvement of Food Crops (PCCMCA), which is very important to the Central American NARS.

(b) CIAT. The center's beans program has three representatives in the region, the regional coordinator located in Costa Rica and two other scientists, a plant breeder and an agronomist, at ICTA in Guatemala. This arrangement has proven to be very effective. CIAT scientists have helped the various countries to assume responsibilities in areas in which they had comparative advantage. For example, Guatemala is the leader in golden mosaic virus research, whereas Costa Rica is the leader in web blight research. Research results are shared periodically, especially at the PCCMCA meetings. Need for a regional rice coordinator has been expressed.

(c) CIP. CIP participates regionally as a founder of the regional cooperative potato program, PRECODEPA. This type of organization has been very successful. Each country is assigned leadership or sub-leadership in a given aspect of potato research, and results are shared during periodic seminars and meetings. This arrangement gives the national scientists visibility and recognition for their expertise, and

the author found them to be the most stable, motivated and enthusiastic ones in the NARS.

3.5 Information and Training

The rating by NARS scientists of the provision of information and training by the IARCs are summarized in Table 13.

Table 13. Guatemala: Rating of the collaboration of the IARCs in terms of their provision of information and training

Centers	Program	Provision of Information				Training			
		Bad	Fair	Good	Excellent	Bad	Fair	Good	Excellent
CIMMYT	Maize				X				X
	Wheat				X				X
CIMMYT/ICRISAT	Sorghum			X					
CIAT	Rice			X					
	Beans			X					X
	Seed			X					X
CIP/PRECODEPA	Potato				X				X

Note: Programs not included were not rated.

The table shows that these activities were also rated highly by NARS scientists, but they made the following comments or observations.

The stipend provided by both CIMMYT and CIAT was not enought and affected the trainees negatively.

There was general agreement that more in-country trainin should be done; this might save resources. The need for refresher courses was also expressed. The biggest preocupation, however, was with the need for more graduate training, emphasizing general agronomy, plant pathology,

entomology, etc. instead of plant breeding.

The technology validation and socioeconomics teams have been the last ones to be considered for training both by ICTA and by the IARCs.

3.6 Relationship Between the IARCs and the NARS

With a few exceptions, it was found that the pattern of division of research efforts was similar to that of other countries. This means that the international centers do the basic variety research and the crosses and the NARS tests the genetic materials for adaptation and carries out further selection. Because ICTA is so well organized and capable, there were some exceptions. For examples, in beans, the collaboration ICTA/CIAT has reached the point where they work as partners. ICTA is now doing crosses in Guatemala and is even sending materials to CIAT and to other countries. Recently CIAT received a prize for developing with ICTA a variety resistant to golden mosaic. In corn, the release of the quality protein variety Nutricta by ICTA proves that this national program is gradually doing more of the things only the IARCs used to do. The development of better agronomic practices has been done mainly by the NARS alone, although IARCs agronomists participate and assist.

According to the information obtained from the national scientists, the main channels through which their needs are communicated and met by the international centes are periodic visits of center specialists to their commodity programs and the international nurseries through which they obtain valuable genetic materials. Regional arrangements like the CIAT beans program and PRECODEPA have been very successful in matching the country's needs with the centers' priorities.

There were only two cases in which national needs seemed at odds with the IARC's priorities. In rice, CIAT emphasizes and devotes more of its resources to irrigated rice, while Guatemala grows mainly upland rice. In sorghum, most of ICRISAT materials were not suited for region VI, and the NARS has not been able to get help with the "mosquita del sorgo", a national problem.

CHAPTER 4. RESEARCH IMPACTS ON AGRICULTURAL PRODUCTION

4.1 Important Innovations

A brief description, by crop, of the innovations introduced in Guatemala follows:

(a) Corn. The ISU team (ISU, 1981) reported the following list of lowland varieties and hybrids developed by ICTA from materials provided by CIMMYT between 1973 and 1980:

Hybrids or Varieties	Year	Hybrids or Varieties	Year
ICTA B-1 (white)	1973	HB-11	1978
La Maquina 7422 (white)	1977	HB-19	1980
A:4 (yellow)	1980	HB-28 (yellow)	1980
ICTA T101 (hybrid white)	1973	HB-33	1980
		HB-44 (hybrid)	1980

Other varieties and hybrids developed by ICTA for the lowlands are ICTA V-1, developed from CIMMYT's Tuxpeño; ICTA-302 and the hybrid HB-83, which rated No. 1 in regional trials.

In Region V (highlands), for which CIMMYT has no appropriate material, ICTA scientists' work consisted of improving the local genetic material through selection. This effort produced the varieties V-301 (white), Barcena 71 (yellow), V-302 and V-304 (yellow), and Chanin, which is much earlier than the local varieties. Chanin has a cycle of 160 days compared to 270 days for the locals.

The collaboration of ICTA, CIMMYT and INCAP produced in 1983 the high quality protein variety, Nutricta, of which 560 Ha were grown in 1984.

(b) Wheat. Table 14 contains a list of the wheat varieties developed by ICTA in collaboration with CIMMYT over the period 1973-84.

Table 14. Guatemala: Wheat varieties developed by ICTA for different regions (1973-1984)

Variety	Year	Adapted to highland	Variety	Year	Adapted to highland
Altense	1973	Western	Chivito	1977	Western
Xelapan	1973	Western	Tecpan	1979	Central
Gloria	1974	Western	Balanya	1980	Central
Maya	1974	Central	Sara	1982	Western
Quetzal	1975	Western	Comalapa	1984	Central
Reyna	1976	Central	Patzun	1984	Central

Source: ICTA.

(c) Sorghum. Almost all the seed currently planted is of imported hybrids. ICTA's sorghum program is very young. It released in 1984 the hybrid ICTA-450 (red), which it claims is equal to or better than the imported ones. This was developed using lines from ICRISAT and Texas A&M University. For the 1985 season, it expects to produce enough seed to plant 3,000 ha.

(d) Beans. ICTA has released three beans varieties which have proven to have a wide range of adaptation. These are ICTA Quetzal, ICTA Tamazulapa and ICTA Jutiapan. They have been adapted to Region IV.

(e) Rice. ICTA has developed the following two high yielding varieties from CIAT materials: ICTA-Virginia and ICTA-Tempisque.

(f) Potato. ICTA/PRECODEPA has developed and spread the technique of rustic storage, which has enabled farmers to store their potatoes for seed and consumption up to 8 months instead of 4 or 5. There are about 600 of these facilities in Guatemala, which are expected to increase consumption at the

farm level. The high yielding, disease-resistant variety Tollocan, developed by the Mexican program, has also been introduced.

4.2 Adoption of Innovations

4.2.1 Transmission Organization

In Guatemala the official technology transferring agency is DIGESA, the extension agency. But ICTA, by working directly with the farmers in the technology validation stage of their process, does a great deal of transmission. The system otherwise is not very effective because of the lack of communication and coordination between ICTA and DIGESA.

4.2.2 Adoption

Corn. It is estimated that 40-50 percent of the corn hectarage in the western lowlands (Region IV) is planted to high yielding CIMMYT-based materials. This represents 80,000-100,000 ha. In the highlands (Region I), scientists estimated that about 60 percent of the farmers were using improved materials.

Wheat. Adoption of ICTA varieties was estimated to be 100 percent.

Beans. Adoption of ICTA varieties was estimated to be 50 percent in Region VI. The ISU team estimated that 25 percent of beans farmers were using improved seed.

Certified seed. Using ICTA data on the supervised production of "ICTA Certified" seed in 1978, an evaluation team (McDermott, 1982) attempted to estimate its use and impact on Guatemalan agriculture. Table 15 gives their estimates of production and availability of certified seed, and Table 16

shows the uses of maize improved seed over the period 1976-1982. Table 17 presents Acceptance Indices (percent of collaborating farmers accepting times the percent of their croop area dedicated to the recommendations) for four ICTA recommendations in one area of Region IV called "La Maquina", over a 5-year period. For the seed varieties and seeding distance recommendations acceptance increased gradually. For the weed control and insecticide recommendations, an overall increase in acceptance was recorded.

Table 15. Estimated amount of "ICTA Certified" seed available from growers, 1978 [a]

Crop	Number of growers	Area of seed production (mz)[b]	Average seed production (cwt/mz)[c]	Estimated amount of "ICTA Certified" seed available (cwt)
Maize	23	583	30	17,490
Beans	2	17	15	255
Rice	7	120	75	9,000
Wheat	4	43	35	1,505
Sesame	4	45	12	540

[a]Not all of the seed developed by ICTA is included in these calculations because some companies and associations produce seed outside the ICTA system.

[b]mz = manzana = 0.7 hectareas = approximately 1.5 acres.

[c]cwt = hundredweight.

Source: ICTA (calculations made by McDermott and Bathrick).

Table 16. Guatemala: Use of ICTA improved maize seed (1977-1982)

Period	Production (tons)	Sales (tons)	Area planted
1976-1977	318	182	11,200
1977-1978	260	260	16,000
1978-1979	632	632	38,920
1979-1980	1106	1100	67,200
1980-1981	1200	1200	73,840
1981-1982	1545	1545	95,070

Source: McDermott and Bathrick.

Table 17. Acceptance Indices for ICTA recommendations for maize, La Maquina, 1975-1979

ICTA recommendations	Year				
	1975	1976	1977	1978	1979
Seed varieties	47	53	61	71	69
Seeding distances	16	28	36	54	52
Weed control	19	38	12	11	31
Insecticide	36	59	70	66	52
Yearly average	29.5	44.5	44.8	50.5	52

Source: ICTA (from McDermott, 1982).

4.3 Production Effects

Corn. The new corn hybrid, HB-83, was reported to have a yield potential at the field level of 4-5 tons/ha and is well accepted by farmers. In the highlands, the materials developed by ICTA, with a few improved practices, have yields 3 to 3.5 tons/ha, compared to the previous 1 to 1.5 tons/ha. The variety Nutricta has shown a yield potential of up to 4 tons/ha.

Wheat. The wheat varieties developed by ICTA, although well adopted, have not had major impact on yields and production because of the marginal lands on which most of the

wheat is grown. Scientists said that the new varieties ICTA Patzun and ICTA Comalapa have the potential of yielding 3 to 4 tons in those same areas.

Potato. In 1981, ICTA socioeconomics (Orellana, 1983) conducted a study with nine farmers in Jalapa, Guatemala, where they compared the performance and acceptance of the new variety Tollocan to the one planted at that time, Loman. With Tollocan, they obtained yields ranging from 18.6 to 42.5 ton/ha while Loman yields ranged between 2.7 and 21 ton/ha with an average of only 10 ton/ha, and all Tollocans other characteristics were either preferred by or acceptable to the farmers.

The sizeable increase in production and yields of rice, beans, corn and sorghum between ICTA's creation (1973) and 1983 has been attributed to the varieties and other technologies developed by the NARS in collaboration with the IARCs over that period. Table 18 illustrates.

Table 18. Comparison of production yield and importation of basic grains in Guatemala, 1973-1983

Grain	1973			1983		
	Yield kg/ha	Production Thousands of cwt	Import Thousands of cwt	Yield kg/ha	Production Thousands of cwt	Import Thousands of cwt
Maize	1,180	14,540.2	1,588.5	1,636	22,735.4	53.7[a]
Bean	636	1,288.8	8.6	986	2,266.3	--
Rice	1,600	427.0	4.6	2,850	933.0	3.2[b]
Sorghum	1,360	1,341.2	3.4	2,080	2,183.4	3.5[b]

Source: Banco de Guatemala.

[a]Maize for animal feed.

[b]Seed.

The effects of the use of improved seed in 1978 were estimated by McDermott (1982) and are presented in Tables 19 and 20.

4.4 Other Effects

(a) Income. Table 20 presents McDermott's estimate the value of increased production stemming from the use of ICTA certified seed. The table shows that the income effects are significant, especially in the maize and rice-producing sector.

Table 19. Estimated increased production of five crops resulting from production of "ICTA Certified" seed, 1978[a]

Crop	Estimated amount of "ICTA Certified" seed available (tons)	Seed needed for planting (kg/ha)	Estimated farm areas planted (ha)	Increased[b] yield (kg/ha)	Estimated increase in crop production (tons)
Maize	804.0	15.2	52,009	912	48,187
Beans	11.7	46.0	238	304	74
Rice	414.0	61.6	6,702	1,216	3,280
Wheat	69.2	90.3	700	1,094	824
Sesame	24.8	3.7	6,702	243	1,656

Source: ICTA (calculations made by McDermott and Bathrick).

[a]Not all of the seed developed by ICTA is included in these calculations because some companies and associations produce seed outside the ICTA system.

[b]Increased yields obtained over traditional unimproved varities.

Table 20. Estimated value of increased production resulting from production of "ICTA Certified" seed, 1978[a]

Crop	Estimated increase in crop production (tons)[b]	Price ($/tons)	Estimated value of increased production ($)
Maize	48,187	152.2	7,333,200
Beans	74	434.8	32,000
Rice	8,280	217.4	1,800,000
Wheat	824	250.0	206,080
Sesame	1,656	543.5	900,000
Total			10,271,280

Source: ICTA (calculations made by McDermott and Bathrick)

[a]Not all of the seed produced by ICTA is included in these calculations because some companies and associations produce seed outside the ICTA system.

[b]The Guatemalan quetzal was equal to one dollar; prices used came from ICTA bulletins.

(b) Nutrition. The government has formed a multi-institutional committee to promote the production of the high quality protein maize, Nutricta, and its use in hispitals, orphanages, schools, etc. Because of its high lysine and tryptophane content, it's expected to play a major role in the improvement of the nutrition of the Guatemalan poor.

4.5 Innovations with Potential Impact

Wheat. ICTA released in 1984 two wheat varieties, ICTA Patzun and ICTA Comalapa, which they developed from material introduced by CIMMYT in 1979. They claim that these varieties are tolerant to important diseases and have the potential to increase yields by 15 to 25 percent.

Beans. In Region V, where the problem has been the earliness of the local varieties, ICTA plans to release three new varieties soon which will alleviate the problem. No estimates of possible impact were given.

Rice. In 1985 two new varieties will be released to substitute for ICTA Virginia and ICTA Cristina, which are now susceptible to pyricularia. They claim that the impact will be significant.

Sorghum. A new variety, ICTA C-21, developed from ICRISAT's material, will be released soon. In 1984 it was in the technology validation stage and proved to yield an average of 4 tons/ha. A good characteristic is that it can be planted after corn.

Corn. Table 21 shows a list of planned releases of corn varieties or hybrids by ICTA. It does not, however, show any estimate of their possible impact.

Table 21. Guatemala: Planned releases of corn varieties and hybrids

Varieties or hybrids	Liberation dates	Color	Area Adapted to
Don Marshal	1984	Yellow	Chimaltenango
HE-1	1985	White	0-1000 m
RM-1	1985	White (mildew resistant)	0-1000 m
B-7	1984	White (drought resistant)	0-1000 m
ICTA 612	1984	White	2700-2900 Quetzaltenango & Totonicapan
HE-2	1986	White	0-1000 m
HB-83	1984	Yellow	0-1000 m
Sutuj	1986	White	Valley of Chimaltenango

Source: ICTA.

CHAPTER 5. CONCLUSIONS

The following observations and conclusions are based on interviews with many scientists and directors at ICTA, directors of other agencies within the Public Agricultural Sector, managers of businesses in the private sector, and directors of non-CGIAR support institutions and/or programs.

ICTA's greatest problem appears to be financial. Most programs lack the resources to do a good job, and the salaries are eroding. ICTA managers complain that with the current system any additional grants they receive do not increase their allocation by a similar amount. This is why the managers of ICTA have been trying to form a private foundation to finance ICTA's operation. This foundation (FUNDICTA) could then receive donations, loans and grants that would directly increase ICTA's budget. This seems like an appropriate solution to the problem. The international agricultural financial community could, by this means, partially finance the salaries of ICTA's qualified researchers, so as to reduce attrition and increase the effectiveness of the system.

The need for much more graduate training is deeply felt in ICTA. The continued success of this agency is going to depend on it being able to keep and upgrade its personnel. Unfortunately, the highest attrition rate seems to be among those with graduate degrees. The IDB project calls for training a large number of scientists of the graduate level, which would solve that aspect of the problem. The formation of FUNDICTA, which would enable ICTA to properly remunerate its scientists, would solve the other aspect of the problem.

It is apparent that greater participation of the private sector in the production of certified seed is vital to the success of the collaboration of ICTA and IARCs. ICTA's arrangement has been flexible enough to allow the formation of

a private seed-producing industry. The question is, where do they want to go? How far should they venture into the research end of it (ICTA's territory)? Should the IARCs give materials directly to these producers, so that they might develop their own varieties or hybrids? At the moment ICTA wants to be the only one doing the research and they want to be able to protect the materials after they are released. But the private producers would also like to have differentiated materials on which they can capitalize, especially for maize hybrids. This issue should be given some serious thought, since it appears that a vigorous private sector might be an answer to the technology transfer problem.

The regional beans program, although financed by the SDC (Swiss Development Corporation), does not function like PRECODEPA, even though different countries in the region tend to specialize in different problems. The program however, appears to be as successful as PRECODEPA, and the NARS scientists are very happy with the arrangement.

In light of the consumer preferences manifested, it seems pertinent to ask why ICTA/CIAT doesn't work on the improvement of the long-grained American-type rice varieties. If these are preferred, then it might be useful to try to incorporate some resistance in these materials. This might be easier than trying to improve the milling quality of the current materials to the point where they can compete with the others.

The NARS scientists felt strongly that the IARCs should devote more time and resources to research in the areas of plant pathology, entomology, weed control, etc. The scientists expressed great need for training and guidance in these areas.

In general, the scientists in the NARS are very happy with their collaboration with the IARCs. The corn program

scientists were happy that they could pick up the phone during an emergency and get immediate help. They are happy with the flow of genetic material from the centers, which constitutes the base of their program. In the case of beans, strong regional representatives have virtually put the program together. Without the kind of training they received at the IARCs, I doubt that there would be national commodity research programs.

Despite the apparent advancement and achievements since the creation of ICTA, it appears that there remains still a long way to go. The assessment of the current situation by others looking at the system has not been favorable. The IDB found the following limitations: (a) need of more varieties better adapted to the conditions of the country; (b) deficient agronomic practices, which are the concern of the technology validation teams; (c) great susceptibility to insects and diseases; and (d) inadequate supply of good seed of the recommended varities. The committee for the restructuring of the College of Agriculture of the University of San Carlos, in 1981, assessed the situation the following way. It said:

> There is an intimate relation between the socio-economic situation of the country, the use of the resources and the development, application and diffusion of knowledge. In Guatemala there clearly does not exist at the national level a scientific-technological policy that implies a system that will generate, test, transfer and diffuse science and technology adequately within the socio-economic and ecological context which can be incorporated into the production process (p. 3).

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