CRiN Caribbean Rice Improvement Network
Red de Mejoramiento de Arroz para el Caribe
Cooperación: CIAT – CIDA – IRRI – IICA – SEA – UNDP

REPORT OF ACTIVITIES DEVELOPED BY CRIN FROM 1986 TO 1992

C O N T E N T S

REPORT OF ACTIVITIES DEVELOPED BY CRIN FROM 1986 TO 1992[1]

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INTRODUCTION

The Caribbean Rice Improvement Network, **CRIN**, started its activities in February, 1986, with headquarters at the Centro de Investigaciones Arroceras, **CEDIA**, in Bonao, Dominican Republic.

CRIN is sponsored by the International Center for Tropical Agriculture, **CIAT**, the Canadian International Development Agency, **CIDA**, and the International Rice Research Institute - International Network for Genetic Evaluation of Rice, **IRRI - INGER.** The Ministry of Agriculture of the Dominican Republic, **SEA**, provides the required facilities and the Inter-american Institute for Cooperation in Agriculture, **IICA**, provides logistic support. **CRIN's** Member countries are: Belize, Jamaica, Cuba, Haiti, Dominican Republic, Trinidad & Tobago, Guyana, and Suriname.

The objectives of the Caribbean Rice Improvement Network are:

- To support national rice research programs.
- To stimulate collaborative research.
- To facilitate technology transfer amongst member countries.
- To ensure support and collaboration of international agricultural research centers.

The objective of present report is to summarize the different research and support activities developed by **CRIN** from 1986 to mid 1992 in coordination with the research, lecturers and extension personnel of its 8 member Countries, **CIAT** Rice, Training and Communication Programs and Seed Unit, and **INGER.**

1/ Project mostly financed by **ACDI** and implemented by **CIAT** in 8 Caribbean Countries.
2/ **CRIN**-Coordinator.

II. BACKGROUND

In 1983 a meeting was held in Port of Spain, Trinidad & Tobago by the Permanent Secretaries and Agricultural Research Directors of the member Countries of the Caribbean Cooperation and Development Committee (CCDC). The recommendations made suggested that a Network be created to facilitate regional cooperation in areas of common interest in rice research. The guidelines for the creation and development of the Network and its objectives resulted from a workshop on the Caribbean Cooperative Rice Research Network, carried out in Santiago, Dominican Republic, from August 20-24, 1984.

Participants to this workshop recommended: a) The creation of a rice research network based in the Dominican Republic, b) a tentative five-year work plan, and c) the creation of the Network's Technical Advisory Committee.

2.1. Meetings of CRIN's Technical Advisory Committee

The first meeting of **CRIN**'s Technical Advisory Committee (**TAC**) was held on December 1-2, 1986 in the Dominican Republic. At this meeting, the **TAC** approved the Network's Work Plan for the term 1987-1990.

The second meeting of **CRIN**'s **TAC** was held on August 9 and 10, 1986, at **CIAT** - Colombia, coinciding thus with the VII Conference of the **IRTP** (at present **INGER**) for Latin America. In this meeting the work plan approved for 1987-1990 was re-adapted, redefining some working fields, and extending its horizon to cover the period 1991-1995.

The **TAC**'s third meeting took place from November 8 to 10, 1989 in the Dominican Republic. This time the following recommendations were approved: i) **CRIN**'s internal regulations,
ii) nomination of a projects sub-committee, iii) funding of two regional research sub-projects on "Integrated Pest Management",

proposed by Suriname,and "Evaluation of Small Farm Machinery", proposed by Jamaica.

The fourth **CRIN**'s **TAC** meeting was held on November 19 and 20, 1990 in Central University of Las Villas, Santa Clara, Cuba. At this time, the relevant recommended issues were: i) **CRIN**'s internal regulations were discussed again and finally approved, ii) **CRIN**'s Coordinator Annual Report 1990 was approved, as well as Work Plan of **CRIN** for 1991, iii) Mexico was selected as host country for the fifth **CRIN**'s **TAC** Meeting which coincided with 8th International Rice Conference of **INGER** - Latin America and iv) Recommended the topics to be included in **CRIN**'s Phase II, which are; Germplasm, Training, Technology Transfer, Small Farm Machinery, Milling, Women's Role in Caribbean Rice Production, Land Leveling and Water Management, Integrated Pest Management, Agrochemical Effects on the Environment and Scientific Exchange.

The fifth meeting of **CRIN**'s **TAC** took place on November 13th, 1991 in Villahermosa, Tabasco, Mexico. In this meeting the approved issues were;

i) Unanimous approval of fourth **CRIN**'s **TAC** Minute, as well as the Annual Reports 1991 of **CRIN** Coordinator, Agronomist and Economist.

ii) Dr. T. W. Carr and Miss B. Forde, Trinidad and Guyana Representatives respectively, presented the Advances Report of Integrated Pest Management Regional Subproject, currently conducted in Trinidad & Tobago (bioecological studies in Sogatodes spp., Hydrellia and survey on rice pests) and Guyana (rice blast management with resistant and susceptible varieties). Mr. J. Bhansing, Suriname Representative submitted the proposal "Towards the Development of IPM in Rice Cultivation in Suriname" with required estimated budget, indicating the availability of two rice entomologists for this activity.

iii) Mr. Ancel Williams, Jamaica Representative released a minimal report about Small Farm Machinery Evaluation Subproject, indicating that the responsible to write it was Mr. O. Gilpin, former Jamaica Representative, who did not like to share information with **CRIN**'s **TAC**.

iv) **TAC**'s member approved the **CRIN**'s Work Plan for 1992, whose development was depending on budget availability.

v) **CRIN's** Phase II (1992-1997) Components were discussed including budget requirement. A total of US$6,170,122.00 was estimated, split in US$2,859,506.00 to be supplied by funding agency, US$1,643,400.00 by **CIAT** and US$1,667,216.00 by **CRIN** member Countries. Difficulties to get the financial support were also discussed, since **CIDA** did not clearly contemplate the approval at that time, hence Country Representatives were encouraged to inform to top government authorities in order to develop common efforts with **CIAT** Director General to reach the economical support for **CRIN** Phase II.

vi) Mr. R. Huiswood, Suriname observer, mentioned about existing high probabilities of Commonwealth soon approval of the Caribbean Rice Research Institute (**CARRI**) which would include five Caribbean English speaking countries indicating that there exist strong wishes to coordinate with **CRIN** activities.

The sixth and last meeting of **CRIN**'s **TAC** was held on July 25 and 26, 1992 at **NARI** of Guyana, which was attended by Dr. Gustavo Nores, **CIAT**'s Director General which had an active participation.

Minutes of 1992 (5^{th} **CRIN**'s **TAC** Meeting, 1991) were read, discussed and ammended. **CRIN**'s Coordinator presented the "Progress Semestral Report (January to June, 1992) of **CRIN**'s Activities" as well as the "Summary Report of **CRIN** Research and Support Activities to its Member Countries from 1986 to June 1992". both were unanimously approved.

A **CRIN**'s Transfer Phase Project issued by **CIAT** Rice Program and **CIAT**'s General Director, was fully discussed and ammendments were recommended. Among the conclusions and recommendations issued are:

i) To request the support of **CIAT** for the preparation of two project proposals for funding, to be requested to **CIDA** (shor term) and EEC (long term) through appropriate chennels.

ii) **CRIN**'s **TAC** requested **CIAT** to be the Executive Agency of the Projects.

iii) The Project Proposal "Transfer of **CRIN**" was analyzed and modified some paragraphs accordingly.

iv) The network headquarters (NH) was discussed and recommended to move it from Dominican Republic to Guyana, starting Phase II. Additionally, it was agreed to move the headquarters every 4 to 5 years from one country to another one; after **TAC** analyze if this is fully necessary, since additional marginal costs are involved.

v) It was approved to shift the **TAC** to Steering Committee, since this body is advising and executing, and also enlarge it, including to **CARICOM**-Secretariat (Observer), **IICA** (Observer) and **CARDI** as member.

vi) It was recommended to published the Highligths of **CRIN** (1986-1992) based upon the "Summary Report of **CRIN** Research and Support Activities to Its 8 Member Countries, from 1986 to June 1992", presented before **TAC** by **CRIN**'s Coordinator.

vii) The **TAC** of **CRIN** extended a gratitude and appreciation to the Coordinator (Dr. J. L. Armenta) and Staff of **CRIN** by the excellent services given in their functions.

III. CRIN'S RESEARCH AND SUPPORT ACTIVITIES

CRIN's main technical activities are; i) Germplasm Management, ii) Training, iii) Technology Transfer, iv) Support to Research Subprojects Funded by **CRIN** and Caribbean Countries, v) Collaborative Research and vi) Surveys of Technological Constraints and vii) Other Supports.

3.1. Germplasm Management

In Table 1 can be observed the three main rice production ecosystems and specific identified problems of the 8 Member Countries of **CRIN**. According to this, on yearly basis, **CRIN's** headquarters used to ship different types of observational nurseries (Table 2) which were coded as set numbers.

A total of 6102 lines and varieties were evaluated from 1986 to 1992, and selected 1639 (Table 3) which were shipped in 154 different sets to the Caribbean Countries.

3.1.1. Results

3.1.1.1. Yield trial

The practical results of these efforts are; in 1990 **CEDIA** (Rice Research Center) of Dominican Republic released to rice farmers the variety Juma 64 whose pedigree is P3831F_3-RD38-8-1M-J182 and parents are 5730//7152/Costa Rica. This line variety was selected after intensive regional testing in 4 different locations of D. R. A Summary of yield potencial and other agronomic characteristic are observed in Tables 4 and 5.

Table 1. Rice Production Ecosystems in the Caribbean.

Ecosystems and Requirements	Country
IRRIGATED	
Sub-ecosystem 1: Fav. temp., fertile soils. Problems: Fungal dis., Hb-Sog.	Belize, Cuba, Jamaica, Guyana Dominican Rep., Trinidad & Tobago, Surinam.
Sub-ecosystem 2: Fav. temp., Mod. acid soils. Problems: Fe tox., fungal dis. Hb-Sog.	Belize, Dominican Rep., Trinidad & Tobago, Surinam, Haiti.
Sub-ecosystem 3: Unfav. temp. fertile/acid soils. Problems: Low temp., fungal dis. Hb-Sog.	Cuba, Jamaica, Guyana, Haiti, Dominican Rep., Trinidad & Tobago, Surinam.
Sub-ecosystem 4: Fav. temp. neutral/alkaline soils. Problems: Salinity, fungal dis., Hb-Sog.	Cuba, Jamaica, Guyana, Haiti, Dominican Rep., Trinidad & Tobago, Surinam.
Sub-ecosystem 5: fav. temp., organic soils. Problems: Nutritional, fungal dis., Hb-Sog.	Jamaica, Dominican Rep., Trinidad & Tobago.
RAINFED	
Favorable temp., fertile-mod. fertile soils. Problems: Fungal dis., moderate drought.	Jamaica, Dominican Rep.,Trinidad.
UPLAND	
Sub-ecosystem 1: Mod. fav. upland. Problems: Fungal dis., moderate drought.	Belize, Haiti, Guyana, Trinidad.
Sub-ecosystem 2: Acid soils (savana). Problems: Nutritional, Al tox. defic. of P, Mn, fungal dis., Hb-Sog.	Belize, Guyana.
Sub-ecosystem 3: Traditional (Subsistence). Problems: Fungal dis., Hb-Sog. Defic. N,P,K, moderate drought.	Belize, Haiti, Dominican Rep., Trinidad & Tobago.

_1/ Approved by the Caribbean Network Technical Advisory Committee.

Table 2. Germplasm Commonly Shipped to CRIN Member Countries During the Period of 1987-1992.

Country	Set No.	Observational Nursery[1]
Belize, Cuba, Dominican Republic, Guyana, Jamaica, Haiti, Suriname Trinidad & Tobago.	1	Irrigated set. Tol: fungal diseases, Fe Tox, Hb-Sog. Cycle 110-120 days.
Cuba, Dominican Republic.	2	Irrigated set. Tol: Low Temp., fungal diseases, Hb-Sog. Cycle 110-120 days.
Cuba, Dominican Republic, Guyana, Haiti, Jamaica, Suriname, Trinidad & Tobago,	3	Irrigated set. Tol: Salinity, fungal diseases Hb-Sog. Cycle 110-120 days.
Dominican Republic, Jamaica, Trinidad & Tobago.	4	Irrigated set. Tol: organic soils, fungal diseases, Hb-Sog. Cycle 110-120 days.
Dominican Republic, Haiti, Guyana, Jamaica, Trinidad & Tobago.	5	Rainfed set. Tol fungal diseases, Hb-Sog., submergence. Cycle 120-140 days.
Belize, Cuba, Dominican Republic, Haiti, Guyana, Trinidad & Tobago.	6	Mod. Fav. and traditional upland set. Intermediate and vigorous varieties. Tol. fungal diseases, Hb-Sog., moderate drought. Cycle 120-140 days.
Belize, Guyana.	7 6	Upland set. Acid soils, Tol: P Def., Mn and Al tox., fungal diseases, Hb-Vector, 120-130 days growth duration.

1) Each set of materials with long grains, good milling and cooking quality (amylose contents to intermediate to high).

Table 3. Evaluated and Selected and Shipped Germplasm to CRIN Member Countries, from 1986 to 1992.

Nurseries[1]	Origin	1986		1987		1988		1989		1990		1991		1992		Total	
		E[2]	S[3]	E	S	E	S	E	S	E	S	E	S	E	S	E	S
VIOAL	CIAT	318	177	189	36	-	-	-	-	363	64	-	-	-	-	870	277
VIOAL-ACID SOILS	CIAT	-	-	26	13	52	2	-	-	-	-	-	-	-	-	78	15
VIOAL-IRRIGATED-ARID	CIAT	-	-	-	-	138	63	-	-	-	-	-	-	-	-	138	63
VIOAL-IRRIGATED-FAVORED UPLAND	CIAT	-	-	-	-	107	31	-	-	-	-	-	-	-	-	107	31
VIOAL-IRRIGATED-TOL. FUNG. DIS.	CIAT	-	-	-	-	96	39	-	-	-	-	-	-	-	-	96	39
IRSATON	IRRI	64	14	81	21	98	41	75	41	44	12	43	0	-	-	405	129
IRON (VE, E, M)	IRRI	184	17	180	40	205	40	189	59	315	38	170	4	-	-	1243	198
LOW TEMPERATURE	CIAT	-	-	62	0	-	-	-	-	200	30	-	-	-	-	262	30
IRSWON	IRRI	-	-	90	7	-	-	-	15	-	-	-	-	-	-	90	7
IRCTN	IRRI	-	-	63	4	-	-	75	-	-	-	79	10	-	-	217	29
ANTHER CULTURE	IRRI	-	-	29	10	-	-	-	-	-	-	-	-	-	-	29	10
IMPROVED LINES	CIAT	-	-	13	12	-	-	-	-	-	-	86	0	-	-	99	12
COMMERCIAL VARIETIES	CUBA	-	-	5	5	-	-	-	-	-	-	-	-	-	-	5	5
COMMERCIAL VARIETIES	MEXICO	-	-	2	2	-	-	-	-	-	-	-	-	-	-	2	2
COMMERCIAL VARIETIES	TAIWAN	-	-	2	2	-	-	-	-	-	-	-	-	-	-	2	2
IURON	IRRI	-	-	-	-	97	23	89	26	85	10	95	0	-	-	366	59
CARIBBEAN LINES	CIAT	-	-	-	-			239	131	-	-	-	-	-	-	239	131
COMMERCIAL VARIETIES	CIAT	-	-	-	-			120	74	-	-	-	-	-	-	120	74
LINES CEVACU PROGRAM	MEXICO	-	-	-	-			-	-	132	148	118	18	-	-	250	166
LINES IIA PROGRAM	CUBA	-	-	-	-	-	-	-	-	103	51	-	-	-	-	103	51
NARI LINES	GUYANA	-	-	-	-	-	-	-	-	-	-	17	8	-	-	17	8
MDP LINES	JAMAICA	-	-	-	-	-	-	-	-	-	-	1	0	-	-	1	0
IRAT VARS.	FRANCE	-	-	-	-	-	-	-	-	-	-	2	2	-	-	2	2
WORKSHOP-CIAT-90	CIAT	-	-	-	-	-	-	-	-	-	-	209	39	-	-	209	39
WORKSHOP-CUBA-90	CUBA	-	-	-	-	-	-	-	-	-	-	459	53	-	-	459	53
SAVANNA-CIAT	CIAT	-	-	-	-	-	-	-	-	-	-	32	28	-	-	32	28
WORKSHOP-CIAT-91	MEXICO	-	-	-	-	-	-	-	-	-	-	-	-	736	193	736	193
TOTAL		566	208	742	152	793	239	787	346	1242	353	1311	162	736	193	6102	1639

1/ IURON: INTERNATIONAL UPLAND RICE OBSERVATIONAL NURSERY
VIOAL: VIVERO INTERNACIONAL DE OBSERVACION PARA AMERICA LATINA
IRSATON: INTERNATIONAL RICE SALINITY + ALKALINITY TOLERANCE OBSERVATIONAL NURSERY
IRON: (VE, E, M) INTERNATIONAL RICE OBSERVATIONAL NURSERY, VERY EARLY AND MEDIUM GROWTH DURATION
IRSWON: INTERNATIONAL RAINFED RICE SHALLOW WATER OBSERVATIONAL NURSERY
IRCTN: INTERNATIONAL RICE COLD TOLERANCE NURSERY

2/ Evaluated 3/ Selected

Table 4. Main Agronomic Characteristics of 15 Lines and Varieties Tested in a Regional Trial. Juma, Bonao 2nd Sem. 1988.

Order number	Variety number	Designation	Days to maturity	Yield[1] (kg/ha)	Lodging resist	WC[2]	Milling recovery (%)
1	1	P3831F3-RH38-8-1M-J182	144	7678a	MR	0.3	65
2	3	P4729F2-30-1-J2	134	6925ab	S	2.5	41
3	2	P4729F2-2-2-J198	142	6891ab	S	0.4	56
4	6	J295-104-1-1-1-7	146	6698ab	R	2.5	57
5	12	JUMA 58 (CHECK)	149	6617ab	R	1.1	60
6	11	JUMA 57 (CHECK)	148	6572ab	R	1.6	55
7	4	P4729F2-30-1-J92	134	6570ab	S	1.5	43
8	8	P3059F4-25-3	134	6542bc	MR	1.2	45
9	15	ISA 40 (CHECK)	142	6483bc	S	1.0	48
10	5	P4743F2-65-1-J230	138	6002bc	S	1.0	54
11	9	P3790F4-13-1B	139	5952bc	MR	0.9	57
12	14	JUMA 62 (CHECK)	131	5915	R	1.5	25
13	7	J292-39-1-2-1-3	136	5898bcd	MS	2.8	53
14	13	JUMA 61 (CHECK)	134	5417cd	R	1.3	50
15	10	J297-72-1-1-1-1	139	4767d	S	3.1	38

LSD (5%) = 1114 kg
C.V. = 10.5%
1/ Data follwed by a common letter are not statistically different at 5% p-level.
2/ WC: White Center

Table 5. **Average Yield in 4 Locations of 15 Lines and Varieties, in Dominican Republic. 2^{nd} Sem. 1988[1].**

Order number	Variety number	Designation	Yield[1] (kg/ha)
1	12	JUMA 58 (CHECK)	7070a
2	11	JUMA 57 (CHECK)	6845ab
3	1	P3831F3-RH38-8-1M-J182	6581AB
4	6	J295-104-1-1-1-7	6500ab
5	9	P3790F4-13-1B	6267abc
6	15	ISA 40 (CHECK)	6239abc
7	2	P4729F2-2-2-J198	6227abc
8	4	P4729F2-30-1-J92	6165abc
9	3	P4729F2-30-1-J2	6110abc
10	14	JUMA 62 (CHECK)	5960bc
11	5	P4743F2-65-1-J230	5818bc
12	10	J297-72-1-1-1-1	5632c
13	8	P3059F4-25-3	5579c
14	13	JUMA 61 (CHECK)	5395c
15	7	J292-39-1-2-1-3	5300c

LSD = 1078 kg
C.V. = 9.74%

1/ Evaluations:
a) El Pozo, Nagua
b) Cruce de Esperanza, Mao
c) Juma, Bonao
d) San Juan de la Maguana

1/ Data followed by the same letter are not significantly different at 5% p-level.

3.1.1.2 Planting dates.

A planting dates complementary study was also practiced which included to Juma 57, Juma 58, Tanioka and Juma 64 varieties it started on August 30, 1989 and ended on July 27, 1990. Twenty three planting dates data were gathered and analized.

Table 6 shows a highly significant difference in characters such as yield and days to flowering among different planting dates and varieties. A significant interaction of planting date and varieties shows that the performance of varieties varies according to planting date.

Table 6. Analysis of Variance of the Study on Planting Dates of 4 Varieties. Juma, Dominican Republic, 1989-90.

Source of variation		Calculated F value	
	DF	Yield	Flowering
Planting date	22	11.11 **	62.94 **
Replication (Trial)	46	1.49	2.37
Varieties	3	98.19 **	580.40 **
Planting date x variety	65	3.16 **	9.71 **

** Statistically significant at 1%

According to Duncan's test, grain yield of varieties JUMA 64, CICA 8 and JUMA 57 were in the highest significant statistical group in 14, 8 and 1 of all 23 planting dates, respectively (Table 7). Variety TANIOKA showed lower yield potential than the remaining 3 varieties in all 23 planting dates. In comparing average yield of the 4 varieties during the 23 planting dates, the highest yield corresponded to JUMA 64 (5790 kg/ha), followed by CICA 8 (5580 kg/ha), JUMA 57 (4761 kg/ha), and TANIOKA (4476 kg/ha). The general average yield of JUMA 64 was statistically higher than that of JUMA 57 and TANIOKA, but the same as that of CICA 8.

Table 7 and Figure 1 show that the highest yielding planting season during various consecutive planting dates was from February 22 to June 12, 1990 (from 13th to 20th planting) for varieties JUMA

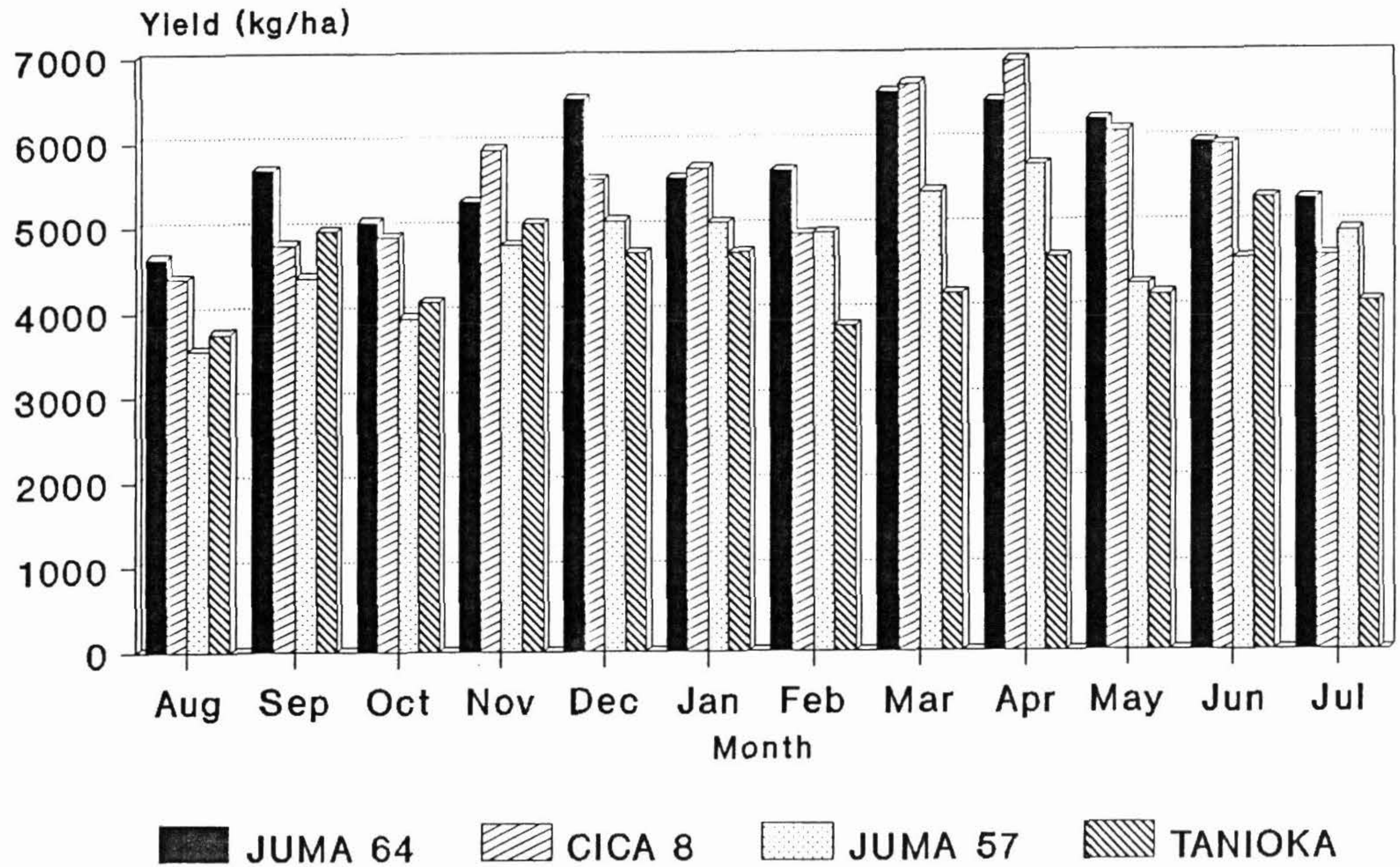
Table 7. Yield of 4 Rice Varieties in 23 Planting Dates. Juma, Bonao, Dominican Republic, 1989-90.

Trial	Planting date (D/M/Y)	Yield per variety (kg/ha)[1]			
		JUMA 64[2]	CICA 8	JUMA 57	TANIOKA
1	30-08-89	4636 a	4405 ab	3552 b	3758 ab
2	14-09-89	5749 a	4683 b	4288 b	4848 b
3	28-09-89	5600 a	4907 ab	4533 b	5067 ab
4	12-10-89	5823 a	5040 b	3787 c	4747 b
5	27-10-89	4304 ab	4725 a	4069 ab	3493 b
6	10-11-89	4883 b	6384 a	5257 b	5332 b
7	24-11-89	5707 a	5440 ab	4320 c	4747 bc
8	08-12-89	5600 a	4675 b	3963 b	4382 b
9	22-12-89	7397 a	6437 ab	6165 b	4987 c
10	06-01-90	5600 a	5621 a	5125 a	5291 a
11	21-01-90	5523 ab	5749 a	4955 ab	4091 b
12	07-02-90	4223 a	3947 a	4213 a	3328 a
13	22-02-90	7088 a	5856 ab	5616 ab	4320 b
14	09-03-90	6411 a	6107 a	5723 a	4011 b
15	27-03-90	6736 a	7221 a	5051 b	4368 b
16	09-04-90	6299 ab	6567 a	5605 b	4069 c
17	24-04-90	6624 ab	7301 a	5808 b	5157 c
18	11-05-90	6304 a	6155 a	3856 b	3941 b
19	28-05-90	6160 a	6037 a	4716 b	4395 b
20	12-06-90	6014 a	6278 a	4811 b	5278 b
21	27-06-90	5920 a	5587 a	4363 b	5307 a
22	12-07-90	5894 a	4922 ab	4722 ab	4111 b
23	27-07-90	4678 a	4306 a	5089 a	4044 a
	Average	5790 a	5580 ab	4761 bc	4476 c

1/ On the same line, data followed by the same letter are not statistically different, according to Duncan's Test at 5%.

2/ Line P3831F3-RH38-8-1M-J182 was released by CEDIA in Dominican Republic as variety Juma 64.

Figure 1. Average yield of 4 rice varieties planted during 12 months. Juma, Dominican Republic, 1989-1990.



64 and CICA 8. As to JUMA 57, a consistent yield was observed between February 22 (planting No.13) and April 24 (planting No.17). In regards to TANIOKA, a better yield was observed between November 24 (planting 7) and January 6 (10th planting), as well as between May 28 (19th planting) and June 27 (21st planting).

Figure 2 shows the number of days from planting to flowering of the 4 varieties evaluated. This data show that variety JUMA 57 has longer vegetative cycle than the other varieties. It is observed also that the cycle of all varieties was longer for plantings carried out from December 1989 to early April 1990 (from 8th to 16th planting).

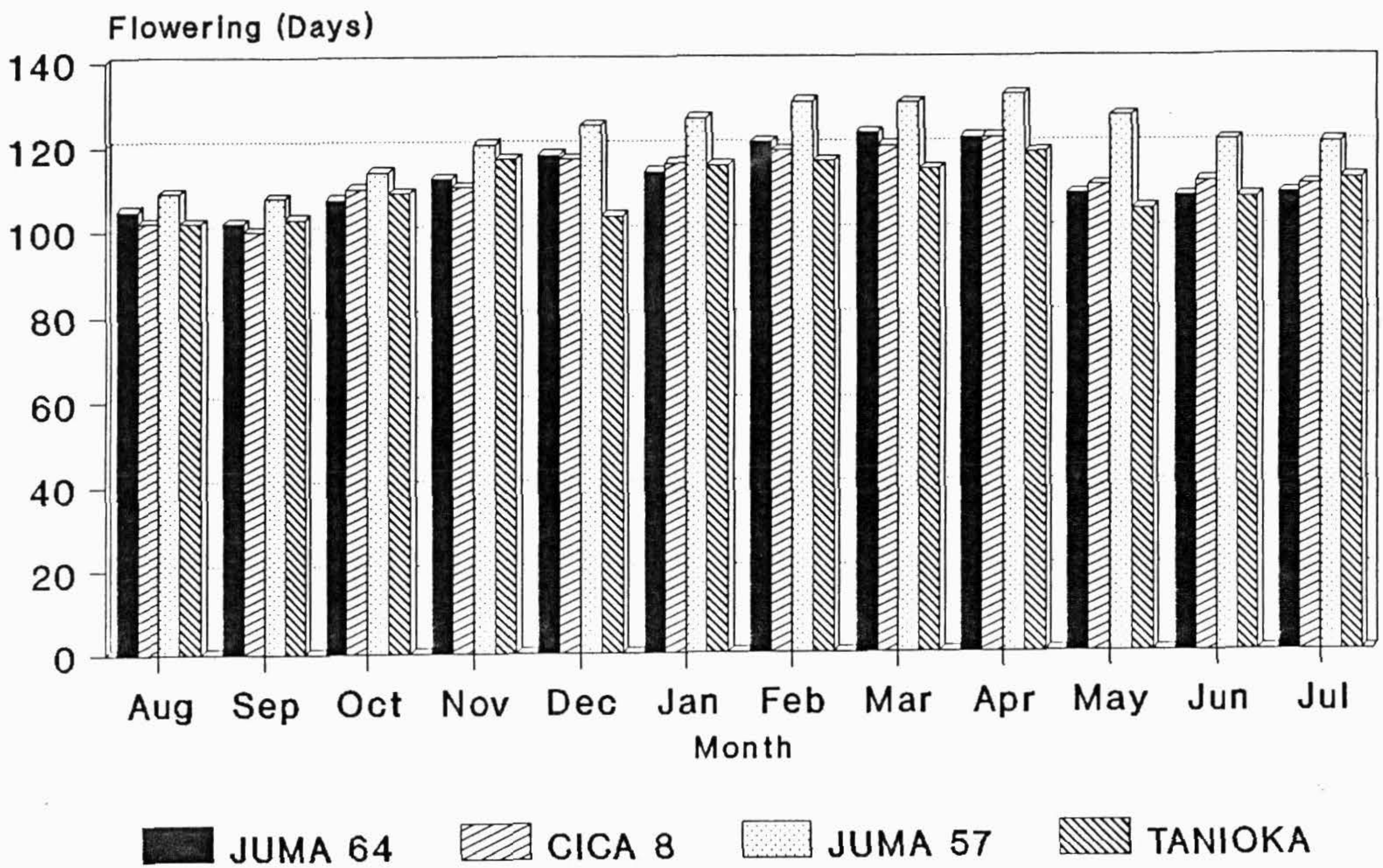
3.1.1.3. Other released varieties

Belize also released their own variety named as **CARDI** 70 (P2053F4-26-4-6//P1897-15-1-4-1-B/Metica 1), as well as Jamaica whose varieties are; No. 2 (Suakoko/Ceysvoni), DR35 and T3299. Trinidad & Tobago farmers are mostly planting ORYZICA 3 and CICA 8. Campeche A80 was identified as suitable for moderately favored upland. In 1992 Guyana, released the variety IR 44624 which is resistant to blast and is long grain with high head rice recovery. In short future is expected to replace to RUSTIC variety (most popular one) since this is very susceptible to blast. Cuba, Suriname Dominican Republic and Guyana Rice Programs have also commonly used **CRIN** germplasm as parents to develop their own lines, which in short future will also be farmer's varieties.

3.1.1.4. Workshops

As a component of this chapter, **CRIN** organized two "Workshops of Germplasm Evaluation and Selection", the first one in 1989 in Dominican Republic and the second one in Cuba, in 1990, where all rice breeders of its member Countries participated. The advantages of this event are; research personnel have the opportunity to exchange experiences, rice lines selections are personally made according to their own needs (appropriate ecosystems) and the young

Figure 2. Days to flowering of 4 rice varieties during 12 months. Juma, Dominican Republic, 1989-1990.



ones learn modern criteria about selection.

In 1991 Caribbean breeders joined to the Workshop of Germplasm Evaluation and Selection organized by **INGER** in Mexico, doing selections in semi-arid and humid tropic ecosystems. The selected germplasm (736) was planted in D. R. on early 1992 and selected 193 lines which will be shipped to **CRIN** member countries on early 1993.

3.2. Training

3.2.1. In Country Courses

Table 8 shows the evaluation of training in number and type of courses and workshops given to Caribbean rice scientists and technicians. Thirty (30) agricultural scientists and technicians were trained in 1987, 47 in 1988, 118 in 1989, 81 in 1990, 19 in 1991 and 1 in 1992, for a total of 296 in 5 and a half years.

3.2.1.1. Cascade Training

Considering the importance of developing methodologies for technology transfer; in 1987 **CRIN** financially supported one course about rice production technology in Dominican Republic (D.R.). However, in mid-1988 began steady efforts to develop a Subproject named "Cascade Training" whose main objectives were; i) To develop training methodologies in order to apply them later on the other **CRIN** member Countries, ii) To promote self sufficiency in human resources with a good knowledge level in rice technology production, as well as methodological tools about communication and organization, that allow them to train to other technicians and rice farmers of different rice growing ecosystems.

This activity was started with the support of the Rice Program and the Training and Scientific Communication Program of **CIAT**, **IICA**, **CENACA** (National Training Center), Rice Extension (Fomento), **CEDIA** (Rice Research Center) and the Chinese Technical Mission in the Dominican Republic, which consisted on organizing courses on "Modern Technology" for Rice Production and Workshops on

Table 8. Training of scientific personnel of CRIN member countries from 1987 to mid 1992.

ACTIVITIES/COUNTRIES	Number of participants														TOTAL
	1987	1988	1989						1990			1991		1992	
IN-COUNTRY COURSES															240
Dominican Republic	15[a]	21[a]	24[a]	15[c]	24[a]	113[c]		12[e]	18[a]	18[c]					
Haiti	2[a]	2[a]	1[a]	1[c]	2[a]	3[c]	6[d]	1[e]			27[f]	3[d]	2[g]		
Cuba	2[a]	2[a]	1[a]	1[c]											
Trinidad & Tobago			1[a]	1[c]				1[e]							
Belize								1[e]	1[a]	1[c]					
Guyana								1[e]							
Suriname								1[e]							
Guyana		13[b]													
Belize		1[b]													
Haiti		1[b]													
Trinidad & Tobago		1[b]													
IN-SERVICE COURSES															56
CIAT															
Rice Program	7	3			1				10[h]	1	3	1		1	
Seed Unit	1	2			1					1		10[i]			
Agricultural Economy					1										
Agronomy (Espec. Stage)					1										
Data Systematizatión					1										
Thesis (Post-Graduate)												1			
IRRI															
Thesis (Post-Graduate)	1														
Productión System	1														
International Conference	1				1										
Technology Transfer					1										
Agricultural Engineering					1					1		1			
Irrigation Water Management												1			
PROVARZEAS (BRAZIL)		1													
TOTAL	30	47	118						81			19		1	296

a/ Course on Technology, for Irrigated Rice Prouction held in Dominican Republic.
b/ Course on Seed Production Technology, held in Guyana.
c/ Workshop Training for Trainers, held in Dominican Republic.
d/ In-Service Course on Seed Production Technology, held in Dominican Republic.
e/ Caribbean Workshop-course on Rice Seed Production Technology, held in Dominican Republic.
f/ Course on Irrigated Rice Production, held in Haiti.
g/ In Service Course on Small Farm Machinery Fabrication, held in Dominican Republic.
h/ Rice Trainers Perfectioning Course
i/ Caribbean Workshop-Course on Development Sytems for Seed Production and Processing at Small Enterprise Level

Training to Trainers". These training activities were mainly attended by rice technicians of the Dominican Republic, and selected technicians from Haití, Trinidad & Tobago, Belize and Cuba.

The sequence of implemented activities of the above subproject is as follows:

i) In September - October 1988, 21 agricultural extensionist who work in the generation and transfer of technology in the main growing areas of the Dominican Republic, as well as two from Haiti and two from Cuba took part in the "First International Course on Technology, for Irrigated Rice Production".

ii) The "II International Course on Technology, for Irrigated Rice Production was held on April 2 to 29, 1989, which was attended by 24 agricultural professionals of the Dominican Republic, one from Cuba, one from haiti, and one from Trinidad & Tobago.

Prior to the second course, selected technicians were requested to carry out surveys among rice farmers to collect informations that enable them to identify constraints to rice production, this was as a preliminary step in defining possible strategies, for solving such problems in the seminar that they would organize and develop by themselves during the course.

At the end of this activity 17 technicians were selected to integrate the training team. This team consisted of six technicians who had participated in the 1988 course, and 11 graduates of the 1989 course, including the three participants from Cuba, Haiti and Trinidad & Tobago. The relevant criteria for selection were academic improvement, leadership capacity, location of the working area and interest shown during the course.

The "First International Workshop on Training to Trainers" was implemented with the support of the Training Program and

Communication of **CIAT**, where the 17 participants in this process completed the Stage I of the training project, being trained on methodologies and techniques for developing instructional units that will enable them to train both, rice technicians and farmers.

iii) Stage II of the project was started with the accomplishment of the "III International Course on Technology, for Irrigated Rice Production" from October 23 to 28, 1989. This course was attended 24 technicians from the Dominican Republic and 2 from Haiti. This activity had the difference that five technicians graduated in the First Workshop on Training for Trainers were selected to work as co-instructors. Sixteen (16) technicians out of the group 26 were selected to take part in the "II International Workshop on Training to Trainers", carried out from October 30 to November 3, 1989.

The five co-instructores joined the group and acted as advisors-technical consultants of five working groups which then elaborated instructional units related to the different aspects of the modern technological process of rice production. Co-instructors were supervised by Trainers of **CIAT** and **CRIN**.

iv) The III stage of the Cascade Training Subproject included the accomplishment of the "IV International Course on Technology, for Irrigated Rice Production from March 8 to 17, 1990, and the "III International Workshop on Training to Trainers" from March 19 to 24, 1990. Both activities were attended by 19 technicians, 18 from the Dominican Republic and one from Belize.

Ten graduates of the previous courses on "rice production and workshops on training to trainers" sponsored by **CRIN** attended the international course as instructors. Each of them was responsible for the total organization, production of written materials, and presentation of the conferences on different technological aspects involved in rice production, such as: land preparation, sowing, crop protection and harvest.

During the workshop on Training to Trainers, the 10 instructors became advisors of four working groups, which were conformed for the elaboration of instructional units related to the technological sequence for rice production. For a better result, these instructors were supervised by experienced trainers both from **CIAT** and **CRIN**.

The experience was very benefitial in the advance and definition of methodologies on training and technology transfer, which will ease its introduction and application in other Caribbean countries.

v) The IV and final Stage of "Cascade Training" activities was implemented with the attendance to **CIAT** (October 8 to November 16, 1990) of 8 Dominican and 2 Haitian technicians-trainers in order to participate in a "Training to Trainers" course. The objectives of this activity were:

a) To increase and strenthen their knowledge on rice production (agronomy and **IMP/ICM** issues), b) to enhance their knowledge and skills on bibliography search, c) to perfect the teaching materials for training, previously prepared in other courses and workshops, and d) develop a national training and technology transfer project, to be presented to government authorities of their own countries.

3.2.1.1.1. Results

3.2.1.1.1.1. On November 1990 was terminated the first phase of this Cascade Training Subproject in Dominican Republic, and in same year was extended to Haiti. The activities developed in a 2.5 year period were; six (6) Courses about Modern Rice Production Technology, three (3) Workshops of Training to Trainers, all these at D.R. and Haiti and one (1) Special Training in Communication and

Advanced Rice Production Technology at **CIAT**-Colombia. The technicians trained were 171 from D. R., Haiti, Trinidad & Tobago and Belize (Table 9).

3.2.1.1.1.2. Trained technicians organized by themselves, short practical courses about rice production technology in Laguna Nisibón (D.R. Eastern Region) as well as Course-workshop about plot development (straight levees, and pool leveling with small farm machinery or horses) in Nagua (D.R. North-east), these activities were addressed to rice extensionists.

3.2.1.1.1.3. Demonstration Plots were established by trained technicians in Limón del Yuna, Angelina, La Amarga, Laguna Nisibón, Rincón and Jumunucu-La Vega, Juma, in D. R. where a number of field days were organized and addressed to extensionists, bank and land reform officers and rice farmers.

3.2.1.1.1.4. Eight different "Learning Units" as Components of Manual of Training in Rice Production Technology were developed, in order to use it as support to training activities in D. R. whose titles are:

- Plot Development and Land Preparation for Rice Production.
- Growth and Development Stages of Rice Plant.
- Seeding Methods of Rice.
- Rice Certified Seed Production.
- Fertilization of Rice Crop.
- Integrated Management of Rice Insect-Pests.
- Rice Diseases Management.
- Integrated Control of Weeds

3.2.1.1.1.5. High impact on rice yield was generated in technically assisted rice farmers by trained technicians. In Table 9 can be observed that North-east rice growers increased their yield in 53.5% and the ones from East in 38.1%, on the average, this was due to technical assistance services received.

Table 9. Farms in the Dominican Republic benefitting from technical assistance provided by CRIN-Trained technicians, 1989. (Cascade Training Project)

Region	Number of farmers	Average yield (kg/ha)	Average yield increase (%)
North-east	13	7,676	53.5
East	11	5,889	38.1

3.2.1.1.1.6. Based upon former experiences, the Ministry of Agriculture of D. R. developed a Project of Training and Technology Transfer for Eastern Region, which is going to be financially supported by the Ministry and a private Agricultural Development Foundation with the aim of promoting social and economical development in the region.

3.2.2. Other Courses

Additionally five (5) "In-Country and In-Service Courses", were organized, two (2) Courses-Workshops of Rice Seed Production (Guyana, 1988; Dominican Republic, 1989) with regional participation, and two (2) local (D.R.) Courses about Irrigated Rice Seed Production Technology addressed to Haitian technicians. In 1991 at **CIAT** Seed Unit a Regional Workshop-Course on Development Systems for Seed Production and Processing at Small Enterprises Level was addressed to English & French Speaking **CRIN** member Countries. Other courses offered at **CIAT** Rice Program (Colombia), **IRRI** (Philippines) and Brazil were also attended in different years by Caribbean scientists for a total of 296 (Table 8).

3.3. Technology Transfer

In Coordination with D. R. local institutions, rice production technologies developed by **CEDIA** (National Rice Research Center), **IRRC**'s and some technology modifications done by **CRIN** were, validated.

The objective of this activity was to validate technologies developed by **CEDIA** (National Rice Research Center), International Agricultural Research centers, and technology modifications done by **CRIN**. Working sites were; Juma (Club 2000 year Association), Juma-Caracol, Limón del Yuna and Los Barros Communities.

The main technological components applied were: i) Plot development (straight levees and pool leveling), with Yanmar and PT-3 (**IRRI** design) Powertillers, to which a special leveler was adapted being developed by **CRIN** personnel, as well as a couple of oxes; ii) Chemical control was used with preemergent herbicides [Butachlor (5.0 l/ha) or Pendhimetalin (4.0 l/ha) or Oxifluorfen (1.0 to 2.0 l/ha)]; whereas a mixture of Propanil and 2,4-D was used in post-emergence (8.0+1.0) l/ha or a tree way combination of Butachlor + Propanil + 2,4-D (4.0 + 6.0 - 8.0 + 0.3 - 0.5) l/ha; iii) NPK fertilization formula (100 to 120 - 40 - 40) split in three applications, using Urea and Triple 15-15-15 as main sources of N, and P and K, respectively; iv) Seeding rates used were 80 to 120 kg/ha for direct sowing with pregerminated seeds and 48 to 72 kg/ha for mechanized transplanting.

3.3.1. Results.

3.3.1.1. Club Año 2000 Association, 1988.

In 1988 **CRIN** in Coordination with **CEDIA** and **DFA** selected 10 farms of 3.0 ha each, with the aim to validate available rice production technologies and adapt the suitable ones to local farmers. In 6 (six) of the farms seed was broadcasted (101 kg/ha) and in the other 4 (four) mechanized transplanting was practiced.

Data of Table 10 shows that yield increased in 231 kg/ha (4%) in broadcast, and 2425 kg/ha (52.3%) in mechanized transplanting. In both planting methods -broadcast and mechanized transplanting - production costs-were reduced in 18% and 19% respectively.

Table 10. Economic Analysis of Production of Farms in which CEDIA/CRIN Technology was Applied. Dominican Republic, 1989 (Club Año 2000)

Concept	Average yield of last 3 crops	Yield (kg/ha)	Production cost/ha (RD$)[a]	Net income/ha (RD$)[b]	B/C Rate
Average _c/	5,602	6,418	3,471.39 (595.76)	2,932.81 (467.09)	1.78
Broadcast	5,758	5,989	3,857.38 (614.23)	2,371.35 (377.60)	1.61
Mechanized Transplanting	4,635	7,060	3,567.41 (568.06)	3,774.99 (601.11)	2.06

a/ Figures in parentheses are the equivalent in U.S. dollars US$1.00 = RD$6.28
b/ Average figures for 10 farmers, Club Año 2000
c/ Price/kg of Paddy = RD$1.04

The average net income of each farmer was of RD$2,932.88 (US$467.09) per hectare with an average benefit/cost rate of 1.78. In comparing the two sowing systems, broadcast seed produced a net benefit per hectare of RD$2,371.35 (US$377.60), being surpassed by mechanized transplanting, which produced RD$3,774.99 (US$601.11). The benefit/cost rate was of 1.61 and 2.06 for broadcast and mechanized transplanting, respectively. This indicates that the latter was more efficient than broadcast in reducing costs and increasing production.

3.3.1.2. Juma-Caracol, 1989

CEDIA/CRIN technology impact over the yield can be observed in Table 11, which was applied in a rice farmer plot; the check plot (farmer) yield was 3939 kg/ha and **CEDIA/CRIN** one's was 8560 kg/ha. Net income in both cases was US$70.9/ha and US$1861.2/ha, respectively; differences in price sales did more remarkable the difference in income. After this positive experience, new farmers joined to this activity following year.

Table 11. Economic analysis on production of farms in which CEDIA/CRIN technology was applied, Juma-Caracol project, Dominican Republic, 1989.

Technology	Yield (kg/ha)	Production cost (RD$/ha)	Net income (RD$/ha)[b]	Benefit/Cost Ratio
Farmer	3,939	3,139.0 (499.8)[a]	495.50 (70.9)[a]	1.1
CEDIA/CRIN	8,560	5,003.7 (796.7)[a]	11,688.3 (1,861.2)[a]	3.3

a/ Figures in parenthesis are the equivalent in U.S. dollars.
b/ Price/kg of Paddy = RD$0.91 (Farmer) and RD$1.95 (CEDIA/CRIN) due to price market variations.

3.3.1.3. Juma-Caracol and Los Barros, 1990

In Table 12 can be observed harvested yield by 4 rice farmers benefitted with advanced technology during first semester 1990, which had a rank of 6122 kg/ha to 7482 kg/ha. Net income per hectare of farmers Almonte, Martínez, Cruz y Frías was of US$927.76, US$1,316.38, US$758.93 and US$1,298.34, respectively, with its correspondent high benefit/cost ratio (B/C) of 1.85, 2.22, 1.65 and 2.48, respectively.

3.3.1.4. Juma-Caracol and Barraquito-Limón del Yuna, 1990

Data of 1990 second semester (Table 13) show yields in a rank of 4401 kg/ha (Frías) to 6112 kg/ha (Ventura) with net incomes per hectare of US$766.01, US$471.23, US$549.65, and US$747.42, for farmers Martínez, Cruz, Frías and Ventura, respectively, which had a B/C ratio in rank of 1.61 to 2.18. It's convenient to mention that during second semester yield goes down due to solar radiation is affected by cloudness, as well as lesser light-hours due to season changes, as compared to first semester.

Table 12. Economic analysis on production of technology transfer farms of Dominican Republic. First semester, 1990.

Farmer	Yield (kg/ha)	Sale[c] price (RD$/kg)	Gross income (RD$/ha)	Production cost (RD$/ha)	Net income (RD$/ha)	Benefit/Cost Ratio
Fausto Almonte[a]	6,122.39	2.30 (0.33)	14,074.50 (2,019.30)	7,608.00 (1,091.54)	6,466.50 (927.76)	1.85
Gilberto Martínez[b]	7,482.46	2.33 (0.32)	17,458.72 (2,391.61)	7,849.12 (1,075.22)	9,609.60 (1,316.38)	2.22
Erasmo de La Cruz[b]	6,225.28	2.25 (0.31)	14,028.25 (1,921.68)	8,488.06 (1,162.75)	5,540.19 (758.93)	1.65
Rafael Frías[b]	6,557.85	2.42 (0.33)	15,868.06 (2,173.71)	6,390.19 (875.37)	9,477.87 (1,298.34)	2.48

a/ The farm's data correspond to the first crop after land development, located in Los Barros-Bonao. Figures in parenthesis are the equivalent in U.S. Dollars, 1.00US$ = RD$6.97. (Average January - June, 1990).

b/ Data of G. Martínez, E. de La Cruz and R. Frías farms correspond to the first, second and third harvest respectively, after land development, located in Caracol-Bonao. Figures in parenthesis are the equivalent in US$ Dollars, US$1.00 = RD$7.30

c/ Paddy rice.

Table 13. Economic analysis on production of technology transfer farms. Dominican Republic. Second Semester, 1990.

Farmer	Yield (kg/ha)	Sale[c] price (RD$/kg)	Gross income (RD$/ha)	Production cost (RD$/ha)	Net income (RD$/ha)	Benefit/Cost Ratio
G. Martínez[a]	4,710.60	3.55 (0.31)	16,722.65 (1,454.14)	7,913.49 (688.13)	8,809.16 (766.01)	2.11
E. de La Cruz[a]	4,439.89	3.23 (0.28)	14,340.74 (1,247.02)	8,921.56 (775.79)	5,419.18 (471.23)	1.61
R. Frías[a]	4,401.60	3.28 (0.29)	14,434.63 (1,255.19)	8,113.60 (705.53)	6,321.03 (549.65)	1.78
F. Ventura[b]	6,112.65	2.60 (0.23)	15,892.89 (1,381.99)	7,297.51 (634.57)	8,595.38 (747.42)	2.18

a/ Data of G. Martínez, E. de La Cruz, and R. Frías farms correspond to the second, third and fourth harvest respectively, after land development, located in Caracol-Bonao. Figures in parenthesis are the equivalent in US$ dollars, US$1.00 = RD$11.50.

b/ Farm's data corresponds to the first crop after land development. Located in Barraquito - Limón del Yuna. Figures in parenthesis are the equivalent in US$ dollars, US$1.00 = RD$11.50.

c/ Paddy rice.

3.3.1.5. Juma-Caracol and Los Barros, 1991

Data of 1991 first semester (Table 14) show the steady good yields of these farmers with a rank of 5614 kg/ha (Cruz) to 7139 kg/ha (Martínez). The net income and B/C ratio for rice farmers Martínez, Cruz and Frías was, US$1283.40 (2.25) US$799.98 (1.78) and US$1289.03 (2.29), respectively, indicating that farmers are aware of derived benefits using appropriate technology.

Table 14. Economic analysis of production of three technology transfer farms in the Dominican Republic. First semester, 1991a.

Farmers[b]	Yield (kg/ha)	Price (RD$/kg)	Gross income (RD$/ha)	Production cost (RD$/ha)	Net income (RD$/ha)	Benefit/ Cost Ratio
Gilberto Martínez	7,139.80	4.04 (0.32)	28,827.65 (2,306.21)	12,785.15 (1,022.81)	16,042.50 (1,283.40)	2.25
Erasmo De La Cruz	5,614.85	4.07 (0.33)	22,875.33 (1,830.03)	12,875.65 (1,030.05)	9,999.68 (799.98)	1.78
Rafael Frías	6,945.23	4.12 (0.33)	28,631.73 (2,290.54)	12,518.90 (1,001.51)	16,112.83 (1,289.03)	2.29

a/ Data in parenthesis are the equivalent in U.S. dollars, US$1.00 = RD$12.50.
b/ Data from farms of Mssrs. Martínez, De La Cruz and R. Frías correspond to the 3th, 4th and 5th crop, respectively, after land development.

Table 15 shows the economic results of the six rice farms assisted by DFA-CRIN during the second semester of 1991. According to the data presented, Mssrs. Fabián Méndez and Gilberto Martinez had the highest yields (6513 and 6304 kg/ha, respectively), whereas the lowest was produced by Mr. Maximiliano Jorge (4808 kg/ha).

Production costs of the farmers ranged from RD$11,474.80 to RD$15,441.86. The highest cost corresponded to Mr. Martínez, and the lowest to Mr. De La Cruz. According to the benefit-cost analysis, Mssrs. Méndez and Martinez had the highest return per peso invested with RD$1.94 and RD$1.88, respectively, while Mr. Jorge had the lowest return of all six farmers (B/C ratio = 1.29).

Actually farmers who actively participated in this technology transfer activities, have satisfactorily evolutioned, technical, social and economically.

Table 15. Economic Analysis of Production of the Transfer of Technology Farms Assisted by DFA-CRIN. Second Semester, 1991[1].

Farmer	Paddy yield (kg/ha)	Sale price (RD$/kg)	Gross income (RD$/ha)	Cost of producción (RD$/ha)	Net Income (RD$/ha)	B/C Ratio
Gilberto Martínez	6,304	4.61[2] (0.37)	29,061.44 (2,324.92)	15,441.86 (1,139.35)	13,619.58 (1,185.57)	1.88
Erasmo de La Cruz	5,238	3.45 (0.28)	18,071.10 (1,445.69)	11,474.80 (917.98)	6,596.30 (527.70)	1.57
Rafael Frías	5,805	3.66 (0.29)	21,246.30 (1,699.70)	13,831.80 (1,106.54)	7,414.50 (593.16)	1.54
Dionisio Frías	5,542	3.74 (0.30)	20,727.08 (1,658.17)	13,492.06 (1,079.36)	7,235.02 (578.80)	1.54
Fabián Méndez	6,513	3.65 (0.29)	23,772.45 (1,901.80)	12,284.42 (982.75)	11,488.03 (919.04)	1.94
Maximiliano Jorge	4,808	3.61 (0.29)	17,356.88 (1,388.55)	13,495.00 (1,079.60)	(3,861.88) (308.95)	1.29

1/ Figures in parenthesis are the equivalent in U.S. dollars, US$1.00 = RD$12.50
2/ Mr. Gilberto Martínez obtained a higher price because a big part the paddy produced was sold as rice seed.

3.4. Support to Research Subprojects Funded by CRIN and Caribbean Countries.

3.4.1. Small farm machinery evaluation and development

3.4.1.1. Dominican Republic

Mechanization of agriculture in the Dominican Republic and other Caribbean countries is considered as essential for the improvement of rice production, because the shortage and high costs of labor create large increase in production costs per land unit.

With the aim to adapt and/or develop new technologies for rice production, in 1987 and 1990 **CRIN** introduced from **IRRI**-Philippines to D. R. different sets of small farm machinery in order to evaluate its performance, to demonstrate to rice farmers its potential and to promote its adoption based upon their preference.

Therefore, the first set of introduced machines to the Dominican Republic was; i) One PT-3 Power Tiller, ii) One RE-2 Reaper, and iii) One TH-8 Thresher. These three machines were under continuos evaluation to determine their utility and to decide whether to fabricate them in the Dominican Republic or other Caribbean Countries.

The second set of introduced small farm machinery from the Philippines to D. R. was; i) HT-1 Hydrotiller, ii) PT-3 modified Power Tiller, iii) TR-5 Manual Transplanter, iv) Eight-Row Drum Seeder, and v) Cone Hand Weeder.

3.4.1.1.1. Methodology of Evaluation.

The testing sites for the above machines were: i) Rice Research Center **(CEDIA)** of the Dominican Republic, ii) Juma-Caracol Agrarian Project, and iii) Limón del Yuna Agrarian Project. The general variables studied according to the type of machine to be evaluated were:

i) Time (productive or not) in Seconds.
ii) Fuel consumption (lt/hour).
iii) Soil's depth (cm).
iv) Number of seedlings/hill
v) Number of hills/m^2
vi) Operational Field Capacity (O.F.C.) (ha/hour).
vii) Effective Field Capacity (E.F.C.) (ha/hour).
viii) Efficiency (%).

Here is a definition of the methodology applied according to the recommendations of the Regional Network for Agricultural Machinery **(RNAM)**:

i) <u>Working Time and Speed.</u>

With the use of a chronometer, both the time used by the machine in doing a specific work, which was called "productive time" and the spent in turning, making adjustments, etc., called "nonproductive time" were recorded.

Speed was calculated with the following equation:

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

ii) Fuel Consumption.

Before beginning to work the tank was filled up with fuel and at the end of the evaluation of each treatment, the tank's volume was completed through adding fuel with a test tube. This variable was expressed in liters per hour (l/hour).

iii) Operational Field Capacity (O.F.C.).

It was calculated through the following formula:

$$\text{O.F.C.} = \frac{\text{Area } m^2}{\text{PT + NPT (second) *}} \times 0.36 = \text{ha/hour}$$

Effective Field Capacity (E.F.C.).

The following equation was used:

$$\text{E.F.C.} = \frac{\text{Area } m^2}{\text{Productive Time (second)}} \times 0.36 = \text{ha/hour}$$

v) Efficiency (Ef.)

The following equation was used:

$$\text{Ef} = \frac{\text{O.F.C.}}{\text{E.F.C.}} \times 100 = \%$$

3.4.1.1.2. Results.

Table 16 shows the data on effective yield of the first set of those machines, leading to the following conclusions:

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* PT = Productive Time
NPT = Nonproductive Time

Table 16. Effective yield determination of small machinery in Dominican Republic. CRIN.

Machinery type	Activity	Evaluated area (ha)	Evaluated volume (kg)	Effective yield
Powertiller PT-3	Plowing	0.33	-	0.07 ha/hour
	Leveling	7.69	-	0.12 ha/hour
Reaper RE-2	Rice plant reaping	1.58	-	0.22 ha/hour
Thresher TH-8	Rice threshing	-	3600	624 kg/hour

Source: Adapted from: CRIN, 1988. Avance de La Evaluación de Maquinaria Agrícola para Pequeños Agricultores en República Dominicana, p. 9.

i) The effective yield of the Power Tiller in a single plowing was 700 m^2/hour. (14.3) hours/ha). The previous information reported from **IRRI** is of 1250 m^2/hour.

ii) Leveling one hectare took 8 hours, when a leveling board was connected to the rake of the Power Tiller, perpendicular to the soil.

iii) The semi-mechanized cutting-and-threshing operation was more efficient than the manual by 23%, equivalent to a saving of RD$113.39/ha (US$18.05). Cutting one hectare took 4.5 hours, and 624 kg were threshed in one hour; 8 hours were needed to thresh 5000 kg (the average yield of one hectare)

Evaluation results of machine second set can be observed in Table 17, which are as follows:

i) PT-3 Power Tiller. Plowing one hectare with disc plow required 11.11 hours. When a mouldboard plow was used, 14.29 hours were required to prepare one hectare. Leveling was accomplished with a **CRIN**-designed Leveling Board, with 33.33 hours being required for leveling one hectare.

ii) HT-1 Hydrotiller. The first pudlling pass was accomplished in 6.25 hours for one hectare. iii) TR-5 Manual Transplanter. One hectare was transplanted in 12.5 hours. iv) Drum Seeder. Sowing one hectare with pregerminated seed required 4.55 hours. v) Manual Cone Rotary Weeding one hectare with 3 to 4 leaf weeds required 10.0 hours.

Table 17. Evaluation results of small machinery introduced to Dominican Republic by CRIN.

Machinery type	Evaluated area (ha)	O. F. C.[a] (ha/hour)	E. F. C.[b] (ha/hour)	Efficiency (%)
1. Modified Powertiller PT-3:				
a) Disk Plow	0.57	0.08	0.09	85.98
b) Mouldboard	0.48	0.06	0.07	95.07
2. Hydrotiller HT-1	1.68	0.17	0.16	92.55
3. Manual Drum Seeder	0.24	0.18	0.22	84.50
4. Transplanter TR-4	0.25	0.06	0.07	90.00
5. Manual Cone Rotary Weeder (one row)	0.15	0.08	0.10	79.87

Source: Adapted from: Armenta S., J. 1990. Informe de las Actividades Realizadas por el Personal Técnico de CRIN en 1990. Rep. Dominicana. p. 52.
a/ O.F.C. = Operational Field Capacity
b/ E.F.C. = Effective Field Capacity

3.4.1.2. Jamaica

In early 1990, the Jamaican Government acquired **IRRI**-designed small machines; among them there are:

One PT-3 Power Tiller, One HT-1 Hydrotiller, one TH-8 Thresher, one RE-2 Reaper, and one Drum seeder.

The interest for evaluating these machines was based on the need of defining their potential under Jamaican conditions; this information is feasable to be applied in the Dominican Republic, Trinidad & Tobago and Haiti.

In order to support the systematic evaluation of those machines, Mr. A. Leury, **CRIN** Agricultural Engineer, helped to write the project, and a methodological catalogue for the evaluation of the machines, was made. This methodology is based mainly on methodologies developed by the Regional Network for Agricultural Machinery (**RNAM**), that operates in Asia and the Pacific.

In March, 1990, **CRIN** granted the Ministry of Agriculture of Jamaica the amount of US$3,150.00, through Eng. A. Leury. This sum was invested in the evaluation of the above machines and the acquisition of other low-price farm implements.

3.4.1.2.1. Results.

As a result of the evaluation of only of two above mentioned machines, it can be seen in Table 18 that:

i) The Hydrotiller required 7.72 hours to complete the first single plowing of one hectare.

ii) The Thresher threshed an average of 324.5 kg/hour. This volume may perhaps be increased as the operator's skill improves.

Table 18. Results of small machinery evaluation in Jamaica. 1990.

Machinery	Evaluation unit	E. F. C.[a]
Hydrotiller HT-1	0.87 ha	0.129 ha/hour
Thresher TH-8	6367 kg	324.5 kg/hour

Source: Adapted from: Armenta S., J. 1990. Informe de Las Actividades Realizadas por el Personal Técnico Científico de CRIN en 1990. Rep. República, p. 51.
a/ E. F. C. = Effective Field Capacity

3.4.1.3. Implications.

- Leveling Board. **CRIN** designed a leveling board for the **IRRI**-designed PT-3 Power Tiller, which can also be used with Yanmar Power Tillers for land preparation (leveling, straight leveeing). The Rice Extension Department and farmers of the Agrarian Reform have build 26 units, which shows a good level of technical innovation.

- Leveling Floater. This implement was developed with the help of a Cuban technician which is mainly used for plot leveling after land preparation under puddling system. Actually Dominican Government is using it in a National land leveling project.

- Hydrotiller. **CENATA** (National Center for Appropriate Technology) developed the first prototypes with **CRIN**'s help, later on followed by private workshops (**INDUMET**, Loposolo) in D. R.

  In Jamaica, the first Hydrotiller was developed by the Meylersfield Development Program, which was suited to their own soil conditions.

  In Trinidad and Tobago, **CARIRI** developed the first prototypes of Hydrotiller, Thresher and Water Pump, and actually a Private Company (AJAX) is commercially developing these machines.

- Rotary Cone Weeder. A diverse local small workshops in D. R. are fabricating this manual machine since weed control is improved and costs are minimized.

- Eight Rows Drum Seeder. This manual machine was also fabricated by local workshops (D.R.) and farmers use it for drilling with pregerminated seeds, implying a 20 to 30% less seeding rate as compared to broadcast seeding method.

- From March 4 to 7, the Commonwealth Secretariat and the Caribbean Industrial Research Institute (**CARIRI**) organized a Workshop on Agricultural Mechanization in the Caribbean in Trinidad & Tobago (Port of Spain). Technicians from Belize (1) Dominican Rep. (2), Haiti (1) Guyana (1) and **CRIN** Agricultural Engineer participated with **CRIN**'s support. The activities developed by **CARIRI** and **CRIN** on agricultural mechanization in the region were highlighted in this workshop. It was agreed to nominate a group of representatives from different Caribbean agencies (**CARDI, CARIRI, U.W.I., CARICOM**, etc.), with the objective of preparing a detailed proposal for organizing an Agricultural Mechanization Network in the future to be submitted for discussion before the Steering Committee of Ministers Responsible for Agriculture (SCMA).

- Engs. G. Malena and A. Leury, **CENATA**'s Technician and **CRIN** Agricultural Eng., respectively, participated in the evaluation of machinery used in seed processing (cleaning, drying and storage) of beans, to which some adaptations were made by the technical personnel of **CIAT** Seed Unit to be used in rice. This activity was held at **CIAT** from march 11 to 23, 1991. According to this evaluation, the necessary adjustments were made to such machines, and were used to organize a seed course for Caribbean Scientists at **CIAT**.

- Two research papers on small farm machinery were published on the bulletin Rice in the Caribbean Vol 5 (2), 1991, whose titles are: Agricultural mechanization of rice crop in the Caribbean, by J. L. Armenta, et. al.; and Highlights on the evaluation of **IRRI** designed HT-1 hydrotiller and axial flow TH-8 thresher in Jamaica, by O. Gilpin, et. al.

- A methodological catalogue for small farm evaluation was issued by **CRIN** and written by Agr. Eng. A. Leury.

3.4.2. Integrated Pest Management

This topics corresponds to a regional subproject approved by **CRIN's-TAC** in 1989 under the title "Integrated Pest Management in Rice Cultivation in the Caribbean Region Through Improved Systems of Pests and Crop Management". Countries involved in these research activities funded by **CRIN**, local governments and para-state entities were; Guyana, Trinidad and Suriname.

3.4.2.1. Guyana.

Three (3) **IPM** studies were carried out in Guyana on rice blast (Pyricularia grisea Sacc.). The experiments here reported were carried out at **NARI**'s Experimental Station, Coastal Plains Unit, in Burma, Guyana. These works were implemented by Eng. Cleveland Paul, **NARI**'s counterpart in the **IPM** sub-project, and advised by Eng. J. Coulombe, **CRIN**'s Agronomist.

Rice blast is known as the most serious rice disease in Guyana. For this reason, **NARI**'s rice program has put a major emphasis on the introduction and development of rice lines resistant to leaf and neck blast. The rice variety RUSTIC, highly susceptible to rice blast, covers around 70% of the rice area of the country, but farmers continue to plant it because of its good grain quality for export.

According to the above, it is required to identify different management strategies of the disease using a susceptible variety, until a resistant one is identified and released. This points at the need of determining which are the best fungicides, with their dosages and time of application, the most effective combination of such fungicides, as well as appropriate cultural practices (seeding rate, N dosages and water management) that keep the disease's incidence and severity at rentable levels for the farmers. The following studies tried to reach that goal.

3.4.2.1.1. Evaluation of New Fungicides for Rice Blast Control.

This experiment was carried out with variety RUSTIC in two seasons (1st and 2nd semester) of the year in order to evaluate the effectiveness of different fungicides which include the use of products separately or in mixtures, applied to the seed or the plant, to control rice blast.

3.4.2.1.1.1. Evaluation of fungicides for seed treatment.

The systemic fungicides Tricyclazole and Pyroquilon were evaluated in seed treatment for leaf blast control caused by *Pyricularia grisea* Sacc. Solution for one kg of seed was prepared by suspending the amount of active ingredient (a.i.) of product in one liter of water. For Tricyclazole, the dosage used was 1.5 g of a.i. per liter of water. For Pyroquilon, it was 1 and 2 g of a.i. per liter of water. Seed treatment was made by soaking the seeds into the solution for 24 hours. After soaking, the seeds were kept in a shady place during 3 days for incubation. Treatments were laid out in plots of 5 x 5 m size in a R.C.B.D. with four replications.

3.4.2.1.1.1.1. Results.

Due to the low incidence of leaf blast, it was not possible to evaluate the effectiveness of the seed treatments. However, the results show that treating seed with Tricyclazole and Pyroquilon with an incubation of 3 days reduced seed germination (Fig. 3). In the future, seed treatments for rice blast control should be better calibrated and choose an area of high pressure of the disease.

3.4.2.1.1.2. Evaluation of fungicides for foliar application.

Six fungicides were evaluated at their recommended dosage for blast control through foliar application (Table 19). The first application was made at appearance of first symptoms of the disease, and the second one at 5 and 80% of panicle emergence for the first and second season, respectively.

A randomized complete block design with 4 replications was used. Plot size was 5 x 5 m. Panicle blast incidence was determined at grain dough stage by counting affected panicles of 8 random samples of 25 panicles per plot. Affected panicles were defined as panicles with lesions partially or completely around the panicle base or the uppermost internode or the lower part of panicle axis near the base.

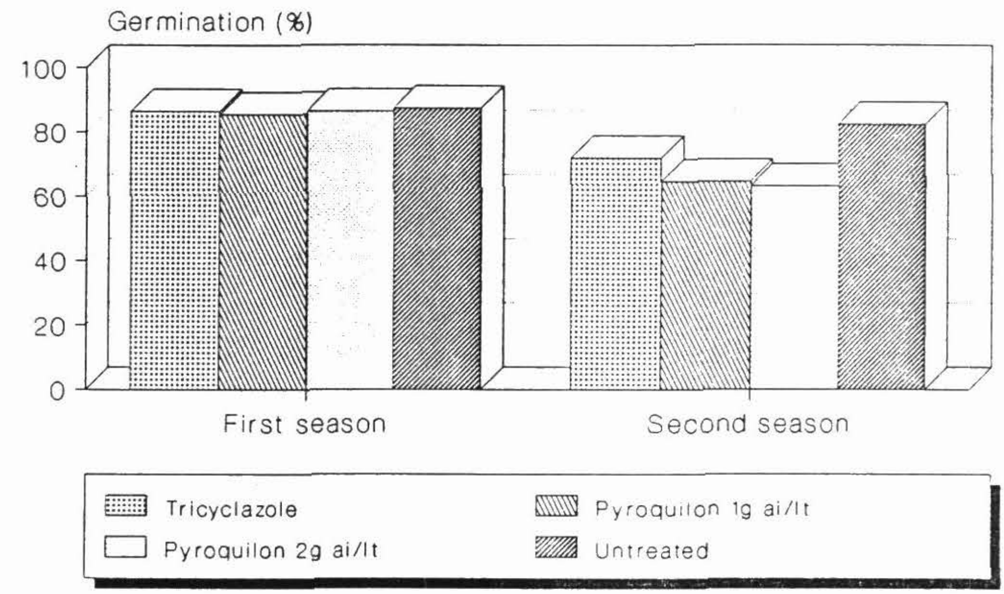


Figure 3. Effect of seed treatment on germination of rice variety Rustic. Guyana, 1991.

Table 19. Fungicides and and Dosages Evaluated for Blast Control by two Foliar Applications. Guyana, 1991.

Treatment	Product	g of a.i./ha[1]
1	Busan (Metham-Sodium)	450
2	Carbendazim	225
3	Carbendazim + Metiram	125 +1200
4	Edifenphos	500
5	Iprobenfos	480
6	Tricyclazole	225
7	Untreated (check)	-

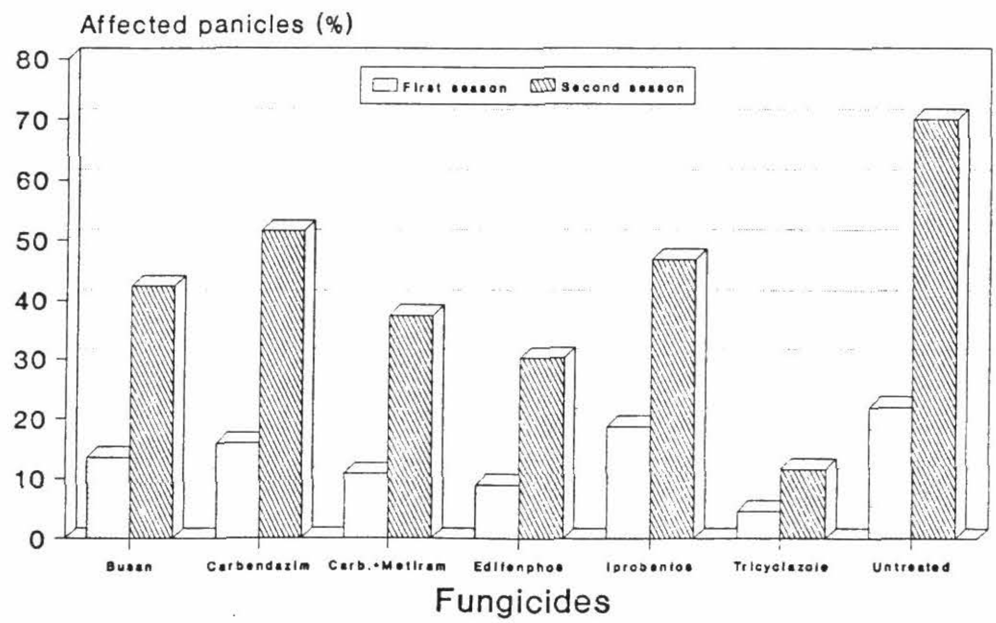
1/ Dosage/application

3.4.2.1.1.2.1. **Results.**

Due to the low incidence of leaf blast, no differences were observed between fungicides for the first foliar application; therefore no data was collected.

In both seasons in which the experiment was conducted, Tricyclazole caused a significant decrease in the percentage of panicles affected by blast (Fig. 4). In the first season, when less pressure of the disease was observed, Edifenphos and the mixture of Carbendazim and Metiram also reduced panicle blast incidence. However, the effectiveness of these fungicides was less than

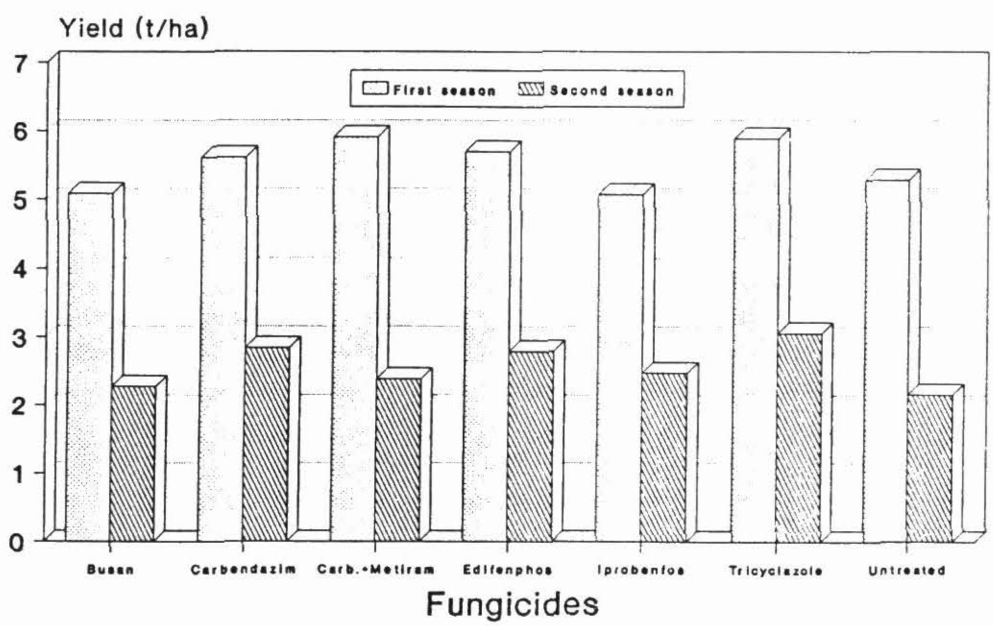
Figure 4. Effect of various fungicides on panicle blast control of rice variety Rustic. Guyana 1991.



Tricyclazole during the second season, when the disease's pressure was greater and the second application was made late (80% of panicle emergence).

During the first season, fungicide treatments did not have a significant effect on rice yield (Fig. 5). Late infection of panicles with blast and its low level of incidence (22% for check without treatment) seems to hide the positive effect of Tricyclazole, Edifenphos, and the mixture of Carbendazim and Metiram.

Figure 5. Effect of various fungicides on grain yield of rice variety Rustic. Guyana, 1991.



In the second season, plots treated with Tricyclazole produced the highest yield (Fig. 5). However, this yield was not significantly higher than that of plots treated with Carbendazim and Edifenphos.

In both seasons, Iprobenfos, which is the fungicide used by farmers in Guyana, reduced slightly the panicle blast incidence, but did not increase the grain yield, significantly.

Until a commercial variety resistant to blast be released in Guyana, Tricyclazole appears to be the most effective fungicide in reducing blast incidence and therefore increasing the yield of variety RUSTIC. Nevertheless, the economic feasibility of using Tricyclazole in large fields has to be examined.

3.4.2.1.2. Evaluation of 2 Doses of Nitrogen with 2 Fungicide Treatments and 3 Seeding Rates.

This experiment was carried out during the second semester of 1991. The treatments were laid out in a split-split plot design with 4 replications. Nitrogen doses, fungicide treatments and seeding rates were assigned to main, sub and sub-subplots, respectively. Fungicides Tricyclazole and Iprobenfos were applied at the same time with and doses indicated in point 3.4.2.1.1.2. and Table 19. Panicle blast incidence was determined with the same methodology of the previous experiment.

3.4.2.1.2.1. Results.

In all fungicide treatments used, the decrease of seeding rate had no effect on panicle blast incidence and grain yield of variety RUSTIC (Fig. 6 and 7). On the other hand, a high dose of N (120 kg/ha) increased panicle blast incidence slightly and had a negative effect on grain yield as compared to a low dose (Fig. 8 and 9).

Figure 6. Effect of seeding rate and chemical treatment on panicle blast incidence of variety Rustic.Guyana 1991.

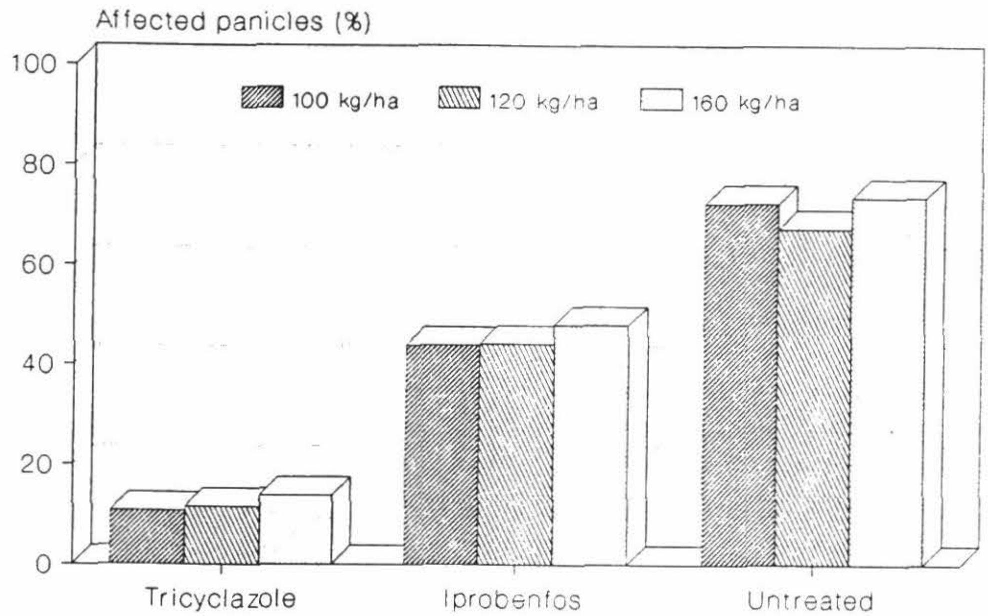


Figure 7. Effect of seeding rate and chemical treatment on grain yield of variety Rustic. Guyana 1991.

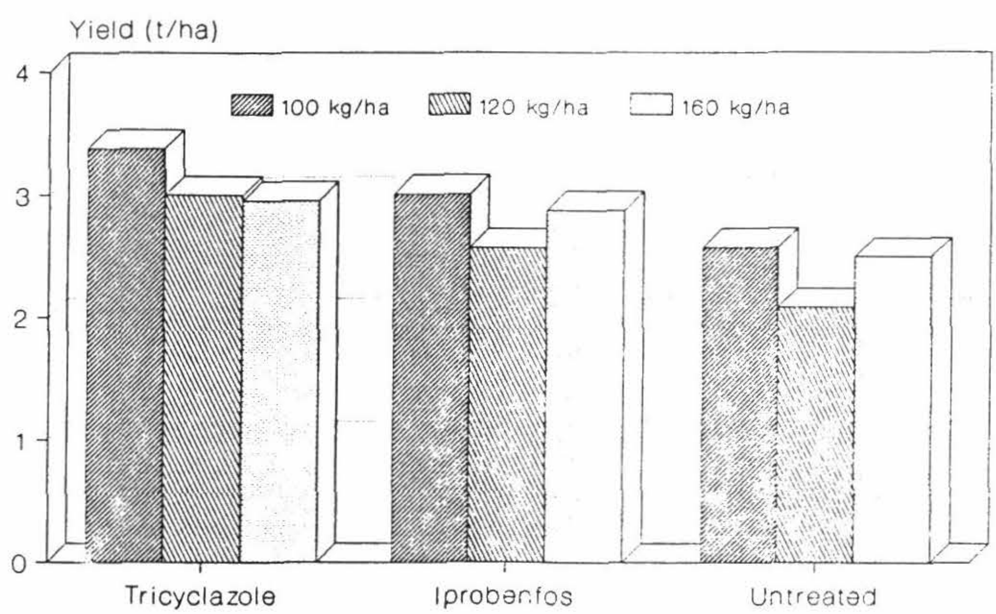


Figure 8. Effect of two nitrogen doses and chemical treament on panicle blast incidence of variety Rustic.Guyana 1991.

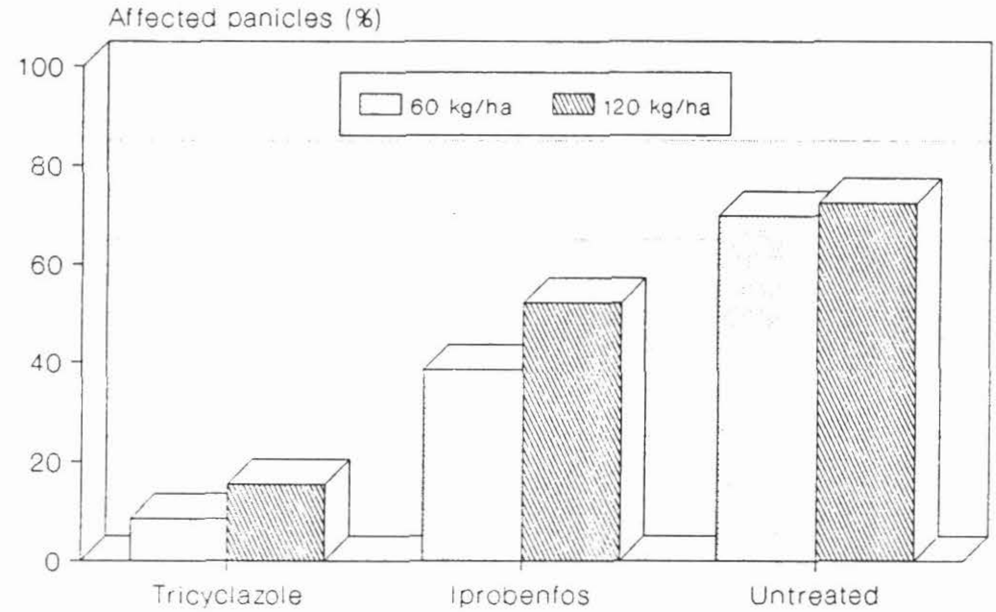
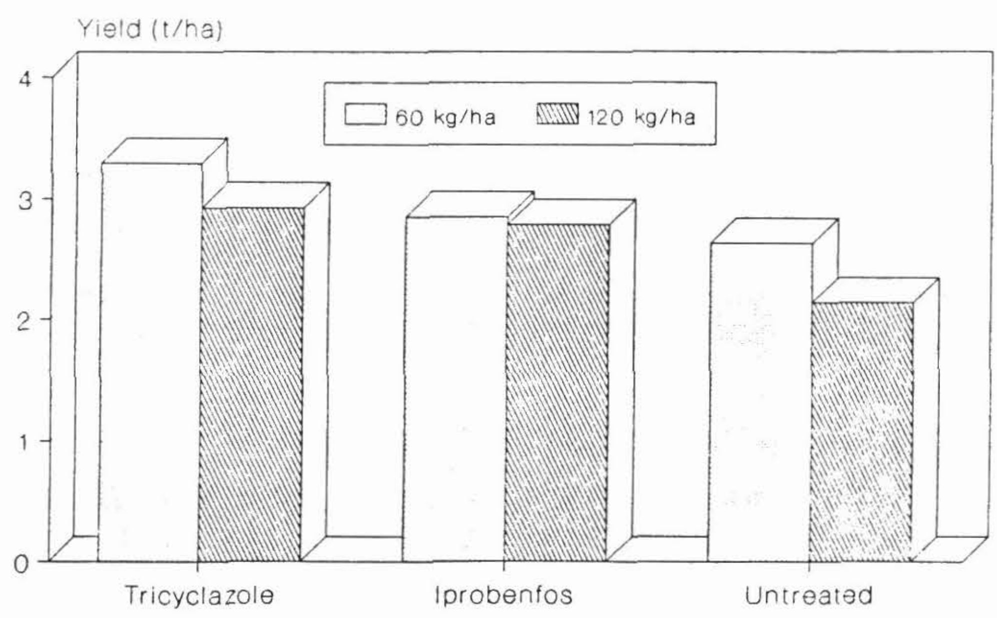


Figure 9. Effect of two nitrogen doses and chemical treament on grain yield of variety Rustic. Guyana 1991.



3.4.2.1.3. Effect of the Dose of Nitrogen on the Incidence of Rice Blast in Two Rice Varieties, with and without Chemical Protection.

This experiment was carried out during the second semester of 1991. Treatments were laid out in a RCBD in split plot with four replications. The varieties IR44624 and RUSTIC, were used as main plots, which are resistant and highly susceptible to rice blast, respectively. The doses of Nitrogen used were 0, 40, 80, 120 and 160 kg/ha. Field protection was made with 2 foliar applications of Tricyclazole (225 g of a.i./ha, each). The first application was made upon appearance of the first symptoms of the disease on the leaves, and the second one when rice plants were at 80% panicle emergence.

Leaf blast incidence was determined by visual assessment of the percentage of leaves attacked at 40 days after seeding, following the methodology described in point 3.4.2.1.1.2.

3.4.2.1.3.1. Results on blast incidence.

For the variety IR44624, the percentage of leaf area and panicles affected by rice blast was less than 1% for all doses of Nitrogen, with and without chemical protection.

For the variety RUSTIC, both leaf and panicle blast incidence increased gradually with increasing doses of N up to 120 and 160 kg/ha without and with chemical protection, respectively (Fig. 10 and 11). Leaf and panicle blast incidences were drastically reduced by Tricyclazole at all doses of N. However, its effect increased with increasing N doses up to 120 and 160 kg/ha for leaf and panicle blast, respectively.

Previous results indicate that by properly managing N fertilization,leaf and panicle blast can be reduced. However, for a susceptible variety like Rustic a suitable combination of chemical control and N fertilization should be used in order to attain better results.

Figure 10. Effect of Nitrogen dose and chemical protection on leaf blast incidence of variety Rustic.Guyana 1991.

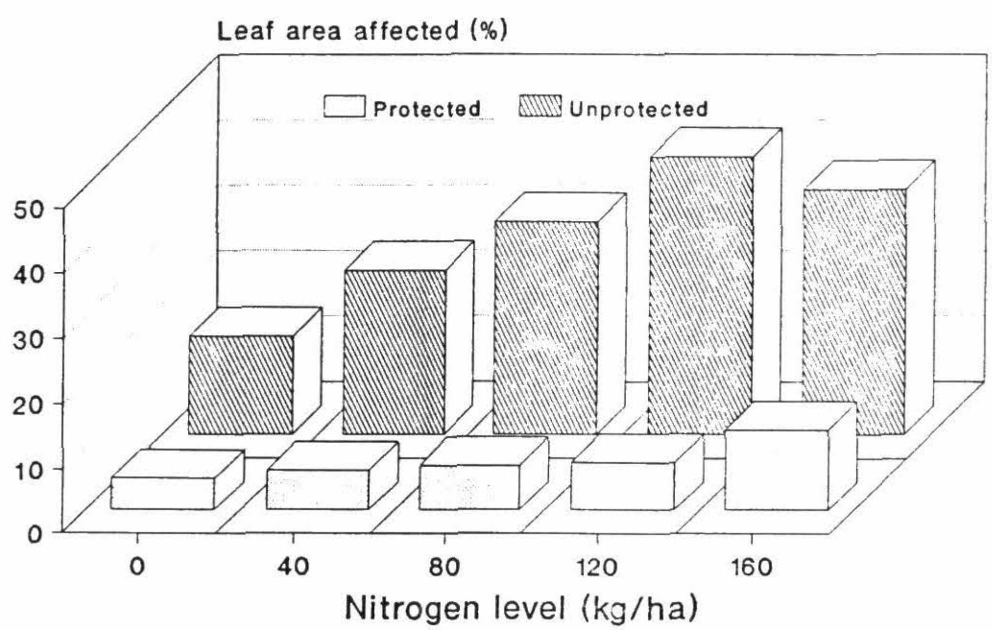
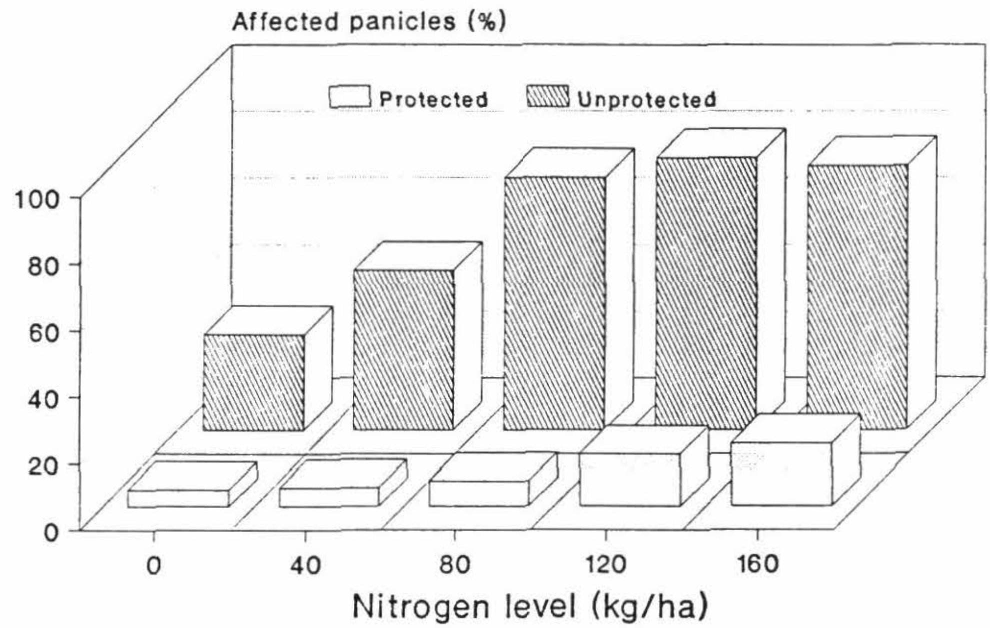


Figure 11. Effect of Nitrogen dose and chemical protection on panicle blast incidence of variety Rustic.Guyana 1991.



3.4.2.1.3.2. Results on grain yield.

For the variety IR44624 (resistant to blast) grain yield increased with increasing doses of N up to 80 kg/ha (Fig. 12). However, this effect was not significant in unprotected plots.

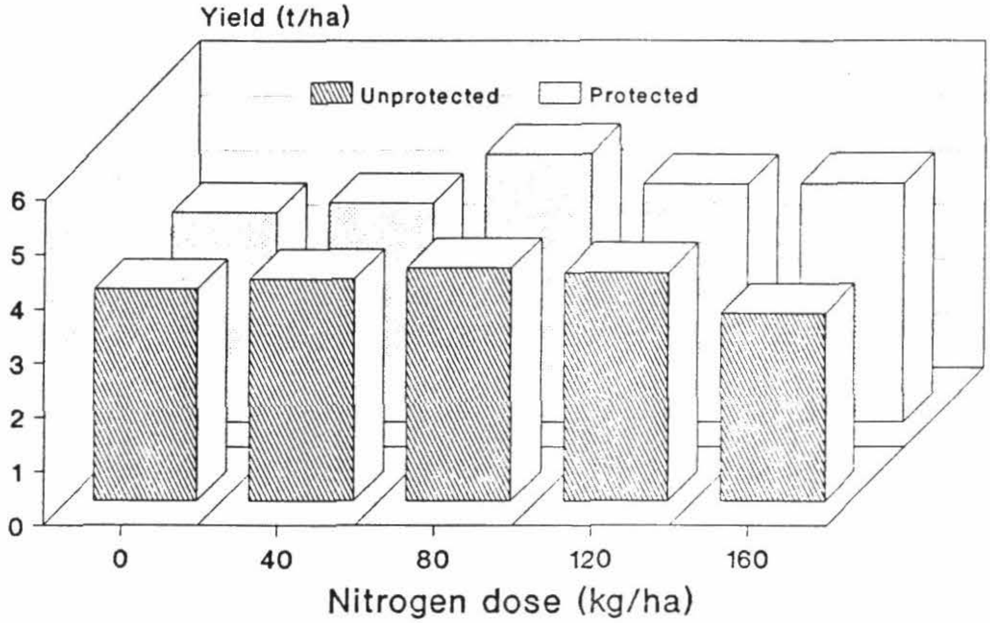
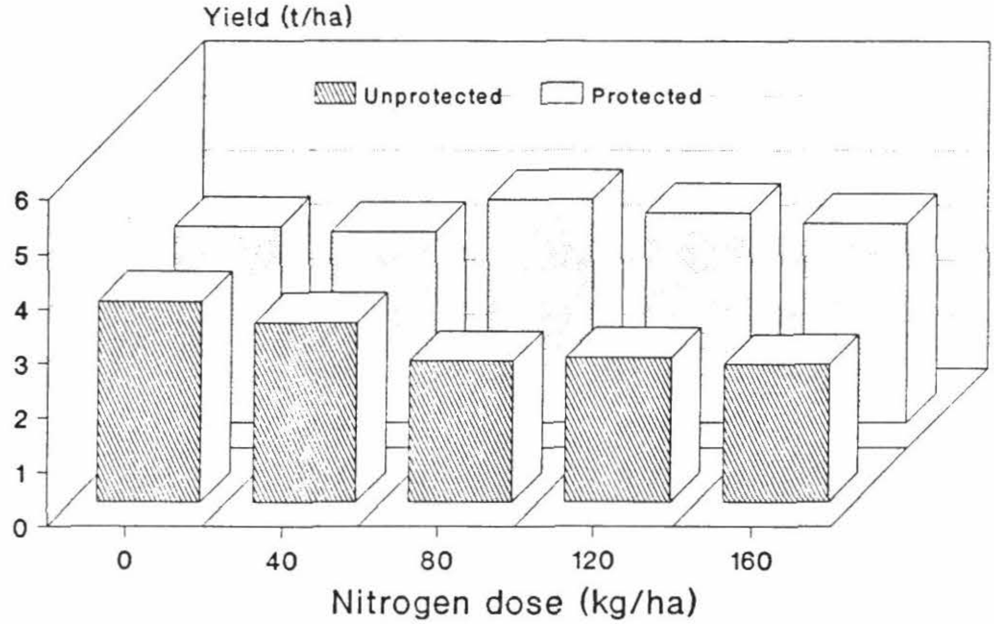


Figure 12. Effect of Nitrogen dose and chemical protection on grain yield of variety IR 44624. Guyana, 1991.

In unprotected plots of the variety RUSTIC (susceptible to blast) grain yield decreased with increasing doses of N (Fig. 13). N doses did not affect significantly the grain yield of variety RUSTIC in protected plot against blast with 2 applications of Tricyclazole. It should be noted, however, that there was no significant effect on grain yield in protecting the crop with Tricyclazole in plots without N fertilization and with the dose of 40 kg of N/ha.

Figure 13. Effect of Nitrogen dose and chemical protection on grain yield of variety Rustic. Guyana, 1991.



In conclusion, grain yield response to N fertilization is different for resistant and susceptible varieties to blast under a favorable environment for disease development. Although grain yield increased with the protection of Tricyclazole in variety IR44624, because of the low incidence of blast in both protected and unprotected plots, additional studies are required to support this result. For variety IR44624, other studies have to be conducted in order to determine the optimum dose of N under different conditions. As to variety RUSTIC, further studies should be conducted with doses of N up to 80 kg/ha, in order to determine if these cultural and chemical practices are effective and economical under different conditions.

3.4.2.2. Trinidad and Tobago.

The research activities here reported, were supported jointly by **CARONI** (1975) Limited, CAB-International Institute of Biological Control, University of the West Indies (WIU), the Ministry of Food Production, Marine Exploitation, Forestry and Environment (MFPMEFE) and the Centro International de Agricultura Tropical (**CIAT**) through its regional Project-**CRIN**.

3.4.2.2.1. Thesis.

Two thesis studies were developed corresponding to two Master of Philosophy of WIU whose topics are described as follows:

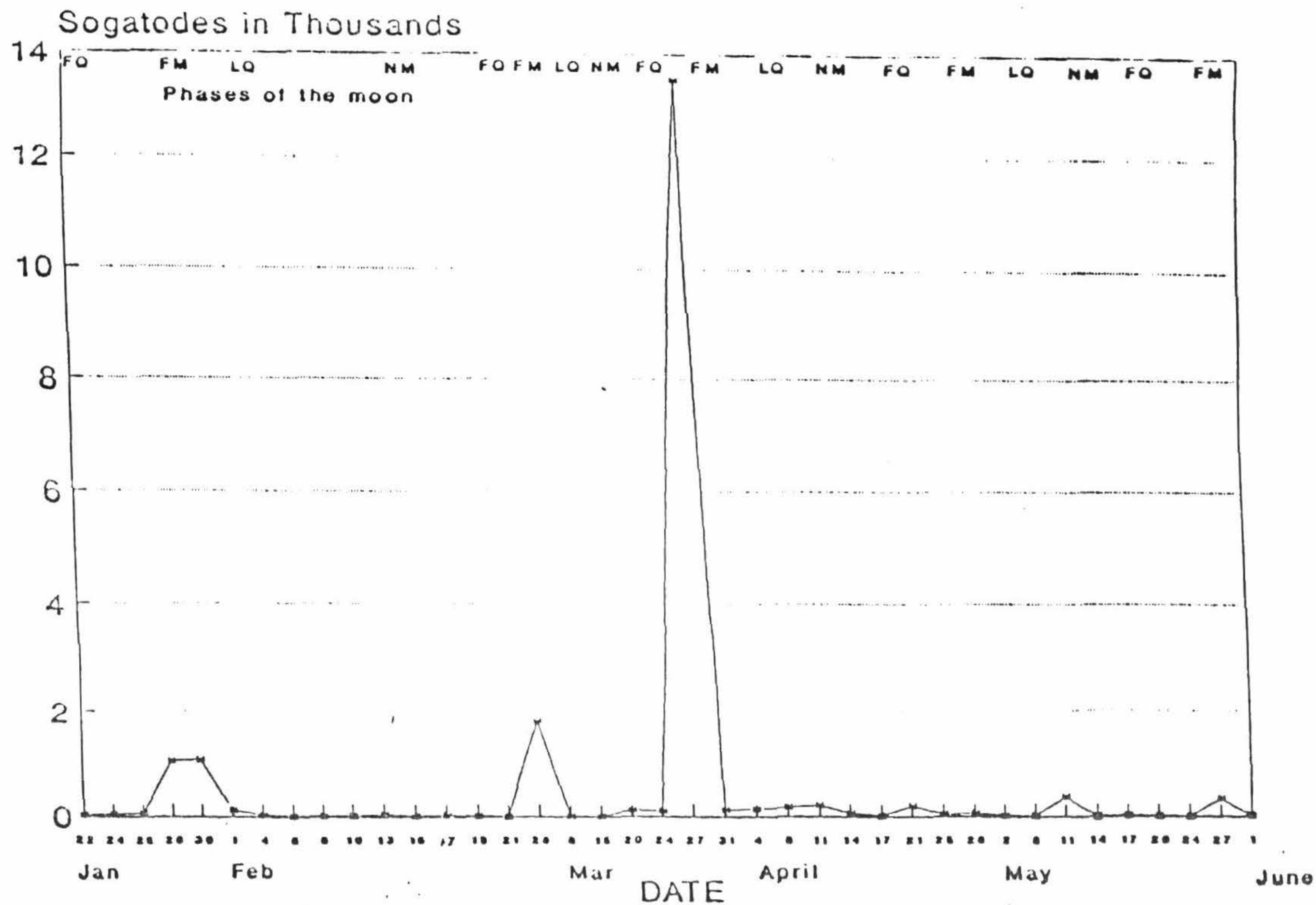
3.4.2.2.1.1. Mr. Dyal Thesis.

Mr. S. Dyal started on late 1989 the study "Field Bioecological Studies of _Sogatodes_ _oryzicola_ and _S. cubanus_", and was terminated on early 1992. The research was practiced in the **CARONI** (1975) Limited irrigated rice project (800 ha) in north Trinidad. Different methods of sampling were evaluated, and studies were done on population trends.

3.4.2.2.1.1.1. Results.

Among outstanding results are; no significant difference was found among light trap, net sweeping and visual method as sampling techniques. Population dynamics studies (Jan.-June, 1990) indicate a sharp increase in size on 4^{th} week of March (Fig 14.) and also two peaks in the activity of _Sogatodes_ spp. were determined to

Figure 14. Incidence of Sogata in the period January - June, 1990. **CARONI** - Trinidad.



occur at twilight and dawn, where diurnal feeding activity was greatest (Fig. 15 and 16); effect of moon phase on dispersal was also observed.

This research is specially important because Rice Hoja Blanca Virus (RHBV) incidence has increased recently in the project area and is considered to be having and adverse effect on yield in some fields.

3.4.2.2.1.2. Mr. Granger Thesis.

The second topic of thesis was named "Damage/Loss Assessment Studies on Rice to Simulate the Effects of Hydrellia sp. (Diptera: Ephidridae) in Trinidad", which conducted at **CARONI** facilities by Mr. L. Granger. The variables tested in this study were; five levels of leaf clipping (0, 25, 50, 75 and 100%) at 21, 28, 28, 49 and 63 days after planting (DAP).

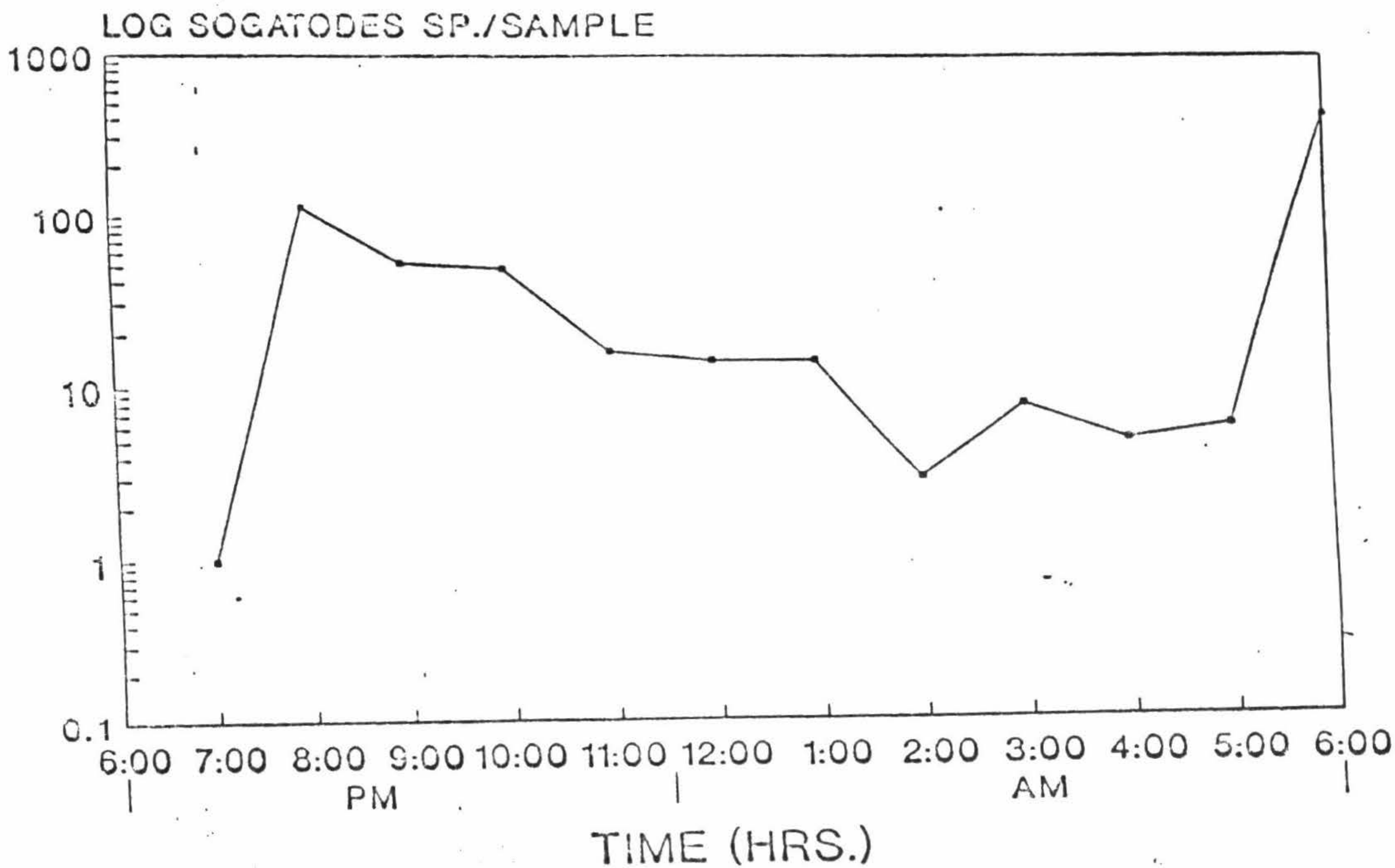
3.4.2.2.1.2.1. Results.

Rice plants appeared to have recovered very rapidy from all except the 100% leaf removal treatments and 10 to 15 cm plant height difference was observed between 100% leaf clipping treatments in the last two stages (49 and 63 DAP).

3.4.2.2.2. Field Pests Survey.

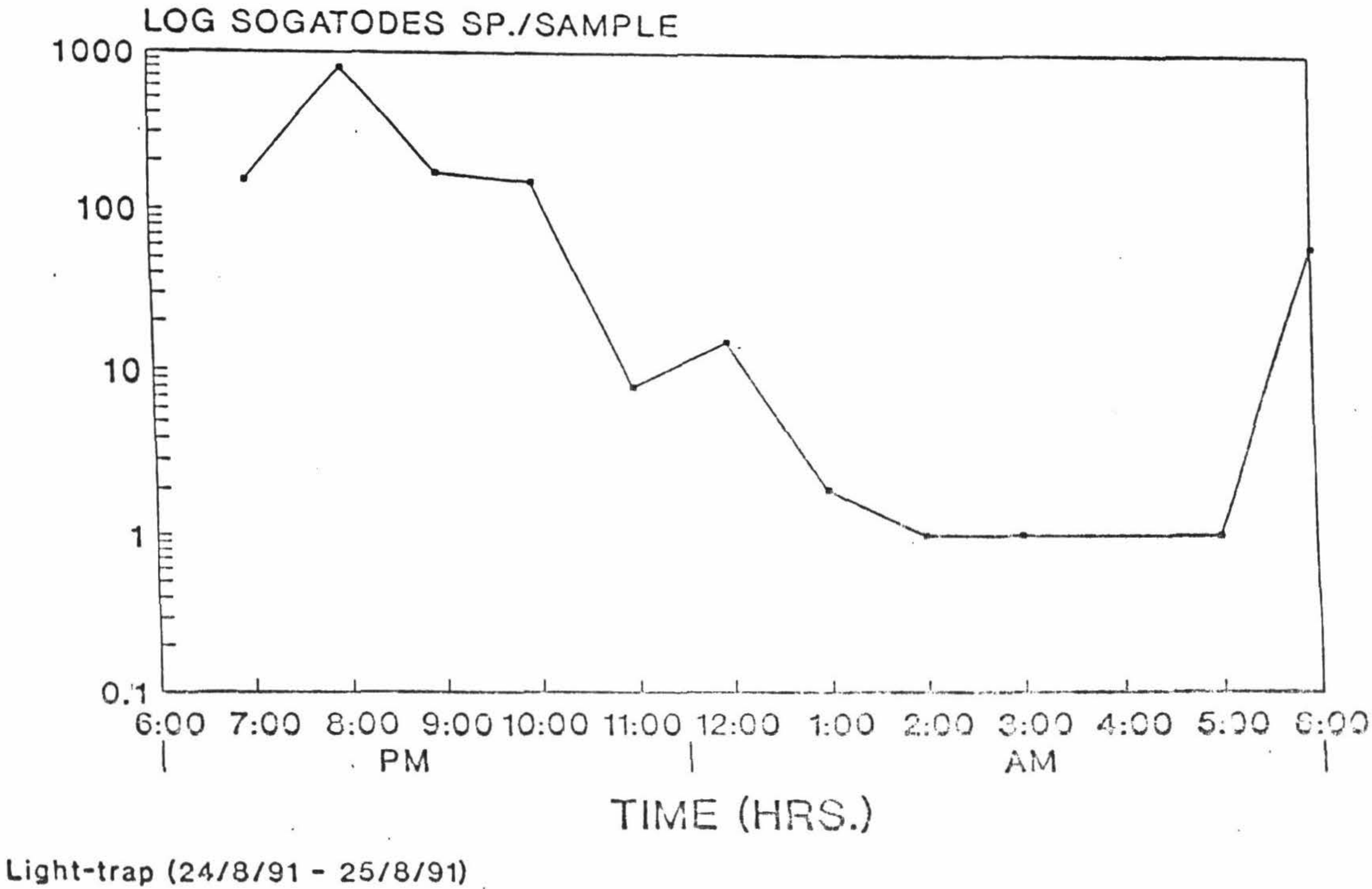
The survey started in October 1990 on rice pests in small farmers' fields and was completed in the first semester of 1991.

Figure 15. Nocturnal activity of Sogatodes sp. on rice on 7-8 February 1990, using light-trap sampling method. CARONI - Trinidad.



Light trap (7/2/90 - 8/2/90)

Figure 16. Nocturnal activity of Sogatodes sp. on rice on 24 - 25 August, 1991, using light-trap sampling method. CARONI - Trinidad.



Eng. B. Cooper, Trinidad's counterpart in this sub-project compiled the results and prepared a report in collaboration with Dr. W. G. des Vignes. Sixty three small farmer fields were sampled in the five Counties of Trinidad where rice is grown (**Caroni**, St. Andrew, St. Patrick, Victoria and Nariva/ Mayaro) capturing about 5% of the overall acreage under cultivation. Estimations were made of the incidence of insects pests, diseases and weeds.

3.4.2.2.2.1. Results.

This study shows that weeds appear to be the most serious problem for small farmers. Eleven genera of weeds were recorded, which are: Hymenachne amplexicaulis (Rudge) Nees, Leersia hexandra, Sw., Echinochloa colonum (L.) Link, Ludwigia decurrens Walt., Ludwigia hyssopifolia (G. Don) Exell., Sphenochlea zeylanica Gaertn., Ischaemum rugosum Salisb., Leptochloa scabra Nees., Fimbristylis littoralis Gaudich., Aeschynomene sensitiva Sw., Marsilea minuta L., and Ipomea aquatica Forsk.

Seven collected insect pests have certain importance in rice crop. However, populations of such pests were from moderate to low in most cases. Four beneficial insects were observed, in addition to nine rice diseases, which incidence was from moderate to low in the evaluated fields. The highest incidence of sheath blight (Rhizoctonia solani) was observed in Northern Counties and narrow brown leaf spot (Cercospora janseana) at moderate-low levels throughout all the farms.

3.4.2.3. Suriname.

Although Suriname was the Country who originally requested financial support to work along IPM researches, the difficulties to hire local entomologist delayed research planning and implementation and no fund were supplied by **CRIN**.

3.4.2.4. Implications.

- In order to summarize efforts done along IPM research activities by Guyana, Trinidad and Suriname rice researchers, it was organized a Monitoring Tour and Workshop on IPM in Guyana and Trinidad (October 7-11, 1991), where Cuban and **CIAT** rice scientists also participated. Twenty five research papers were discussed (Table 20 and 21).

- Actually a book is in Process of editing to include the research papers listed on Tables 20 and 21.

- It was printed a book intitled "Round Table on Crop Protection" which covers experiences developed in Cuba along IPM (insects and weeds, as well as in Colombia and other Latinamerican Countries.

- Two research Thesis were developed at **CARONI** (1975) Limited headquarters, of Master Degree level by two students of University of West Indies located at Port of Spain, Trinidad.

- National Research Center of Suriname appointed two entomologists to work along IPM in close coordination with the other researchers of Guyana and Suriname.

- **NARI** of Guyana released the rice variety IR44624 which is resistant to blast, equivalent milling quality of RUSTIC variety (most popular), and 15-20% higher yield potential of RUSTIC.

Table 20. Research Papers Presented During the First Meeting of the "Monitoring Tour and Workshop on Integrated Pest Management" Carried out in Guyana and Trinidad & Tobago (October 7-11, 1991). Guyana.

Topic	Institution[1]	Country	Speaker
- Virulence Analysis in Rice.	CIAT (Rice Program)	Colombia	Dr. F. Correa
- The Role of Agronomic Practices in the Incidence and Management of _Hydrellia wirthi_ Korythowski in Colombian Rice Fields.	CIAT (Rice Program)	Colombia	Dr. A. Pantoja
- Interference of Red Rice with Rice and Implication for its Management.	CIAT (Rice Program)	Colombia	Dr. A. Fischer
- Integrated Management of Red Rice in Cuba.	IIA	Cuba	Dr. G. Antigua
- Crop Protection Practices in Rice Cultivation in Guyana.	NARI	Guyana	Mr. E. Ralph
- Evaluation of New Fungicides for Rice Blast Control in Guyana.	NARI	Guyana	Mr. C. Paul
- Distribution and Relative Abundance of Species of Rice Paddy Bugs in Guyana.	FAO/NARI	Guyana	Dr. A. Duodo
- Weed Incidence on Selected Farms in Guyana.	NARI	Guyana	Ms. C. Richards-Haynes

1/ **CIAT**-Centro Internacional de Agricultura Tropical; **IIA**-Instituto de Investigación del Arroz; **NARI**-National Agricultural Research Institute.

- It was identified Tricyclazole as better fungicide than Iprobenfos (most popular), which implies higher yield at lower cost.

- It was concluded that N doses are more important than seeding rates in crop management practices for blast control, using a susceptible variety like RUSTIC.

- RUSTIC variety (susceptible to blast) yielded properly with 80 kg N/ha when chemical protection was suitable practiced.

Table 21. Research Papers Presented During the Second Meeting of the "Monitoring Tour and Workshop on Integrated Pest Management" Carried out in Guyana and Trinidad (September 7-11, 1991). Trinidad & Tobago.

Topic	Institution[1]	Country	Speaker
- Integrated Weed Management in Rice at Cuba.	IIA	Cuba	Dr. G. Antigua
- Chemical Weed Control in Rainfed Transplant Rice (Oryza sativa L.) in Trinidad.	CES	Trinidad	Mr. D. Ramdin
- A Review of Efforts to Control Weeds in Swamp Rice.	CARONI	Trinidad	Dr. G. F. Mason
- Approaches for Competition Studies.	CIAT (Rice Program	Colombia	Dr. A. Fischer
- Screening Rice Germplasm for Tagosodes orizicolus Resistance and Detecting the Percentage of Vector.	CIAT (Rice Program	Colombia	Drs A. Pantoja, R. Zeigler and F. Correa.
- Towards the IPM of insect Pests of Rice in Trinidad CARONI.	CARONI	Trinidad	Dr. W. G. des Vignes
- Basic Ecological Studies on the Rice Planthoppers, Sogatodes orizicola and S. cubanus in Trinidad.	UWI	Trinidad	Mr. S. Dyal
- Damage/Loss Assessment Studies on Rice to Simulate the Effects of Hydrellia sp. (Diptera: Ephydridae) in Trinidad.	CARONI	Trinidad	Mr. L. Granger
- Biological Control of Water Weevil Lissorohptrus brevirostris in Cuba.	IIA	Cuba	Dr. R. Meneses
- Pest and Their Management at the Foundation for Mechanized Agriculture in Suriname.	SML	Surinam	Mr. G. Van Der Kooye
- Review of the Efforts Made Towards the Development Integrated Pest Management in Rice Cultivation in Suriname.	SNRI	Surinam	Mr. F. R. Grawde
- Genetic Studies of Sources of Resistance to Rice Hoja Blanca Virus.	CIAT (Rice Program)	Colombia	Ms. D. Vergel, Drs. F. Cuevas and F. Correa
- Rice Diseases at CARONI and Approaches to their Control.	CARONI	Trinidad	Dr. R. H. Phelps
- Brown Leaf Spot Disease x Fertilizer Interaction in Rice at CARONI (1975) Limited.	CARONI	Trinidad	Drs. C. R. Shand and R. H. Phelps
- Notes on Pest and Disease Problems at CARONI Rice Project.	CARONI	Trinidad	Dr. E. Rampersad
- Diseases of Rice in Trinidad and Tobago: Historical Incidence and Observations.	CES	Trinidad	Mr. G. L. Rajnauth
- Integrated Pest Management (IPM) of Rice (Under Lowland Rainfed Conditions). Extensive Survey of Pests and Diseases of Rice in Trinidad. Phase I.	Agricult. Extension Service	Trinidad	Mr. B. Cooper

1/ **IIA**-Instituto de Investigación del Arroz; **CES**-Central Experiment Station; CIAT-Centro Internacional de Agricultura Tropical; **UWI**-University of the West Indies; **SML**-Foundation for the Development of Mechanized Agriculture in Suriname.

3.5. Collaborative Research

3.5.1. Integrated Management of Red Rice and other Weeds in the Dominican Republic.

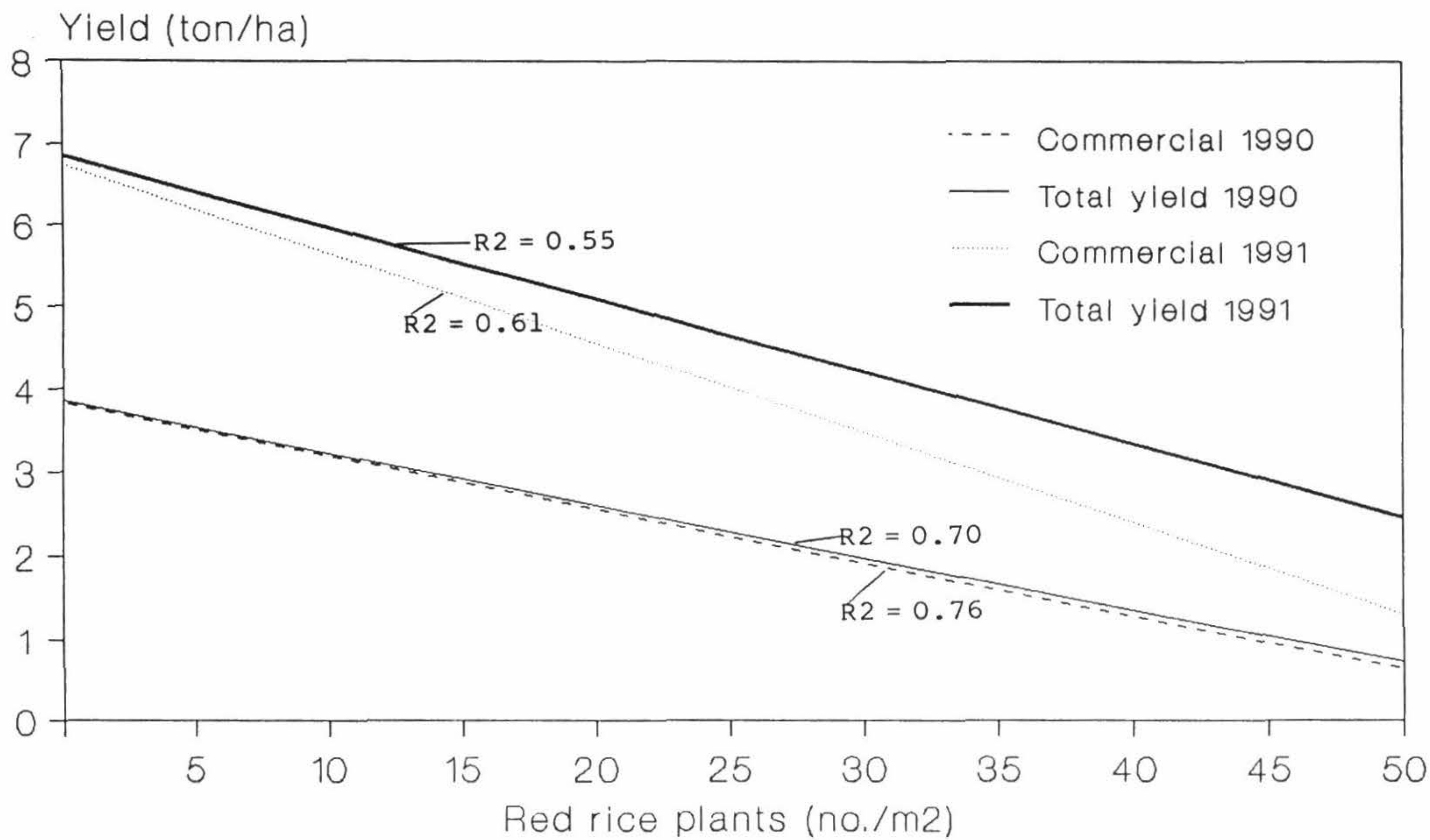
Red rice(<u>Oryza</u> <u>sativa</u> L.) affects approximately 34% of the national rice area in the Dominican Republic and is considered a serious problem to rice production. We use the term "red rice" to refer to all spontaneous rices that belong to the same genus and species of the commercial variety. In the Dominican Republic, the most widely distributed spontaneous rices are the well known red rice with red pericarp and another called locally "No Me tope". Many biotypes of red rice with the red pericarp are observed in the country. "No Me Tope" plants are tall and tiller profusely. Their grains do not have a red pericarp and shatter easily at maturity. The technology developed in the Dominican Republic could be useful for rice farmers in other Caribbean countries where red rice and other annual weeds difficult to control, are present.

These studies on integrated management of red rice and other weeds, were carried out in coordination with the Rice Research Center **(CEDIA)** and the Rice Extension Department **(DFA)**.

3.5.1.1. Interference of Red Rice with Commercial Rice.

In 1990 a study was conducted in Limón del Yuna, Dominican Republic, in order to quantify losses in rice yield caused by different infestation levels of red rice. In 1991 a second study was carried out, as shown in point 3.5.1.3. Data of both studies were used to calculate regression curves (Fig. 17), in order to

Figure 17. Interference of red rice plants with rice yield. Dominican Republic, 1990 & 1991.



estimate potential crop losses, due to the interference of red rice.

The effect of red rice populations on commercial and total rice yield was different for the two experiments (Fig. 17). This difference was due to the fact that red rice biotypes, commercial rice varieties and field conditions were different in each case.

In the 1990 study, red rice biotypes were mainly tall plants, with high tillering capacity; whereas the infestation of red rice in 1991 consisted of a mixture of short and tall plants. Those short plants have less tillering capacity and are less competitive with the commercial rice. In 1990, variety CICA 8 (ISA 40) lodged, both in the infested and non infested plots. Lodging increased as the infestation level increased.

In the 1991 study, no lodging was observed in variety JUMA 64. The highest yield observed in 1991 as compared to 1990 was due mainly to better field conditions and not to varietal differences, since varieties JUMA 64 and CICA 8 have similar yield potential.

A better knowledge of the interaction among major biotypes of red rice, agricultural practices (planting rate, dosage of fertilizer, etc.) and rice varieties will be very useful in taking decisions for the control of red rice in the Dominican Republic.

3.5.1.2. Chemical Control of Red Rice.

This study was carried out on a highly infested farm with red rice. Eight chemical treatments were randomly distributed in a RCBD with four replications. Plot size was of 15 m^2. Concerning the treatments with Glyphosate, Paraquat and the check (Table 22), a post-emergence mixture of Propanil + 2,4-D was required to control annual grasses, sedges and broadleaf weed.

After data were taken an **ANOVA** was practiced, observing statistical difference among treatments and Duncan Test was ran out to compare mean treatments (Table 22).

Red rice and commercial variety yields were separately harvested and analized individually and grouped.

3.5.1.2.1. Results and Discussion.

Red rice yield of check plots was higher (462 kg/ha) than other treatments, as expected.

According to the Duncan test, 5 statistical groups were identified, (Table 22), out of which the highest yields of CICA 8 (4145 and 4070 kg/ha) corresponded to both treatments with Oxyfluorfen with 0.48 and 0.72kg of active ingredient/ha respectively. On the other hand, the lowest yield corresponded to herbicide Pretilachlor, and also coincided with the highest lodging (9.0).

Table 22. Evaluation of 4 Herbicides in Chemical Control of Red Rice. Dominican Republic. 1990.

Treatments	Rate (kg a.i./ha)	Time of[1] Application	Lg[2] (0-9)	Yield of Paddy Rice[3] (kg/ha) Red Rice	Commercial Variety	Total
Oxyfluorfen	0.48	6 DBS Flooded	4.7	238 b	4145 a	4384 a
Oxyfluorfen	0.72	6 DBS Flooded	3.3	137 b	4070 ab	4206 ab
Paraquat	0.70	2 DBS Drained	0.7	255 b	3464 bc	3718 bc
Glyphosate	0.75	2 DBS Drained	0.0	175 b	3473 bc	3648 bc
Paraquat	0.40	2 DBS Drained	0.0	235 b	3200 bc	3435 c
Check	-	-	4.3	462 b	2664 d	3126 cd
Glyphosate	1.50	2 DBS Drained	0.0	222 b	2406 de	2628 d
Pretilachlor	1.25	2 DBS Flloded	9.0	112 b	1697 e	1809 e

1/ Days before sowing and application made with field flooded or drained.
2/ Scale 0-9; 0 = no lodging, 9 = more than 80%.
3/ Data with the same letter are not statistically different at 5% level of probability according to Duncan's Test.

At least, it was observed in this study that the application of one single product does not completely control red rice, and also that other annual weeds escaped the effect of Glyphosate and Paraquat. This shows the need of searching for an integrated management of practices that enable to make weed control more efficient.

3.5.1.3. Evaluation of Water Management and Mechanical Weeding for the Control of Red Rice in Row-Seeded Rice.

This study was carried out with the objective of identifying the best combination of cultural practices which could achieve an efficient control of red rice. The experiment was established in March 1991 on a farm highly infested with red rice, owned by Mr. A. Jiménez, located in La Ceiba, Bonao. A split-split plot experimental design with 4 replications was used. Large plots, sub-plots and sub-sub-plots corresponded to pre-plant herbicide application, water management and mechanical weed control, respectively.

The pre-plant herbicide application consisted of applying Oxifluorfen (3.0 lt/ha) into a water layer 6 days after the final plot leveling. The field was drained 6 days after the application and seeded the day after. The water management consisted of flooding subplots 5, 10, and 15 (Check) days after seeding. Each sub-plot and sub-sub-plot was leveled individually.

The planting method used was row-seeding with pregerminated seed using the manual drum seeder. Seeding rate was of 85 kg/ha at a distance of 20 cm between rows and the variety used was JUMA 64. Mechanical weeding was accomplished 23 days after seeding, through the use of the single-row cone weeder. In order to make treatments uniform, a mixture of Propanil + 2,4-D (4.0 + 0.25 lt/ha, respectively) was applied to control weeds, complemented by one hand weeding.

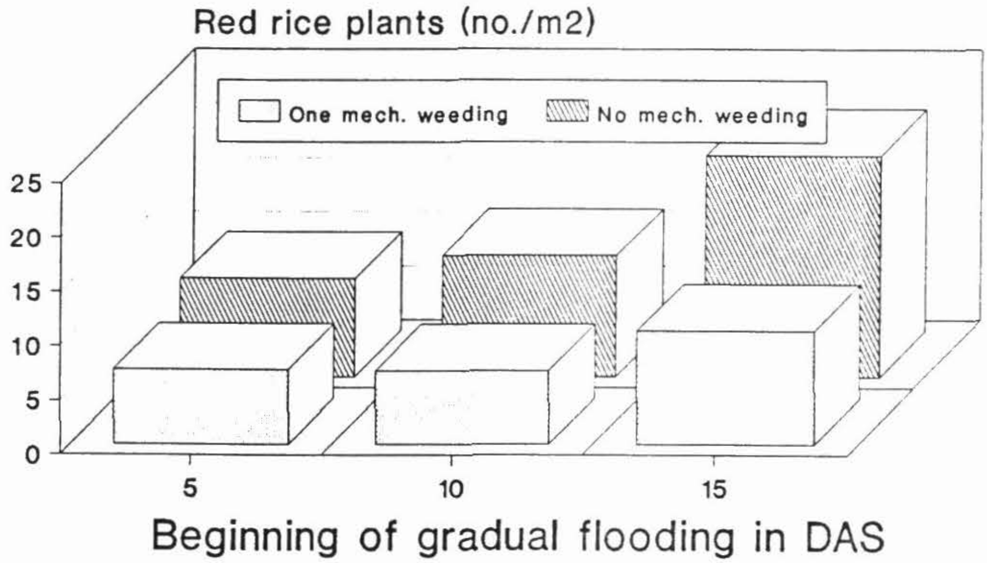
3.5.1.3.1. Results and Discussion.

Regardless of the chemical and mechanical control used, flooding plots gradually at 5 and 10 days after seeding reduced the number of red rice plants, and consequently, increased commercial rice yield (Fig. 18 and 19). One mechanical weeding 23 days after seeding controlled red rice by 40% and increased commercial rice yield by 12% (Table 23).

The data show that the combination of gradual flooding 5, 10 and 15 days after seeding (DAS) and one mechanical weeding, resulted in a better control of red rice (Fig. 18) and a higher yield (Fig. 19). As to treatments without mechanical weeding, gradual flooding at 5 and 10 DAS achieved a significant control of red rice, which also resulted in a higher yield (Fig. 18 and 19).

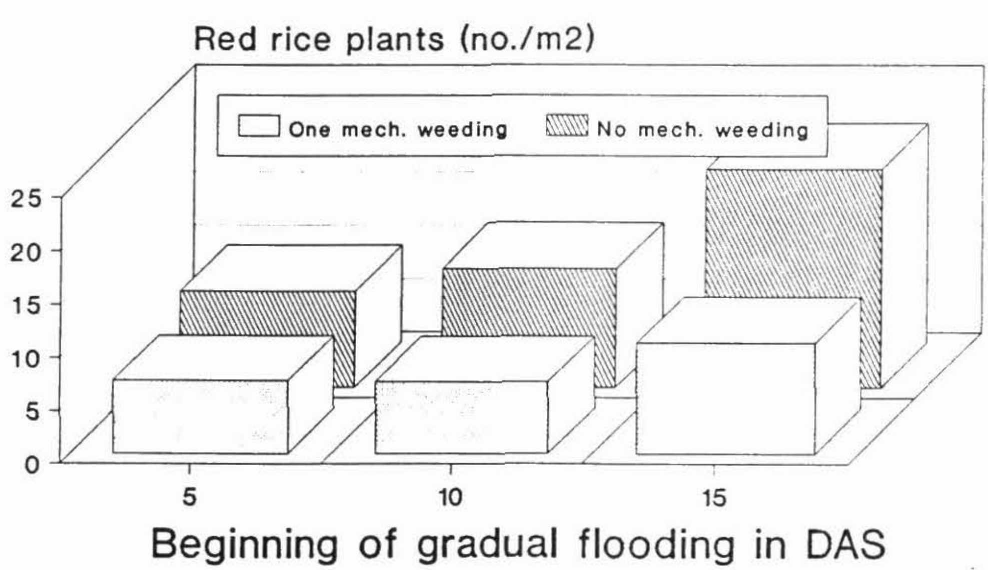
The results show the potential that exists in combining water management and mechanical weeding to control red rice in irrigated fields.

Figure 18. Effect of the beginning of gradual flooding on red rice control. La Ceiba, Dominican Republic, 1991.



DAS = Days after seeding

Figure 19. Effect of the beginning of gradual flooding on rice yield. La Ceiba, Dominican Republic, 1991.



DAS = Days after seeding

Table 23. Effect of Mechanical Weeding on the Number of Plants of Red Rice and Yield. La Ceiba, Bonao, Dominican Republic. 1991.

Mechanical weeding	Red rice plants (no./m^2)	Yield (kg/ha)
1[a]	8.1	5935
none	13.6	5315
Difference	- 40%[b]	12%[b]

a/ At 23 days after seeding.
b/ Statistically significant at 1%.

3.5.1.4. Validation of Methods for Control of Red Rice with Farmers' Participation. Los Barros, Bonao.

These studies were carried out in the Community of Los Barros, Bonao where Eng. Jesús Rosario, a **CRIN**-trained and **DFA**'s extensionist, pointed out the presence of a heavy infestation with red rice.

Before beginning the studies, a meeting was held with 8 cooperating farmers in order to analyze the rice problem, determine the feasible choices for solution, choose the research plot, and schedule the activities. Based on this, three experiments were conducted during 1991.

The experiments No. II and III were designed according to the results of experiment No. I as well as former results on water management and mechanical weeding studies, and farmers' criteria.

The objective of these experiments was to validate new technologies on integrated red rice and weed control with the participation of small farmers.

3.5.1.4.1. Materials and Methods

3.5.1.4.1.1. Experiment I was established in february 1991 on a commercial farm highly infested with red rice. This study consisted of five observational treatments of 500 m2 each without replication. Treatments' description is shown on Table 24.

All treatments were hand-weeded twice at 61 and 82 days after seeding. Red rice plants were not eliminated in 6 representative plots per treatment which were randomly distributed, in order to evaluate the efficiency of all treatments and quantify the damage caused by red rice.

3.5.1.4.1.2. Experiment II was conducted with the same farmer of experiment I and consisted of six treatments of 400 m^2 with 2 replications. Treatments' description of experiment II is shown on Table 25.

The land preparation consisted of 2 passes with the Hydrotiller. Leveling was completed immediately after the second tillage for treatment 1 (Oxifluorfen) and 7 days later for the other treatments. Oxifluorfen (3.0 lt/ha) was applied on a water layer 4 days after the final leveling. The plots were drained 6 days after the application and seeded the day after. All treatments were planted (direct seeding and transplanted) in rows 20 cm apart, mechanical weeded twice and hand-weeded once.

Table 24. Description of Treatments in Experiment No. I.

Treatment	Description
T_1	Land preparation (2 puddlings) and leveling in 7 days; flooding with a water layer during 19 days; drainage; row seeding; mechanical weeding at 20 and 32 days after seeding.
T_2	Land preparation (2 puddlings) and leveling in 7 days; soil kept wet for 8 days to stimulate weed germination; weed control with Paraquat; light flooding 2 days after herbicides application and seed broadcast the day after. Weed control in early post-emergence with a mixture of Butachlor, Propanil and 2,4-D (3.0 + 4.0 + 0.3 lt/ha, respectively).
T_3 (Check)	Land preparation (2 puddlings) and initial leveling; soil kept wet for 11 days; final leveling and seed broadcasting the next day. Weed control in early post-emergence with a mixture of Butachlor, Propanil and 2,4-D (3.0 + 4.0 + 0.3 lt/ha, respectively).
T_4	Land preparation (2 puddlings) and leveling in 7 days, soil kept wet during 6 days to stimulate weed germination; application of Oxifluorfen (3.0 lt/ha) on a water layer and draining the field 6 days after the application. Broadcast the day after; weed control in early post-emergence with a mixture of Propanil and 2,4-D (3.5 + 0.3 lt/ha, respectively).
T_5	Land preparation (2 puddlings) and initial leveling; soil kept wet for 11 days, and then final leveling. Row seeding, mechanical weeding at 20 and 32 days after seeding.

Table 25. Description of Treatments in Experiment II.

Treatment	Description
T_1	Oxifluorfen, row-seeding, post-emergent herbicides and mechanical weeding.
T_2	Row-seeding and mechanical weeding.
T_3	Row-seeding, post-emergent herbicides and mechanical weeding.
T_4	Mechanical transplanting, post-emergent herbicides and mechanical weeding.
T_5	Manual transplanting and mechanical weeding.
T_6	Manual transplanting, post-emergent herbicides and mechanical weeding.

A manual row seeder was used with pregerminated seed for the direct seeding. Mechanical transplanting was done with a manual transplanter designed by IRRI and under evaluation in Dominican Republic. Seedlings of 25 days were used for mechanical and manual transplanting. The early post-emergence weed control consisted of one application of a mixture of Propanil and 2,4-D (4.0 + 0.2) lt/ha, respectively. In treatment 1, it was decided to include mechanical weeding because of the poor control of red rice achieved by Oxifluorfen. JUMA 64 was the variety used.

3.5.1.4.1.3. Experiment III was carried out in a commercial field seeded in rows 20 cm apart, using the variety JUMA 57. The experimental field was infested with red rice and well levelled. A randomized complete block desing (RCBD) with 3 replications was used. Table 26 shows the description of the treatments. The single-row cone weeder was used for the mechanical weeding.

Table 26. Description of Treatments in Experiment III.

Treatment	Description[1]
T_1	One mechanical weeding at 15 DAS[2], followed by 2,4-D + Propanil at 20 DAS, and one mechanical weeding at 33 DAS.
T_2	2,4-D + Propanil at 20 DAS (Farmers' practice).
T_3	2,4-D + Propanil at 20 DAS, followed by two mechanical weedings (24 and 33 DAS).
T_4	2,4-D + Propanil + Butachlor at 20 DAS.
T_5	One mechanical weeding at 15 DAS, followed by 2,4-D + Propanil + Butachlor at 20 DAS.

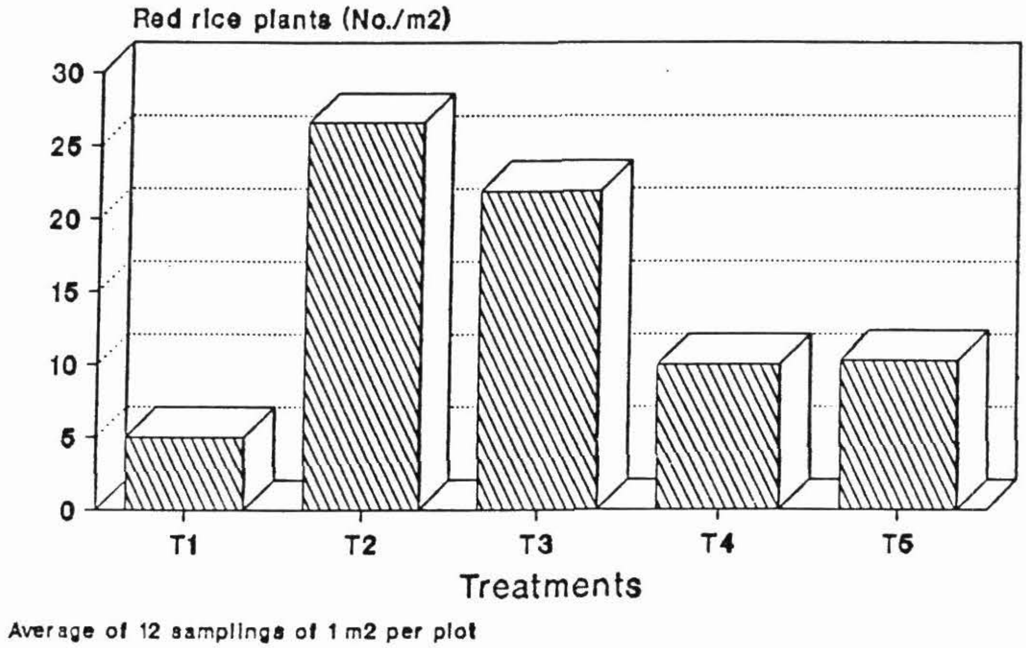
1/ Herbicide dosage: 2,4-D = 0.350 lt/ha, Propanil = 5.0 lt/ha, Butaclor = 4.0 lt/ha
2/ DAS = Days after seeding

3.5.1.4.2. Agronomic results and discussion

3.5.1.4.2.1. Control of red rice and other weeds

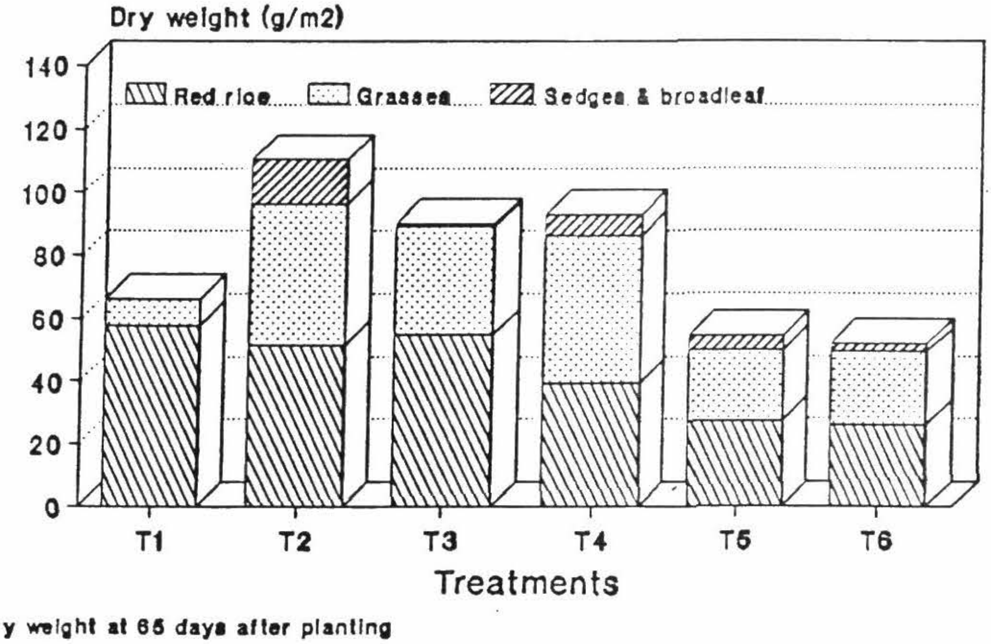
In experiment I, the effects of the treatments on red rice control are summarized in Figure 20. Flooding and mechanical weeding (T1), chemical control with Oxifluorfen (T4) and mechanical weeding alone (T5) significantly decreased plant population of red rice, as compared to check without control (T3). On the other hand, it can be observed that the treatment with Paraquat as suggested by farmers (T2) was not effective. It should be pointed that in check treatment (T3) there was an 11 days span between initial and final leveling. This practice influenced the decrease of red rice population, since this was less than the observed in treatment with Paraquat (T2).

Figure 20. Red rice plants as influenced by methods of control. Experiment I. Los Barros, Dominican Republic, 1991.



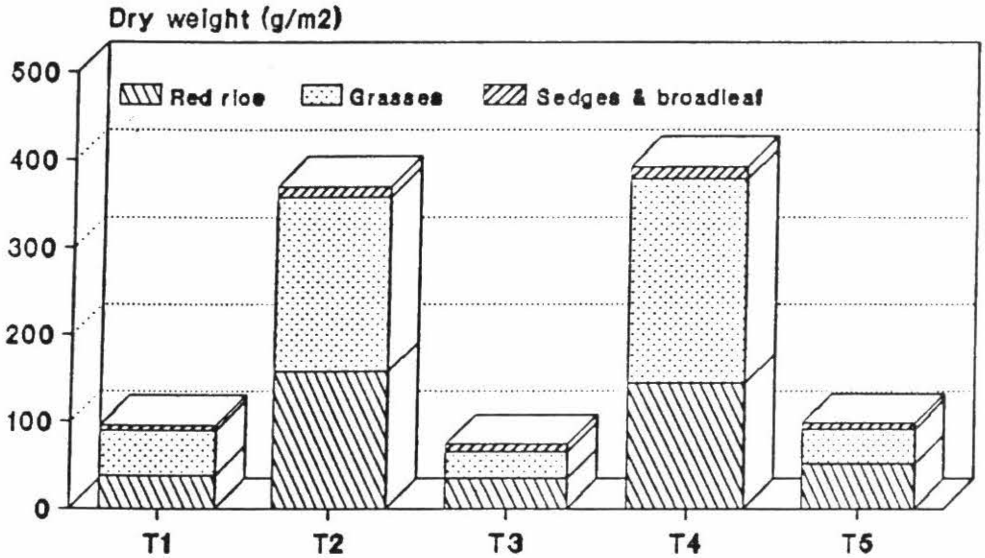
In experiment II, the effects of treatments on red rice and other weeds are shown in Figure 21. Rice transplanted manually in rows followed by two mechanical weedings (T5 and T6) had greater effects in decreasing red rice infestation than the other treatments. On the other hand, treatment with Oxifluorfen (T1) was not effective in controlling red rice. The poor control of red rice with Oxifluorfen observed could, however, be ascribed to low rate of germination at the moment of its application (only 4 days after the final land preparation). The application in post-emergence of 2,4-D and Propanil before mechanical weedings reduced grasses, sedges and broadleaf weeds, in row-seeded rice (T3 versus T2 of Fig. 21). The effects of these herbicides were not significant in transplanted rice (T6 versus T5 of Fig. 21).

Figure 21. Weight of weeds as influenced by methods of control. Experiment II. Los Barros, Dominican Republic, 1991.



In experiment III, the effects of the mechanical weeding in row-seeded rice are shown in Figure 22. In plots treated with 2,4-D and Propanil, two mechanical weedings (T1 and T3) reduced significantly the infestation of red rice and grass weeds as compared to the chemical control alone (T2). Passing the rotary weeder before (T1) or after (T3) the application of the mixture of the post-emergent herbicides did not influence significantly the control of all weeds. One mechanical weeding before the application of the mixture of 2,4-D, Propanil and Butachlor (T5) decreased also red rice and grass weeds infestation as compared to chemical control alone (T4).

Figure 22. Weigth of weeds as influenced by methods of control. Experiment III. Los Barros, Dominican Republic, 1991.



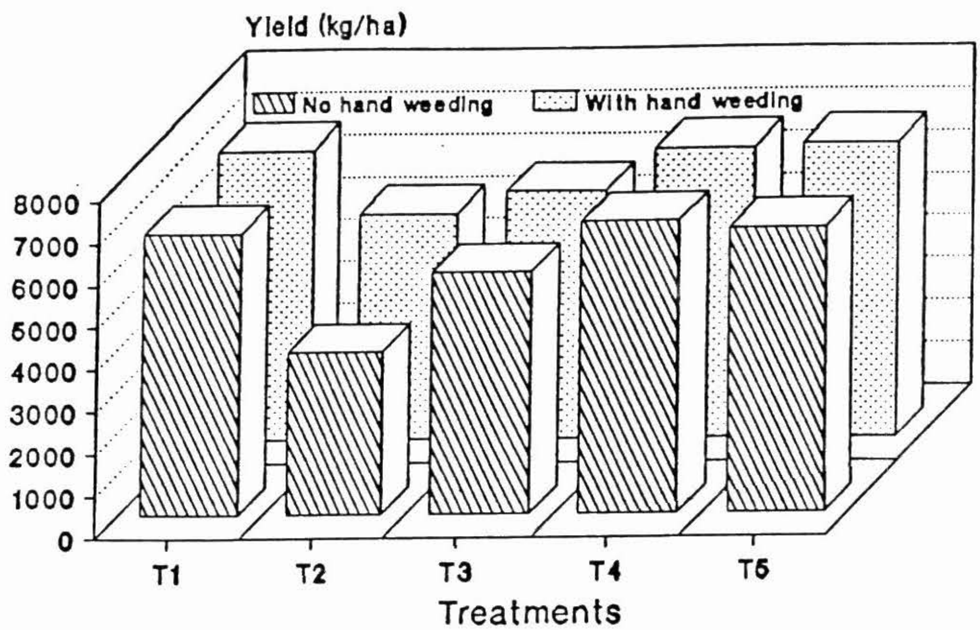
Dry weight at 85 days after seeding.

The effects of early post-emergence application of 2,4-D and Propanil followed by two mechanical weedings on weed control in row-seeded rice were similar in experiment II and III (T3 in both Fig. 21 and 22). In general, mechanical weeding, with or without chemical weed control, provided a significant degree of control of red rice and other weeds. In contrast, Oxifluorfen had a significant effect on red rice control in experiment I, but not in experiment II.

3.5.1.4.2.2. Rice yield

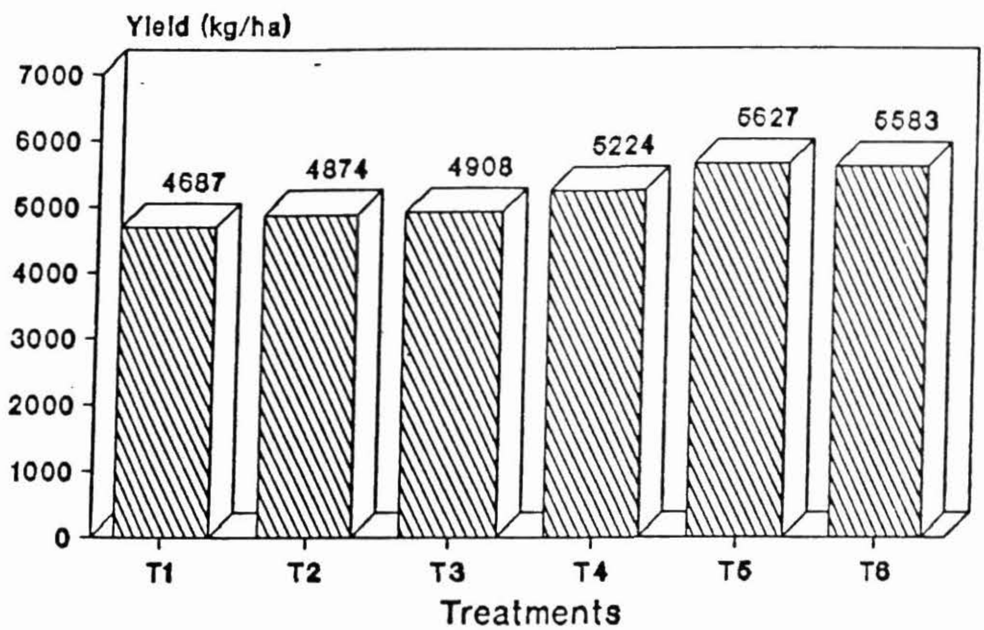
In experiment I, treatments with flooding and mechanical weeding (T1), Oxifluorfen (T4) and mechanical weeding alone (T5) produced the highest yields, in a range from 6694 to 6955 kg/ha (Fig. 23). On the other hand, except for treatment with Paraquat (T2), the elimination of red rice plants through hand weeding did not influence total rice yield significantly (Fig. 23).

Figure 23. Rice yield as influenced by methods of weed control. Experiment I. Los Barros, Dominican Republic, 1991.



In experiment II, manually transplanted rice (T5 and T6) produced the highest yield (Fig. 24). Yield of row-seeded treatments with direct seeding (T1, T2 and T3) was lower than the transplanted one, probably because the plots were harvested too early by the farmer and sampling had to be done at the same time. At that time, a high proportion of the kernels in the lower portion of panicles were still at the milk and soft dough grain stages. On the other hand, mechanically transplanted rice (T4) produced slightly less than the treatments transplanted manually presumably because of mechanical problems with the manual transplanter since about 40% of the hills had to be replanted. At harvest time, many of the plants from these hills were still at milk and soft dough grain stages.

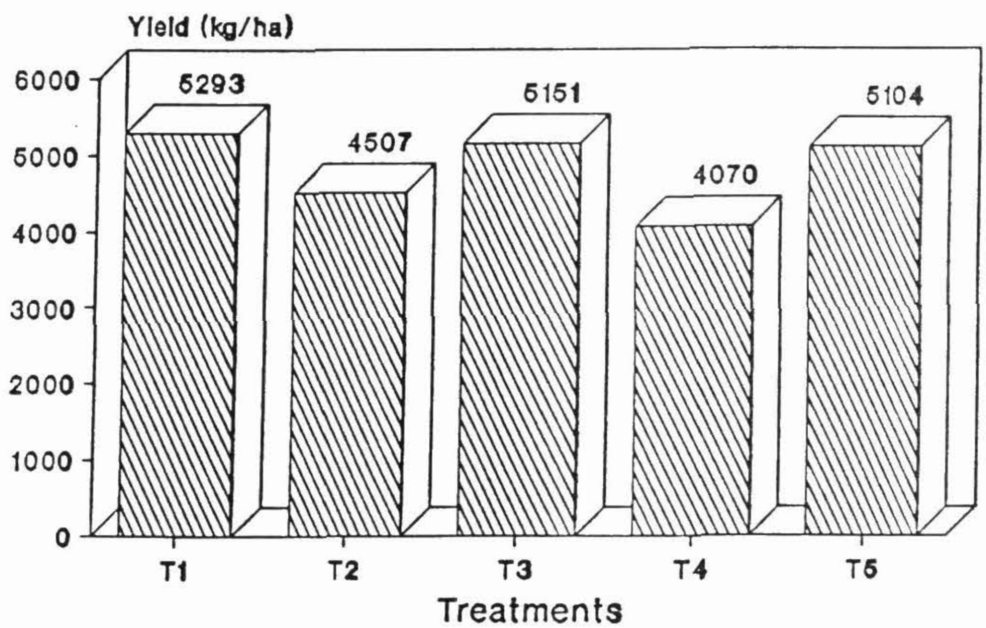
Figure 24. Rice yield as influenced by methods of weed control. Experiment II. Los Barros, Dominican Republic, 1991.



In experiment III, the plots with mechanical weeding (T1, T3 and T5) produced the highest yields, ranging from 5104 to 5293 kg/ha (Fig. 25). Mechanical weeding decreased the weed population to be controlled later by hand (Fig. 22), resulting in enhanced rice grain production.

In summary, an effective early control of red rice and other weeds by chemical and/or mechanical methods had a marked effect on rice production.

Figure 25. Rice yield as influenced by methods of weed control. Experiment III. Los Barros, Dominican Republic, 1991.



3.5.1.4.3. Economic Results.

Figure 26 and Table 27 show the cost and gross income of treatments in experiment I. According to these results, treatment 1 was the most efficient in economic terms since its cost (RD$3,001.00/ha) was much lower than the rest of the treatments, which costs varied from RD$5,056.00/ha to RD$7,660.00/ha. In addition, its yield was the second highest of the trial (6866 kg/ha) as indicated in Figure 23.

Figure 26. Cost of treatments in experiment I by method of weed control

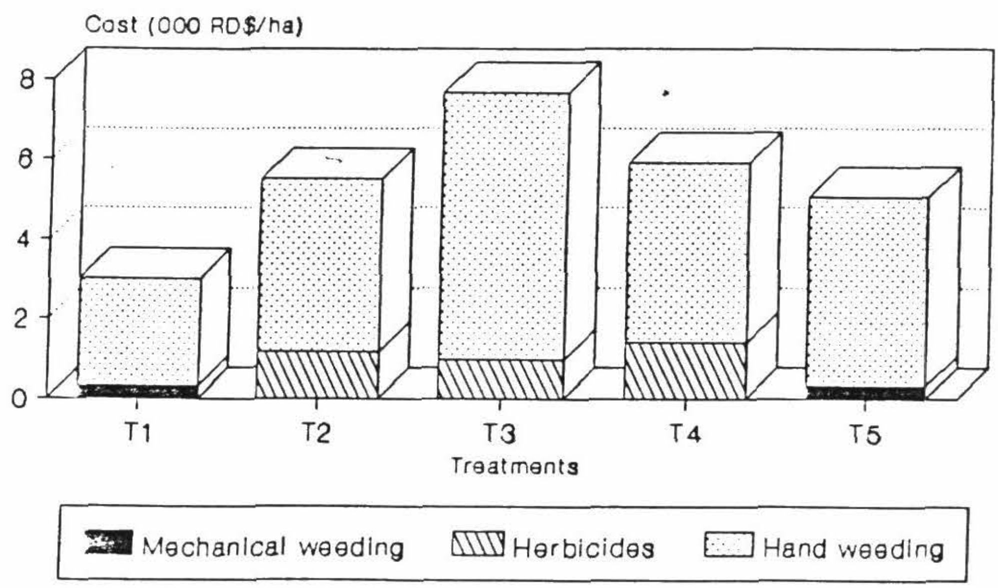


Table 27. Economic Efficiency of Treatments in Experiment I. Los Barros, Dominican Republic. First Semester, 1991.

Treatment (No.)	Yield paddy (kg/ha)	Gross[1] income (RD$/ha) (A)	Total cost of weed control (RD$/ha) (B)	A/B Ratio
1	6866	28,013.00	3,001.00	9.33
2	5348	21,820.00	5,519.00	3.95
3	5870	23,950.00	7,660.00	3.13
4	6855	27,968.00	5,897.00	4.74
5	6955	28,376.00	5,056.00	5.61

US$1 = RD$12.50
1/ Sale price = RD$4.08/kg of paddy rice

Treatments 4 and 5 also produced high yields (over 6855 kg/ha), but their hand-weeding expenses reduced their economic efficiency as compared to treatment 1. On the other hand, treatments 2 and 3 (check) had the least economic efficiency among all treatments, due to high hand-weeding costs and lower yield (5348 and 5870 kg/ha, respectively).

Even though treatment 3 achieved better control of red rice than treatment 2, its hand-weeding cost was much higher. This was due to a high infestation with Ischaemum rugosum and Cyperaceae, which were better controlled by the herbicide Paraquat used in treatment 2.

The economic results of experiment II are presented in Figure 27 and Table 28. These results show that treatments 5 an 6 had the lowest costs of the trial, with RD$2,671.20/ha and RD$3,021.00/ha, respectively, as well as the highest gross income (RD$20,145.30/ha and RD$19,986.30/ha, respectively), making them the most efficient in economic terms. These treatments were followed in order of economic efficiency by treatments 4, 3 and 2.

Figure 27. Cost of treatments in experiment II by method of weed control

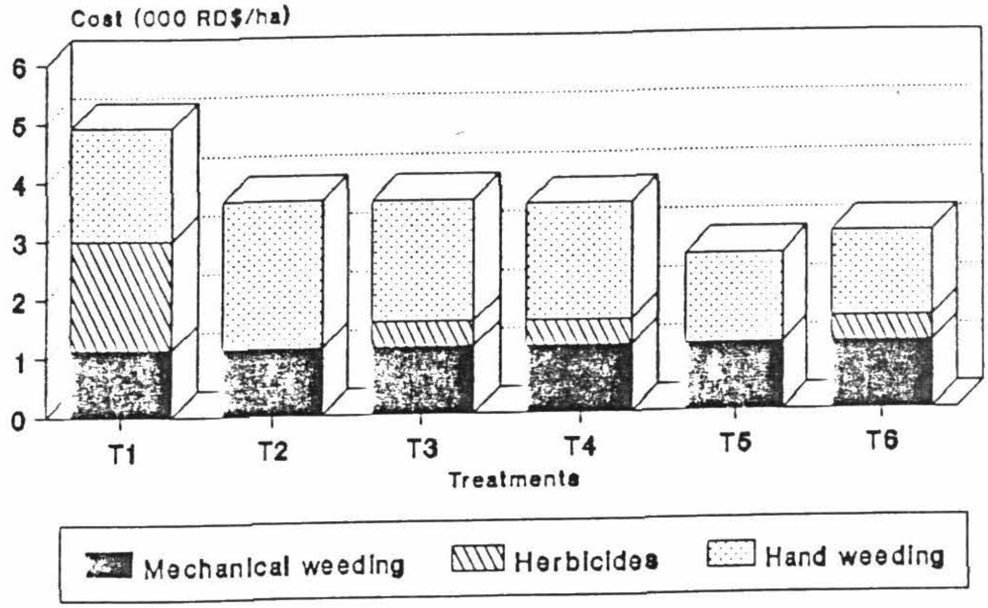


Table 28. Economic Efficiency of Treatments in Experiment II. Los Barros, Dominican Republic. Second Semester, 1991.

Treatment (No.)	Yield paddy (kg/ha)	Gross[1] income (RD$/ha) (A)	Total cost of weed control (RD$/ha) (B)	A/B Ratio
1	4687	16,790.40	4,929.00	3.41
2	4874	17,474.10	3,657.00	4.78
3	4908	17,585.40	3,641.10	4.83
4	5224	18,730.20	3,561.60	5.26
5	5627	20,145.30	2,671.20	7.54
6	5583	19,986.30	3,021.00	6.62

US$1 = RD$12.50

1/ Sale price = RD$3.58/kg of paddy rice

Treatment 1 had the least economic efficiency, due to the great expenses incurred in herbicides as compared to the other treatments. The use of more herbicide did not prevent this treatment from having the lowest yield of the trial (4,687 kg/ha), and therefore the lowest gross income.

3.5.1.4.4. Evaluation and Adoption of the New Technology by Farmers.

Prior to the evaluation of the technologies, a "field day" was held in the Community of Los Barros in order to show the land preparation work (design of straight levees and land leveling), the study of alternatives for the integrated management of red rice, and the equipment used (8-row drum seeder and single-row cone weeder). This activity was attended by 11 technicians and 25 farmers.

Before and after harvest of each experiment, the treatments tested in the field were discussed and evaluated with all 8 participating farmers.

At the end of the first season, from the options for the integrated management of red rice in experiment I, the farmers chose the treatment that includes "flooding the field before planting, row-seeding and mechanical weeding" as the most effective and economical one. However, the treatment including only row-seeding and mechanical weeding seems to be a very good prospect.

During the second season, the treatment including row-seeding, post-emergent herbicides and mechanical weeding was chosen by the farmers as the most economical on integrated control of red rice and other weeds under their conditions. However, it was pointed out that heavy rain dispersed the seeds sowed in rows in two fields. In this case, the rotary weeder could not be used without destroying many rice plants.

Because of the good control achieved on red rice, some farmers preferred the treatments in which rice was transplanted manually in rows, followed by two mechanical weedings (T5 and T6 of experiment II).

The adoption of new technologies is evident in the Community of Los Barros. From its 23 farmers: i) Thirteen are developing their land (straight levees and pool leveling totally or partially; ii) Four of them have row-seeded and three used the cone weeder; iii) One farmer has transplanted rice manually in rows and will use the cone weeder to control red rice, and; iv) Eight farmers planted the new variety JUMA 64, because of they saw its good yielding potential and earliness, on the farms with integrated management of red rice. However, and v) Recent information (1992) indicates improvement on above mentioned data.

3.5.1.5. Determination of the Efficiency of Urea Placed in Residual Soil Layer with a Pneumatic Injector.

This study was carried out with the objective of obtaining research-level results under Caribbean conditions on the efficiency of Urea injected to the soil with a pneumatic injector provided by the Netherlands Fertilizer Institute, as compared to top-dressed application. This study is part of an agreement between **CRIN** and the above Institute.

Two field experiments, each conducted during the first and second semester of 1991, were practiced at CEDIA, Dominican Republic. Soil was a silty clay loam with a pH 5.6 and 2.8% organic matter.

3.5.1.5.1. Materials and Methods.

Planting methods were, transplanting and row-seeding during the first and second semester, respectively. For transplanting, seedling 25 days old were used and planted at a distance of 20 x 20 cm. Row-seeding was made with pregerminated seed using the manual row seeder. Seeding rate was of 85 kg/ha at a distance of 20 cm between rows.

In both experiments, variety JUMA 64 was used. In each experiment, all plots were fertilized before transplant with an equivalent of 80 kg/ha of P_2O_5 and K_2O. The experiments were laid out in a RCBD with four replications. Plot size was 3 x 10 m.

The evaluated treatments correspond to the application of 0, 60, 90 and 120 kg of N/ha using the injection and top-dressing methods. Injection of total N was made at one week after transplanting and three weeks after row-seeding. The distance between injections was 40 x 40 cm in transplanted plots and 40 x 50 cm in row-seeded ones. Plots were kept flooded (5-10 cm) for injecting Urea. In top-dressed method, the total dosage of N was split in 40, 40 and 20% of total N, applied at 1 and 4 weeks after transplanting and at panicle initiation, respectively. In row-seeded rice this was made at 3 and 6 weeks after seeding and at panicle initiation, respectively. Plots were drained one day before top-dressed application and re-flooded the day after.

3.5.1.5.2. Results and Discussion.

Results of the experiments are presented in Table 29 and 30. In the transplanted rice experiment, deep placement of Urea with the pneumatic injector significantly increased grain yield as compared to top-dressed application of equal levels of Nitrogen (Table 29). In the row-seeded experiment, however, there was no significant effect of Urea application methods on grain yield.

In the transplanted rice experiment, the highest yields of variety JUMA 64 (7653 and 7419 kg/ha) corresponded to the application of 120 and 90 kg/ha of injected N, respectively (Table 29). No significant difference in rice yield was found between the application of 60 kg/ha of injected N, (6493 kg/ha) and the application of 120 kg/ha of top-dressed N (5830 kg/ha). However, the injected-N treatment surpassed the top-dressed one in 663 kg/ha.

Table 29. Treatments and Results of the Comparative Study on Urea Application Methods in Transplanted Rice. Juma, Dominican Republic, 1991[1].

No.	Treatment description	Plant height (cm)	Yield (kg/ha)	Panicles/m2 (no.)	Grains/ panicle (no.)	1000 grains weight (g)
1	Check (0 N)	79 d	3656 e	179 c	80a	30.7a
2	60 kg of N/ha injected	95ab	6493 b	275ab	91a	31.5a
3	90 kg of N/ha injected	95ab	7419a	286a	89a	31.7a
4	120 kg of N/ha injected	96a	7653a	290a	92a	31.2a
5	60 kg of N/ha top-dressed	89 c	5018 d	202 c	80a	31.3a
6	90 kg of N/ha top-dressed	90 bc	5362 cd	244 b	84a	31.7a
7	120 kg of N/ha top-dressed	91 bc	5830 bc	247 b	93a	31.6a
Coefficient of variation (%)		3.7	7.9	8.3	8.8	2.0

1/ In the same column, data followed by the same letter are not statistically different according to Duncan's Test at 5%.

Plant height and the number of panicles per m^2 were increased by the injection of Urea in both experiments. In the transplanted experiment, none of the treatments with Urea had significant influence on the number of grains per panicle and 1000-grain weight (Table 29). In the row-seeded experiment, these yield components were, however, affected by the methods of Urea application (Table 30). For the application of 90 and 120 kg/ha of total N, the injection decreased the number of grains per panicle as compared to top-dressed. But this effect was not reflected in the grain yield because of the higher number of panicles per m^2 in the injected Urea treatments (Table 30).

Table 30. Treatments and Results of the Comparative Study on Urea Application Methods in Row-Seeded Rice. Juma, Dominican Republic, 1991.[1]

No.	Treatment description	Plant height (cm)	Yield (kg/ha)	Panicles/m2 (no.)	Grains/ panicle (no.)	1000 grains weight (g)
1	Check (0 N)	73 d	3553 c	276 c	42 c	29.5a
2	60 kg of N/ha injected	88 bc	5987 b	369 b	52ab	30.7a
3	90 kg of N/ha injected	92ab	6483ab	443a	47 bc	30.5ab
4	120 kg of N/ha injected	93 a	6785ab	486a	47 bc	30.2 b
5	60 kg of N/ha top-dressed	85 c	5778 b	350 b	52ab	30.1 b
6	90 kg of N/ha top-dressed	85 c	6602ab	389 b	55ab	30.8a
7	120 kg of N/ha top-dressed	90ab	7115a	391 b	58a	30.5ab
Coefficient of variation (%)		3.1	10.6	7.9	11.4	0.9

The results obtained from this study show that, in transplanted rice, deep placement of Urea increased Nitrogen efficiency as compared to top-dressing in the conditions of Juma, Dominican Republic. However, in row-seeded rice, deep placement of urea did not improve the efficiency of N.

3.5.1.6. Implications.

i) It was defined the economical importance of yield losses on commercial rice yields caused by different population of red rice plants/m^2.

ii) An integrated crop management (**ICM**) as control method of red rice and other weeds was developed, where a combination of diverse practices such as; seeding methods, chemical treatment, water management and mechanical weeding, play an important role.

iii) The **ICM** approach for weed control is; reliable practical and economical, where small farm machinery is efficiently utilized in combination with the agronomy of crop management.

iv) Research development with farmers participation was a rice experience practiced and results implemented at Los Barros Community, Bonao, in Dominican Republic.

v) The general and specific results released from the collaborative research chapter are feasible to implement in other rice producers Caribbean Countries since there exist likeness in rice production.

3.6. Surveys of Technological Constraints.

3.6.1. Surveys of Technological Constraints to Rice Production in the Dominican Republic.

This survey started in 1990 in cooperation with the Rice Extension Department **(DFA)** of the Ministry of Agriculture **(SEA)**. Questionnaires were distributed and collected during 1990 with final analysis being completed in 1991.

The objective of the survey was to define the technology use by rice farmers and identify the main constaints limiting rice production in the Dominican Republic. This information would be very useful in the design of research and extension policies aimed at overcoming those constraints.

3.6.1.1. Methodology.

The sample selected consisted of 160 rice farmers from the 5 most important rice producing regions, which comprise 97% of total area planted (Table 31). This sample included small, medium and large private farms, as well as those distributed by the Agrarian Reform. The interviews were carried out with the cooperation of Extension Agents from **DFA**.

Table 31. Number of Rice Farmers Selected in the Dominican Republic, 1990.

Region	% National area planted	No. of farmers
Northeast	18 %	27
Northcentral	40 %	60
Northwest	26 %	40
Southwest	10 %	23
East	3%	10
Total	97%	160

3.6.1.2. Results

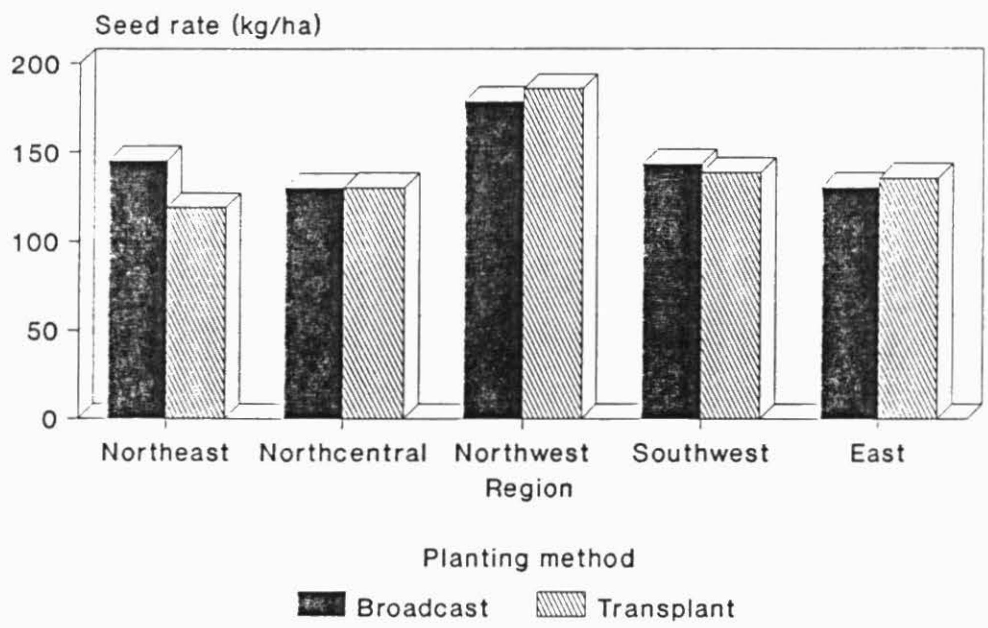
From the 160 questionnaires distributed, 127 were completed and collected (80%). The remaining 33 questionnaires could not be completed due to logistic and budgetary constraints. The main results that came out of the survey include:

3.6.1.2.1. Land Preparation. Farmers carry out three to four operations during land preparation before leveling. The most cammon method of land preparation consist of 3 to 4 puddlings with power tiller. In the Northwest and Southwest regions is very common that farmers first prepare the land dry and then puddle the soil using a tractor or a power tiller.

3.6.1.2.2. Planting. Direct seeding is the planting method used by the majority of rice farmers in the country. A few years ago, transplanting was the prefered practice, but sharp increases in labor costs lowered the interest of farmers in using this method.

Farmers are using an average of 145.3 kg of seed/ha in direct seeding and an equivalent of 141.6 kg/ha in transplanting (Fig. 28). They claim that a high seeding rate is necessary in order to compensate for the low quality of rice seed available in the market, as well as for the seed losses caused by rats on the field and on seedbeds.

Figure 28. Seed rate used by rice farmers in the Dominican Republic, 1990.



The highest seeding rates were found in the Northwest region, with 178.5 and 185.7 kg of seed/ha for direct seeding and transplanting, respectively. A survey carried out by **DFA** in 1983 placed the use of seed in this region in 119.0 and 129.0 kg/ha for direct seeding and transplanting, respectively. This indicates that seeding rate has increased in this region over the past decade. The Southwest region has also observed an increase in seeding rate during the same period, from 83.0 to 143.0 kg/ha (72.3%) for direct seeded rice, and from 94.0 to 138.5 kg/ha (47.3%) for transplanted rice. On the other hand, it was observed that farmers are using approximately the same seeding rate for either broadcast or transplanted rice.

For transplant, most farmers are using seedlings over 30 days old, except for the East region where 67% of farmers use seedlings 20-30 days old (Table 32). In the case of the Southwest region, 67% of farmers polled use 41 day-old seedlings for transplanting.

Table 32. Age of Rice Seedlings Used for Transplant in the Dominican Republic, 1990.

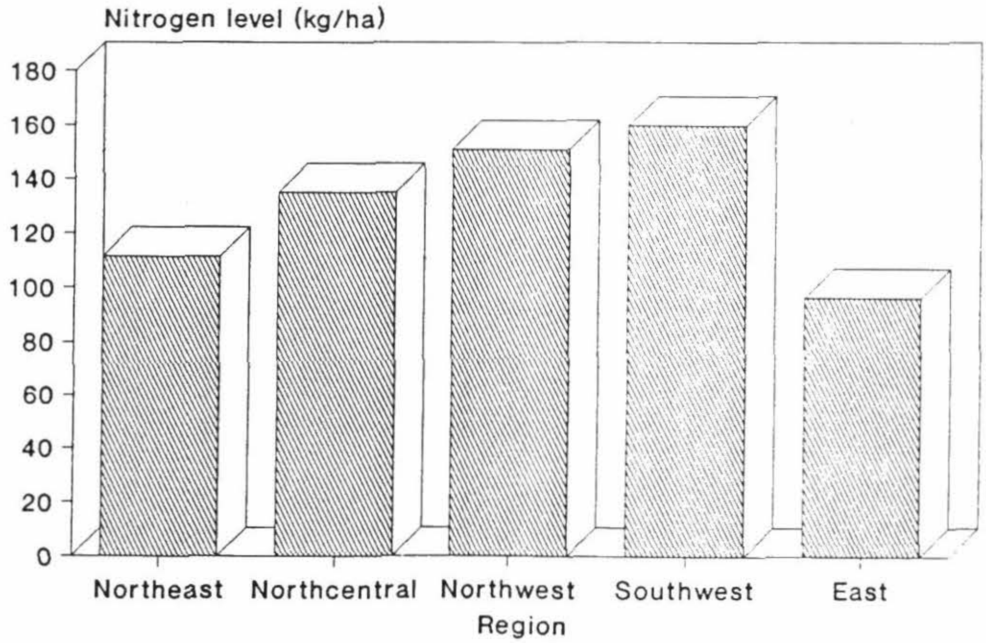
Region	Mean age (Days)	Percentage of farms		
		20-30 days	31-40 days	Over 40 days
Northeast	36	24	59	18
Northcentral	37	18	53	29
Northwest	35	23	64	14
Southwest	41	0	33	67
East	36	67	0	33

Older seedlings usually recover more slowly than younger seedlings. However, older seedlings are sometimes prefered because they give better weed competition, especially when weeds are not controlled early. Late transplanting may also be a result of delays in land preparation caused by unavailability of machinery at the time needed.

3.6.1.2.3. Fertilization. The level of Nitrogen applied by the farmers polled varied from o to 282.0 kg/ha, with a mean level of 150.8 kg/ha, usually divided in 3 aplications (Fig. 29). Farmers in the Northwest and Southwest apply the most Nitrogen, while those in the East region only apply 96.6 kg/ha, the lowest in the country. The Nitrogen level has increased considerably in the Northwest and Southwest regions since 1983, when the dosage reported was 119.5 and 96.6 kg/ha, respectively.

The average amount of Phosphorus and Potasium applied to the rice crop were of 59.3 and 46.2 kg/ha, respectively.

Figure 29. Nitrogen level used by rice farmers in the Dominican Republic, 1990



The majority of farmers make their first fertilizer application in the period between 22 and 35 days after seeding (DAS) (Table 33). However, 67% of farmers in the East region prefer to make this application before 21 DAS, while in the Northwest they do it when crop is over 35 days old. In transplanted rice this application is usually made at 7-15 days after transplanting (DAT). Nevertheless, a considerable proportion of producers make this application after 15 DAT, especially in the Northwest region (45%).

Table 33. Time of First Fertilizer Application in Rice Crop in the Dominican Republic, 1990.

	Direct seeding (% of Farms)			Transplanting (% of Farms)	
Region	= < 21 DAS[a]	22-35 DAS	> 35 DAS	7-15 DAT[b]	> 15 DAT
Northeast	12	79	9	83	17
Northcentral	0	100	0	55	45
Northwest	38	62	0	75	25
Southwest	8	50	42	67	33
East	67	17	17	N. A[c].	N. A.

a/ DAS = Days after seeding
b/ DAS = Dat after transplant
c/ N.A. = Not available

3.6.1.2.4. Crop Protection.

3.6.1.2.4.1. Weed Control. The common practice used by farmers for weed control consists of one application of the mixture Propanil + 2,4-D, and then complement with the necessary hand-weedings. The herbicide application is made at 15 to 30 DAS in direct seeded rice, depending on the type of weed present and the infestation level (Table 34). In the Southwest, however, 43% of farmers make the application after 30 DAS, which may be due to the fact that 87% of these farmers rotate rice with beans, corn and sweet potatoes, which helps reduce weed pressure on rice crop.

Table 34. Time of First Herbicides Application in Direct Seeded Rice in the Dominican Republic, 1990.

Region	Percentage of Farms			
	7-14 days	15-22 days	23-30 days	After 30 days
Northeast	0	38	53	9
Northcentral	22	33	44	0
Northwest	11	56	33	0
Southwest	0	0	57	43
East	0	43	57	0

Rice farmers usually hand-weed twice during one season, though many farmers hand-weed up to 4 times when weed infestation, especially with Echinocloa spp, becomes serious; thus increasing cost of production (Table 35). Another reason for the need of 2 or more hand-weedings is the fact that herbicide applications are not being managed properly. For instance, knapsack sprayers are not being calibrated before application and hollow cone nozzles are widely used for herbicide applications instead of the recommended fan nozzles.

Table 35. Number of Hand Weedings Performed by Rice Farmers in the Dominican Republic, 1990.

Region	Range	Mean	% farmers making 2 or more weedings
Northeast	1-4	2.1	30
Northcentral	0-3	1.6	22
Northwest	1-3	2.0	88
Southwest	1-2	1.7	67
East	1-2	1.6	55
Mean (Weighted)		1.90	

3.6.1.2.4.2. Insect control

Farmers sometimes make up to 5 application of insecticide in one season, with the national average being 2 applications per crop (Table 36). In the Northwest, farmers made 3.1 application in average due to the serious attacks of Oebalus sp. which occur in this region.

Table 36. Number of Insecticide Applications Made by Rice Farmers in the Dominican Republic, 1990.

Region	No. of Applications		% farmers making 2 or more insecticide applications
	Range	Mean	
Northcentral	0-5	1.9	30
Northeast	0-5	2.2	37
Northwest	2-5	3.1	70
Southwest	0-3	1.0	7
East	0-4	1.5	27
Mean (Weighted)		2.1	

3.6.1.2.4.3. Disease control

None of the farmers interviewed mentioned diseases among the main factors affecting rice production in their farms. Nonetheless, approximately one half of the farmers in the Northeast, Northcentral and Southwest regions apply fungicide at least one time during the cropping season. In the East only 10% of the farmers used fungicide; whereas in the Northwest, 88% of the farmers polled applied fungicide, with 61% applying at least twice per season.

Farmers make many fungicide applications because they like to include a fungicide in each insecticide application they make. The main reasons given for applying fungicide are to obtain heavier and cleaner rice grains, better plant growth, and disease prevention.

3.6.2. Technology of and Constraints to Rice Production in Guyana.

This study describes the results of a farm survey in the main rice producing regions of Guyana. The objective of the survey was to define the technology of rice production and identify the main constraints limiting rice production in Guyana. This would allow the development of suitable research projects that would appropriately address farmers' needs.

The survey was jointly organised and funded by the Caribbean Rice Improvement Network **(CRIN)** and the National Agricultural Research Institute **(NARI)**.

3.6.2.1. Methodology.

The survey was conducted in the main rice producing regions of Guyana, designated region Nos. 2, 3, 4, 5, & 6. One hundred and eighty farmers were selected from the farm registers of the Guyana Rice Milling and Marketing Authority **(GRMMA)**, the Mahaica-Mahaicony-Abary/Agricultural Development Authority **(MMA/ADA)** and Regional Administration Region No. 4 (Agric. Dept.).

The distribution and number of sampled farmers in regions 2,3,4,5 and 6 were; 50, 40, 30, 30 and 30 respectively, however only one hundred and forty nine questionnaires (83%) were completed. The remaining 17% represented farmers who were inactive for reasons of death, migration, or diversification etc. Interviews were conducted by the regional agricultural staff (mainly crop reporters).

3.6.2.2. Results.

Results from the survey showed that productivity was highest in Region 3 (4.1 t/ha of paddy) and lowest in Region 5 (2.7 t/ha); the highest yield was 52% better than the lowest. Mean yield of paddy was 3.5 t/ha with Region 5 and 6 being respectively, 23% and 3% below the mean; Regions 3, 4 and 2 were respectively 17%, 9% and 6% above the mean (Table 37). The difference in productivity between those farms above the mean and those below could be attributed to both non-technological and technological factors. This discussion will underscore the differences between the highest and lowest yield which is indicative of occurrences for the other regions.

Table 37. Mean Paddy Yield of Rice Farmers in Guyana, 1991.

Region No.	Mean Yield		% deviation from mean yield
	t/ha	S. E.	
3	4.1	0.14	+ 17
4	3.8	0.16	+ 9
2	3.7	0.08	+ 6
6	3.4	0.11	- 3
5	2.7	0.16	- 23
Mean (weighted)	3.5	0.52	

3.6.2.2.1. Non-technological Factors. Three non-technological reasons could be identified as contributory factors to differences in yield between Regions 3 and 5. Firstly, highest yield were associated with farms of small size in Region 3, practically all farms were less than 8.1 ha (20 ac), with 73% being less than 4.0 ha (10 ac). However, in Region 5 most farms (78%) were between 4.5 - 24.3 ha (11 - 60 ac). This suggests that farmers were more efficient in managing smaller holdings than larger ones.

Secondly, it was found that a higher proportion of farms in Region 5 were engaged on other agriculture and non-agricultural activities, while in Region 3, the well being of farmers was more dependent on rice production, therefore more time and effort go towards ensuring the success of the rice crop.

Associated with this is the third reason, that farmlands in Region 5 are located further away from the homestead that those in Region 3. Hence the frequency of farm visits and the rapidity with which corrective action could be taken in the event of crop disturbances (eg. in water management, crop protection) may be lower and slower in Region 5.

3.6.2.2.2. Technological Factors.

Three contributory factors were identified here and these were, time of sowing, frequency and quantify of Urea applied and crop protection. Generally, farms with above average yields planted mid-late June, while those farms below average planted before and after this period. In Region 5, farmers planted early June and early May as opposed to farmers in Region 3 who planted early-mid June. Planting mid June may have allowed the rice crop to be in a position to capitalize on optimum environmental conditions. Studies could be initiated to examine the correlation between planting date and yields.

Rice responds positively to increasing levels of Nitrogen and more frequent applications. In Region 3, farmers apply Urea 2 and 3 times as opposed to Region 5 where equal proportions of farmers (48%) apply it once and twice (Table 38). Eighty-three kilograms Urea per hectare is applied once in Region 5 and 122 kg/ha twice; while in Region 3, 138 kg/ha is applied twice and 168 kg/ha three times (Table 39). Thus, farmers in Region 3 apply up to 100% more Urea than farmers in Region 5.

Table 38. Percentage of Rice Farmers in Guyana Applying Urea at Various Frequencies, 1991.

	No. of Urea applications		
	1	2	3
Region No.	% of farmers		
2	6	90	4
3	10	66	24
4	15	85	0
5	48	48	4
6	14	48	38
Mean (weighted)	16	70	13

Table 39. Quantity of Urea Applied at Various Frequencies by Rice Farmers in Guyana, 1991.

	Frequency of Urea application									
	1 application	2 applications				3 applications				
	1st	1st	2nd	Total	S. E.	1st	2nd	3rd	Total	S. E.
Region No.	kg Urea/ha									
2	64	59	70	129	8.9	77	56	46	185	42.8
3	72	70	68	138	12.4	56	56	56	168	0.0
4	59	63	61	122	3.3	0	0	0	0	-
5	83	50	72	122	13.1	63	63	63	188	0.0
6	105	63	66	129	5.7	55	55	52	161	4.2
Mean (weighted)	81	61	67	129		58	57	53	167	

3.6.3. Survey on the Rice Situation in the Artibonite Valley, Haiti.

This study was carried out with the support of the authorities and scientific staff (extensionists) of the Artibonite

Valley Development Agency (**ODVA**), in order to identify the main problems limiting rice production and hence to define research projects that enable to solve the prioritary problems identified.

The main conclusions drawn from this study were:

i) Inadequate land preparation, ii) Lack of knowledge on fertilization principles (rate, stage, types of fertilizer, etc), iii) High damage levels caused by pests and diseases due to the lack of pesticide or to the lack of knowledge on its use, vi) High cost of labor in peak periods (transplant, weed control, cutting and threshing), v) Unavailability of certified rice seed, and vi) Credit shortage.

3.6.4. Survey on the Rice Mill Industry in the Artibonite, Valley, Haiti.

During the second semester 1989 a survey of the rice industry operating in the Artibonite Valley was carried out in order to gather enough information to determine the convinience of replacing the old rice mills now in operation for more modern ones, or, if this is not possible, to obtain the necessary advice to improve the operation of the old ones.

With the support of **ODVA**'s scientific staff, four rice mills were visited where seven different milling equipment were evaluated. Four commercial rice varieties were used in tests conducted to determine the milling capacity and quality of those mills.

The mills evaluated were brands Bill Brook and Koeber (old models), and Yanmar (New Model). The old models dehull and polish in a single operation, mixing thus the husk with the bran; whereas the new model dehulls, and polishes in two different operations, separating the husk and bran from the milled rice.

The evaluation method consisted of processing 10 marmites (volumetric container used instead of conventional weight units). The data taken were the weight of paddy rice, milled rice, bran and hull.

Among the results obtained there are: i) The moisture content of the processing grain varies from 9 to 11.3%, that is, below of what is recommended (13-13.5), ii) The percentage of head rice varied from 30.4 to 57.2, depending both of grain drying and adjustments or calibration of operating mills iii) Broad variation in the acceleration of engine powering Huller type mills through a pulley, which greatly affects the percentage of broken grains, iv) It was noticed that as acceleration was increased in both old and new mills, the percentage of broken grains also increased from 20 to 50% in new models, and from 20 to 70% in the old ones, v) The percentage of broken rice in new mills (Yanmar) varied from 28.4 to 37.4%, whereas old mills ranged from 16.7 to 37.4%. This shows that old mills can be as efficient as the new models or better, provided that their operation is improved.

3.6.5. Survey on Rice Seed Industry in The Dominican Republic.

This activity was carried out in 1989 among seed processing plants and rice seed growers of the Dominican Republic. The objectives of such study were: i) To identify the problems experienced by the seed producing sector of the country, ii) To know the different participants in the seed sector and their roles, iii) To know the management given to rice seeds by processing plants, iv) To serve as base information for discussion and analysis to national and international technicians attending the "Workshop- Course on Rice Seed Production for the Caribbean".

The main results obtained were:

i) Seed processing plants have on the fundamental equipment and facilities to accomplish a proper management of rice seed.

ii) Only 56% of the processing capacity of those plants was being used at that moment.

iii) Plants make a minimun use of their laboratory equipment.

iv) The produccion of "basic seed" by the government is much lower than the amount required by seed plants, therefore the latter has to multiply the basic seed they get many times.

v) Seed growers are, in general, large rice farmers who own farm machinery, and make an intensive use of inputs.

vi) Technicians of the processing plants supervise seed multiplication fields, but the crop management is left to the farmers.

vii) trere are not written agreements between the processing plants and the seed growers, but only verbal deals that either party may violate at harvesting time.

viii) The lack of periodical increases of rice seed prices causes that considerable volumes of seed be sold for human consumption, reducing thus the avaibility of seed for the future.

ix) Seed plants produce around 13,000 MT of rice seed per year and are planning to increase their production in the near future.

x) Seed plants have a distribution system that covers all the rice growing areas of the country.

xi) Seed plants do not receive any kind of inspection of technicians from the State Seed Department.

Nowadays (1992) a Seed Certification Unit is working on this matter with economical support of seed industry and government.

3.7. Other Supports

3.7.1. Regional conference

On 1988 was organized a Regional Conference, whose host Country was Guyana; 13 Caribbean rice researchers participated including five **CIAT/CRIN** Staff members, which are as follows; Jamaica (1), Trinidad & Tobago (2), Guyana (2), Suriname (3), **CIAT** (1) and **CRIN** (4). Previous to this event, a Monitoring Tour was also held where main rice growing areas of Trinidad and Guyana were visited, both events were developed from October 27th to November 2th, 1988.

The presented research papers discussed during the conference, were all published in "Rice in the Caribbean", English and Spanish versions.

3.7.2. Scientific exchange

Based upon **CRIN's-TAC** recommendation; this topic was included in the annual work plans with the idea to promote scientific exchange among Caribbean rice researchers.

3.7.2.1. Trip to Guyana and Suriname

CRIN Coordination gave financial and logistical support (**CIAT** Funds) to Drs. L. Alemán and M. Socorro, Deputy Directors of Cuban Rice Research Institute, in order to facilitate technical visits to Irrigation Districts of Guyana and Suriname, with the aim of learning about land leveling & drainage methods developed in Guyana and Suriname rice growing areas.

3.7.2.2. Trip to Cuba

In June 17th to 23th, 1990, Engs. Suárez and J. Sánchez, Head and Officer of Seed Certification Unit of Dominican Republic, visited Cuba with the main objective of participate in a "In Service Training" activity, related with the processes of seed production and post-harvest seed management (pre-cleaning, cleaning, drying, storage, quality control, etc.), as well as normativity used to different seeds (basic, registered & certified).

Actually the Seed Certification Unit is properly working in D.R. with the economical support of private seed enterprises, service was reestablished after several years of unoperativeness.

3.7.3. Round table

On 1990 (November 20), after concluding the IV **CRIN**'s **TAC** meeting, was organized a "Round Table About Plant Protection" being the University of Las Villas, Cuba, the host institution. The topics covered were; red rice control and integrated insect-pest management in rice crop.

The objective of the event was; to exchange experience in IPM (weed and insects) applied to rice crop between Caribbean scientists and **CIAT**'s Rice Program research personnel, the specific themes discussed were about, insect-pest management (S. oryzicola, O. insularis, L. brevirostris, Hydrellia spp. and S. frugiperda); integrated weed management; and influence of agronomic practices on insects incidence and its management. proceedings were published.

3.7.4. Monitoring tours and workshop

3.7.4.1. Trinidad and Guyana

On 1988 was organized the first monitoring tour for Caribbean researchers, this activity was previous to a Regional Conference held in Guyana. The visited Countries were Trinidad and Guyana and the participants were from Belize, Jamaica, Trinidad, Guyana and Suriname. On 1991 a second monitoring tour was held, visiting again same countries. In both events irrigated rice fields problems were observed. In this year after field visits in each country, research paper about integrated pest management were presented and discussed, giving a total of 25. Research personnel of Guyana, Suriname, Trinidad and Tobago, Cuba, **CIAT** (Colombia) and **CRIN** (D.R.) participated. Proceedings will be published in 1992.

3.7.4.2. Cuba

On 1990, Caribbean researchers participating in different **CRIN** activities, attended to a monitoring tour organized by Instituto de Investigaciones Arroceras of Cuba, where Agroindustry Complex Sur del Jíbaro rice fields were visited. Aspects observed were; land preparation with cage wheels and heavy machinery, mechanical harvesting, visit to a *Bauveria bassiana* Lab. multiplication, to be used to control rice water weevil, and modern irrigation district with supreme land leveling with the aim to do a better use of land, water management and human resources.

3.7.5. Information exchange

3.7.5.1. Rice in the Caribbean

This is a rice bulletin for the Caribbean having two issues per year. On June, 1987 was released the volume 1, No.1 whose content was an averview of **CRIN**-Network (objectives and strategies) and the conclusions and recommendations of the first **CRIN**'s **TAC** meeting held at **CEDIA** in Dominican Republic (1986). After this one, continued the following numbers. Rice in the Caribbean, till now has been very informative to researchers of the region where they have had opportunities to publish their own research papers. At present time, have been printed in English and Spanish languages six (6) volumes and ileven (11) numbers (1987-1992).

3.7.5.2. Proceedings and bulletins

Several proceedings have been printed in life span of **CRIN** which are as follows:

a) Proceedings of the First Meeting of the Technical Advisory Committee (December 1 and 2, 1986). 152 p. D. R. (English and Spanish versions).

b) Proceedings of the Workshop about Caribbean Rice Research Cooperative Network, held in Dominican Republic. August 20-24th, 1984. **CIAT-ISA-SEA-CEPAL.** 138 p. (English and Spanish Versions)

c) Round Table on Plant Protection. Santa Clara, Cuba, November 20, 1990, 107 p. (English and Spanish versions) Printed in D. R. 1991.

d) Proceedings of the Workshop on Integrated Pest Management in Rice held in Trinidad and Tobago, and Guyana. October 7 to 11, 1991. (Reviewing process, in English).

e) Comparative Study of Two Technologies Applied to Lowland Rice production in Dominican Republic, 1988. (Club 2000 Year Case). **CRIN**'s Technical Bulletin No. 1-89, 16 p. Juma, Bonao, D. R. 1989. (Spanish)

f) Advances of Rice Regional Trials in Dominican Republic; Second Semester 1988. **CRIN**'s Technical Bulletin No. 2-89. 29 p. Juma, Bonao, D. R. 1989. (Spanish)

3.7.5.3. Research papers

i) Research papers issued during mid-1992.

During first semester of 1992, thirteen (13) research papers (Table 40) were written by **CRIN**'s personnel, which will be published on Rice in the Caribbean, International Rice Research Newsletter and Arroz en las Américas.

ii) Research papers supplied to Libraries

CRIN has been contributing on permanent basis to **CRIN** Member Countries Libraries with selected papers related to rice crop, as well as books. In 1988, nineteen (19) books related to rice were supplied to each library of National Rice Programs.

Generally the information supplied refers to: Rice Abstracts (**IRRI-CAB**), and complete selected papers related to Agronomy, milling, genetics, soils, pests and diseases, weed control, grain drying, seed production, biotechnology, training, biofertilizers and others. As instance in 1991 were sent 74 different scientific papers to each library of 8 **CRIN** member Countries.

Table 40. List of publishable papers written by CRIN's personnel during the first semester of 1992.

No.	Paper Title	To be published on
1.	Mechanical weeding: An Economical Alternative for an Integrated Weed Control in Direct Seeded Rice.	Rice in the Caribbean or Arroz en las Américas
2.	Water Management and Mechanical Weeding to Control Red Rice (<u>Oryza sativa</u> L.) in Direct Seeded Rice, in Dominican Republic.	Rice in the Caribbean or Arroz en las Américas
3.	Field Evaluation of Urea Top-dressed Application vs. Deep Point Placement in Irrigated Rice.	Rice in the Caribbean or Arroz en las Américas
4.	Evaluation of Fungicides for Rice Blast Control in Guyana.	Int. Rice Research Newsletter (IRRN)
5.	Field Evaluation of Urea Deep Point Placement in Irrigated Rice.	Int. Rice Research Newsletter (IRRN)
6.	Water Management and Mechanical Weeding: Components on Integrated Weed Management in Rice.	XXVIII Annual Meeting of Caribbean Food Crops Society. August 9-15, 1992 Dominican Republic.
7.	Manual Drum Seeder and Manual Rotary Weeder Evaluation on Irrigated Rice in Dominican Republic.	Arroz en las Américas

Table 40 (cont.)

Table 40. List of publishable papers written by CRIN's personnel during the first semester of 1992.

No.	Paper Title	To be published on
8.	Mechanical Weeding in Combination with Herbicides on Red Rice and other Weeds Control.	Arroz en las Américas
9.	Studies on Integrated Blast Management in Guyana.	Proceedings of the Workshop on Integrated Pest Management in Rice, Held in Guyana and Trinidad. October 7 to 11, 1991.
10.	Editorial: Rice in the Caribbean Vol. 5 (2): 1991.	Rice in the Caribbean
11.	Agricultural Mechanization of Rice Crop in the Caribbean.	Rice in the Caribbean
12.	Semestral Report of Activities Carried out by **CRIN**'s personnel (January to June, 1992)	-
13.	Summary Report of **CRIN** Research and Support Activities to its 8 Member Countries, from 1986 to June 1992.	-
14.	Report of Activities Developed by **CRIN** from 1986 to 1992.	-