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WEST AFRICA RICE DEVELOPMENT ASSOCIATION

ASSOCIATION POUR LE DEVELOPPEMENT DE LA RIZICULTURE EN AFRIQUE DE L'OUEST

WARDA

SECOND QUINQUENNIAL

REVIEW

VOL. 3: SECOND QUINQUENNIAL REPORT OF WARDA RESEARCH ACTIVITIES 1978–1982

WEST AFRICA RICE DEVELOPMENT ASSOCIATION

SECOND QUINQUENNIAL REVIEW OF WARDA BY CGIAR

PART I: CHAPTERS I-IV

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P R E F A C E

This report gives a technical and detailed account of the activities of the WARDA Research Department between 1978 and 1982, after the 1978 First Quinquennial Review. The report is primarily meant for the perusal of the Second Quinquennial Review panel and discussion with WARDA staff.

The report gives background on the structure and administration of the Research Department and suggestions for internal changes. The relationship between research and other programmes, national programmes and international institutions is discussed.

In developing plans for the future, the Research Department has taken cognizance of the fact that a number of projects which had been identified and planned still await implementation because of financial limitations. They were also aware of the fact that funding sources for international research are currently very scarce. Consequently no major proposals have been made that will make substantial changes in the overall budgeting. Savings might be made with the redeployment of certain research staff from headquarters as also there is an obvious need to improve the quality and scope of research at the Special Research Centres with additional support. There is need to create greater impact of the sub-regional programmes at national levels.

It is recognized that for the Research activities to be successful and to make the necessary impact on rice production in the region, there has to be a long-term and committed financing.

CHAPTER I

RESEARCH COORDINATION

Staff:

It consists of the following:

1) B.A.C. Enyi, Ph.D. as the Director of Research;

2) G.A. Paku, Ph.D. as Agronomic Statistician; and

3) G. Varango, B.Sc., DPLG, as Architect.

Management:

WARDA's Research Department is the largest and one of the four departments of the Association; the others are Finance and Administration, Training and Development. The Department's Director, who is directly answerable to the Executive Secretary and his Deputy, is assisted and advised on research programmes by a core of scientists located at the WARDA Headquarters. These scientists who constitute the Technical Support Services provide leadership to the special research projects. Major technical coordination of the activities of the Department is provided by them. The greater part of the Department is situated in the field at two levels:

i) The special or regional research projects which
c constitute multidisciplinary teams for research on specialized types of rice culture, i.e. mangrove rice at Rokupr, Sierra Leone; irrigated rice at Richard Toll, Senegal; deep water and floating rice at Mopti, Mali. WARDA also makes a modest contribution to the upland rice improvement programme at Bouake, Ivory Coast through the location and support of a breeder to the rice research programme. The Bouake station has more recently been upgraded into a fully fledged WARDA regional special project for upland rice.

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ii) The sub-regional centres with headquarters at Banjul for Zone 1 to serve Mauritania, Senegal, the Gambia and Guinea Bissau; Conakry for Zone II to serve Guinea, Sierra Leone and Liberia; Bobo-Dioulasso for Zone III to serve Upper Volta, Ivory Coast and Mali; Accra for Zone IV to serve Ghana and Nigeria; and Niamey for Zone V to serve Togo, Benin and Niger. These sub-regional centres are designed mainly to disseminate WARDA findings and information emanating from the Secretariat and the Special Research Projects, International Centres, other institutions as well as WARDA Member Countries; to assist the Member Countries in improving their research capacities and to help develop good working relationships between WARDA and its Member States.

The WARDA research programme gets its overall administrative support from the Department of Finance and Administration and every effort is made to integrate its activities with those of the Training and Development Departments.

Functionally, the Research Programme is fully integrated (Figure 1.1) with the following main components:

i) The Research Director has overall responsibility for the various aspects of the programme and is directly responsible to the Executive Secretary;

ii) each Special Research project has a team leader who is directly answerable to the Research Director;

iii) the Sub-regional Coordinators direct field activities at the national levels; they are directly responsible to the Director of Research;

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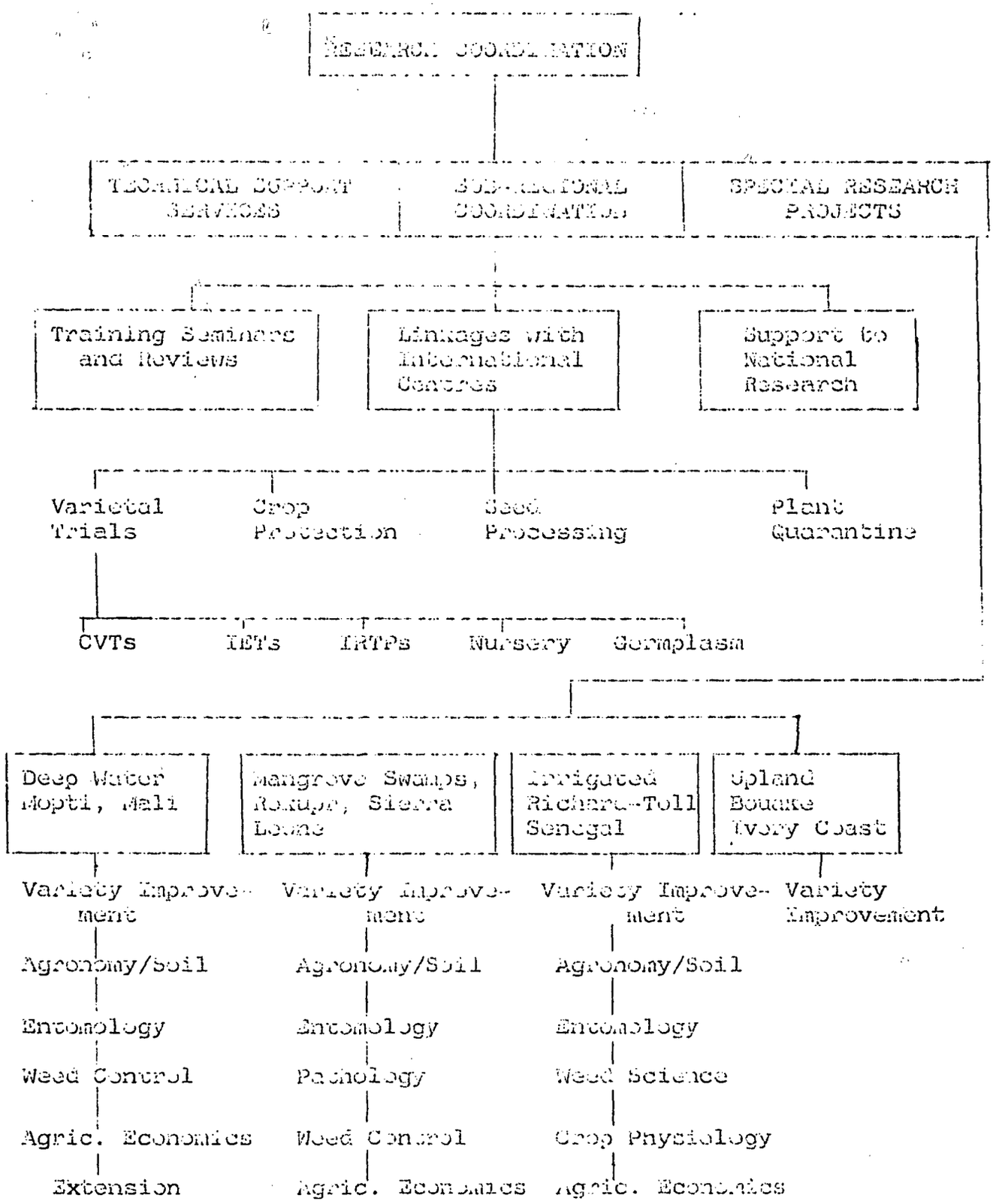
Fig 1.1 Research Structure



iv) active linkages with international institutions are maintained;

v) linkage between the special research projects and national research activities are fostered by the team leaders cooperatively with the sub-regional coordinators and national scientists;

vi) working relationships among the special research projects are maintained by direct contact among subject matter specialists in each field and by exchange of visits;

vii) harmonization of the special research activities with national research of host countries and cooperation with national institutions in the transfer of technology acquired;

viii) organization of WARDA seminars, workshops, regular visits of WARDA staff to national projects and participation in national research meetings; and

ix) assistance in organizing meetings of the WARDA statutory bodies, i.e. Scientific and Technical Committee (STC) and Governing Council (GC) Meetings.

Future Plans:

Structural changes have been suggested. It is now proposed to divisionalise the WARDA research activities so as to facilitate and improve intra-departmental communication. The proposed restructuring of the Department and re-deployment of the scientists in the Department are as follows:

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a) The Director of Research is the overall head of the Department and also head of the Research Coordination Division.

b) The Director of Research is to be assisted at Headquarters by four senior scientists who will form the Technical Support Division:

Plant Breeder
Agronomist
Crop Protection Specialist
Agronomic Statistician

The Division is to be headed by the most senior of these scientists and he will be responsible to the Director of Research.

c) The four scientists that will be assisting the Director will also be responsible for backstopping the Special Projects, National research and WARDA Sub-regional activities. More emphasis will be placed on the backstopping of national research programmes.

d) With the retention of four senior scientists at Headquarters, the two pathologists could be re-deployed: The Senior and Associate Plant Pathologists can be assigned to Bouake and Mopti respectively. These positions are currently being funded by the CGIAR.

e) The Agro-Statistician who is presently located under Research Coordination is to be transferred to the Technical Support Division. He would devote more time in direct support to national activities in planning trials and analysing the results. With this, the Statistician will require technical personnel support.

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f) The Sub-regional Coordinators will come under Research Coordination Division and will be responsible to the Director of Research. The Assistant Sub-regional Coordinators, instead of being located at sub-regional offices, will now be distributed to the countries in each zone, depending on the size of the countries and area under rice cultivation in that zone. In this way, there will be wider coverage at reduced cost.

g) The other divisions of the Department are the four Special Projects. Since each special project centre is headed by a qualified scientist, each project can be regarded as a Division, headed by a Team Leader who is directly responsible to the Director of Research.

The re-organised organigramme is shown in Figure 1.2.

Coordinated Trials:

Since the last Quinquennial Review, a number of changes have been made in the coordinated trials. The coordinated varietal trials were re-classified in 1980 to reflect more realistically the vast climatic and ecological conditions affecting each type of rice production. The details are contained in Table 1.1.

The number of coordinated trials to be conducted each year has been consolidated at 224. In 1978, 251 trials were planned out of which 119 were successfully conducted (Table 1.1). For 1979 and 1980, 237 trials were planned assuming a minimum of 10 percent failure. Of these, 177 and 131 respectively were successful. The number of planned trials in 1981 was reduced to 215 due to elimination of plant protection trials. This number

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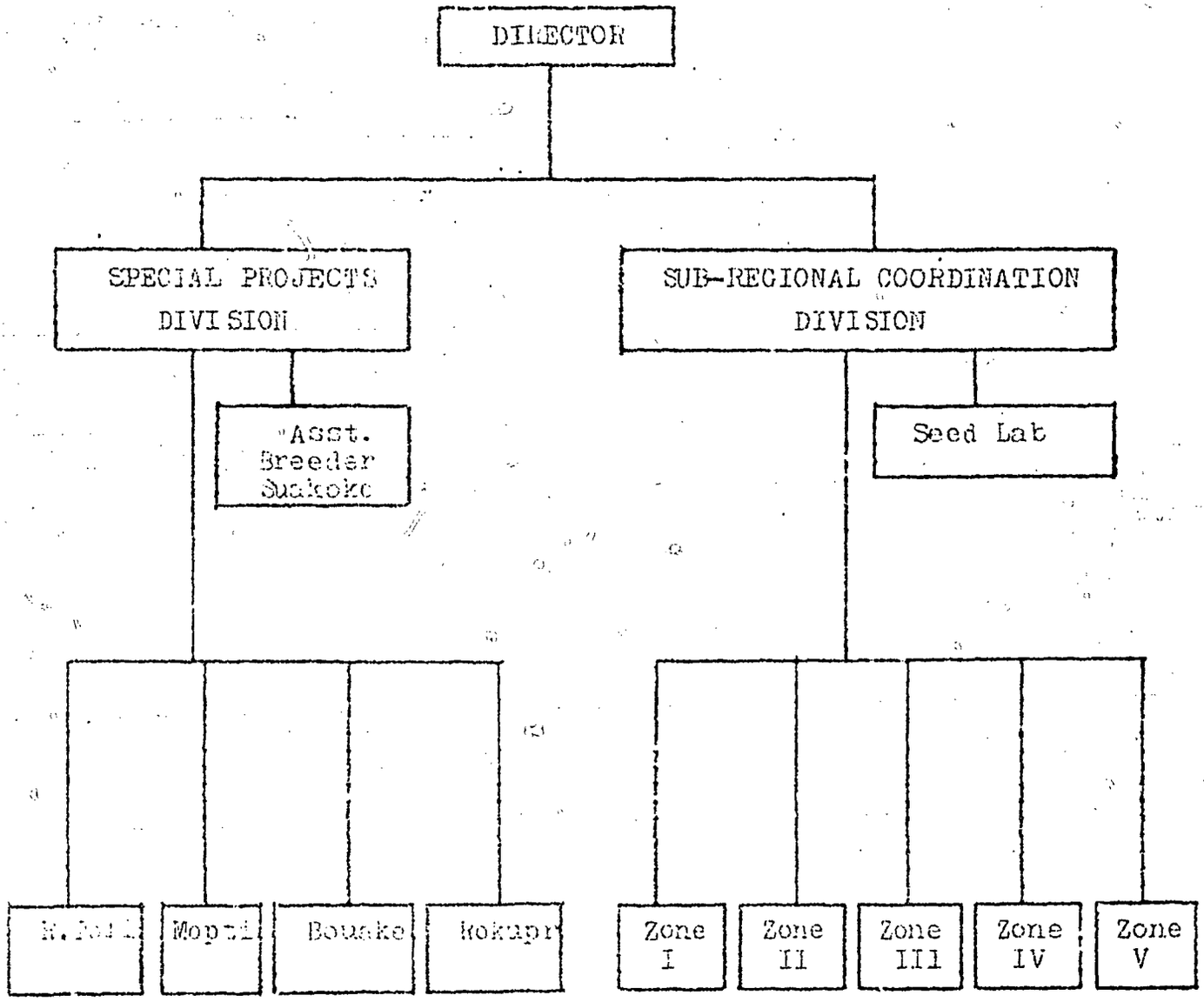
DIRECTOR
SPECIAL PROJECTS DIVISION
SUB-REGIONAL COORDINATION DIVISION
Asst. Breeder Sukoko
Seed Lab
Bouake
Zone I
Zone II
Zone III
Zone IV
Zone V

Table 1.1 Number of Coordinated Varietal Trials (including IET) and Plant Protection Trials conducted in Various Years 1978-1982

NUMBER OF SUCCESSFUL TRIALS

TRIALS	1978	1979	1980	1981	1982
Varietal Trials	100(195)*	140(195)	114(215)	123(215)	(201)
Plant Protection Trial	-	-	-	-	-
Herbicide	9(29)	19(22)	17(22)	-	=
Insecticide	10(27)	18(20)	-	-	-
TOTAL	119(251)	177(237)	131(237)	123(215)	(201)
Percentage of Successful Trials	47%	74%	55%	57%	

* Number in parenthesis shows the number of trials planned.

was further reduced in 1982 to 201 due to elimination of some unsuitable sites.

More recently, certain changes have been proposed primarily to distinguish the strictly upland rice which grows on freely drained soils from other types. Upland rice culture is further classified into two types - short and long rainy seasons. Under these categories, monomodal and bimodal conditions are further distinguished. Rainfed lowland conditions which are often described as hydromorphic are classified separately. Deep flooded rice is distinguished into shallow flooded and deep flooded. A set has been included for the cold tolerance. The new classification as well as the trials sites are shown in Table 1.2.

Special Research Projects:

Considerable progress has been made in this area as reflected in the results presented in Chapters 3 to 6. The Team Leaders are now funded by the CGIAR based on the recommendation of the first Quinquennial Review panel. The Team Leader for Bouake has only been recently appointed and that for Mopti, only identified. New programmes have been introduced and new staff recruited. However, work at Mopti has been affected over the past three years by drought. There is a need to improve water supply situation on the station in order to prevent future failures of experiments. The upland rice project located at Bouake, Ivory Coast, has been finalised, and WARDA is now seeking funds for the full implementation of the project.

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Table 1.2 - Proposed Re-Organization of the Coordinated Variety Trials

I. Strictly Upland - One short rainy season (Short Duration)

Zone I : Sapu (Gambia), Sefa (Senegal), Contuboel (Guinea Bissau).
Zone III: Sikasso (Mali), Farako Ba (Upper Volta).
Zone IV : Mokwa (Nigeria).
Zone V : Lama Kara (Togo), (Benin).

II. Strictly Upland - One long rainy season

a) Short Duration

Zone II : Man, Odienne (Ivory Coast), Suakoko (Liberia), Rokupr (Sierra Leone).

b) Medium Duration

Zone II : Guekedou (Guinea), Rokupr, Kenema (Sierra Leone), Suakoko (Liberia), Man, Odienne (Ivory Coast).

Zone IV : Onne (Nigeria).

III. Strictly Upland - Bimodal rainfall

a) Short Duration (Sowing in 1st Season, heading in 2nd Season)

Zone III: Bouake (Ivory Coast).

Zone IV : Nyankpala (Ghana) + other sites.

b) Medium Duration (Sowing in 1st Season, heading in 2nd Season)

Zone III: Bouake (Ivory Coast).

Zone IV : Nyankpala (Ghana) + other sites.

Zone V : Sotouboua (Benin).

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c) Short Duration (Sowing and heading in 1st Season

Zone II : Gagnoa (Ivory Coast)

Zone IV : Ibadan (Nigeria)

d) Medium Duration (Sowing and heading in 1st Season

Zone IV : Ibadan, Ikonne (Nigeria).

IV. Irrigated Short Duration

Zone I : Kaedi (Mauritania), Contuboel (Guinea Bissau), Djibelor (Senegal), Sapu (Gambia).

Zone II : (To be decided).

Zone III: Kogoni (Mali), Valley du Kou (Upper Volta), Korgho (Ivory Coast).

Zone IV : Badeggi (Nigeria), Bende (Nigeria), Kpong & Tono (Ghana).

Zone V : Libore (Niger), Diakessa (Niger).

V. Irrigated Medium Duration

As above, plus the following:

Zone III: Dabou (Ivory Coast), San Pedro (Ivory Coast).

Zone V : Mission Tove (Togo).

Zone IV : Kpong & Tono (Ghana).

VI. Mangrove

Zone I : Jenoi (Gambia), Djibelor (Senegal), Caboxanque (Guinea Bissau).

Zone II : Rokupr (Sierra Leone).

Zone IV : Warri (Nigeria).

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VII. Shallow Flooded (20cm-50cm)

Zone I : Jahali (Gambia), Djibelor (Senegal).

Zone IV : Birnin-Kebbi (Nigeria).

Zone V : Kolo (Niger), Grand Popo (Benin).

VIII. Deep Flooded (50cm-80cm)

Zone I : Jahali (Gambia), Djibelor (Senegal).

Zone III: Sikasso (Mali).

Zone IV : Benin-Kebbi (Nigeria).

Zone V : Kolo (Niger), Grand Popo (Benin).

IX. Floating

Zone III: Mopti (Mali), Gao (Mali).

Zone IV : Birnin-Kebbi (Nigeria).

Zone V : Diakena (Niger).

X. Cold Tolerance Trials

Zone I : Fanaye (Senegal)

Zone III: Kogoni (Mali), Ouagadougou (Upper Volta), Valley du Kou (Upper Volta).

Zone IV : Sokoto (Nigeria).

Zone V : Kolo (Niger).

XI. Rainfed Lowland Trials

Zone I : Sapu (Gambia), Djibelor (Senegal), Contuboel (Guinea Bissau).

Zone III: Banfora (Upper Volta), Nianai (Upper Volta).

Zone IV : Nyankpala (Ghana).

Zone V : Musuru (Benin), Sotouboua (Togo).

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On-Farm Trials and Technology Transfer

In an endeavour to systematise and hasten the transfer of technology at the farmers' level, the Research and Development Departments together set up a Technology Assessment and Transfer programme (TAT) which tests production packages and ensures that results obtained by WARDA can readily be transferred to and utilized by the farmers. In this regard, all the special research projects except Bouake now have economists and/or extension liaison scientists who together with research staff undertake farmers field trials, with farmers' participation. The Rokupr and Richard Toll projects made considerable progress in this area. Efforts are being made to extend these activities to Member Countries not hosting the special research projects.

With respect to the coordinated activities, on-farm pre-extension trials are being conducted in most countries. Most of these trials are on varieties, but fertilizer and herbicide trials have been conducted in a few countries. The conduct of these trials has led to the adoption of several varieties for production in several WARDA Member Countries as reported individually for each country in Chapter 7. The introduction of the single-axle tractor on the mangrove swamps in Sierra Leone has created tremendous interest among farmers for its contribution to labour saving in land preparation and in weed control. Farmers are now being organized to use these tractors and other techniques, i.e. fertilizers and varieties on large production scale.

Support to National Activities:

WARDA has, over the last five years, implemented this through its sub-regional research programmes. As in the previous

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Quinquennial Review, emphasis has been placed primarily on training of national scientists and the supply of limited equipment for use in their national research activities. Limited financial support has also been given to worthy rice research programmes in Member States. Unfortunately, the shortfall in financing has limited the impact of this activity.

Infrastructural development programmes were undertaken in Guinea Bissau, Benin, Mauritania and Togo. WARDA also continued to be involved in developing national research strategies as well as getting its scientists both at headquarters and in the field in pre-feasibility and feasibility studies in Member States.

Details of support to national research and its impact varied from country to country and these are reported individually in Chapter 7.

Funding:

Funding for the research activities has come from three sources viz. CGIAR funds (Table 1.3); bilateral funds (Table 1.4) and WARDA Special Fund.

The CGIAR funding grew from $5m for the period 1973-1978 to $13m for the period 1979-1983. The CGIAR members which contribute to WARDA budget are West Germany, Sweden, Netherlands, Canada, African Development Bank, IFAD, Japan, France, Nigeria, Belgium and OPEC.

The special projects are funded bilaterally and currently by donors which include USAID, CIDA, IDRC, Overseas Development Administration of the United Kingdom, Saudi Arabia and WARDA Member States.

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Table 1.3 - CGIAR Funding of the WARDA Research Activities
($000)

	1979	1980	1981	1982	1983	1984*
Research Coordination	467	572	619	605	687	754
Technical Support Services	370	700	592	789	780	910
Sub-Regional Coordination	883	1079	911	1137	1117	1285
Administrative Support	350	417	285	347	371	443
T O T A L	2070	2768	2407	2878	2955	3392

* Proposed

Table 1.4 - Bilateral Funding of the Special Projects
($000)

	1978	1979	1980	1981	1982
Mopti	308.5	461.2	486.3	529.6	812.7
Richard-Toll	54.3	402.4	425.8	556.0	468.6
Rokupr	273.5	379.4	480.4	276.2	932.9
Bouake	26	-	-	100.0	316.1
T O T A L	662.3	1243.0	1392.5	1461.8	2530.3

Training:

During the last five years, training trends changed considerably from those during the first Quinquennium. Growing numbers of staff have undergone or are undergoing higher degree courses overseas and locally. This training is essential to strengthen and improve WARDA research output.

The CGIAR continued to fund the field assistant training course, but during the period under review, also funded the training of research assistants at the WARDA Training Centre. This latter training of both WARDA and national scientists has helped to raise the quality of the WARDA coordinated trials in several countries and hopefully, will make positive contribution to research at the national level.

The training of national scientists is organised and executed by the Training Department. A summary of participants attending WARDA training courses per country between 1973 and 1982 is presented in Table 1.5.

International Linkages and Support Mechanisms to National Programmes

a) Support Mechanisms

WARDA activities can be interrelated with the International Programmes as well as the various national programmes of the WARDA Member States. The following are the most important elements of these interrelationships:

a) WARDA Headquarters should be essentially, a coordinating centre for regional research activities;

b) its field research activities which constitute coordinated and on-farm trials of various types under varying ecologies

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Table 1.5

Total Number of Trainees by Country and Course

1973-1982

	Research Assistants Course (2)	Rice Production Specialists Course (3)	Field Assistants Course (7)	Post Harvest Technology Course (5)	Refresher Course on Milling (1)	Seed Multiplication & Certification (3)	Rice Project Management Course (3)	Rice Water Management Course (2)	Integrated Pest Management Course (1)	TOTALS BY COUNTRIES
1) SENEGAL	3	24	27	7	2	7	6	3	7	86
2) SIERRA LEONE	2	20	25	13	-	7	4	2	1	74
3) LIBERIA	4	20	21	11	2	4	6	4	-	72
4) MALI	6	19	18	10	1	7	6	3	1	71
5) GHANA	1	13	13	9	3	6	3	4	1	53
6) TOGO	6	14	12	12	-	6	6	3	2	61
7) UPPER VOLTA	4	19	6	8	3	4	7	3	2	56
8) BENIN	4	13	14	7	-	4	6	4	2	54
9) GAMBIA	3	16	14	7	-	4	7	4	2	57
10) NIGERIA	1	21	8	6	-	3	4	4	4	51
11) MAURITANIA	2	9	14	5	-	3	5	2	1	41
12) GUINEA	6	10	6	12	-	4	6	2	3	49
13) GUINEA BISSAU	2	10	9	8	2	3	3	1	2	40
14) IVORY COAST	1	5	12	3	-	6	5	-	-	32
15) NIGER	1	6	7	4	1	6	1	3	-	29
TOTALS BY COURSES	46	219	206	122	14	74	75	42	28	826

Numbers in parenthesis indicate number of times each course has been held.
Data provided by the WARDA Training Department.

should receive technical or backstopping support in the following ways:

i) through the four regional research programmes each specialising in one form of rice cultivation (mangrove, rainfed, irrigated, deep water/floating): the activities at these centres should also be coordinated and the results of their research which are partly adapted from international programmes, fed into the regional coordinated trials; these programmes should be developed and reviewed yearly with the participation of the international centres and national scientists;

ii) through a technical services division located at Headquarters: it has laboratory facilities for seed services and a nursery-farm for large scale introduction of materials from abroad; for screening activities; for monitoring pest and disease incidence in West Africa; nomination of varieties in consultation with national scientists and international institutions and distributing seed for testing at various locations, which is working very well now;

iii) through active linkage with international and other national institutes having strong programmes on rice i.e. IRRI, IRAT, BRRI, ICAR, IITA, CIAT, etc. there should be a constant two-way contact between WARDA Headquarters and these institutes on all aspects of rice work i.e. research, training, germplasm collection and exchange; seminars and conferences, exchange of research results and other publications, etc.

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A procedure has already been established but should be strengthened to extend these linkages to the national programmes and enable them to successfully participate in the regional trials; to readily provide the necessary feedback to the international centres through WARDA and to strengthen their research activities along the following lines:

i) through sub-regionalisation, the sub-regional coordinators contribute to the rice research activities in the countries in which they are located;

ii) the regional coordinators should assist in developing research services at national levels; these activities should be backstopped by the four regional research projects and coordinated by Headquarters;

iii) the sub-regional programmes should provide support for the field activities of the special research projects; and

iv) WARDA Headquarters should maintain direct contact with Member States inspite of the sub-regional centres. This is generally in organizing workshops and seminars; review meetings; training programmes; supply of experimental equipment and maintaining the active interest of Member States in these activities.

These interrelationships strengthen national research activities through (i) developing research programmes and infrastructure; (ii) training of personnel for the coordinated trials and regional research projects associated with the respective national programmes; (iii) funding the coordinated trials, assisting with the trials and ensuring that these trials are run directly by the national research or extension services

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with only assistance from WARDA staff; etc.

Reciprocal Responsibilities

The effective implementation of these interrelationships will largely depend on the International Programmes, as well as the Regional/National Centres discharging certain responsibilities.

A. Requirements of the international centres:

(a) strong inter-disciplinary research;
(b) adaptation of results through feedbacks from regional programmes;
(c) support to regional programmes through:

i) staff training
ii) backstopping research activities through consultation, reviews, etc.;
iii) international seminars;
iv) developing research programmes; and
v) supply of research materials and information.

B. Requirements of the regional/national centres:

(a) Maintain active communication with other centres;
(b) establish jointly, strong feedback mechanisms;
(c) provide facilities for short-term research workers from the international centres; and
(d) supply of local germplasm and other materials for scientific research at the international centres.

Finally, this system of linkages has the following main advantages:

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i) it makes research less expensive at all levels;

ii) it tends to clearly show the role of the international centres as against the regional and national programmes both in terms of division of labour and the type of research that is required - this prevents unnecessary duplication and rivalry;

iii) grouping countries with similar background enables them to work together at technical, social and political levels for mutual benefits;

iv) it has greater propensity in mobilizing local resources;

v) the use of localised organizations generates political goodwill and enthusiasm among local scientists; compared with the direct management by foreign institutions, this system would tend to be more permanent;

vi) it establishes definite lines of communication and exchange of materials and information at all levels; similarly, it facilitates international allocation of funds for research; and

vii) simple, adapted trials conducted in several places under one coordinating regional unit produce quicker, more reliable results that could have a direct impact on rice production.

The primary goal of the WARDA effort is to generate at national levels a genuine need and consciousness of utilizing

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available research information effectively, at a minimum cost. To motivate national research and development activities and to gradually adopt a viable and economic approach to a West African Rice Production Technology.

b) Collaborative Activities

WARDA has over the years developed collaborative research programmes and other working relationships with many national and international centres and institutions. Highlights on some of the current ones are given below.

Catholic University - Louvain, Belgium (UCL)

The agreement between UCL and WARDA is to study the use of *Azolla* and blue-green algae as a source of nitrogen for rice production. Trials have been conducted at Suakoko and Rokupr but the main project site is at Fanaye, Senegal. The Belgium Government provides funds for the *Azolla* project.

International Centre of Insect Physiology and Ecology (ICIPE)/ WARDA Cooperative Programmes on Lepidopterous Rice Stemborers

WARDA and ICIPE (located in Nairobi, Kenya) agreed to undertake collaborative research work on rice stemborers. The excellent facilities available at ICIPE were to be utilized in implementing the more basic research portion of the project while WARDA would carry out the applied and field studies. This joint project intends to encourage collaboration among the two institutions for mutual benefit. However, lack of funds has delayed implementation of the project.

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International Rice Research Institute (IRRI)

Since 1973, IRRI has been supplying WARDA with lines and varieties for tests. In 1974, WARDA and IRRI reached a formal agreement to take an active role in the International Rice Testing Programme. To further strengthen the linkage between WARDA and IRRI, late in 1978, IRRI posted a liaison scientist to Africa based at IITA but with major commitments to the West African region. Other areas of collaborative efforts are in training and monitoring tours, meetings and conferences.

Project on Bird Control

A joint project involving WARDA, OCLALAV, CILSS and the River Basin Authorities of Senegal, Chad and Nigeria was formulated for the control of grain-eating birds of rice. The project document was finalised at a meeting in Dakar in December, 1980, and for this project, the region was divided into four zones representing differences in ecologies and species of the grain-eating bird pests. The UNDP has provided funds for this project and the first phase of it which is training will be implemented this year.

WARDA Collaboration with CICP in its Programme on Integrated Pest Management

The programme included a variety of research, training, extension and farmer demonstration activities in the representative rice agro-ecosystems. WARDA CICP/USAID co-sponsored a course on Integrated Pest Management in Rice in West Africa in Fendall, Liberia in January, 1982. Twenty-eight participants drawn from all over West Africa took part in the training. Collaboration with CICP continues and it is hoped that through this activity, pest control in rice in West Africa would be gradually established on sound ecological basis.

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International Fertilizer Development Dentre (IFDC)

WARDA and IFDC have agreed on a cooperative programme of research on rice fertilizers with respect to crop production. Between 1980 and 1982, IFDC supplied a number of new nitrogenous and phosphorus fertilizers for testing under iron toxic and swamp conditions in Suakoko, Liberia. This work will be extended to the Richard Toll and Rokupr projects under irrigated and mangrove swamp conditions respectively. The agreement with IFDC is a continuous one in which nitrogenous and phosphorus fertilizers will be received for field testing.

International Institute of Tropical Agriculture (IITA)

For the purpose of promoting greater professional collaboration between IITA and WARDA the two parties reached a mutual agreement in 1978 by which an IITA liaison scientist was stationed at WARDA Headquarters. The agreement has been renewed a few times and it is still in force. The collaborative activities include exchange of genetic materials, training programmes, collaborative trials, joint monitoring tours and attending each other's conferences.

Seminars, Reviews and Workshops

The Second WARDA Rice Workshop was held in Nigeria in 1978. The focus was on the long term strategy for the transfer of technology in rice production throughout the West African region. The important role WARDA has to play in this regard was well emphasized. Participants included delegates from 14 Member Countries and WARDA staff, totalling 55.

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Seminars on Bird and Rodent Pests of Rice in West Africa, Monrovia, Liberia, - June 20-23, 1979

The seminar, which was described as technical group discussion, had the objective of seeking expert advice in identifying important areas of research on the management of bird and rodent pests of rice in West Africa and to formulate a project on the same. It was attended by delegates from OCLALAV, UNDP, ORSTOM and ODM.

The presentation of technical papers and discussions that followed enabled exchange of a great deal of valuable and up-to-date information on several relevant aspects of bird and rodent pests of rice in the West Africa region. This led to identification of distinct areas of activity in the proposed WARDA research project on the management of bird and rodent pests of rice.

Seminar on Integrated Management of Rice Diseases and Insect Pests, Bobo-Dioulasso, Upper Volta, in 1979.

WARDA sponsored a seminar on Integrated Management of Rice Diseases and Insect Pests at Bobo-Dioulasso, Upper Volta in 1979. The objective was to explore the status of rice pest problems in West Africa, review current approaches to pest control, and to examine the status and prospects of rice integrated pest management. About 50 scientists representing the national institutes of the WARDA Member Countries, international organizations, private companies and WARDA participated in the seminar. This was the first international technical meeting to address the integrated management problems of rice diseases and insect pests in all WARDA Member Countries.

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At the seminar's plenary session, the participants developed recommendations in support of the formation of an Integrated Pest Management (IPM) project for rice in West Africa. They recommended that the regional IPM programme be coordinated by WARDA and that WARDA takes the initiative to develop the programme's plan of operation.

Workshop on Environmental Constraints on Rice Production in West Africa, 1980, Banjul, Gambia

Participants at this workshop were representatives from WARDA Member Countries as well as delegates from international organizations and WARDA staff members.

The participants discussed the status and progress made in upland rice cultivation in Member Countries as well as technical and economic realities at the regional level.

Workshop on WARDA Upland Rice Research Policy, Monrovia, 1981.

Following the recommendations of the Scientific and Technical Committee and with the approval of the Governing Council at its Tenth Session in Banjul (Gambia) in December, 1980, a workshop on WARDA Upland Rice Research Policy was held in Monrovia, Liberia from 13-15 May, 1981. Participants at the workshop were representatives from almost all WARDA Member Countries as well as delegates from international organizations and staff members from WARDA Headquarters and sub-regional offices.

The participants discussed the situation and progress made in upland rice cultivation in Member Countries as well as technical and economic realities at the regional level.

.../...

Three work groups formulated detailed development strategies and objectives in the following areas:

a) Varietal improvement of upland rice cultivation in West Africa.

b) Agronomic research on upland rice and cultural techniques in West Africa.

c) Diseases, insect pests and weed control in West Africa.

Upland Rice Workshop, Bouake, Ivory Coast, October 4-8, 1982

This workshop was sponsored by IDESSA, IRRI, IRAT, WARDA, IITA and CIAT. Participants were drawn from scientists involved in upland rice research in Africa, Latin America and Asia. The objectives of the workshop were:

i) to assess existing knowledge of upland rice and progress in upland rice improvement;

ii) to review research on upland rice, with emphasis on upland rice environmental factors and the limitations they impose on improvements in yield; and

iii) to develop appropriate collaborative programmes to accelerate progress in the production of upland rice.

The workshop emphasized the need for WARDA amongst other things to intensify its programme on upland rice in West Africa.

.../...

In-House Review

The second In-House Review was held in 1980 in Freetown, Sierra Leone. It critically discussed research activities of the WARDA professional staff. Areas covered were research work at Headquarters (the Seed Laboratory and Seed Nursery Farm at Suakoko), the Special Research Projects,and Research Coordination in the five sub-regional zones.

A similar review was held in Bamako, Mali in 1981. The review dealt with the impact of the WARDA Research activities on regional rice research and development, detailed review of programmes and methodology, and a review of WARDA research structure, objectives and relationships with other WARDA activities, among other things.

Annual Rice Review Meeting

WARDA hosts an annual rice review meeting at the Headquarters in Monrovia, Liberia. The proceedings of the meeting include WARDA Research, Development and Training programmes as well as country reports on national rice activities. Participants are drawn from WARDA Member Countries, international institutions and WARDA staff. The meeting offers opportunity for meaningful interaction between WARDA and Member Countries' scientists and activity plans are set for the current year.

CHAPTER T.6

TECHNICAL SUPPORT SERVICES (TSS)

Staff

M.A. Choudhury, Ph.D.	-	Senior Rice Breeder
A.O. Abifarin, Ph.D.	-	IITA/WARDA Liaison Scientist
D.K. Das Gupta, Ph.D.	-	Senior Agronomist
V.A. Awoderu, Ph.D.	-	Senior Rice Pathologist
E.A. Akinsola, Ph.D.	-	Rice Entomologist
A.K Koroma, Ph.D.	-	Associate Rice Breeder
N.S. Bangura, M.Sc.	-	Associate Rice Pathologist
B.A. Lartinde, M.S.	-	Seed Technologist
L. Kandakai (Mrs.) B.Sc.	-	Assistant Seed Technologist

WARDA GERMPLASM PROGRAMME

Staff: A. O. Abifarin

In 1976, WARDA, IRAT, IRRI, WARDA Member States and Tanzania arrived at a collaborative understanding for germplasm collection in Africa.

Following the series of meetings in 1976 and 1977 on germplasm work in the region, WARDA initiated its germplasm programme. Initial activities included (a) the compilation of information from member states on the status of rice germplasm collection in the region; (b) maintenance of a working collection at the seed laboratory; (c) receiving samples of collections from IITA and IRAT/ORSTOM.

In September, 1978, following a bilateral memorandum of agreement between IITA/WARDA (IITA/WARDA, 1977), an IITA/WARDA Liaison Scientist was placed at WARDA. He assumed, among other duties, the responsibility for the WARDA germplasm programme.

1. Objectives of the WARDA Germplasm Programme

The main objectives of the germplasm programme are:

(a) to extend logistic or administrative support to IITA, IRAT and IBPGR, IRRI etc when needed for germplasm collection, conservation, evaluation, utilization and training in WARDA region;

(b) to evaluate in cooperation with IITA and IRAT, African rice germplasm collected;

(c) to maintain collections in a medium-term storage facilities;

(d) to encourage in the region the utilization of the collected germplasm;

(e) to collect in certain key areas in West Africa;

(f) to make available any of the cultivars in WARDA germplasm bank to any requesting scientist or institution.

2. Germplasm Bank

The construction of the germplasm bank started in 1979 and walk-in coolers installed in 1981. There are two units of combined volume of $59m^3$.

The germplasm bank, when fully functional will have capacity for about 12,000 accessions under the medium term storage. A unit will be made available for preservation of 500 - 1000 gm of all important cultivars recommended in West Africa.

Funding

The germplasm programme is a component of the WARDA technical support services which is funded through the CGIAR BY IFAD. The IITA pays the salary and other benefits of the Liaison Scientist while WARDA pays his post adjustment and other benefits.

Germplasm Collection Activities

WARDA has given administrative support to ORSTOM/ IRAT in their collections in the region. Besides joint expeditions with IITA, WARDA assisted IITA in their collection in the Gambia. WARDA supports the IBPGR programmes in the

region, e.g. collection and training activities.

WARDA Special Research Projects at Mopti, Richard-Toll and Rokupr collect cultivars. Samples of their collections are maintained under the medium term storage at Fendall, Monrovia.

Collections were made in Mali and Nigeria in 1979 through the help of consultants made available to WARDA as a special assistance by the Indian Council of Agricultural Research. The collections in Nigeria were in part, a joint effort between IITA and WARDA. About 560 different species were collected.

Collection by IITA and IRAT/ORSTOM

WARDA has received a total of 1057 accessions from IITA and about 700 accessions from IRAT/ORSTOM.

Evaluation

Each year, samples of the collection are multiplied and evaluated under non-toxic soil conditions. A total of 1103 accessions have been replanted for rejuvenation, multiplication and evaluation. Data collected are being stored on computer.

Conservation

Samples are curently stored in bottles. After the installation of the special drying equipment and reduction of the relative humidity, it is hoped that the samples will be conserved for a period of 20 - 30 years.

Benefits to Member States

The benefits of any germplasm programme may be classified into present, immediate future (next 2 - 5 years) and the far distant future benefits. In general, the long term benefit (preservation for posterit) is the main reason for which a germplasm programme exists.

The present and immediate future benefits depend on the strength of varietal improvement programmes in the region. There are many traits recognized as a result of evaluation of the different collections both at the headquarters and at the special research projects. These are being exploited for hybridization or direct selections for varietal development. After the computerization of the collections, information on their traits will be made available periodically to researchers in and outside the region.

Future programme

The various aspects of the activities described above will continue and be strengthened. These include collection, conservation, evaluation, utilization and computerization.

There will be special emphasis on the reduction of seed moisture content from the present average of 12 - 14% to 6 - 8%. The availability of more laboratory working space in future will contribute towards this goal.

There is a need to have at least two full time technicians to assist in the different aspects of the programme. Present funding difficulties have made this impossible up till now.

Collections will be made in some areas where neither IITA nor IRAT/ORSTOM has collected. Samples of collections made by national programmes as well as all African collections with IRRI will be procured and stored.

International collaboration with IBPGR, IITA, IRAT-ORSTOM and IRRI will be maintained and strengthened.

SEED NURSERY FARM

Background

The Seed Nursery Farm (SNF) is located at Suakoko, 180 km from Monrovia in Liberia. The Farm was started in 1976 with two hectares of irrigated land developed from an inland swamp. The experimental area has been gradually increased to about five hectares; four hectares of lowland and one of upland. The area is adequate for the present need and can be increased if needed. The Seed Nursery Farm building area and field area have been provided by the Central Agricultural Research Institute (CARI) of Liberia. The areas were developed by WARDA.

The SNF is a component of the Technical Support Services of the Research Department of WARDA and its activities are integrated with those of the Seed Laboratory. SNF is funded by IFAD through the CGIAR.

Objectives

The major objectives of the SNF are as follows:-

1. Introduction of rice varieties and breeding lines from International Institutes and national programmes throughout the world.

2. Screening of introduced materials for desirable plant type, height and architecture, disease and insect resistance, tolerance to soil problems, drought tolereance (upland), suitable maturity, grain quality, grain yield and general adaptability.

3. Monitoring performance of elite lines and varieties.

4. Selection of promising lines and varieties for the Initial Evaluation Tests (IETs), Coordinated Variety Trials (CVT) and the activities of the Special Research Projects.

5. Seed increase of selected varieties.

6. Maintaining seeds of promising varieties.

7. Composition of IETs and CVT.

8. To develop appropriate production packages for upland and inland swamps.

9. To develop management practices for iron toxic swamps.

10. To provide professional and technical support to the WARDA special research projects, subregional coordination and national programmes.

11. Collaboration with Development Department in Technology Assessment and Transfer (TAT) programme.

12. To assist in training of rice scientist and technicians.

Infrastructural Development

One laboratory-cum-office building, one tool house and threshing floor provide the infrastructural facilities. The laboratory is equiped with a sample dryer, weighing scales, moisture tester and laboratory tools. Temporary

seed storage facility also exists. The farm has one tractor, two power tillers and other farm tools. Irrigation water is supplied from a nearby dam throughout the year.

Staffing: The following staff are attached to the SNF:

Professional

1 Rice Breeder - since 1976
1 Associate Rice Breeder - from 1980 - 1981, position has been frozen since 1982 due to lack of funds.
1 Agronomist - from 1981.

General Service

1 Senior Field Technician - since 1975
5 Field Assistants: 1 since 1977, 1 from 1978 and 3 since 1980 (1 located at Richard-Toll for seed Increase programme)
1 Clerk/Typist
1 Laboratory Attendant
1 Driver
1 Tractor Driver
- Labourers

The pathologist, Entomologist and the IITA Liaison Scientist (germplasm) use the SNF facilities for their field experiments.

Varietal Introduction and Improvement Activities

Staff: M.A. Chouchury

Introduction and testing done since 1978 are shown in Table 2.1

Table 2.1: Number of Varieties tested at the SNF since 1978

New Introduced Materials for Screening and observation	Years 1978	1979	1980	1981	1982	Total
Upland	-	407	347	453	704	1911
Irrigated	2500	1610	1451	1854	1043	8458
Total	2500	2017	1798	2307	1747	10369

New materials are introduced regularly from IRRI, Bangladesh, Indonesia, India, Sri Lanka, Japan, CIAT and Brazil.

The strains selected from the new introductions are planted in the following season, in the same year or the following year, for seed increase and further observation. The number of selected strains grown in each year for seed increase and observation since 1978 are shown in Table 2.2

Table 2.2: Number of selected varieties grown for Seed Increase and observation since 1978

Varieties	Years 1978	1979	1980	1981	1982	Total
Upland	-	102	216	-	20	338
Irrigated at Suakoko	258	607	704	239	459	2294
Irrigated at Richard-Toll	108	127	252	341	286	1114
Total	393	836	1172	580	765	3746

From the observation made on the selected varieties in each year, promising ones are selected, multiplied and nominated to the upland and irrigated IETs as the case may be. The most promising superior varieties from IETs and other sources are nominated to the CVTs. The number of varieties nominated to WARDA IETs and CVTs from the Varietal Improvement programme at SNF are shown in Table 2.3.

Table 2.3: Number of Varieties nominated from the Varietal Improvement Programme at SNF to IETs and CVTs of WARDA since 1978

Trials	No. of Varieties nominated					
	1978	1979	1980	1981	1982	Total
IETs	270 (84%)*	431 (80%)	367 (67%)	260 (69%)	212 (60%)	1520
CVTs	22 (66%)	25 (89%)	20 (59%)	24 (57%)	17 (43%)	114

All the selected varieties and varieties nominated to the CVTs are multiplied both at Suakoko and Richard-Toll. Seeds produced at Richard-Toll are usually cleaner. Seeds harvested during the rainy season at Suakoko are generally not clean due to hull diseases (glume discolouration). At Richard-Toll, three to four times higher yields are obtained compared to Suakoko (Table 2.4). Hence seed production for the trials is normally done at Richard-Toll.

* percentage of SNF entries in trial

Table 2.4: Average Grain Yield at Suakoko and Richard - Toll, 1981 - 1982

Kinds of Materials	Average Grain Yield in kg/ha	
	Suakoko	Richard-Toll
Experimental Materials		
Pre-IET-Irrigated	1800	-
IET-Upland	700	-
IET-Irrigated	3030	9660
Seed Increase		
Upland Materials under Upland condition	1490	-
Upland Materials under Irrigated condition	1384	3949
Irrigated Materials	1445	5642
Mangrove Swamp Materials under Irrigated condition	1185	4374
Deep Flooded & Floating Materials under Irrigated condition	1204	4026
Average yield in kg/ha of Increase Materials	1342	4498

The names of the varieties nominated from the varietal improvement programme (SNF) in different years to CVTs are shown in Table 2.5.

Table 2.5: Varieties nominated to the CVTs from SNF in different years 1978-1982

Upland short duration

1978: AUS 61, B9C-MD-3-3, B5C-MD-10-2

1979: C 168, CR 1002, KN 144

Savanna Upland short Duration

1980: 62-155-C1, DV-110-B1, G11B-SI-141-2-C1

1982: M18

Upland medium duration

1978: 4320, MRC 172-9, IRI529-242-3, IR 3880-17

1979: COL 38, LD 125, IET 3226, Sein Ta Lay, B 541b-KN-91-3-4

Moist Zone Upland Short Duration

1980: CR 1015, Dharial, IR 2922-22A

1982: ECLA 4-10-1, CMBP 217, M 55

Moist Zone Upland Medium Duration

1980: C22, FH109, IRI529-430-3, Mata J/11, MRC 172/9

1982: R_9-1-6-1-3-1-1

Irrigated short duration

1978: B 90-2, BW 78, IET 2775, BPI 76/9 x DAWN, BR 51-46-5, IET 1444, IR 2071-586-5-6-3

1979: IET 1785, IR 2042-178-1, IR 2798-107-3, IR 3273-P339-2, MRC 505, MTU 8431

1980: B 541-PN-58-5-3-1, BR 168-2B-23, IET 3137

Sahel irrigated short durstion

1981: 75-8430, B9C-MD-3-3, B 2360-8-9-5, B2360-11-3-2-9, BR 13-47-3, IET 4247, IR 2823-399-6-6, IR 5179-2-2-A, IR 9782-144-3-3-3, KN 361-1-8-6, Rasht 448, Toc 4688

1982: 84312, C22, IR40

Irrigated mediun duration

1978: IR 2070-414-3-9, BW 191, BW 19t, 4414, BG 374-1

1979: H 5, IR 5666-15-2

1980: BW 248-1, Nizersail, IR 18 20-210-3, IR 3464-4-3-2, IR 4442-165-1-3-2, B8i-Dsi-28-2

Sahel irrigated medium duration

1981: BR51-91-6, BR 51-319-9, BW 170, CR 1015, IET 6496, Vijaya (selection), Improved Mahsuri

1982: FH 109

Moist zone irrigated short duration

1981: B541B-KW-19-3-4, CNM 31, CR 1022, IET 3137, KN 144

1982: IR 2360-8-5-LR-43, BR 20-29-2, BR 24-2-1, BR 508-B_2-9, IET 4506, IET 6056, IR 2928-7-3-1-1

Mangrove swamp trial

1978: DA 29,

1979: B 911-11, B 934-8, IR 1529-430-3, Kumragoir, Pokkali

Deep Flooded Trial

1978: DM 12, IR 4442

1979: Kaikka, RD 5, Habiganj, A II, RD 7

The finalization of nomination of entries is done by a variety nomination committee which meets once yearly. The committe is composed of the WARDA Senior Rice Breeder and other members from IITA, IRRI, IRAT/IDESSA and the Special Research Projects of WARDA. This committe also prepares and revises trial protocols and decides on scoring systems for the trials.

In addition to the seed produced at the SNF at Suakoko and at Richard-Toll (Senegal), seeds also come from WARDA Special Research Projects; IITA, IDESSA and national programmes.

In addition to supplying seeds for regular trials, seeds produced at the SNF are also sent to some countries outside WARDA region at their request (Table 2.6).

Table 2.6: Number of Varieties sent from SNF to Countries outside WARDA Region since 1978

Year	Number of Varieties	Countries
1978	-	-
1979	55	Cameroun, Tchad, Kenya
1980	69	Mozambique, Philippines, Cameroun, Tchad
1981	44	Cameroun, Tchad, Philippines
1982	70	Cameroun, Tchad, Kenya

Since 1981, segregating population of Rapid Generation Advance (RGA) crosses were introduced from IRRI. The crosses introduced in 1981, their parentage and plant selection made are shown in Table 2.7.

Table 2.7: The RGA crosses introduced in 1981 and plant Selection made in 1981-82

RGA #	Generation at Introduction	Parents	Plant Selected for Mopti Project	SNF SUAKOKO
2	F_4	Aswina/IR4432-103-3	40	22
12	F_4	Fulkari/IR4422-164-6	81	48
17	F_4	Habiganj/DW1/IR422-164-3-6	60	33
30	F_4	Sungwale/IR4816-70-1	80	31
33	F_4	Nonsail/IR2071-105-4	56	53
36	F_4	IR 2207-217-2-3/BKN 6986-147-2	23	9
189	F_3	Digha/BR 4	26	4
202	F_3	Nigersail/BR51-76-6	-	25
		Total	366	225

Progenies selected for Mopti project were grown at Mopti in 1982 but failed due to severe drought. A duplicate set preserved at the coldroom at Fendall will be retested in 1983 at Mopti.

In each cross, one deep water rice variety suited to shallow water depth having photoperiod sensitivity was used. The other parent is a non-deep water type. The progenies showing deep water tendency such as nodal roots, bending at nodes, weaker and longer internodes were selected for Mopti project. The progenies showing semi-tall habit with longer duration (photoperiod sensitivity) were selected for a further selection at Suakoko. The objective is to get photosensitive varieties for inland swamps. Plant selection will continue in 1983 at Suakoko.

in 1982, sixteen RGA crosses were introduced at Suakoko. Plant selection will be made in 1983. Seven crosses were in F_4

and 9 crosses in F_5 generation. Twelve crosses involved rainfed lowland varieties and irrigated varieties and four crosses had an upland variety crossed with an irrigated variety. The objective of this introduction is to identify lines adatable to different water regimes in inland rainfed valley swamps.

Support to Special Research Projects

The Rice Breeder assisted the Mopti project by supporting its breeding programme through procuring elite varieties from Asian countries, namely, Thailand and Bangladesh; by devising testing methods, parental selection and hybridization techniques; selection procedures; field evaluation of materials and programme development.

The Rice Breeder assisted the Richard-Toll project by supporting its Breeding Programme through procuring and supply of elite irrigated rice varieties and evaluating their performance. The Rice Breeder was directly involved in the seed increase programme.

Other Activities

Other activities of the Rice Breeder include:

- Regular lectures at the WARDA Training Centre;
- Review of the trial sites each year for the IETs and CVTs;
- Preparing the protocols for the trials;
- Preparing the record booklets for the IETs;
- Interpretation and presentation of trial results;
- Development of the book "Rice Varieties Recommended in the WARDA Region", Second Edition, 1982.
- Report writing, budget preparation etc.

Futur Plans

The SNF will continue to perform the role as the centre of introduction of new materials, their improvement and supply of seeds for the WARDA initial evaluation tests, coordinated variety trials and other needs, During the next five years,

emphasis will be given to the following aspects:

1. Introduction and selection of varieties for rainfed lowland condition. Major crateria will be higher yield, disease resistance, medium maturity, semi-tall and iron toxicity tolerance.

2. Introduction of and selection from segragating populations for rainfed lowland rice development.

3. Selection of varieties for higher rainfall upland areas in close collaboration with Bouaké and upland rice project. Major crateria will be, medium duration, moderate drought tolerance, higher yield, blast resistance and semi-tall. This will envolve introduction of segregating progenies and fixed lines from Bouaké and outside sources.

Agronomy Activities
Staff: D.K Das Gupta

Upland rice

Yield Constraints Study to Find out the Factors Limiting Rice Yield in the Upland Soil when put under Continuous rice Crop

This study was initiated in 1981 in the upland where thick secondary bush was cleared in the 1979-1980 dry season and a crop of rice was grown in the 1980 wet season. The trial was repeated in the 1982 wet season at the same site. The factors included in the study were:

- method of planting (line and broadcast)
- fertilizer (N40 P30 K30 in 1981 and N50 P40 K40 in 1982).
- weeding
- insect pest control (Puradan 3G at 1.2 kg a.i./ha was applied 1/3 each at 10, 30 and 60 days after seeding), and
- water conservation practices (by bunding).

The treatments were so designed as to develop a complete package (CP = line sowing, fertilizer, weed and insect pest control, and water conservation by bunding), and also an intermediate package (IP = CP-bunding). Tradition al method consisted of braodcast seeding, no fertilizer and no insect pest control. The variety LAC 23 was used in the experiment. The results are presented in Table 2.8.

Table 2.8: Yield Response of Upland Rice to Various Agronomic Practices

Agronomic Practices	1981 Yield (kg/ha)	1981 Reduction in yield (kg/ha)	1981 Reduction in Yield %	1982 Yield (kg/ha)	1982 Reduction in yield (kg/ha)	1982 Reduction in Yield %
Intermediate Package (IP)	1250	-	-	1060	-	-
IP - Insect Control	1260	-	-	849	211	20
IP - Weeding	653	597	48	557	503	47
IP - Fertilizer	638	612	49	534	526	50
IP - Line Sowing	1264	-	-	906	154	15
Traditional Method	550	700	56	344	716	68
L. S. D. (0.05)	80			108		
CV (%)	5.8			10.4		

It was inferred from the study that:

- in bush follow-rice-rice systems, grain yield of traditional method (550 kg/ha) could be increased by over 100 percent by adopting a package consisting of line sowing, fertilizer application and weed control in areas where the population of destructive insect has not reached the level of economic threshold; while in
- third rice crop after two consesecutive rice grain yield of traditional method (344 kg/ha) could be increased over 200 percent by a package of line sowing (for proper weeding), fertilizer application, weeding and insect pest control. In the third rice crop about 20 percent yield reduction could be expected if insecticide is not applied.

With regard weed population, the number of various weeds in 1982 were higher than those in 1981 in all treatment. In both years, grass weed dominated. The number of grass and broad-leaved weeds increased, while sedges decreased sharply in the succeeding rice crop in 1982. IP minus weeding had the highest number of total weeds, followed by the two traditional methods and IP minus line sowing in both years.

Yield response of rice varieties to nitrogen levels in upland bush fallow-rice-rice-systems

The trial was conducted for the first time in 1980 at a site after clearing a thick bush in the 1979-80 dry season. The trial was repeated in the 1981 and 1982 wet seasons at the same site.

Results for 1980 and 1981 suggest that in rice-rice systems 40 to 60 kg N/ha is necessary to maintain reasonable grain yield (1.3 to 1.5 t/ha) in seccessive years. (Table 2.9).

Table 2.9: Yield response of medium duration rice varieties to nitrogen under bush fallow-rice conditions (1980 and 1981 wet season at Suakoko, Liberia)

Varieties	Days to 50% Flowering	Grain yield (kg/ha) in various nitrogen (N) levels (kg/ha)								
		1980				1981				
		N_0	N_{20}	N_{40}	Mean	N_0	N_{20}	N_{40}	N_{60}	Mean
ROK 3	88	1462	1809	2381	1884	–	–	–	–	–
4418	93	1019	2805	3567	2464	909	1260	1449	1665	1346
IR 2035-1082	94	1128	2519	3024	2224	–	–	–	–	–
MAC 172-9	86	1090	3114	3257	2487	–	–	–	–	–
LAC 23	95	1648	2495	3081	2408	789	1127	1285	1458	1165
IRAT 13X	92	–	–	–	–	732	802	1053	1337	981
C 22	99	–	–	–	–	705	944	1386	1698	1183
Mean		1269	2548	3062		804	1033	1293	1544	
C. V. (%) for N					17.9					8.7
C.V. (%) for N x V					6.1					8.5
LSL (0.05) for N x V					237					143

55

Table 2.10: Yield response of rice varieties to levels of nitrogen under bush fallow-rice-rice-rice conditions (1982 Wet Season at Suakoko - Liberia

Varieties	Days to 50% Flowering	Grain yield (kg/ha) in various nitrogen levels (kg/ha)				
		0	30	60	90	Mean
1. LAC 23(white)	104	720	1178	1667	2106	1418a
2. LS91)-19-1-1	107	542	939	1485	1909	1219bc
3. TOX 502-2SLR-LS2--5B	97	489	841	1212	1879	1105c
4. SEL IRAT 194/1/2	86	735	1019	1485	1932	1293ab
Mean	-	621d	994c	1462b	1956a	

The grain yield data of the 1982 trial are presented in Table 2.10. The grain yield increased with increasing levels of nitrogen. LAC 23 gave the highest yield (mean 1.42 t/ha) followed by SEL IRAT 194/1/2 (mean 1.29 t/ha).

In general, the grain yield in 1982, regardless of levels of nitrogen and varieties, were lower than those in 1980 and 1981. It was inferred that:

a) for the first rice crop after bush fallow, a dose of 20 - 40 kg N/ha is needed to obtain a grain yield more than 2.0 t/ha. However, without added nitrogen, a grain yield of about 1.0 t/ha could be achieved, and this is what the farmers are getting at present.

b) for the second rice crop, a dose of 40 -- 60 kg N/ha is needed to maintain a reasonable grain yield of 1.5 t/ha.

c) for the third rice crop (1982), a dose of 60 - 90 kg N/ha is needed to obtain a grain yield between 1.5 and 1.9 t/ha.

However, it is doubtful that from the soil fertility point of view, nitrogen application alone will maintain grain yields. Further work on crop rotation, green manure or cover crops etc. will be initiated in upland bush fallow-rice systems.

Inland valley swamp rice

Evaluation of various sources of nitrogenous fertilizers

The trial was conducted in 1981 and 1982 at the same site. The objective was to evaluate the compund fertilizer (15 -15 -15) as against sulfur coated Urea (SCU) of various disolution rates (14.8, 20.7, 22.0, 34.5 and 35.5), Urea super granule (1g and 2g) and commercial urea as sources of nitrogen for lowland swamp affected by iron toxicity.

Suakoko 3 was used as test variety. In various N sources, 60 kg/ha each of N, P_2O_5 and K_2O were applied, while the control treatment had only 60 kg/ha each of P_2O_5 and K_2O. Commercial urea and potassium (muriate of potash) was applied in three equal split doses at 10 days after transplanting, maximum tillering and panicle initiation stages; while phosphorus (triple super phosphate) was applied at transplanting. All SCU and urea super granule (1g and 2g) and compound fertilizer (15 - 15 - 15) were applied at transplanting. There were bunds around each treatment plot and irrigation water was brought into each plot separately without passing through adjacent plots.

The yield data showed that all N sources gave significantly greater yield than the control treatment (Table 2.11)

Table 2.11: Effects of various sources of Nitrogen on grain yield of Suakoko 8 under lowland swamp conditions at Suakoko, Liberia (1981 and 1982 wet season

SOURCES OF NITROGEN	1981			1982		
	Grain Yield (kg/ha)	Increase over yield control (kg/ha)	%	Grain Yield (kg/ha)	Increase over yield control (kg/ha)	%
1. Control (without N)	2161	–	–	2037	–	–
2. SCU-14.8DR (36.7% N)	3805	1644	76	3114	1017	53
3. SCU-22.0DR (36.7% N)	3847	1686	78	3279	1242	61
4. SCU-34.5DR (37.8% N)	3420	1259	58	3105	1068	52
5. SCU-20.7DR (38.6% N)F	3408	1247	58	3002	965	47
6. SCU-35.5DR (39.1% N)F	3387	1226	57	3035	998	49
7. Urea Supergranule (46 %N) 1.g	3395	1234	57	3010	973	48
8. Urea Supergranule (46 % N) 2.g	3403	1247	58	3014	977	48
9. Commercial Urea	3408	1247	58	3238	1201	59
10. Compound Fertilizer (15 - 15 - 15)	2778	617	28	2534	497	24
C.V.(%)		11.19			10.13	
L.S.D. (0.05)		536 kg			434 kg	

DR = Dissolution Rate

F = Forestry Grade

Among the N sources, significantly lower yield was obtained from 15 - 15 - 15 compound fertilizer. In both 1981 and 1982, there was no significant difference in grain yield among commercial urea, all SCU and the two urea super granules.

It may be inferred from the two years' results that one application of Urea super granule or SCU at transplanting would give similar grain yield as commercial urea applied three times at various growth stages of the rice plant in low land swamp.

Evaluation of various sources of phospohrus (P) fertilizer

The trial was conducted in the 1981 wet season, 1981/82 dry season and 1982 wet season . The objective was to evaluate phosphate rocks such as Tunisia (30% P_2O_5), Morocco (33.4% P_2O_5), Jordan (32.0% P_2O_5) and Togo (36.5% P_2O_5) and triple super phosphate for agronomic effectiveness in lowland swamp affected by iron toxicity. All the 15 phosphorus fertilizer treatments were applied before transplanting as basal. After harvest of the 1981 wet season rice crop, rice seedlings were transplanted again in each treatment plot with minimum soil disturbance to study the residual effect of various sources of phosphorus. Nitrogen (Urea), potassium (Muriate of potash) were applied in all plots at the rate of 60 and 40 kg/ha respectively in three equal split dressings. IR 5 was used as the test variety. There were bunds around each treatment plot and irrigation water was brought into each plot separately without passing through adjacent plots.

The results (table 2.12 and 2.13) showed that the direct effect of applied phosphorus on grain yield increased significantly with increasing P_2O_5 levels from 20 to 60 kg P_2O_5/ha/. The yield response to phosphorus was highest in Tunisia phosphate rock followed in order by Jordan P.R. and triple super phosphate, Morocco and Togo phosphate rocks.

The residual effects (1982 dry season) of phosphorus on grain yield was significant. Regardless of phosphorus sources, the residual effect of 40 and 60 kg P_2O_5/ha on grain yields was significantly greater than that of 20 kg P_2O_5/ha. The highest residual effect, was noted in Jordan phosphate rock and lowest in triple super phosphate (table 2.13).

Considering combined (direct and residual) effects on grain yield, Tunisia and Jordan phosphate rocks are superior to other phosphorus sources.

The trial was repeated in 1982 wet season at the same site. The two wet seson results are similar (tables 2.12 and 2.14).

Table 2.3: Direct and residual effects of sources and rate of phosphorus on grain yield of IR 5 under lowland swamp conditions at Suakoko, Liberia (1981 wet season and 1981/82 dry season and 1982 wet season)

SOURCES	Direct effect 1981 wet season			Residual effect 1981.82 dry season			Direct effect 1982 wet season		
	Yield (Kg/ha)	Yield increase over control (Kg/ha)	%	Yield (Kg/ha)	Yield increase over control (Kg/ha)	%	Grain yield (Kg/ha)	Increase over control ((kg/ha)	%
1. Control ($P_0N_{60}K_{40}$)	2819	-	-	3679	-	-	2898	-	
2. Tunisia P.R. ($P_{20}N_{60}K_{40}$)	3169	350	12	4600	921	25	3151	253	8.7
3. Tunisia P.R. ($P_{40}N_{60}K_{40}$)	3657	838	30	4709	1030	28	3520	622	21.5
4. Tunisia P.R. ($P_{60}N_{60}K_{40}$)	4556	1737	62	4751	1072	29	4348	1450	50.0
5. Jordan P.R. ($P_{40}N_{60}K_{40}$)	3550	381	13	4529	850	23	3201	303	10.4
6. Jordan P.R. ($P_{60}N_{60}K_{40}$)	3550	731	26	4924	1245	34	3520	622	21.5
7 Jordan P.R. ($P_{60}N_{60}K_{40}$)	3916	1097	39	5062	1383	37	3934	1036	35.7
8. Morocco P.R. ($P_{20}N_{60}K_{40}$)	3108	289	10	4691	1012	27	3134	236	8.1
9. Morocco P.R. ($P_{40}N_{60}K_{40}$)	3489	670	24	4811	1132	31	3387	489	16.9
10. Morocco P.R. ($P_{60}N_{60}K_{40}$)	3657	838	30	4829	1150	31	3569	671	23.2
11. Togo P.R. ($P_{20}N_{60}K_{40}$)	3108	289	10	4356	677	18	3089	191	6.6
12. Togo P.R. ($P_{40}N_{60}K_{40}$)	3246	421	15	4607	928	25	3267	369	12.7
13. Togo P.R. ($P_{60}N_{60}K_{40}$)	3520	701	25	4652	973	26	3511	613	21.1
14. Trip.Sup.Phos. ($P_{20}N_{60}K_{40}$)	3124	305	11	4201	522	14	3159	261	9.0
15. Trip.Sup.Phos. ($P_{20}N_{60}K_{40}$)	3505	686	24	4638	959	26	3478	580	20.0
16. Trip.Sup.Phos. ($P_{60}N_{60}K_{40}$)	3912	1093	39	4691	1012	27	3892	994	34.3
c.v. (%)	8.7			7.3			6.7		
L.S.D. (0.05)	433			479			328kg		

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Table 2.13 : Direct and residual effects of sources and levels of phosphorus on grain yield of IR 5 in lowland swamp at Suakoko, Liberia (1981 wet and 1982 dry seasons)

Sources of Phosphorus	Yield (kg/ha) in various phosphorus levels ($kg\ P_2O_5$)							
	20		40		60		Mean	
	1981	1982	1981	1982	1981	1982	1 981	1982
1. Tunisia P.R.	3169	4600	3657	4709	4556	4751	3794	4687
2. Jordan P.R.	3200	4529	3550	4924	3916	5062	3555	4838
3. Morocco P.R.	3108	4691	3489	4811	3657	4829	3418	4777
4. Togo P.R,	3108	4356	3246	4607	3520	4652	3291	4583
5. Trip.Sup.Phos.	3124	4201	3505	4638	3912	4691	3514	4510
Mean	3142	4475	3489	4738	3912	4797		

LSD (0.05) of sources:
For 1981 = 250kg
For 1982 = 277kg

LSD (0.05) of levels of P_2O_5:
For 1981 = 194kg
For 1982 = 214kg

Table 2.14: Direct effects of sources and levels of phosphorus on grain yield of IR5 in lowland swamp at Suakoko, Liberia (1982 wet season)

Sources of phosphorus	Grain yield (kg/ha) in various phosphorus levles (kg P_2O_5/ha)			
	20	40	60	Mean
1. Tunisia phosphate Rock	3151	3520	4348	3673 a
2. Jordan " "	3201	3520	3934	3552 a
3. Morocco " "	3134	3387	3569	3363 b
4. Togo " "	3089	3267	3511	3289 b
5. Triple Super Phosphate	3159	3478	3892	3510 a
Mean	3147 c	3434 b	3851 a	
LSD (0.05) of sources =	189kg			
LSD (0.05) of levels =	147kg			

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The residual effect trial of phosphorus on grain yield in the 1982/83 dry season is in progress.

Yield response of rice varieties to levels of nitrogen in low land iron toxic swamp during the dry season (1982)

This is a collaborative experiment, between IITA and WARDA, conducted during the 1982 dry season (January - June) at Suakoko. The objective of this study was to determine the yield response of varieties, with different duration, to two levels of nitrogen (60 and 120 Kg/ha) under iron toxic swamp conditions.

Fifteen varieties, out of which 13 IITA series, were received. One local check variety (Suakoko 8), tolerant to iron toxicity was included in the trial.

Nitrogen (Urea) was applied in three equal split doses at transplanting, three and six weeks after transplanting. Phosphorus (triple super phosphate) and potassium (Muriate of potash) were applied in all plots as basal at the rate of 30 kg P_2O_5/ha and 30 kg K_2O/ha respectively.

Only the varietal differences were significant. The highest yield of 5.3 t/ha was noted in ITA 239 and ITA 243 followed by FARO 15 (5.2 t/ha), ITA 254 (5.0 t/ha), ITA 250 (5.0 t/ha) and ITA 245 (5.0 t/ha). The lowest yield of 1.5 t/ha was noted in ITA 234. The local check Suakoko 8 yielded 3.8 t/ha.

It was observed that application of 120 kg N/ha caused reduction in growth especially general vigor and tillering in some varieties perhaps due to iron toxicity. It was observed in a separate trial in 1981 wet season that in iron toxic swamp at Suakoko, grain yield increased with increasing N level from 0 to 40 kg N/ha while further increase in N from 40 to 80 kg N/ha caused a decrease in yield (Table 2.15) and increase in bronzing and iron toxicity symptoms in most of the varieties.

It may be inferred from this study that in iron toxic swamp, only a moderate of nitrogen (40 to 60 kg N/ha)is needed for higher grain yield.

Further field trials using some cultivars (especially ITA series), which exhibited better yield performance that Suakoko 8, an iron toxic tolerant cultivar, will be grown during the wet season.

Table 2.15: Yield response of short duration rice varieties to nitrogen under lowland swamp conditions, 1980 and 1981 wet seasons at Suakoko

VARIETY	Days to 50% flowering	Grain Yield (kg/ha) in various nitrogen (N) levels(Kg/ha)							
		1980				1981			
		N_0	N_{40}	N_{80}	Mean	N_0	N_{40}	N_{80}	Mean
DJ 346 D	98	2905	4074	3492	3490	-	-	-	-
BR51-118-2	85	2100	2942	2735	2592	-	-	-	-
BR51-46-5	97	3317	4360	3471	3716	3333	4474	4086	3964
BG 90-2	96	3286	4503	4201	3997	-	-	-	-
ADNY 11	91	3222	4529	3243	3665	3359	4378	3843	3860
IET 1444	95	3386	4339	3995	3907	3346	4247	3856	3816
4414	94	2746	4656	4339	3995	2836	4336	3945	3706
DJ 684 D	93	3280	3963	4233	3825	-	-	-	-
BR51-319-9	96	2905	3704	4037	3549	-	-	-	-
IET 1996	78	-	-	-	-	4163	4686	4112	4320
BR168-2B-23	76	-	-	-	-	3022	3836	3343	3400
Mean		3016	4119	3749	-	3343	4326	3864	-
C.V. (%)for N				3.0					8.5
C.V. (%)for N x V				7.4					4.5
L.S.D. (0.05)for N				54					231
L.S.D. (0.05)for V				180					142
L.S.D. (0.05)for N x V				311					246

Deep floating Rice

A field trial entitled "Effect of fertilizer application on the plant growth and development, and nutrient uptake of the rice plant under deep water conditions at Mopti (Mali)" was conducted in the 1981 wet season. This study was carried out in collaboration with the Special Research Project. The details of this experiment have been presented in the report of the Special Research Report.

Irrigated rice

A field trial entitle "Effects of methods of fertilizer application and planting (traditional and broadcastable seedligns) on the growth and plant development and grain yield of irrigated rice (cultivar KH 998) during the cold season at Richard-Toll/Fang Senegal" was conducted in the 1981-82 cold season. This study was carried out in collaboration with the Speical Research Project. During the 1982 wet season, a similar trial was conducted ar Trichard-Toll/ Fanaye. The details of these studies have been presented in the report of the Special Research Project.

Mangrove swamp rice

Direct involvement and support given to the Rokpur Project were in the area of weed control and M.Sc degree programme of the weed scientist. Also during the 1982 wet season, assistance was given to the Technology Assessment and Transfer (TAT) programme of the Development Department.

On the basis of field observations assistance was given to the agronomist in planning future field trials on

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phosphorus and potassium, changes in soil characteristics and properties due to mechanical ploughing, soil properties of soft and hard mud of mangrove swamps.

Support to Sub-Regional Coordination and National Rice Programmes

The following activities were undertaken:

i. Assisted in on-farm variety and weed control trials

ii. As per request of the Central Agricultural Research Institute (CARI) Suakoko, Liberia, provided detail trial protocols on fertilizer (N, P, K) application under upland and low land swamp conditions. In addition the station is utilizing the findings of agronomy trials conducted at the WARDA/SNF.

iii. by request of the Crop Research Institute (CRI), Nyankpala, Ghana prepared and submitted a detailed proejct proposed on rice research extension in Northern Ghana (with budget for 5½ years).

iv. by request of the USAID in Liberia and Guinea-Bissau, visited mangrove swamp rice producing area in Guinea-Bissau, (Caboxanque) and submitted a detailed programme on the following:

- soil chemistry,
- hydrology and water management,
- agronomy and plant protection,
- mechanization and
- transfer of technology

for mangrove swamp rice in Guinea-Bissau.

FUTURE ACTIVITIES IN AGRONOMY

Seed Nursery Farm, Suakoko, Liberia

i. In close collaboration with the Bouake Upland Rice Project, field trials will be conducted on :
   - agronomy (rice based cropping system and crop rotation) and weed science;
   - studies on relative efficiencies of some common upland crops.

ii. Studies on the effects of various tillage practices in the wet and dry season rice crops on the incidence of various weed species (annuals and perennials), weed dry weight and grain yields under low land swamp conditions (long term experiment);

iii. Yield constraints and maximization studies in low land swamp during the wet and dry seasons.

iv. Studies on the development of appropriate combination of improved rice cultivars and agronomic practices for the low land (iron toxic) swamp;

v. Continuation of on-going programme.

Deep Water/Floating Rice Special Research Project Mopti, Mali

i. Further study on the effect of fertilizer application on the plant growth and development, and nutrient uptake of rice in various water regimes (shallow, deep and floating). In these studies improved rice cultivars such as BKN series will be included ;

ii. Studies on yield maximization and constraints in

various water regimes with a view to develop an economic package of practice;

iii. studies on yield components of newly introduced rice cultivars; this study includes contribution of main plant, secondary tillers and nodal tillers, panicle length etc. to the total grain yield per plant.

Irrigated Rice Special Research Proejct, Richard-Toll/ Fanaye, Senegal

i. Yield maximization and constraints studies; the objective of this study is to find out the factors that are limiting rice production in the ecology when put under continous rice crop. The treatments are so designed to develop a complete and intermediate packages of agronomic practice for wet, cold and hot season;

ii. evaluation of various sources of phosphorus fertilizers (direct and residual effect on grain yield);

iii. methods of phosphorus application;

iv. long term studies on the effects of various tillage practices in the first, second, third and fourth rice crops on the incidence of various weed species, weed dry weights and grain yields;

v. studies on the effects of land preparation methods during the fallow period on weed infestation, seed bed tillage requirements and grain yield in succeeding rice crops;

vi. secreening of herbicides;

vii. continuation of the on-going programme(i.e., effects

of fertilizer application and planting on plant growth and development, and grain yield of irrigated rice during the cold and wet seasons.

Mangrove Swamp Special Research Project, Rokpur Sierra Loene

i. Evaluation of various sources of nitrogenous fertilizers;

ii. Studies on the rates of phophorus and efficiency of various sources of phosphorus fertilizers;

iii. Long term studies on the direct and residual effects of phosphorus on grain yield;

Fertilizer requirement and soil amendment for associated mangrove swamp affected by iron toxicity

v. Long term studies on land preparation and weed control methods in pure and associated mangrove swamps with a view to develop a suitable combination of tillage practice and weed control methods

vi. Screening of herbicides.

Upland Special Research Project, Bouake, Ivory Coast

In close collaboration with the Upland Special Research Project, agronomy and weed control trials will be conducted in high rainfall upland areas.

Sub-regional Coordination and National Rice Programme

i. Continuation of on-going programme in Liberia and elsewhere;

ii. Active support will be given as per need of the Su-regional Coordination and national programme of the WARDA member countries in the field of agronomy and

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weed science.

iii. Monitoring tours to assess and identity infestation of various weeds in various rice ecologies, and monitoring performance of elite cultivars and lines.

THE WARDA SEED LABORATORY, FENDALL, LIBERIA

Background

WARDA Seed Testing laboratory is located on the campus of the University College of Agriculture of Liberia situated in Fendall, Liberia (about 30 kilometers from the WARDA headquarters, Monrovia). The Seed Testing laboratory, which was built with funds provided by the United States Aid for International Development (USAID), was commissioned in 1974. The objective of the seed laboratory is to ensure the provision of disease-free high quality seeds of improved rice varieties for the various research activities of WARDA and its member states. Consequently, the seed testing laboratory has continued to play a major role in receiving, testing, processing, treating with hot-water and chemicals as well as packaging and distributing elite materials to WARDA experimental sites and cooperators in and outside West Africa.

Infrastructure and facilities

The infrastructure at the centre includes seed processing and treatment facilities, seed testing and storage unit as well as seed health testing section. The facilities for processing seed comprise a super speed scalper-cleaner, three laboratory model seed testers and a small capacity gravity table. The processed seed is treated with hot-water in a locally designed hot-water bath at 55°C for 20 minutes after which the seed is dried to about 13 percent moisture content in a modified IRRI-type batch drier. The hot-water treatment is undertaken to ensure that seed dispatched to member states and cooperating institutes in West Africa are free of such virulent/

destructive seed-borne diseases such as white-tip (Aphelenchoides besseyi), bacterial straek (Xanthomonas translucence f.sp. oryzacal)and bacterial leaf blight (Xanthomonas oryzae). This treatment has also been observed to reduce spores of blast fungus (Pyricularia oryzae).

Seed Service Activities

Staff: M.A.Larinde

The staffing situation of the laboratory has imporved during the period under review. At present the laboratory has two professional staff (Seed Technologist and Assistant Seed Technologist) and six supporting staff comprising three laboratory assistants, two laboratory attendants and one typist. In view of the bulk of the work involved in getting trial materials ready within a short period of three to four months in the early part of each year, on an annual basis, casual laborers are recruited for a period of four to five months to cope with the work load at the peak period.

In realization of the importance of a trained and competent man-power in a successful seed programme, the staff have undergone both formal and informal (on-the spot) training in different aspects of seed handling. The seed Technologist completed a Masters of Science degree at the Mississippi State University,USA in 1979 while the Assistant Seed Technologist is expected to complete a similar programme this year. Also one of the laboratory assistants after participating in the WARDA six-week rice post harvest technology course of 1980 again under-went an intensive two-month training in Seed Health testing at the Danish Institute for Seed Pathology, Coppenhagen in 1982. The remaining two laboratory assistants attended the 1981

WARDA field assistants course which was conducted at Fendall, Liberia.

The laboratory has been actively involved in the programmes of other WARDA departments and WARDA member countries in the past five years especially in the field of training, seed testing and dispatch of breeder seedsto national programmes (on request).

The Seed Technologist has continued to play a pivotal role in WARDA training programmes especially the Seed Multiplication course.

The Seed Technologist carried out Seed Technology training courses on behalf of the German Technical Cooperation (GTZ) and FAO for nationals of Sierra Leone in 1980 and 1982 respectively.

A total of 64 people from three countries have been trained in different aspects of seed testing and handling ranging from two weeks to three months duration while four are expected to be trained in 1983.

A total of 738 packages of seed were also dispatched to member countries and cooperating international institutes during the period under review (Table 2.16).

The laboratory backs up the activities of the Development Department of WARDA by conducting analysis on samples collected from WARDA member states so as to determine their quality.

Table 2.16 : Number of varieties supplied to National and International Institutes between 1979 and 1982

Instutites/Countries	1979	1980	1981	1982	1983
USA	17			8	21
Liberia	20				
Soviet Union				200	
Zaire	5				
Gambia			66		
Argentina	3				
France					
Japan				200	
Sierra Leone (Rokupr)	27		93		3
Madagaskar	10				
Kenya			1		
Netherlands					1
Mozanbique	6	6			
IRRI	23		9		4
Nigeria		28			
Ivory Coast (IRAT)		32	29		
WARDA Trainees	24	32			22

The seed laboratory is one of the vital supporting units of WARDA Initial Evaluation Tests (IETS) and the Coordinated Varietal Trials (CVTS). The staff is responsible for processing, treating, storing testing and packaging seed for dispatch to the net-work of WARDA trial sites in West Africa (Table 2.17)

Table 2.17:

Particulars of improved seed supplied to WARDA Member Countries Through WARDA Varietal Testing Programme from 1979-1983

Factor	1979	1980	1981	1982	1983
No.of WARDA member countries served	15	15	*16	*16	18
No.of trials sites served	151	160	179	179	131
No.of trials types	10	11	12	15	12
Total number of varieties involved	457	447	370	252	475
Total number of entries in the trial	626	641	529	471	473
Quantities of improved varieties dispatch (tons)	93	1.04	1.15	1.20	1.19
No.of seed packages prepared	9,855	9,799	7,532	12,692	7,880

* Some limited trial varieties were dispatched to the Republics of Tchad and Cameroun.

A total of about 7,358 varieties have been distributed to the Seed Nursery Farm and special projects for seed increase and first stage studies while a total number of 264 IRTP nursery have been received from IRRI for redistribution within the region.

Research activities of the laboratory is geared towards the studies of seed quality problems in the region. The areas of studies include maturity indices of some of the varieties introduced in the WARDA region; studies of fungi flora in seed from different member states; study of dormancy mechanism of the wild rices (O.barthid. O.O.longistaminata and O.stapfii).

Future activities

These will consist of follow-up studies of the research already initiated as well as the following:

1. Studies on the relationship between the occurence of seed-borne pathogens and seed germinability as well as storability of the infected seed ;
2. Working with the Breeder (s) in variatal maintenance programme ;
3. Continuation of storage insect experiments ;
4. Systematic studies of seed-borne pathogens associated with seed production in the different ecological zones of West Africa.

Also in the near future the seed storage facilities of the laboratory will be expanded to keep pace with increase seed flow and the planned activities.

Plant Pathology Activities

Staff. V.A. Awoderu

The Pathologist assisted the Sub-Regional Coordinators for Zones I and IV in assessing varietal trials in Nigeria and Senegal respectively for reaction to diseases. No disease problem was found on any of the varieties in Richard-Toll and Fanaye. LRC 23 exhibited no glume discoloration at maturity in Fanaye, contrary to what was observed in Fendall, Suakoko and Gbanah, Liberia, where this same variety was being multiplied.

In November 1982, a disease survey revealed and confirmed the incidence of bacterial blight at Fanaye. In a seed multiplication plot, the rice variety Jaya was moderately susceptible while I Kong Pao showed resistant reaction. However, a subsequent experiment showed that the resistance of I Kong Pao decreased with increase in soil fertility.

A joint survey and assessment of bacterial problems in Niamey, Niger and its environs was carried out with the Sub-Regional Coordinator and his Assistant on coordinated variety trials, initial evaluation trials and farmers' fields.

At Sadin, seedlings of Tchounchen 22 were most affected. Other varieties that showed symptoms of bacterial blight in varying degrees include IR 15, IR 23 and IR 22. However, the rice variety D 52-37 developed

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for the shallow flooded ecosystem and adapted to the irrigated system did not show any infection. D 52-37 also produced heavy panicles. The infected varieties are short duration semi dwarf types.

It is suspected that the primary source of infection is from seed-borne bacterium. Irrigation water could also serve as a dispersing agent for this disease. Heavy infection of blast was noted on the weed Echinocloa spp. Despite this, all the WARDA varieties under test were free from both leaf and neck blast.

At Libore and Tilleberi, varieties IR 40 and IR 9872-144-3-3-3 showed scores of 3-4 to bacterial blight. Other varieties showed moderate resistance to moderate susceptibility to the disease.

Eight varieties selected for multiplication from the 1977 trial at Libore and Tilleberi were rated as resistant to leaf blast, leaf scald, neck rot, brown spot and bacterial blight. These varieties are:

1. BR 51-46-5
2. BW 78
3. ADNY 11
4. BG 90-2
5. BKN 6986-59P (deep flood variety)
6. IR 3273-3392-12
7. H5
8. IR 1529-680-3

Study tour to Gao region, Mali, October-November 1982

The Senior Pathologist, together with an Entomologist, a Nematologist from ORSTOM and the Deputy Director of the Mopti Special Research Project visited Gao to identify a long standing malady on deep-flooded rice and made recommendations to solve the problem.

A study trip was made to the Mopti Special Research Project to survey the incidence of bacterial diseases in the Project area. Unfortunately, because of the drought that hit the whole of Mali during 1982, very little could be done. However, the incidence of bacterial blight was reported and documented. Bacterial blight was observed on both the treated and untreated Khao Gaew rice variety under the entomology insecticide screening trials.

In another polder of Khao Gaew, a sativa variety and a variety of Oryza glaberrima, Khao Gaew scored 3-4 (moderately resistant to moderately susceptible) while the glaberrima variety scored 1-2 (resistant to highly resistant) in their reaction to bacterial blight.

From the series of surveys carried out and reports received, the incidence of diseases in the region is up-dated in Table 2.18.

The Senior Pathologist was a member of the Technology Assessment and Transfer (TAT) Committee composed by the Directors of both Research and Development Departments. This Committee is mandated, on the basis of current research findings, to determine the technological packages for on-farm trials related to the different ecologies in the region.

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Table 2.13. Incidence of Rice Diseases in the Region
(Updated from WARDA publication of 1978)

		BENIN	GAMBIA	GHANA	IVORY COAST*	LIBERIA	MALI	MAURITANIA	NIGER	NIGERIA	SENEGAL	SIERRA LEONE	TOGO	UPPER VOLTA*	GUINEA BISSAU	GUINEA
Fungal diseases																
Seedling blast	Pyricularia oryzae		X	X	X	X		X	X	X		X		X		
Leaf blast	" "	X		X	X	XX	X		XX	X	X	X	X	X	X	X
Neck blast	" "	X		X	X	X	X	X	X	X	X	X	X	X	X	X
Node blast	" "			X		X				X			X	X	X	
Brown leaf spot	Helminthosporium oryzae	X		X	X	X	X	X	X	X	X	X	X	X	X	X
False smut	Ustilaginoidea virens	X		X	X	X	X			X		X		X		
Sheath blight	Rhizoctonia solani	X		X	X	X			X	X	X	X	X			
Leaf scald	Rhynchosporium oryzae	X		X	X	X				X	X	X		X	X	X
Stem rot	Helminthosporium sigmoideum	X			X							X				
Narrow brown leaf spot	Cercospora oryzae		X							X	X	X				
Sheath rot	Acrocylindrium oryzae	X		X	X	X			X		X	X			X	
Dirty panicle	Several fungi and bacteria															
Foot rot	Gibberella fujikuroi					X			X		X		X	X	X	
Virus and bacterial diseases																
Bacterial leaf streak	Xanthomonas transluceans f.sp. orizicola		X		X	X	X	X	X	X				X		
Bacterial blight	Xanthomonas oryzae				X		X		X	X	X		X			
Pale yellow mottle	Virus		X		X						X	X				

*A new disease which is yet to be named has been reported in Upper Volta and Mali.

Discussions held at Rokupr revealed that more work is still needed on the effect of fungicide spray on seedling blast affecting seedlings raised on dry (upland nursery) and wet lowland nursery. Three fungicides were put to test the last season. These include Benlate, Kitazin and Kocide. The results will be reported under the special project.

A joint trial was carried out by the Agronomist/ Pathologist with the National Research Institute of Liberia to assess the performance of 6 rice cultivars for their reaction to diseases at 2 different levels of fertilizer application. The results obtained are shown in Table 2.19.

Table 2.19: Reaction Score of 16 Rice Cultivars to Rice Blast Under Different Levels of Nitrogen

120 kg N/ha		60 kg N/ha	
Varieties	Scores	Varieties	Scores
ITA 234	4.26a	ITA 234	2.83a
ITA 241	3.16b	BG 90-2	2.33b
ITA 253	3.16b	ITA 237	1.33c
ITA 247	3.16b	ITA 253	1.00c
BG90-2	3.16b	ITA 242	1.00c
ITA 243	3.16b	ITA 254	1.00c
ITA 252	3.00b	ITA 252	1.00c
ITA 237	3.00b	ITA 247	1.00c
ITA 250	2.16c	ITA 245	1.00c
ITA 236	2.00c	FARO 5	1.00c
ITA 245	1.83c	Suakoko 8	1.00c
Suakoko 8	1.83c	ITA 239	1.00c
ITA 242	1.33d	ITA 236	1.00c
ITA 254	1.16d	ITA 250	1.00c
ITA 239	1.16d	ITA 243	1.00c
FARO 15	1.00d	ITA $@!	1.00c

The data indicate that leaf blast incidence increased with increase in level of nitrogen for most of the rice cultivars. All the cultivars exhibited high resistance to leaf blast except ITA 234 which showed moderate resistance.

Two hundred and fifty six rice varieties from IRBN of IRTP were screened for their resistance to blast in the Seed Nursery Farm at Suakoko. The results showed that 90 varieties exhibited a highly resistant reaction. Fifty eight were resistant, seventy nine were moderately resistant, one was moderately susceptible, twenty showed susceptible reaction and one was highly susceptible. Seven varieties did not germinate.

Seed processing and seed health testing

The results so far obtained from seed health studies indicate that the seeds are heavily infected with seed-borne diseases (Table 2.20). Hot water treatment of seeds removed the seed-borne diseases present.

Table 2.20: Seed-borne diseases in West Africa

DISEASES	CAUSAL ORGANISM	% SEED-BORNE
Blast	*Pyricularia oryzae* Cav.	0.01-0.04
Brown leaf spot	*Drechslera oryzae* Subramanian & Jain	2.5-81.9
False smut	*Ustilaginoidea virens* (Cke) Tal	1.0-40.5
Udbatta disease	*Ephellis pallida* Pat.	5.2-8.2
Narrow brown leaf spot	*Cercospora oryzae* Miyake	3.0-10.2
Root rot	*Fusarium moniliforme* Sheld	4.5-25.5
Stack burn	*Trichoconis padwickii* Ganguly	3.2-56.3
Stem rot	*Sclerotium oryzae* Catt	1.7-50.5
Kernel smut	*Tilletia barclayana* (Bret) Sacc. & Syd	0.5-32.3
Crown sheath rot	*Ophiobolus oryzinus* Sacc. (Uyeda & Ishiyama) Dowson	1.3-40.2
Bacterial blight	*Xanthomonas oryzae* (Jones, Johnson & Reddy) Dowson	0.5-6.8
	Xanthomonas translucens f-sp. *oryzicola* (Fang et al Bradbury)	0.09-10.2
White tip nematode disease	*Aphelenchoides besseyi* (Christie)	0.10-15.2

The Pathologist assisted in the following training programmes:

a. Rice Production Training Programme, (IITA, Ibadan) organized for Africa;
b. Training course on Integrated Management of Pests and Diseases (WARDA/CICP);
c. WARDA Field Assistant Training Course;
d. WARDA Rice Production Specialist Course;
e. Research Assistants Course (WARDA).

Future plan

The following trials will be undertaken in collaboration with the special projects:

i. Fungicide trials on upland nursery seeds in Rokupr under wet and dry conditions against rice blast (P. oryzae);
ii. Screening of rice varieties for seedling blast resistance under wet and dry upland nursery seeds in mangrove swamp zones (Rokupr);
iii. Fungicide trials in Niger and Richard-Toll (Senegal) under irrigated rice and Mopti under flooded rice against bacterial blight (Xanthomonas oryzae).
iv. Screening of rice varieties for resistance to kresek and bacterial leaf blight under:
    a. irrigated system:
        i. nursery (Richard-Toll, Senegal)
        ii. transplanted rice
    b. deep-flooded/floating rice (Mopti)

    Inoculation will depend on natural infection in each case.

v. A monitoring tour organized by WARDA in cooperation with other plant protectionists in the region will be desirable in the coming season to monitor the incidence of bacterial leaf blight in the Sahelian zone. This could be done simultaneously for the other threatening diseases like leaf scald and pests. More detailed study of bacteria leaf blight, e.g. races is essential.

Staff: N. Bangura

Apart from assisting in the pathology programme, the Associate Pathologist was involved in the following activities:

- Seed handling and processing at the Seed Laboratory at Fendall.
- Germination tests of nominated material for the trials.
- Conduct of IRBN or IRTP at Suakoko and monitoring of coordinated trials.
- Special responsibility for monitoring progress of the pathology programme at Rokupr in the absence of the Pathologist who was on study leave.
- Lectures at Field Assistants Course and Rice Production Specialists Course on Nematodes and Virus Diseases of West Africa and their Control.
- Lectures at the Seed Multiplication Course in Kenema on the Seed-Borne Pathogens of Rice and their Control.
- Conduct of chemical trial at Suakoko against neck blast with the use of two chemicals, namely, PP 389, Benlate and control.
- Joint mission with Entomologist to assess varietal performance at World Bank Project at Adani, Anambra State of Nigeria.
- On the invitation of the ACRE Project, special mission for field lectures on the "Field Standard Evaluation Systems in Crop Damage" for Field Assistants in the five zones of Njala, Kenema, Makeni, Kabala and Rokupr in Sierra Leone.

- Cooperative interdisciplinary work, assessment of performance of germplasm materials at Suakoko.
- Special responsibility for Azolla work at Rokupr.
- Assisted in sub-regional coordination of Zone II activities.

A preliminary evaluation of fifteen promising varieties at Suakoko in Liberia in the main season of 1979 showed that neck lesions do not determine tolerance of a variety to neck blast. In addition, the time and severity of attack should be taken into account.

Table 2.21: Reaction of some promising varieties to neck blast

Variety	Necks with lesions	No. of collapses	% collapse
IR 934-450-5	50	19	38.0
BG 371-1	53	29	54.7
ADNY 26	18	7	38.9
BP 176/9 x DAWN	26	12	40.2
BG 90-2	29	12	41.4
BR 51-118-2	18	8	44.4
ADNY 11	0	0	53.0
IR 2071-586-5-6-3	13	7	53.8
BR 51-46-5	29	14	48.3
IR 416-131-5	0	0	0
BR 51-319-9	13	3	61.5
IR 31	0	0	0
4448	0	0	0
Suakoko 8	10	3	30.0
BW 196	0	0	0

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In collaboration with the Agronomist, a granular fungicide with the code name PP389 (4,5 dihydro-4-methyl-tetrazole) developed by ICI was tested for control of neck blast. It was observed with IR 5 that the application of this chemical 10 days before booting gave 89% yield increase over the control (Table 2.22).

Neck blast control efficiency of the fungicide was evaluated as follows:

$$E = (1-n/N) \times 100$$

where E = neck blast control efficiency (%)

N = number of neck blast tillers per m^2 in control treatment at maturity

n = number of neck blast tiller per m^2 in fungicide treatment at maturity.

RESULTS

Table 2.22: Efficiency of Chemical Control of Rice Neck Blast 1980

Treatment	Average Grain Yield (kg/ha)	Increase over Control		Average No. of Tillers per m^2	Average No. of Tillers With Neck Blast	Neck Blast Control Efficiency (%)	Neck Blast Rating (0-9 Scale
		kg/ha	%				
PP 306	2053a	972	89	166	5	58.3	3
Benlate	1133b	102	9	170	13	8.3	5
Control	1080b	0	-	171	12	-	5

CV	14.3	
F	40.3**	
SE	84.0	
LSD	264.9	1% = 376.9

A second test of the fungicide PP 389 was conducted at Sunkoko with the variety C22 in the main season of 1982. It was again observed that the application of the chemical 10 days before booting gave 117% yield increase over the control, while Kocide and Benlate gave 75% and 60% respectively over the control (Table 2.23).

Table 2.23. Efficiency of chemical control of rice neck blast 1982

Treatment	Average grain yield (kg/ha)	Increase over control		Average No. of tillers per m^2	Average No. of tillers with neck blast per m^2	Neck blast control (%)	Neck blast ratio (0-9) scale
		kg	%				
PP 389	5925a	3200	117	121	6	66.7	3
Kocide	4775ab	2050	75	119	10	44.5	4
Benlate	43626	1637	60	120	12	33.3	5
Control	2725c	0	0	120	18	0	7
CV (%)	20.49						
F	8.6*						
SE	45.5						
LSD	145.6	1 = 209.1					

THE PROCEDURE FOR CONDUCTING THE COORDINATED TRIALS

VARIETY TRIALS

Staff: M.A. Choudhury

Initial Evaluation Tests (IETs)

Three IETs, one each for upland, irrigated and deep-flooded conditions, are conducted every year in the region.

Nominations: The criteria used for nominating entries into the IETs are: homogeneity of the entries; acceptable plant height, 100-120 cm for upland, semi-dwarf to semi-tall for irrigated condition and tall or elongation ability for deep-flooded conditions; blast resistance; leaf scald resistance; resistance to brown spot; resistance to glume discoloration; acceptable grain quality; newly identified from breeding programme and confidence of breeder on the entries.

The number of entries vary from year to year depending on the availability of new entries. Varieties currently nominated into the CVTs are also retained in the IETs. Entries are normally not repeated in the next year except for those nominated to the CVT and exceptionally good new entries are repeated.

Selection Methods: Along with the seeds, general guidelines for conducting the IETs are provided. These guidelines are as follows:

For each variety, plant 2 to 3 rows of 5m or 5 to 6 rows of 3m.

Use either direct seeding (upland, deep-flooded) or transplant as needed.

Use standard spacing.

Apply standard fertilizers.

Use insecticides if essential.

Use check varieties after every 20 entries.

Experimentors are asked to collect the major information, such as flowering, plant height, number of panicles per metre, grain yield, disease reactions, insect damages, sterility, etc. A standard booklet is provided for recording data.

The experimentors are also asked to provide such information as time of planting, dose and time of fertilizer applications, spacing, rainfall, irrigation, temperature, etc.

Coordinated Variety Trials (CVTs)

Nomination: The criteria used for nominating various entries of upland coordinated variety trials are: drought tolerance, accpetable plant type such as suitable height (100-120 cm); stiff straw; semi-erect to erect leaves; stable higher yield; appropriate maturity; moderate tillering; blast resistance; leaf scald resistance; resistance to brown spot; resistance to glume discoloration; acceptable grain quality and proven performance under upland condition.

Irrigated semi-dwarf to semi-tall; stiff straw with erect leaves; moderate to high tillering; higher yield; appropriate maturity duration; fertilizer responsiveness; resistance to blast, leaf scald and brown spot diseases and acceptable grain quality.

Mangrove swamp trial, semi-tall to tall; photoperiod sensitiveness or medium to late maturity; tolerance to submergence; high tillering; resistance to major diseases; higher yield; salt tolerance and acceptable grain quality.

Deep-flooded and floating condition: appropriate elongation ability; submergence tolerance; drought tolerance at seedling stage; nodal rooting and tillering habit; photoperiod sensitiveness and acceptable grain quality.

Cold tolerance trial: cold tolerance at seedling stage; semi-dwarf; stiff straw with erect leaves; fertilizer responsiveness; higher tillering; early to medium maturity; resistance to major diseases and acceptable grain quality.

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Duration of Entries: Usually, a variety is tested for three years. If a variety performs poorly, it is deleted after the first or second year depending on availability of information at the time of nomination.

Methods: The number of entries used per trial do not usually exceed 15. Fourteen entries are provided and experimentors are asked to add a standard local check variety. Four to six replications are recommended. For direct seeding, $15m^2$ net and for transplanting $8m^2$ net plot sizes are recommended. General guidelines for the CVTs are provided along with the seeds. The guidelines help the cooperators in management practices and scoring for diseases, insects, plant characters, etc.

Strategy of the trials

Nomination Committee: The Varietal Nomination Committee, which comprises rice breeders in the region, meets once every year in December of January and make nomination of entries into the IETs and CVTs. The committee members make their own nominations and collect nominations from national programmes for consideration. The members change from time to time. The Senior Rice Breeder of WARDA at headquarters serves as the chairman. IRRI, IITA and IRAT are represented on the committee and these institutes make regular nomination of entries.

The role of the Technical Support Services: The Senior Rice Breeder's major roles are nomination of entries, coordination of seed supply for the trials and protocols for the trials. The Seed Technologist processes the seeds for the trials, treats them and makes packages for distribution. The Pathologist and Entomologist provide feedback on the performance of the entries.

Role of Sub-Regional Coordination: The Sub-Regional Coordinators make site selections for the trial on the basis of competence of local supervisory staff, availability of resources and ecological fitness. They distribute the seeds and coordinate the execution of the trials. The Coordinators provide feedback on the performance of entries and frequently make data collections. They collect results and send them to headquarters for analyses.

Role of International Institutes: IRAT, IITA and IRRI make very effective contributions towards varietal nominations for trials. These institutes participate in the WARDA monitoring tours in the region and provide feedback on the varietal performance and future needs. Every year, varieties are chosen from IRTPs and nominated into IETs. IRTP is a major source of new materials in the region. Since 1980, international deep water rice nurseries have been used for WARDA deep-flooded IET (with some additions from WARDA) due to lack of sufficient new materials in the region.

Table 2.25: Number and Type of Coordinated Variety (including IET) Trials Done in Various Years: 1978-1982

Trials	Number of Successful Trials				
	1978	1979	1980	1981	1982
1. IET Upland	7(15)*	12(15)	8(14)	11(14)	(13)
2. IET Irrigated	9(19)	14(19)	12(19)	12(19)	(18)
3. IET Deep Flooded	-(5)	3(5)	5(8)	1(8)	(8)
4. Off Season IET	19(45)	21(45)	9(45)	11(43)	(43)
CVT					
5. Savanna Upland Short Dur.	-	-	4(7)	9(9)	(8)
6. Moist Zone Upland Short Dur.	-	-	14(18)	16(18)	(17)
7. Moist Zone Upland Medium Dur.	-	-	15(21)	14(21)	(19)
8. Sahel Irr. Short Dur.	-	-	6(8)	5(8)	(10)
9. Sahel Irr. Medium Dur.	-	-	6(8)	6(8)	(10)
10. Moist Zone Irr. Short Dur.	-	-	(12(18)	14(18)	(14)
11. Moist Zone Irr. Medium Dur.	-	-	14(18)	14(18)	(14)
12. Cold Tole-le-rance	-	-	-(8)	1(8)	(8)
13. Mangrove swamp	-	-	2(9)	2(9)	(5)
14. Deep Flooded Condition	-	-	5(9)	6(9)	(9)
15. Floating Condi-tion	2(4)	5(4)	2(5)	1(5)	(5)
16. Upland Short Dur.	10(19)	17(19)	-	-	-
17. Upland Medium Dur.	7(18)	15(18)	-	-	-
18. Irr. Short Dur.	19(28)	21(28)	Reorganization of trials		
19. Irr. Medium Dur.	20(30)	20(30)	-	-	-
20. Mangrove swamp/ Deep Fld.med.dur.	3(6)	5(6)	-	-	-
21. Mangrove swamp/ Deep Fld.late dur.	4(6)	7(6)	-	-	-

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Table 2.25 cont'd

Total Number of Successful Trials	100	140	114	123	
Total Number of Trials Planned	(195)	(195)	(215)	(215)	(201)
Percentage of Successful Trials	51%	72%	53%	57%	

*Number in parenthesis shows No. of trials planned.

Status of the Coordinated Trials
Since the First Quinquennial Review of WARDA

After the first Quinquennial Review, the maximum number of coordinated trials to be conducted each year was consolidated at 224. In 1978, 251 trials were planned but 119 were conducted (Table 2.25). In 1979 and 1980, 237 trials were planned, assuming a minimum of 10% failure so as not to exceed the approved number of trials. The number of experiments successfully conducted in 1979 and 1980 were 177 and 131 respectively. The number of planned trials in 1981 fell to 215 due to the elimination of plant protection trials. The trials were further reduced in 1982 to 201 due to the elimination of some unsuitable sites.

Facilities

Suakoko and Richard-Toll: Facilities exist at Suakoko for the introduction, screening and observation of breeding materials and elite varieties. Promising varieties selected in the process are advanced for nomination of entries into upland and irrigated IETs. Superior varieties are produced in bigger plots for detailed observation and seed production at Suakoko. Some of the superior varieties are advanced for nomination of entries into CVTs for upland and irrigated conditions. The nominated varieties are produced both at Suakoko and Richard-Toll. Seeds of the nominated varieties are sent to the seed laboratory for processing, treatment and despatch to the trial sites.

Seed Laboratory: The seed produced at Suakoko and Richard-Toll and seed collected from other variety nominating scientists in the region are sent to the seed laboratory. The seed laboratory cleans the seeds and removes underdeveloped grains. The seeds are given hot water treatment and dried before taking final germination tests. Seeds are dressed, packaged, and distributed among the trial sites through the Sub-Regional Coordinators. Trial protocols and data collection sheets are supplied along with the seeds.

Plant quarantine: The Regional Plant Quarantine facility exists at Ibadan in NIgeria. WARDA gives partial support towards its operation for quicker service. Imported materials take several weeks to several months for clearance. However, for urgent materials like IRTP, a follow-up is provided for quicker release. WARDA trial materials going to Nigeria also pass through the quarantine center and often seed arrival to the sites is delayed. In 1982, some seeds were found to contain bacteria. Since it could not be determined whether the bacteria were pathogenic or not, all entries carrying bacteria were removed from the trials in all countries. According to standard procedures, after hot water treatment and seed dressing, pathogenic bacteria cannot survive in the seeds.

TRIAL PROTOCOLS

INITIAL EVALUATION TEST (IET) - 1982 PROTOCOLS

General Information

Country..... Name of station..... Season.....

Date seeded..... Date transplanted.....

Fertilizers - Number of application (kg/ha) Time of application

N: 1st ....

2nd ....

3rd ....

4th ....

P_2O_5..... .....

K_2O ....

Plot size - Number of rows per plot.....Lenth of row .....

Spacing between rows..... Within rows.....

Number of seedlings per hill.....

Weather - Total rainfall during the trial period.....

Average maximum temperature during trial.....

Average minimum temperature during trial.....

Management - Total amount of irrigation water applied.....

Herbicide applied.....Insecticide applied.....

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General observation

List major diseases.....

.....

List major insects.....

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List soil problems.....

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List environmental constraints.....

.....

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List management problems.....

.....

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Other comments.....

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Planting methods to be used

1. Plant 2 or 3 rows of 5 metres for each entry, or plant 5 or 6 rows of 3 metres each.
2. Use either direct seedling or transplant method.
3. Use your standard spacing; if there is no fixed standard, use 25 x 15 cm for transplant (2 seedlings per hill) and 25 x 3 cm for direct seedling.
4. Apply standard fertilizer rates.
5. Use insecticides only if essential.

Data collection

1. Fill out all the colums for each entry.
2. Additional information for each entry can be furnished under "Comments".
3. For "Plant height", measure from ground level to the tip of panicle.
4. For "Reactions", use 0-9 scale, where 0 is no information; 1 is no symptom, and 9 is complete death of all plants of the entry.
5. At the end of the ist, name 20 entries that you consider or select best.

PLEASE FILL IN ONE BOOKLET OF THE RECORD BOOK AND RETURN IT TO:

Research Department
W.A.R.D.A.
P.O. Box 1019
Monrovia, Liberia

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Column number in data sheets

1. Serial number of entry.
2. Name or pedigree of the entry.
3. Germination/Emergence.
4. Plant height in cm cm at maturity.
5. Days to 50% flowering.
6. Number of panicles per one metre length.
7. Total number of hills harvested.
8. Grain yield in gms (specify area).
9. Leaf Blast reaction.
10. Neck Blast reaction.
11. Leaf scald (Rhynchosporium).
12. Helminthosporium.
13. Stemborers - dead heart and white head.
14. Other insects - specify.
15. Soil problems - specify.
16. Bird Damage in %.
17. Rodent Damage in %.
18. Sterility %.
19. Remarks.

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GENERAL GUIDELINES FOR THE COORDINATED VARIETY TRIALS - 1982

VARIETIES AND LAYOUT

1. The number of varieties used per trial should not exceed 15. The entire set of 14 nominated varieties should be included in the trial.
2. The best local variety should be included as a check.
3. Four-six replications are recommended.
4. Plot sizes should be as follows:
   - for direct seeding: 15 square metre net.
   - for transplanting: 8 square metre net.
5. Local standard spacing should be used.
6. Care should be taken for proper technical implementation of the trials: correct sowing, timely weeding, proper fertilization, etc.

MANAGEMENT

Fertilizer application: Actual rates of NPK to be given depend on conditions at the station. Sufficient quantities of fertilizers should be applied for optimum yield. Standard method of application for the station should be followed.

Cultural practices: Weeding, irrigation, etc. should be carried out carefully according to best local knowledge and experience.

Insect control: Insecticides should be applied if only necessary. Select the chemical and determine the dose according to the availability of chemical and mode of application.

Bird control:

Bird control: It is better to plant the trial at about the same time as other trials and seed increase plots. Nets should be used if available, otherwise, bird scarers should be posted after flowering.

Rogueing: Seed or seedling mixtures may arise in various ways. Incidental off-types should be removed early. If too many off-types appear, rogueing may be delayed till harvest time and yields corrected accordingly.

Pure seeds should be obtained and preserved for future use.

DATA COLLECTION

General information: Provide the name of the station, year, season, date of sowing, etc., on the 'Grain Yield Data Record Form' supplied.

Germination/emergence: Scale:

1 = 90 - 100%
3 = 75 - 90%
5 = 50 - 75%
7 = 25 - 50%
9 = - 25%

Grain yield: Record the grain yield replication wise on 'Grain Yield Data Record Form' supplied.

Days to 50% flowering: Note down the date on which approximately 50% of the panicles of the variety are flowering. Calculate the number of days from sowing (or soaking) to 50% flowering.

Panicles per square metre: Determine the number of hills/plant involved in one square metre area and then count the number of panicles. Record this for each replication.

Plant height: Measure the plant height in cm from the ground level to the tip of the tallest panicle in a hill. Record the average of at least 5 plants/hills selected at random for each replication of each variety.

Lodging: Record lodging at maturity. Use standard evaluation system scale:

Scale:
1. No lodging.
3. Most plants slightly inclined.
5. 50-75% plants lodged.
7. 76-95% plants lodged.
9. All plants flat.

Sterility: Spikelet sterility scores may be assigned by observing the sterile spikelets or by grasping the panicle.

Scale:
1. Less than 1% sterility.
3. 1-5% sterility.
5. 5-25% sterility.
7. 25-50% sterility.
9. 50-100% sterility.

Leaf blast: Causal agent: *Pyricularia oryzae*. Symptoms: Typical leaf lesions are spindle-shaped and often develop greyish centers and coalesce on susceptible plants. Scale (leaf area infected per unit area):

1. Less than 1%.
2. 1-3%
3. 4-5%
4. 5-10%
5. 10-15%
6. 15-25%
7. 25-50%
8. 50-75%
9. 75-100%

To be recorded 50 and 80 days after sowing.

Neck and node blast: Causal agent: *Pyricularia oryzae*. Symptoms: Panicle neck or branch with dark necrotic lesions and frequently broken at the point of infection. Panicles in such cases are either partially filled or have no grain and are white if infected early. Scale (% panicle infected):

1. less than 1%
3. 1-5%
5. 5-25%
7. 25-50%
9. 50-100%

To be recorded 20 days after heading.

Brown spot: Causal agent: *Cochliobolus miyabeanus*. (*Helminthosporium oryzae*). Symptoms: Typical leaf spots are small, oval, or circular and dark brown. Larger lesions are usually the same colour on the edges but have a pale, usually greyish center. Most spots have a light yellow halo around the outer edge. Scale (leaf area affected):

1. Less than 1%
3. 1-5%
5. 5-25%
7. 25-50%
9. More than 50%

Leaf scald: Causal agent: *Phynchosporium oryzae*. Symptoms: The lesions occur mostly near the tips, but sometimes start at the margin of the blade and develop into large ellipsoid areas encircled by dark brown, narrow bands accompanied by light brown halo. Scale (leaf area affected):

1. Less than 1%
3. 1-5%
5. 5-25%
7. 25-50%
9. More than 50%

Stemborers: Symptoms: Dead hearts and white heads.

Dead hearts: At the end of the tillering stage, count actual number of tillers and dead hearts in one square meter area (same for panicle) and determine the dead heart percentage. Scale:

1. Less than 1%
2. 1-5%
3. 5-25%
7. 25-50%
9. More than 50%

White heads: After flowering, count actual number of panicle and white heads in one square meter area and determine the white head percentage. Scale:

1. Less than 1%
2. 1-5%
3. 5-25%
7. 25-50%
9. More than 50%

Other inquiries:

(1) Other diseases like sheath rot (*Acrocylindrium oryzae*), glume discolouration (*Pyricularia*, *Helminthosporium*, *Cercospora*, etc.) can also be recorded in 1-9 scale.

(2) Insect damages caused by gall midge (*Pachydiplasis oryzae*), case worm (*Nymphula depunctalis*), leaf folder (*Cnaphalocrosis medinalis*), etc., can be recorded as percentage of tiller or leaf affected (as the case may be) and be converted to scale of 1-9.

(3) Physio-chemical stresses like salt injury, alkaline injury, iron toxicity, cold drought stress etc., and recovery from submergence, elongation in deep water, etc., can be recorded in 1-9 scale system, where 1 is excellent, 3 is good, 5 is intermediate, 7 is poor and 9 is dead.

ENTOMOLOGY

Staff: E.A. Akinsola

Background

It is estimated that West Africa loses about 1 million tons of rice annually. The entomology programme is involved in the developing and implementing of effective control measures for insect pests eventually leading to a reduction in the magnitude of losses caused by the pests.

Monitoring tours

WARDA conducted monitoring tours in member countries to determine the prevalence of pests and diseases within the vast ecological range in which rice is grown in West Africa. In 1977, monitoring visits were carried out in Benin, Ivory Coast, Liberia, Sierra Leone, Mali, Senegal, Upper Volta and Guines Bissau. In 1978, six other countries, Togo, Ghana, Mauritania, Gambia, Niger and Nigeria were covered. These tours revealed in a general way, pest problems in West Africa. Such extensive surveys could not but contain certain inaccuracies. For instance, within the same country, it is often observed that a pest species may be present in one area and absent in another. Also, the stage of crop sample would influence the pest fauna considerably. Results of the surveys are therefore constantly reviewed. Forty-seven species of insects were reported as pests of rice (Table 2.24).

Subsequent monitoring tours were aimed at assessing the economic importance of insect pests in different rice ecosystems. Thus, surveys in parts of Liberia have shown the caseworm, Nymphula depunctalis as a major pest of rice in the coastal humid tropical zones. Studies (Table 2.25) showed that damage could result in complete destruction of rice hills, considerable reduction (about 86%) in the average number of tillers per hill and delayed maturity. A yield loss of 97% was recorded.

Table 2.24 Incidence of Insect Pest on Rice in West Africa

	INSECT PEST INCIDENCE		Benin	Gambia	Ghana	Ivory Coast	Liberia	Mali	Mauritania	Niger	Nigeria	Senegal	Sierra Leone	Togo	Upper Volta	G. Bissau
1.	Pink borer	Sesamia sp.	X	X	X						X	X	X	X		X
2.	Striped stem-borer	Chilo sp.	X	X	X	X	X	X	X	X	X	X	X	X		X
3.	White stem borer	Maliarpha separatella		X	X	X	X	X		X	X	X	X	X		X
4.	White rice borer	Scirpophage spp			X	X		X			X					
5.	Stalk-eyed borer	Diopsis thoracica		X	X	X	X	X			X	X		X	X	X
6.	Rice gall midge	Orseolia oryzae			X	X		X			X	X		X	X	X
7.	Army worm	Spodoptera exempta			X		X				X		X	X		X
8.	Hairy caterpillar	Diacrisia spp.					X									
9.	Whorl maggot	Unidentified						X								
10.	Swarming caterpillar	Unidentified							X							
11.	Cut worm	Unidentified				X	X						X			
12.	Semi looper	Unidentified							X							
13.	Rice skippers	Unidentified							X							
14.	Pentatomid bugs	Unidentified							X							
15.	Rice bug	Riptortus tenuicornis	X		X	X	X						X	X		X
16.	Rice bug	Aspavia sp.		X		X	X		X		X	X	X	X	X	X
17.	Rice bug	Stenocoris southwoodi			X		X							X		X
18.	Rice bug	Diploxys sp.		X												

Table 2.24 (cont'd)

			Benin	Gambia	Ghana	Ivory Coast	Liberia	Mali	Mauritania	Niger	Nigeria	Senegal	Sierra Leone	Togo	Upper Volta	G. Bissau
19.	Stink bug	Unidentified									X					
20.	Green bug	Nezara viridula			X									X		
21.	Ear head bug	Unidentified	X	X												
22.	Locusta beetle	Heteronychus oryzae									X					
23.	Root beetle	Heteronychus sp.														
24.	Rice hispa	Dicladispa armifera					X									X
25.	Epilachna beetle	Epilachna sp. similis					X				X		X			X
26.	Leaf beetle	Chaetochema sp.														X
27.	Blister beetle	Cylindrothorax melanocephala									X					
28.	Haltica beetle	Haltica sp.					X									
29.	Plant hopper	Nilaparvata sp.						X							X	
30.	Brown plant hopper	Nilaparvata sp.					X									
31.	Green leaf hopper	Nephotettix sp.						X	X	X					X	
32.	Leaf hopper	Tettigella sp.								X						
33.	Frog hopper	Locris sp.		X			X					X	X			X
34.	Leaf hopper	Unidentified					X	X		X						
35.	Leaf folder	Pnaphalocrosis sp.				X	X	X					X		X	X
36.	Case worm	Nymphula sp.		X			X					X				X

Table 2.24 (cont'd)

			Benin	Gambia	Ghana	Ivory Coast	Liberia	Mali	Mauritania	Niger	Nigeria	Senegal	Sierra Leone	Togo	Upper Volta	G. Bissau
37.	Case worm	Parnara sp.				X	X									
38.	Case worm	Unidentified					X						X			
39.	Small grass hopper	Zonocerus variegatus								X			X			
40.	Long-horned grass hopper	Conocephasus sp.			X								X			X
41.	Rice grass hopper	Hieroglyphus spp.			XX					X		X	X			X
42.	Grass hopper	Unidentified		X									X			
43.	Crab	Sesarma huzardi			X								X			
44.	Crab	Unidentified											X			
45.	Mole cricket	Gryllotalpa africana														
46.	Termites	Unidentified											X			
47.	Soldeir ants	Unidentified									X		X			
													X			

118.

Table 2.25. Effect of Furadan 3G in the control of rice caseworm Nymphula depunctalis at Fendall (1981)

Treatment	% infested tillers	No. of tillers/ hill	% of missing hills	Yield kg/ha	% Yield loss
Furadan 3G at 1 kg a.i./ha	0	21.6	0	3040	
Control	97	3.1	33.8	92	97

The gall midge, Orseolia oryzae, is a pest of economic importance in the drier sub-Sahelian zones notable in Upper Volta and occasionally in the northern part of Nigeria and Guinea Bissau. Stemborers are major problems on irrigated rice, occuring in vast proportions in the wet season in the Senegal River Valley (Table 2.26) and in the dry season in parts of Nigeria. They also cause heavy yield losses on mangrove swamp rice.

Table 2.26. Effects of Furadan 3G in controlling rice stemborers (Guede, Senegal, 1979) WARDA Special Research Project

Treatment	No. of stems attacked	No. of white heads/m^2	Yield (ton/ha)	% of yield increase
Furadan 3G at 1 kg a.i./ha	32.83	0.30	6.83	78.3
Furadan 3G at 1 kg a.i./ha x 3	51.98	8.60	6.31	64.7
Control	147.86	21.60	3.83	
SE	1.42	4.77	0.42	
LSD 5%	3.10	10.39	0.92	
1%	4.34	14.57	1.29	

Mites and white flies Aleurocybotus indicus David are also serious pests of irrigated rice in the Sahelian zones during the dry season. Two countries, Senegal and the Gambia, have recorded severe infestations by these pests.

Coordinated insecticide trials

During 1978 and 1979, a total of 7 and 21 coordinated insecticide trials were conducted respectively in the five sub-regional zones. The increase in number of trials was mainly due to the fact that some trials planned for 1978 were actually carried out in 1979 in Zone I while Zone 5 which had no trials in 1978 participated in 1979.

The trials were mainly designed to study the rate and frequency of application of systemic insecticide Furadan 3G in controlling insect pest of rice. In general, Furadan 3G (1.2 kg a.i./ha) applied either thrice (at 10, 30 and 60) or twice (at 10 and 60 days) after sowing or transplanting produced significantly greater yields than the control. Yield increases of 46.5 and 56.3% over the control were recorded for two and three applications respectively. At certain localities, yield differences were not significant probably due to low pest densities. Under upland conditions, the effectiveness of Furadan 3G was considerably reduced. Evaluation of insecticides for the control of rice gall midge was conducted in Bobo Dioulasso (Upper Volta). Results showed that most insecticides tested were effective and produced higher yields than the control. Miral (Isazophos) was the most effective, followed by Acothion and Decis.

Coordinated insecticide trials were discontinued in 1980. The responsibility for screening insecticides was passed over to the special Research Project Centres.

A Regional Programme on Integrated Pest Management for Rice in West Africa

Following recommendations in support of the formation of a regional programme on integrated pest management made at the WARDA-sponsored seminar held in Bobo-Dioulasso (Upper Volta) in September 1979, WARDA commissioned a team of crop protection specialists in 1980 to prepare a plan of operation. The team visited selected institutions in West Africa between October 1980 and January 1981 and later produced a document which was widely circulated both at the regional and international levels for comments and suggestions.

The project which included a variety of research, training, extension and farmer demonstrations activities is expected to be a collaborative venture between WARDA and national programmes. Due to lack of funding, the project did not commence as early as anticipated and it is now incorporated into the entire WARDA RESEARCH PROGRAMME.

Support to Special Research Projects

1. Planning and implementing rice entomology programmes at the Special Research Project centres for irrigated rice (Richard-Toll, Senegal); deep-flooded rice (Mopti, Mali); and more recently,

upland rice (Bouake, Ivory Coast). In the absence of the Entomologist at Richard-Toll, the Richard-Toll entomology programme was implemented by the Senior Entomologist at Headquarters.

2. Data collection, processing of experimental results, analysis, interpretation of data and report writing.
3. Technical assistance to the Entomologist at the Special Research Project, Rokupr, Sierra Leone, who is also the Team Leader and head of the station.

Very frequent visits (about 3 to each centre during the cropping season) are made and time expended on these activities is estimated as 50% of his normal working time.

Backstopping activities of Sub-Regional Coordinators and involvement with national programmes

1. Monitoring trips to diagnose insect-related problems and propose solutions, e.g. monitoring trip to Gao, Mali on problems of deep-flooded rice. Trip to Bobo Dioulasso, Upper Volta on gall midge problem of rice. Mites and white fly problem of dry season rice crops in the Gambia, etc.
2. Planned visits to rice entomologists in the region for acquaintance with programme and to offer technical expertise where needed, e.g. visits

to CERCI, Upper Volta; Djibelor, Senegal; NCRI, Nigeria.

3. Evaluation of varieties in the coordinated trials for their reactions to insect pests.
4. As a resource personnel to sub-regional coordinators for immediate consultation on insect-related problems on rice. Twenty percent time is spent on these activities.

The entomologist led a team comprising a pathologist, nematologist, agronomist and a breeder to investigate the problem of deep-flooded rice in Gao, Mali.
The team noted that the drying of leaf tips and the floating rice straw were two distinct maladies. The drying of leaf tips and subsequent blighting were suspected to be symptoms associated with bacterial leaf blight caused by Xanthomonas oryzae. Since nearly all rice straws floating on water surface harbored the stem borer, Maliarpha separatella, it was deduced that this pest was present. The peculiar feeding habit of the borer and the fragile nature of basal internode in the deep-flooded zone provided strong evidence for the hypothesis. The white heads were caused by the stemborer Chilo zacconius. The team recommended control actions to be taken against these pests while at the same time suggesting that more research activities be carried out in the area by the Special Research Project at Mopti.

Observations during the mission to Upper Volta confirmed that the gall midge, Orseolea oryzae was the most

serious insect pest on rice. Field trips were made to Banfora, Karfiguela and Kou Valley. At Karfiguela where attack was most severe, some fields had about 70% of the tillers showing the characteristic onion shoots. Studies had been conducted by the national programme to control the gall midge using insecticides. So far, results have not been encouraging and insecticides such as Furadan and Decis were found to be effective only against stemborers. A set of IRRI gall midge nursery containing 190 entries was handed over in August 1982 for screening in a joint WARDA/national research collaborative work. The results of the screening together with those of an earlier set delivered to the Sub-Regional Coordinator are being expected. It is hoped that from such nurseries assembled internationally and specifically on gall midge resistance would emerge useful materials for WARDA's programme on the gall midge.

Activities of the Entomologist at WARDA Headquarters

1 Assist in screening introduced materials at the Seed Nursery Farm, Suakoko for varietal reactions to insect pests.

2. Coordinate collaborative projects with other international organizations:

   a. Consortium for International Crop Protection (CICP), University of California, Berkeley, USA. WARDA collaborates with this institution in pursuing its programme on Integrated Pest Management (IPM). The first

training on IPM was co-sponsored by CICP and WARDA at Fendall, Liberia in January 1982. Twenty-eight trainees drawn from all over West Africa participated in the course.

b. International Institute of Tropical Agriculture (IITA). Had joint monitoring trips with IITA scientists and assisted as guest lecturer at rice production training conducted by IITA.

3. Teaching rice entomology to Research Assistants and rice production courses organized by WARDA at Fendall.

The overall time expended in these activities is estimated at 30%.

Future plan

During the period under review, crop protection activities of WARDA have been consolidated and coordinated to provide a regional strategy based on an ecological approach to pest control. Pest control technology developed by the Special Research Projects is being made available to areas of the same ecosystem with similar pest problems. In addition, there is a regional network on integrated pest management proposed by WARDA in collaboration with national scientists to formulate control strategies that are cheap, easy to adopt and free from environmental hazards. Several international institutions have indicated their desire to enter into

joint crop protection activities with WARDA. The Entomologist coordinates these activities. In the years ahead, these activities would need to be continued and further strengthened.

Active support to the special Research Project centres will continue and as soon as experienced entomologists are recruited for the centres, involvement of WARDA entomologists will gradually decline in this area while more emphasis will be placed on assistance to national programmes and backstopping activities of the sub-regional coordinators.

Some member states do not have any rice research programme and have wholly depended on WARDA. The entomologist will continue to function as rice protection expert to the region.

The regional programme on integrated pest management is expected to begin as soon as funds are made available. The entomologist will coordinate the programme.

Collaboration among national and international institutions would ensure exchange of ideas and technologies. In this regard, collaborative activities with other institutions that would benefit rice farmers in West Africa in the area of crop protection will be pursued.

The entomologist will continue to assist the breeder in screening germplasm for resistance to major insect pests.

Assistance shall be given to the Training Department and in giving lectures to the trainees.

COORDINATED HERBICIDE TRIALS

Staff: D.K. Das Gupta

Operational strategy

The herbicide trials in the three years (1978-1980) were confined to the main season under rainfed/upland, irrigated, mangrove swamp and deep water conditions. The main objective was to compare selected herbicides and identify the effective ones suited to the various rice ecologies in the West Africa region and the possibility of using selected herbicides as alternatives to manual weeding.

During the period, 45 trials with ten (10) single herbicides and 16 combinations were conducted at 19 locations: 19, 22, 3 and 1 under upland/rainfed, irrigated, mangrove and deep water conditions respectively.

The experimental design and layout were according to a common protocol; however, the test variety and agronomic practices were those locally recommended. Initial introduction of the herbicides was based on their established reputation; their continuance in subsequent trials determined by the performance in the preceding ones. Due to irregular supply of the herbicides and delays in their delivery to the trial sites, it was not possible to include the same set of herbicides in the successive trials, but each of the promising ones were subjected to confirmatory tests for more than one season at one or more locations. In the common protocol, handweeding twice, weed-free (more than two handweeding) and no weeding (control) treatments were included.

The performance evaluation was based on grain yield and yield increase over the control (no weeding). However, at some sites, weed control ratings were also determined.

Results

Out of the 45 trials, no worthwhile information could be derived from 12 trials. Performance of top herbicides, weed-free, handweeding twice and control treatments in terms of grain yield and yield increase over control under rainfed and irrigated/mangrove conditions are presented separately in the sub-regional reports.

Upland/rainfed rice

The results show that in rainfed rice, weeds constitute a major yield limiting factor. The yield losses varied from year to year and amongst the 10 test locations. The grain yield increases due to herbicides and manual weeding observed at Sapu (1978, 1979 and 1980), Farako-Ba (1978 and 1980), Odienne (1978) and Sotuba (1980) were considerable, indicating definite yield increase potentials in the West Africa region. However, in 1979, at Suakoko, where rice was grown the first time after bush fallow, the yield increase over no weeding was small (2 to 18%). This was due to low weed infestation in the rice field after bush fallow. In 1980, at the same site (rice after rice), the yield increase over control (1.39 t/ha) varied between 112% in weed-free followed by 110% in Tamariz (ordinary) and 70% in hand weeding twice.

Manual weeding was generally superior, but several of the herbicides gave comparable performance as far as grain yield and weed control are concerned. In this respect, Tamariz (ordinary) at seven sites followed by Preforan and Stam F34 each at four sites are considered to be effective herbicides for rainfed rice.

Irrigated rice

Unlike upland/rainfed conditions, irrigation with good land preparation offered the advantage of water control and natural weed suppression. However, considering the high grain yield of 6.3, 4, 4.4, 4.0, 4.5, in unweeded plots at Richard-Toll, Kaedi, Sualokro, Kalongo and Mission Tove respectively in 1980, the grain yield increases of 2-42% by herbicides are unquestionalby high. Thus, even under irrigated conditions, especially where satisfactory water control and good land preparation cannot be achieved, herbicides application can help in getting much higher grain yields.

Under irrigated conditions, herbicides were generally superior to hand weeding as far as weed control and grain yields were concerned. In this respect, Tamariz (ordinary), Tamariz (super) Stam Super A, Stam F34, Basagran M + Stam F34 are common effective herbicides at 11, 10, 10, 8 and 7 locations respectively. Similarly, BAS-454-02H, Basagran KV + Stam F34, Machete EC, Machete EC + Stam F34 and Ordram EC + Stam F34 were also effective herbicides at 4 to 5 locations.

It is worth noting that Tamariz (ordinary) and Stam F34 are effective herbicides both under rainfed and irrigated conditions.

Mangrove rice

Of the two trials conducted at Rokupr under mangrove swamp conditions, grain yield in 1978 is considered reasonable. Basagran KV + Stam F34 and Tribunil + Surcopur (i.e. Stam F34) gave 36% and 38% yield increase respectively over control yield of 2.07 t/ha. Basagran KV + Stam F34 gave significant grain yield increase (25%) in 1977. It appeared that good land preparation before transplanting offered adequate weed control.

Plan for 1983-1987

Since 1981, coordinated weed control trials have been discontinued and instead, on-farm weed control trials have been introduced. These trials in farmers' fields are simpler in design and fewer effective herbicides (3 to 4) selected from the coordinated weed control trials are included. These on-farm testing of weed control trials will be continued with the Integrated Pest Management Programme which has been presented elsewhere.

The screening of newer herbicides and supporting research on their selectivity and toxicity problems, etc., have already been undertaken by the WARDA Special Research Projects.

WARDA AND THE INTERNATIONAL RICE TESTING PROGRAMME (IRTP)

Staff: A.O. Abifarin

Background

The International Rice Testing Programme (IRTP) is funded by the United Nations Development Programme (UNDP) and coordinated by the International Rice Research Institute (IRRI). IRTP serves to provide an effective link among the rice improvement programmes around the world including the Genetic Evaluation and Utilization (GEU) programme of IRRI.

The main objectives of the IRTP are to:

1. Make the world's elite germplasm available to rice scientists around the world either for direct use or for use in crosses within their breeding programmes.
2. Provide the rice scientists with an opportunity to assess the performance of their own advanced breeding lines over a wide range of climatic, cultural, soil and disease and insect conditions.
3. Identify varieties with broad spectrum resistance to major diseases, insects and other stresses.
4. Monitor and evaluate the genetic variation of pathogens and insects.
5. Serve as a centre for information on interaction of varietal characteristics with diverse rice growing environments in the world.
6. Promote interactions among rice scientists in the world.

Through this programme scientists of various disciplines can participate in the systematic evaluation and development of the many diverse rices needed to better fit the local conditions of farmers around the world.

The history of active rice cultivar introduction from Asia to West Africa through the International Rice Research Institute started in the late 60s. Introduction continued on a larger scale in the early seventies, especially through the West Africa Rice Development Association (WARDA) and the International Institute of Tropical Agriculture (IITA). In May 1976, IRTP activities in West Africa were formalized as a result of an agreement among IRRI, IITA and WARDA. WARDA was to play the leading role of receiving and disseminating materials to West African countries except nurseries going to IITA and NCRI in Nigeria.

WARDA Coordinated Trials and the role of IRTP in West Africa

Coordinated trials were started in 1973 in West Africa by WARDA. A similar coordinated trial by IITA in 1971-1973 gradually phased out on account of an agreement between IITA and WARDA. Cultivars from the IRTP play a major role in these coordinated trials. WARDA's special research projects also use IRTP materials in their screening and breeding programmes.

Several national and international institutes such as IRAT and IITA welcome the opportunity of being able to receive varieties and lines from many parts of the world. They enable them to assess their cultivars in comparison with the latest available ones from other scientists.

The cultivars from the IRTP supplement the breeder's programme and where there is no breeding programme, they provide an important source of diversity from which selections can be made. The relevance of IRTP in West Africa has also been underscored by both WARDA and IITA with their 1978 agreement to have an IITA Breeder located at WARDA headquarters. He is responsible for the IRTP in West Africa. Also in 1979, IRRI placed its African Liaison Scientist in Ibadan. He is actively involved with IRTP in Africa.

Nursery procurement and coordination

Each year through questionnaires, letters and staff visits, WARDA contacts the national and international researchers in the region requesting for their IRTP nursery needs. These are compiled and sent to IRRI. Upon procurement, WARDA undertakes quarantine activities through the Plant Quarantine Center in Ibadan.

The nurseries received are kept at the cold room in Fendall, Liberia, pending receipt of the seed testing reports from the Plant Quarantine following which recommended treatments are given. WARDA then despatches the nurseries to the requesting stations. WARDA staff monitor these trials and submit a report and results to IRRI. The results of the IRTP are also discussed at WARDA's Annual Rice Review Meetings.

Every other year, IRRI, in collaboration with WARDA and IITA, conducts monitoring tours of the IRTP sites.

West African Nominations into IRTP Nurseries

One of the benefits of participation in the IRTP is to enable scientists in the region to have their materials tested on a global basis. WARDA has therefore encouraged scientists in the region to nominate promising cultivars into appropriate nurseries. Many stations have responded and each year cultivars are sent to IRRI for different nurseries.

Uses in WARDA Coordinated Trials

Each year, WARDA enters many cultivars originating from IRTP into its different coordinated trials which are conducted throughout West Africa. WARDA's Special Research Projects also use IRTP materials in their hybridization programmes.

STATISTICS

Staff : G.A. Paku

WARDA recruited an agronomic statistician in 1977 to provide the statistical basis for research conducted at the special projects and the coordinated trials. Before then, the organization employed the services of various consultants to design and advise on implementation of the coordinated trials. Analyses of the results of the trials were done at various commercial computer set-ups inside and outside the region with much difficulty and often without detail or completeness.

Also at about that time, field work started in earnest at the special projects. However, simplistic experimental designs, often narrow in scope, were favoured and analytical procedures were often based on common sense appeal and intuition rather than on statistical theory.

Work in the early part of the quinquennium under review was therefore concentrated on improvements in design and scope of experiments, field plot techniques, methods of analysis and statistical as well as economic inferences. A micro-computer was acquired in 1979 to facilitate timely analysis of large volumes of data generated from the coordinated trials and the special projects.

Because WARDA does not have a computer programmer, development of the necessary computer software also became the responsibility of the statistician. A library of computer programmes has been generated which now satisfies most experimental situations of the special projects and the Technical Support Services as well as complete systems for the validation, storage retrieval and analysis of data from the coordinated and initial evaluation trials. The library now includes fully tested and frequently used modules for:

1. Completely random design (up to 3 factors).
2. Randomized complete block designs (up to 3 factors).
3. Latin square designs (up to 3 factors).
4. Several variants of split-plot, trip-plot, split-split-plot and strip-split-plot designs.
5. Balanced and partially balanced lattice and rectangular lattice designs.
6. Various incomplete block designs (Types I to V).
7. General regression package (linear, geometric, exponential, sums of up to 3 exponentials, polynomial, stepwise polynomial, multiple, stepwise multiple, general multiple).

The West African region lacks adequate numbers of trained agricultural statisticians and the hardware and software for effective service. Of the already small number of statisticians in the region, few have the expertise, interest and/or experience in agricultural research necessary for effective consultation. In this area, WARDA's statistical services have been extended (on request) to agricultural research establishments of member countries. Countries which

have benefited are Sierra Leone, Gambia, Liberia, Benin, Upper Volta and Ghana. While Upper Volta benefited through supply of software, the others received data processing assistance. It has not been possible to do more than stated above because of staff limitations. The whole set-up is strictly a one-man operation.

Participants at WARDA's Field Assistant and Research Assistant Courses receive instruction in experimental statistics as follows:

Field Assistants: Experimental designs, layout and field plot techniques;

Research Assistants: Experimental designs, layout, field plot techniques, analytical methods.

By the middle of the quinquennium, WARDA started developing computer-based data management systems capable of processing, storing, retrieving and integrating research information. The systems so far in use are described below.

Variety Information Storage and Retrieval System

WARDA introduces thousands of varieties into the region annually for observation and testing. All introductions and local collections are planted at least once in the seed nursery farm or at the appropriate special research project sites to gather data on their morphologic and agronomic traits and to identify desirable traits such as high yield, grain quality and resistance to insects, diseases, drought and toxic soils.

The volume of data so far acquired is enormous. To manage these data, a computerized variety information storage and retrieval system was developed. The system, which was adapted from IRRI's Germplasm Bank Information Retrieval System, stores and updates existing data in appropriate data files that allow easy, rapid, and accurate access by scientist at WARDA and national rice improvement programmes.

Farm Analysis Package (FARMAP)

FARMAP is designed for computer processing of farming systems survey data. The package is sufficiently flexible to capture and handle the diverse data needed for monitoring development or identifying agronomic, environmental, cultural, institutional and socio-economic constraints to the farm household unit. The package was developed by the Farm Management and Production Economics Service (AGSP) of the Food and Agriculture Organization of the United Nation in FORTRAM IV and transplanted to BASIC by WARDA. The BASIC version is fully operational and is used extensively. WARDA has made available to Michigan State University a copy of FARMAP (BASIC version) for use on a USAID-funded farming systems research project in Senegal.

Soil Fertility and Fertilizer Requirements Computation System (COMPFERT)

The system provides computer programmes for answering common questions asked of data in soil fertility research relating to the use of fertilizers. It provides powerful tools for calculating response functions as well as profit functions, optimal fertilizer rates and soil test calibrations etc., both for the guidance of individual farmers and for the

formulation of general recommendations for countries or regions. The package was finalised late in the quinquennium but has been used successfully to analyse on-farm fertilizer requirement trials in the Senegal River Valley.

Benefit Cost Analysis for Project Appraisal (BENCOST)

BENCOST is an adaptation from a CDC 6500 FORTRAN programme by the same name developed at Michigan State University. It calculates net present value, internal rate of return and benefit cost ratios which may be used as decision criteria for long-term investment projects. The system provides powerful tools for agricultural economists.

Activities Network

Type of Activity	% of time spent
Coordinated + Initial Evaluation Trials	15
Special Project - Richard-Toll	10
Special Project - Mopti	10
Special Project - Roxupr	10
Software Development	30
National programmes	5
Training	10
Reports and General Administration	10

Constraints and Proposals

The main constraint to the Statitician's activities is the lack of any kind of personnel support. Thus the skill and experience available is limited to that of one statistician alone; he is grossly overworked and maximum disturbance occurs when he takes leave.

A second constraint stems out of the vast geographical distance which separates the special projects from the statistician.

These two constraints together prevent maximum interaction between experimenter and statistician.

Good choice of experimental design needs much discussion between experimenter and statistician. It often also requires familiarity and thorough knowledge of the site. The design of the experiment involves an extended period of cogitation by the statistician while he gathers and digests new ideas, examines critically the research objectives and design possibilities, and synthesizes his favoured proposal.

Similar demands on the mind apply to analysis of data. It calls for intelligent appreciation of the logic of the problem perhaps trial of several alternative procedures in order to extract information in a readily understandable form. Moreover, constant surveillance of the experiment and information collected in the process facilitates subsequent analysis. Then follows statistical and economic inference which are equally mind bogging.

Does access to a computer help? Certainly! A computer is fast and eliminates the drudgery in certain repeated operations. However, unlike a statistician, a computer is completely incapable of thought. A computer obediently performs the exact task assigned to it following a sequence of

instructions (called a programme) for manipulating the data and printing results. Without a programme, however, the computer, small or large, is incapable of doing anything. A programme may be suitable for processing one type of data but completely unsuitable for another. Thus, there is an unending stream of new programmes to develop.

In short, there is much more that a statistician does other than arithmetic. Short of abandoning certain aspects of his role, a sole statistician may spread himself rather thinly. Neither of the two possibilities has any attraction. It is therefore considered necessary that:

1. Each special project have at least a junior statistician on site (as envisaged for the Bouake project).
2. A programmer be recruited to take charge of all non-statistical use of the computer and assist the statistician in the development of statistical software. This becomes more relevant with the plans to computerize the activities of the WARDA accounts and administration.
3. A data assistant be recruited for the simpler but tedious data entry operations.

Infrastructure

The WARDA infrastructural programme, progress and plans are provided below. There are two types of construction projects undertaken by WARDA.

A. Buildings for residential purposes. These comprise:

- staff houses
- guest houses
- sleeping quarters for trainees or office staff

B. Buildings for working purposes. These comprise:

- laboratories
- cold rooms
- workshops and warehouses
- dining halls and recreation halls
- administrative buildings and offices

LIST OF WORK UNDERTAKEN IN THE VARIOUS MEMBER COUNTRIES BY THE WARDA ARCHITECT SINCE 1978

BENIN

1980 : Supervision of the Bonicon laboratory and cold room construction (area: 240.84 m^2); 80% of the project completed.

IVORY COAST

1979 : Bouaké Special Project: preliminary demarcation of the land to be used for construction and preparation of a general layout plan of the blocks, and equipment. Proposal to convert a shed into offices. Proposed construction of a staff house at Bouaké and a house for the project director, preparation of execution plans, specifications, estimates of qualities and costs (areas: 214.27 m^2 and 200 m^2 respectively).

GAMBIA

1979 : Renovation of a WARDA staff house in Sapu.

GUINEA-BISSAU

1978 : Supervision of construction of the Contuboel laboratory (area: 110 m^2).

Preparation of construction project documents for:

- 1 laboratory with cold room at Contuboel (area: 218 m^2)
- 1 laboratory with offices at Caboxanque (area: 198 m^2)
- dormitories at Contuboel (area: 241.28 m^2)
- dining hall with recreation hall and warehouse at Caboxanque (area: 405.28 m^2)

LIBERIA

1981 : - construction of a rice mill at Fendall; examination of the technical documents supplied by the consultant architect in charge of the project; selection of the contractors and supervision of the work.

Construction of a guest house in Sualoko and water supply system for the Guest House (area of building 3683.80 sq. ft): supply of technical documents, invitation to bid and supervision of work; 90% of the building has been completed.
Construction of a Net House in Sualoko: drawings, invitations to bid (area: 690 sq. ft.)
Construction of a dining hall at Fendall: supply of documents (Project financed by USAID area: 512 sq. ft.)
Construction of a workshop and garage (area:324 sq. ft.) at Fendall: supply of technical documents, drawings, specifications and estimates of quantities and costs (project financed by USAID).

Construction of dormitories and recreation hall at Fendall: preparation of the technical documents, specifications and estimates of quantities and costs. (Project financed by USAID; area: 4123 sq. ft)
Detailed study on the work to be done in particular on the WARDA Headquarters building in Monrovia in order to make it leak - proof.

MALI

1981 : Construction of a house for the Mopti project director (area: 175.63 m^2). Supply of technical documents. Project not yet financed.

Construction of two staff houses in Mopti; supply of plans and specifications. Area per house: 214.27 m^2. Project financed by USAID.

MAURITANIA

1979 : Supervision of the construction of the Kaedi laboratory (area: 110 m^2). Extension of the building in 1981.

SENEGAL

1978 : Evaluation of staff houses and some WARDA construction done at Richard-Toll and Fanaye.

Preparation of documents for the construction of a cold room.

SIERRA LEONE

1978 : Supervision of the construction of staff houses in Rokupr; area per house: 1744 sq. ft.

Construction of a Guest House at Rokupr; preparation of the technical documents, specifications and estimates (area: 260 sq. ft.)

Construction of a staff house at Rokupr; (area: 2089 sq.ft., project financed by USAID). Supply of plans and specifications.

TOGO

1979 : Construction of one laboratory and one cold room at Cacaveli (area: 135.28 m^2). Supply and installation of the laboratory and cold room equipment.

FUTURE PLANS

Most of the projects listed above are still on-going. Their completion is envisaged in 1983.

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CHAPTER THREE

SPECIAL RESEARCH PROJECT ON MANGROVE SWAMP

(ROKUPR, SIERRA LEONE)

STAFF

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SPECIAL RESEARCH PROJECT
MANGROVE SWAMP RICE

BACKGROUND

Rice cultivation presently covers about 200,000 ha of cleared mangrove swamps in The Gambia, Guinea-Bissau, Nigeria, Senegal and Sierra Leone. An additional 150,000 ha can be developed in these countries. Up to the moment, 800,000 ha are unutilized in Nigeria.

Mangrove swamp rice comprises about 7% of the area put under rice in West Africa, and accounts for about 12% of production with an average yield of 2t/ha. There are indications that the use of practical modern techniques can double production per unit area. The relative importance of mangrove swamp rice varies from country to country as indicated below:

Country	Area under Mangrove cultivation(ha)	% of National Rice Area	% of National Rice Production
Guinea Bissau	90,000	80	80
Gambia	10,000	52	54
Guinea	64,000	12	18
Senegal	10,000	20	16
Sierra Leone	35,000	6	12
Nigeria	5,000	-	-

The swamps have been continuously cropped for over 100 years in most countries involving 100,000 farm-families in the region. All farms are manually operated and most cultivated with low yielding varieties without fertilizer, pesticide or herbicide application. The farmers are also constrained by labour, transportation, extension education, lack of credit facilities and input availability.

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Mangrove rice cultivation is affected by ecological variations ranging from dry tropical climate with 100cm of rain in the Casamance, Southern Senegal to humid tropical climate with up to 400cm in Sierra Leone. Successful cultivation of rice in any one area depends on the length of salt-free period which is an interplay of freshwater available and saltwater intrusion from the sea.

The farther a site is from the sea, the longer is its salt-free period. The special project site at Rokupr is about 25 miles away from the sea along the Great Scarcies river. The fields are salt-free for more than 5 months in the year. Between the tidal swamps and the upland lie the associated mangrove swamps which are characterised by excessive grass and sedge weeds.

The Rokupr Special Project was initiated in 1974 and became fully operational in 1977. Its main objective is to solve problems limiting production of mangrove-swamp rice in WARDA Member Countries and to extend improved production methods to extension workers and to farmers.

PRODUCTION CONSTRAINTS OF THE SWAMPS

a. High amount of organic matter;

b. Large amount of sulphate, intensely acidic ((pH 2-3) when allowed to dry; upon drying release free Fe and Al ions;

c. Nutrient deficiencies and disorders, especially, in associated mangrove swamps, and inadequate and absence of balanced fertilizer application;

d) Inadequate and late land preparation; costly and labour consuming manual operation for puddling and absence of mechanization;

e) Poor cultural practices: wide spacing, no gap-filling, weed infestation in associated swamps and crab damage;

f) Salinity in areas of short-wet season when the volume of fresh river water is inadequate to check the incoming tidal-water from the seas. In such areas, rice is grown on ridges after empoldering, and the crop depends upon fresh water from rains. Sometimes, rice crop fails under this condition due to short rainy seasons and inadequate accumulation of rainwater in the polders;

g) Staggered planting, and old and poor quality seedlings;

h) Lack of seed supply and extension services.

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STRATEGY

A multi-disciplinary team of scientists has been established at Rokupr to develop new techniques and test them in Sierra Leone and in cooperation with national personnel in other countries in West Africa.

Since 1977, about 80 trials have been conducted on farmers' fields each season. This is meant to increase the understanding of the farmer's problems and established excellent cooperation between project staff and farmers. Promising techniques are evaluated by the economist and extension agronomist together with farmers on their farms. Successful techniques are then passed on directly to farmers and appropriate extension authorities.

The following interdisciplinary activities have been undertaken:

Varietal Improvement (working in association with Pathology, Entomology and Soil)

- resistance to diseases with special attention on blast
- tolerance to insect pests and crabs
- tolerance to high salt levels and iron toxicity

Entomology (working in association with Pathology and Weed Science)

- insects as vectors of disease especially dirty panicles
- weeds as alternative hosts for rice pests and diseases

Agricultural Economics (Technology Assessment and Transfer - TAT)

The activities of TAT started in the project area in 1980. The programme has three main components, namely:

1. Socio-economic studies;
2. Adaptive trials; and
3. Post-production studies.

During the socio-economic phase of the programme, the farmers' technology is assessed so that appropriately improved technology packages can be designed for their farming system.

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The main objective of the post-production studies is to determine level of losses at different points and to generate awareness and control measures to minimise such losses.

The strategy has involved technology testing on large scale in farmers fields in the following areas:

- testing of improved varieties;
- utilization of urea by means of the injection techniques;
- the use of the single axle tractor;
- pest control practices;
- post harvest pest control, and
- the evaluation of mechanical cultivation and herbicides for weed control.

RESEARCH PRIORITIES

Although research is carried out on multi-disciplinary basis, the priorities are outlined on subject matter basis as follows:

Varietal Improvement

To select from among introductions and hybrids developed at the station higher yielding varieties for the varying spectrum of mangrove swamp conditions encountered in West Africa. Main selection criteria are: high photosynthetic efficiency under low light conditions, salt tolerance, iron toxicity tolerance, adequate plant height and life cycle.

Entomology

To identify and evaluate the importance of insect pests of mangrove swamp rice and develop practical control methods for them and the crabs.

Soil Science

To establish methods for economic use of fertilizer, crop and soil management practices including the use of small scale mechanization.

Weed Science

To determine the types of weeds present and develop their practical control measures including cultural, mechanical and chemical control methods for the mangrove and associated swamp.

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Plant Pathology

To monitor disease incidence and devise practical control methods.

Agricultural Economics

To analyze household incomes and expenditures and labour availability and to determine the economic and social consequences of and limitations to introduction of new techniques for the mangrove swamp farming system. To determine the potential economic profitability and acceptability of these technologies.

STAFF TRAINING

Three of the project scientists have received post graduate training. Two are presently pursuing M.Sc. degree courses.

In August 1982, Mr. Monty Jones attended 3 weeks IBPGR course on Data Management for Gene Banks in Beltsbille, U.S.A. Mr. S. N. Fomba also completed a 3-week course on Concept, Techniques and Applications of Integrated Pest Management in Rice in Africa, at WARDA Training Centre, Fendall, Liberia.

From 1978 to 1980 each year, three of the field technicians underwent the WARDA six-week Field Assistant Course at Fendall, Liberia. Three labourers have been trained for 10 weeks in maintenance and use of single axle tractors at Tinkonko in Sierra Leone.

SUMMARY OF RESULTS (1978-82)

VARIETAL IMPROVEMENT

Introduction

Since 1976, approximately 2000 varieties have been introduced and screened for adaptation to the mangrove swamp ecology (Table 3.1). Most of the varieties originated from IRTP and include advanced breeding lines as well as traditional varieties. The advanced breeding lines have proved most suitable for short duration, non-tidal mangrove areas in the north of the region and the traditional varieties for the tidal-swamps of Sierra Leone and Guinea. Several of these varieties were entered into the coordinated trials for mangrove swamp, deep-flooded and irrigated rice.

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Table 3.1

I Introduced Varieties Screened at Rokupr for Adaptation to Mangrove Swamp Conditions

Year	Number of Introductions	Origin of Materials	Number of Varieties Selected	Number Nominated for Coordinated Trials
1976	330	IITA	54	2
1977	343	WARDA	49	1
1978	437	IRTP, IRRI Germplasm Bank	62	10
1979	57	IRRI Germplasm Bank	18	4
1980	71	IRTP	9	-
1981	536	IRTP	127	-
1982	132	IRTP	22	-
Total	1,906		341	17

Farmers' field trials in Sierra Leone have confirmed that ROK 5 and CP4 are acceptable to farmers and suitable for tidal mangrove swamp areas with 3-4 months and over 5 months salt-free periods respectively. For intermediate areas neither variety appears appropriate. ROK 5, with a duration of 145 days, matures early and is unpopular with farmers in this area as it requires protection from birds. CP4, with a duration of 190 days, matures late and can suffer severe salt damage when the rains end prematurely. An intermediate duration variety which avoids both these problems and is adapted to the growing conditions of this area is therefore required. Kuatik Kundur which has a duration of 175 days has yielded well in trials on farmers' fields and is currently under national trials in Sierra Leone to determine its suitability for release.

Germplasm Collection and Characterization

Collection and evaluation of traditional mangrove swamp varieties from the region was initiated in 1977 to establish the varietal types favoured by farmers and also to provide the basis for a hybridization programme. As of now, the collection contains 639 accessions from

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The Gambia (150), Guinea (51), Guinea-Bissau (9), Nigeria (37), and Sierra Leone (382).

Five hundred and seventy one accessions have been purified and characterized for a range of morphological, physiological and agronomic characteristics according to the IRRI Germplasm Bank system and a catalogue is being prepared. Preliminary analysis has shown the overwhelming majority of varieties to be tall and of long duration. Panicles are large, resistant to shattering and show high spikelet fertility. Considerable variability has been recorded for grain size, shape and colour. Most varieties were rated resistant to leaf blast in the seedling stage but several were susceptible to neck blast. Samples of the 571 purified and characterized accessions have been forwarded to IRRI and IITA for long term storage and are maintained in a working collection at Rokupr in a recently completed cold room for medium term storage.

Five hundred and seven accessions were screened during 1980 for salinity tolerance evaluated by comparing seedling root growth in saline and non-saline culture solutions. Eleven highly tolerant and 57 moderately tolerant varieties were identified. Recommended mangrove swamp varieties and the most extensively grown local varieties were also classified as moderately tolerant. The eleven highly tolerant varieties, six from Sierra Leone and five from Gambia have been forwarded to the Richard Toll project for further salinity screening and the three most tolerant of them, Pa Merr 108A, Pa Foday Yorch 260 and Pa Fant 213, have been nominated for the IRTP salinity screening.

Two hundred accessions were screened for tolerance to iron toxicity in iron toxic soils contained in concrete troughs. Thirty varieties, selected on the basis of visual symptoms, i.e. tiller number and percentage sterility, are undergoing confirmatory testing in the laboratory and the field.

Comparison of Traditional and Improved Varieties

A number of trials have been conducted between 1978 and 1982 to compare the yield potentials of the local varieties with the best improved long and medium duration varieties, CP4 and ROK 5 respectively.

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On the average, CP4 is only marginally better than traditional varieties and is no better than the best of them, while ROK 5 is superior in yield to the best local varieties by about 25 percent. ROK 5's superiority was shown in a test on a saline area at Mapotolon in Sierra Leone, where due to its shorter duration it escaped salt damage better than the local varieties.

In 1982, ROK5 was shown to be superior to local varieties by 45 percent in tests on 15 farmers' fields in the Moriboia area near the mouth of the Great Scarcies river. One bushel (29kg) lots of ROK5 were exchanged for local varieties with local farmers who grew ROK5 and the local variety traditional methods. Yields of ROK5 averaged 2542 kg/ha and those of local varieties 1758 kg/ha.

Hybridization

Selection within segregating materials from 23 crosses obtained from the national research programme at Rokupr has been going on since 1977. The first products of this work have already undergone two seasons of yield testing and two lines, ROHYB 6-WAR-6-2-B-2 and ROHYB 1-WAR-5-2-B-2, have been nominated for inclusion in the 1983 coordinated trials.

A hybridization programme was initiated in 1978 to develop long duration varieties for the tidal mangrove swamps of Sierra Leone and Guinea for which introduced materials appeared to offer little scope. Approximately 100 crosses have been carried out, mainly between local and introduced varieties.

The general aim of these crosses has been to combine the good adaptability to tidal mangrove conditions of local varieties with higher yield potentials of improved ones.

Crosses with more specific objectives such as tolerance to blast, salinity and iron toxicity have also been carried out. Progenies are now up to the F6 generation, the most advanced of them undergoing yield testing. Advanced lines (16) with tall stature and long duration have been nominated for deep flooded IET for 1983. Segregating materials of a few crosses for salt tolerance have been exchanged with Djibelor research station in Senegal.

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A modification of the IRRI Rapid Generation Advance technique has been used to achieve five generations in two years. It is felt that this method can appreciably remove the constraint to generation turnover imposed by the photoperiod sensitivity of most of the parent materials. Furthermore, the reduced requirement for field selection of the method can increase the volume of materials that can be handled, particularly, where such field selection is already severely constrained by the tidal nature of the swamps.

ENTOMOLOGY

Pest Surveys and Collection

Preliminary field surveys have shown a wide range of insect pests on mangrove swamp rice in West Africa with varying intensity of infestation from place to place and country to country. The variation in the extent of infestation depends on factors such as climate, time of planting, variety and soil fertility. The African white rice-borer Maliarpha separatella) has been found to be the most dominant of the rice pests in the mangrove swamps of Nigeria, Sierra Leone, Guinea, Guinea Bissau, and The Gambia. Other common pests are striped rice-borer (Chilo spp), stalk-eyed borer, Diopsis thoracica, rice bugs (Stenocoris southwoodi, Riptortus spp. Mirperus, Aspavia annigera, Diploxys sp).

In northern Sierra Leone Chilo sp. rarely occurs in the mangrove swamps but average infestation of 20 percent is common around Mapotolon, a saline area near the sea. Scirpophaga sp., another rare stemborer was often recorded at Mapotolon. At Caboxangue in Guinea Bissau there was found usually high incidence of gall midge Orseolia oryzae. Chilo zacconius is the common stemborer at both Caboxanque and Djibelor in southern Senegal. Diopsis sp., a stemborer of young rice plants and and rice bugs were common in all rice fields particularly in the associated swamps.

An insect collection programme aims at preserving specimens of all insects associated with the rice crop in the region for insect type comparison and relevant studies. To date, over 479 species of 106 families and 12 orders have been identified and preserved in a small insect museum at Rokupr. About 180 species of the identified insects

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are associated with rice or parasites/predators of rice pests.

Crop Loss Assessment

Crop loss assessment forms the basis for developing a rational and economically sound management practices.

Stemborers

The studies of the relationship between stemborer, Maliarpha separatella, infestation and crop yield on farmers' fields in northern Sierra Leone was initiatied in 1977 and continued for three successive years. Equations were developed to determine yield loss for any given unit of infestation. Various relationships were obtained. The differences between sites indicated the complexity of the operative factors in the field which influence crop loss assessment. These factors include the growth, vigour and resistance of the plant; length of time the larvae fed within the tiller; the part of the tiller attacked by the larvae and the cultural practices of the farmer. However, crop losses due to stemborer infestation in farmers' fields range between 35 and 1000 kg/ha.

Promising Varieties; CP4, BL4E, ROK5,RH2 and AA8A were tested in a replicated trial under protected and unprotected conditions to determine the extent of stemborer (Maliarpha) infestation. ROK5 and BL4E produced the highest increase in yield (16%) caused by insecticidal protection. The varieties RH2 and AA8A showed the least increase in yield (6% and 9% respectively) suggesting that they are the most susceptible to insect damage.

Rice Bugs

Rice bugs in the field are elusive and can cause appreciable loss even when they occur in small numbers on the crop. The economic importance of Aspavia armigera and Stenocoris southwoodi was assessed by placing different numbers of adults of each species in field cages on rice from flowering to harvesting. It was established that the percentage of grain damage increased as the rice bug density increased and that the amount of "dirty panicles" is a reflection of bug damage. Yield losses caused by rice bugs are indicated by the following regression equations.

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Aspavia on ROK5

$$Y = 10.15 - 0.12\,x \quad (r = -98^{**} n = 8)$$

Aspavia on CP4

$$Y = 9.91 - 0.11\,x \quad (r = -99^{**} n = 9)$$

Stenocoris on ROK5

$$Y = 9.2 - 0.15\,x \quad (r = -90^{**} n = 8)$$

where Y is 500 grain weight in grammes and x is percentage grain damage.

Ecological Studies

The project has since 1979 developed a simple light trap using the common kerosene lamp which provides means to measure the population of adult stemborers, plant hoppers, parasites and some other rice pests. The light trap can be used in remote fields and no special skill is needed to maintain it. The effectiveness of this method is compared with that of electric light-trap.

Results of the ecological studies indicate that adult M. separatella occurred in higher numbers at Mapotolon and Rokupr than at Makassa. Peak numbers at Rokupr and Makassa appear in October - November while at Mapotolon the peak is July-August. Chilo spp are rarely recorded at Rokupr but are common at Mapotolon and Makassa. At all sites, Chilo peaked once in October except for Makassa where an additional peak occurred in July.

At Rokupr the number of M. separatella caught in an electric light trap was about six times that from the kerosene trap, but both of them showed the same seasonal trends. Thus the kerosene lamp trap could be used for studying the seasonal distribution pattern.

Collection from electric light traps in northern Sierra Leone indicates that seasonal appearance and population fluctuations of M. separatella follow an annual pattern. This information will help to forecast pest occurrence and time for control measures.

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Light trap data for M. separatella from 1978 to 1982 show pest emergence to be similar in all years. The number of adults trapped were low throughout the dry season. There was slight increase at the end of May followed by a decrease in July. The catches built up in September and reached the only peak during early November following which it tailed off by the end of the month.

An extensive insecticide evaluation programme and adult population studies have indicated that application of granular form of Furadan at the rate of 1.5 a.i/ha at the end of September gives best control of stemborers in the mangrove swamps of northern Sierra Leone.

Varietal Resistance

Since 1978 about 1000 local and introduced rice varieties have been evaluated for resistance to Diopsis thoracica and M. separatella under natural infestation in collaboration with the varietal improvement section.

In general, the introduced varieties appeared more susceptible to"dead heart" than the local varieties. The "dead hearts" recorded during the early stages of plant growth were caused by Diopsis sp. On the other hand, stem infestation which was mainly due to M. separatella was higher in the local varieties than the introduced ones. The female M. separatella lays masses of eggs only on the young and partly folded leaves. Since the local varieties are generally long duration types and have long vegetative phase, more eggs were deposited on them, hence higher infestation than the introduced varieties. A general association between some morphological features, maturity period of the rice plant and resistance to stemborer was established (Table 3.6). Diopsis sp. attached young plants. Maturity period and plant height were negatively correlated with dead heart infestation.

Table 3.2 Correlations between rice plant characters and stem infestation (M. separatella) and dead heart (Diopsis thoracica)

Plant Character	Correlation coefficient
Stemborer infestation	
Time of 50% flowering	+0.76 **
Flag leaf length	+0.45 **
Flag leaf breadth	+0.20 **
Plant height	+0.59 **
Total number of elongated internodes	+0.56 **
Length of elongated internodes	+0.64 **
Diameter of 1st internode	+0.63 **
Maturity duration (Days)	+0.76 **
Dead heart	
Plant height	-0.51 **
Total number of elongated internodes	-0.32 **
Length of elongated internodes	-0.44 **
Diameter of internodes	-0.28 **
Maturity duration (Days	-0.52 **

Cultural Control: Cultural methods restrict or prevent pest damage by reducing pest populations, thus, a useful component of pest management. They are generally economical and widely applicable.

(i) Destruction of rice stubbles after harvest: In the mangrove swamp where burning of stubbles is not feasible due to daily tidal flooding, brushing of

The rice stubbles at base drastically reduce the hibernating Maliarpha population.

(ii) Early transplanting: Early transplanted rice in the mangrove swamps of nothern Sierra Leone escapes the peak infestation of Miliapha and Chilonspp.

The susceptible stages of growth of the crop escape the peak period of the stemborer attack when rice is transplanted later in August or September. Short duration varieties transplanted early are attacked far less than the long duration varieties.

(iii) Plant spacing: Recent preliminary studies using different spacings - 10cm x 10cm. 15cm x 20cm, 20cm x 30cm, and 30cm x 30cm, at Rokupr indicate that closer spacing led to lower Maliarpha infestation in the mangrove ecology. The reason for this is not obvious. However, farmers tended to transplant at wider spacing and this observation might be useful in formulating future control strategy.

Natural factors regulating Rice insect populations: For the past four years detailed studies have been made on biotic factors affecting pest population changes during the season in rice fields in Sierra Leone, as basic elements of integrated pest management studies. The total and rate of Maliarpha larval parasitism varied from field to field and year to year. Parasitism of about 15 percent was recorded six weeks after transplanting. However, high rate of parasitism (90%) was recorded at the later part of the season.

Twenty-two species of egg and larval parasites of eight species of rice pests have been recorded. Eight larval parasites were reared from M. separatella larval parasites and accounted for about 70 percent of larval parasitism. Two egg parasites Telenomus sp. (predominant species) and Pedibius telecomi parasitised Borbo fanta/ Pelopidas mathias (rice leaf defoliators) at the rate of about 70 percent. These egg parasites are effective even at low host densities.

The spider predators, Tetragnatha sp. and Araneus spp. are known to be general feeders of defoliators, stemborers and leaf-hoppers in rice fields. With sweep net their numbers were assessed weekly and found to be predominant during maximum tillering stage. Although there was no definite evidence to suggest that spiders were significant predators of any particular rice pests their presence along with other natural enemies in the field might be of some importance in supressing some pests.

Crabs

Ecological studies: In the mangrove swamps frequently cause extensive destruction of newly transplanted seedlings.

Of the nine species of crabs recorded in rice fields, three of them, Sesarma huzardi, S. alberti and Sermatium curvatum are the most destructive. S. huzardi is the most voracicus and common of the three species in the tidal mangrove swamp along the Great Scarcies river. It is distributed transversely across and along rivers and creeks up to the tidal limits in the associated mangrove swamps.

Crop loss assessment: Experiments were conducted on farmers' fields to find out the relationship between yield and crab damage at different seedling ages and the number of seedling per hill. Highly negative significant correlations were observed between yield and percentage crab damage for all seedling ages and numbers of seedlings per hill.

These results suggest that crab attack on newly transplanted seedlings led to reduction in yield. Losses ranged from 19 kg per ha to 34 kg per ha for every one percent crab damage, and seedlings below 40 days old tended to suffer higher losses.

Chemical control: Extensive evaluation of insecticide formulation and application techniques has revealed that seedlings soaked in Furadan, Dicarbam or Ofranol concentration of 0.1 percent a.i. for 24 hours before transplanting effectively controlled crabs and reduced the damage.

Cultural control: The relationship between seedlings vigour and crab attack was evaluated on fertilized and unfertilized seedlings. unfertilized seedlings suffered twice as much damage as the fertilized seedlings. The vigorous growth of the fertilized seedlings strengthened them against crab damage. However, the unfertilized 60 days seedlings were significantly less damaged than the fertilized 30 days seedlings.

Varietal Resistance: In preliminary studies in 1979 and 1980 it was noted that some rice varieties were more susceptible to crab damage than others. Mass screening of 580 accessions initiated in 1981 continued with the screening of about 150 varieties each year. The results

in spite highly significant difference among varieties in their susceptibility to crab damage. Plant characters shown to be correlated with crab damage are indicated below.

Plant Character	Correlation with crab damage
Leaf length	-0.33**
Plant height	-0.35**
Seedling base thickness	-0.33**
Sheath length	-0.15

Tall seedlings with long leaves and thick base are most tolerant to crab damage. The thickness of cell walls and increased toughness i.e. sclerotization of sheath physically far and deter crabs from feeding.

PATHOLOGY

Disease surveys: In Sierra Leone exhaustive surveys were done on farmers' fields at twelve locations in both the Scarcies region of northern Sierra Leone and along the Bumpeh River in the southwest. Diseases were scored using a standard evaluation scale.

Generally, seedling blast in the nusery was a major problem, however, upon transplanting, affected seedlings recovered if they escaped severe crab damage. Leaf and neck blast incidences were also generally low except for some locations such a Mapotolon in Sierra Leone and Donnia and Koba in Guinea, where neck blast incidence was noted to be relatively greater. Mapotolon and Koba are areas which are characterized by a short, salt-free period and salinity and associated soil stresses.

Table 3.7 SUMMARY OF RICE DISEASES RECORDED IN THE MANGROVE AND ASSOCIATED SEDGE/GRASS SWAMPS OF SIERRA LEONE, GUINEA AND NIGERIA.

Common Name	Causal agent (s)	Location
Rice blast	Pyricularia oryzae cav.	All locations in Sierra Leone ; Panicle blast in Koya Sonfonia and Koba in Guinea; Warri, Bendel State, Nigeria.
Brown Spot	Cochliobolus miyabeanus (Ito and Kuribay) Drechsl. ex Dast. (=Helminthosporium oryzae Breda de Han)	All locations in Sierra Leone, Guinea and Nigeria.
Sheath blight	Corticium sasakii (Shirai) Matsumoto	Rokupr, Robombeh, Luti and Rosinor in Sierra Leone.
Sheath blotch	Pyrenochaeta oryzae Shirai ex Miyake	All locations in Sierra Leone and Sonfonia in Guinea
Sheath rot	Acrocylindrium oryzae Saw	All locations in Sierra Leone, and Sofonia and Koba
Narrow brown leaf spot	Sphaerulina oryzina Hara (=Cerco oryzae Miyake)	All locations in Sierra Leone; Koya and Sofonia in Guinea.
Leaf smut	Entyloma oryzae H. and P. Sydow	Rokupr, Mapotolon, Saiama, and Kassipoto in Sierra Leone.
Cat-tail fungus, sugary disease or 'udbatta'	Ephelis pallida Pat.; Asian counterpart Balansia oryzae Narasimham and Thirumalachar =E oryzae Syd.	All locations in Sierra Leone and Sonfonia in Guinea.
False smut	Ustilagenoidea virens (Cke) Tak = (Ustilago virens (Cke) Tak.)	Rokupr Kassirje. Katik, Mapotolon, Saima, and Kassipoto in Sierra Leone.
Dirty panicles or glume discolouration	Several plant pathogenic fungi including C. miyabeanus	All locations in Sierra Leone, Guinea and Nigeria.
Whitetip nematode Pale yellow mettle	Aphelenchoides besseyi Christie Virus	Rokupr and Mapotolon in Sierra Leone Rokon (near Rokupr) and Saiama (Rotifunk) in Sierra Leone and Koba in Guinea.

1. Leaf and neck blast were incidental in most locations in the swamps except at Mapotalon in Sierra Leone, Warri in Nigeria and Koba, Guinea, where the level of neck blast incidence was decidedly more noticeable; node blast was also recorded at Warri.

TABLE 3.4 SUMMARY OF THE REACTIONS OF SOME MANGROVE VARIETIES/LINES OTHER RICES TO MAJOR FUNGAL RICE DISEASES IN A HORIZONTAL DISEASE SCREENING NURSERY UNDER NATURAL LEVEL OF INFECTION AT ROKUPR, SIERRA LEONE .

Variety/line	Pyricularia oryzae			Cochliobolus miyabeanus			Phynchosporium oryzae			Entyloma oryzae		
	1980	1981	1982	1980	1981	1982	1980	1981	1982	1980	1981	1982
ROK 4	I[2]	R	S	R	R	I	O	I	I	S	I	HS
ROK 5	HR	I	S	HR	R	R	I	O	HR	O	HS	HR
ROK 7	I	HR	S	I	R	I	O	I	I	HS	HS	HS
ROK 8	I	HS	HS	R	R	R	O	O	HR	I	HS	S
BD2	R	R	HS	I	I	I	I	R	I	I	I	HS
CP4	R	I	I	I	I	R	O	I	I	HS	HS	I
Gantang	S	I	HS	I	R	S	I	I	R	S	HS	HR
Kuatik Jambi	R	HS	R	R	R	R	I	I	I	S	HS	HR
Sentral Merah	HR	HR	R	R	R	I	I	I	S	HS	HS	R
Kuatik Putih Tinggi	R	R	HS	R	I	R	O	I	I	I	HS	S
Kuatik Kundur	R	S	HS	R	R	I	I	I	I	I	HS	HS
Cat Dung Ket Lo	S	S	HS	R	R	I	O	I	R	I	O	HR
IR5677-17-3-1	HR	HR	S	S	I	R	I	I	I	S	HS	S
IR4712-113-3-1-2	HR	HR	R	R	R	R	I	I	HR	S	HS	S
IR5677-17-3-1-1	HR	HR	I	R	I	R	S	S	HR	S	HS	HS
IR3880-17	R	HR	HS	R	R	R	O	S	HR	I	I	HS
Haji Haroun	HR	HR	S	HR	R	I	O	I	I	I	HS	S
Raminard Str. 3	HR	HR	HR	I	R	I	I	I	HR	O	HS	I
Mentong	R	R	HS	R	R	I	I	I	S	O	HS	HS
Toma 112 (4914)	HS	I	HS	R	R	I	I	I	I	O	HS	HS
3-3-1-b-1	HR	HR	R	R	R	R	O	I	I	R	I	HR
6-6-2-B-3	R	R	HS	R	R	I	I	I	I	I	HS	I
16-2-4-B-2	R	I	HS	R	R	R	I	I	I	I	I	R
Sokotera	R	HR	I	R	R	R	I	I	I	O	HS	HS

1. Rated in nursery bed prior to transplanting.

2. O = No disease HR = Highly resistant R = Resistant I = Intermediate
S = Susceptible HS = Highly susceptible

Whether these factors are responsible for the relatively higher incidence of the disease is not known at the moment. It was noted in Warri, Bendel State, in Nigeria that the disease was also quite noticeable (table 3.3).

Seedling blast incidence in the nursery was monitored for varietal improvement plots during the cropping season of 1980, 81 and 82. Considerable variations in varietal response to the disease was noted.

Horizontal Disease Screening/nursery were tested for their reaction to the common rice diseases. A summary of results is given in table 3.4. Considerable variation in reactions was noted in several varieties.

Biology of important rice pathogens: Preliminary studies on the cat-tail fungus, sugary disease or 'ukatta' (Ephelis pallida), a disease endemic to the mangrove ecology showed that the pathogen is carried by the seeds; however, it is not known whether this is in the form of a spore or an ascospore in the embryo or as a piece of mycelium on the husk. The pathogen was isolated on rice tissue extract to which glucose and peptone were added at room temperature.

[Preliminary investigation has shown that the organism (causing brown spot disease) infected can be isolated from glumes. However, abundant sporulation was only obtained on glucose peptone agar (GPA), followed by malt agar (MA) when incubated under white fluorescent light at room temperature for nine days.

SOIL SCIENCE

Salinity and pH levels: The salt content and soil pH values along the Great Scarcies and around the Mokuyo farm have been routinely monitored since 1976. The data obtained has facilitated the establishment of safe levels of salinity and acidity rice in different areas of the mangrove swamps.

The pattern of build up and clearance of salt at three points on the Great Scarcies is shown in Fig 3.1. At Rokon, 22 miles from the sea, the soil becomes cleared of salt by mid July. Nearer to the sea (Kamom and Balancera) salt clearance is progressively delayed. The year to year variation in this pattern is related to the onset and intensity of the rains.

Soil pH values range from 5.0 to 6.5 throughout the year in the tidally affected areas of the swamp. In areas of the swamp that dry out between spring tides, pH value is 4.0 or less. By mid August however, pH values in most areas of the swamp catena are between 5.0 and 6.5.

Nitrogen Fertilizer Studies: The project developed a nitrogen injection device for application at depth. The device is made up of a knapsack sprayer with a lance converted into a needle for the placement of an aqueous solution of the fertilizer (urea) at the required depth.

Trials have been conducted to evaluate the effect of deep placement by the injection technique on the yield of mangrove swamp rice. The results indicate that efficient N utilization and increased grain yield are obtained by use of the new technique.

As a once only method for applying N, the injection method fits within the farming practice of the mangrove swamp farmers and in this regard, has considerable advantage over three or four split broadcast applications of N.

The point application technique (by injection) has been tested in over 150 trials on farmers fields over the years in the Scarcies estuaries. The mean data are presented in Table 3.6. The mean results for each year showed a significant increase in rice yield following the application of N by the injection method.

Table 3.5 : Mean Grain Yield in kg per ha for trials done on farmers rice from 1978 to 1982 along the Scarcies river

Year	Trials No.	No.of sites	Kg N per ha			
			Control	20	40	60
1978	1	24	2067	-	-	2747
1979	2	19	1879	2232	2430	2507
	3	7	1597	-	-	2371
	4	15	2102	2520	2746	2764
1980	5	6	1590	-	-	2721
	6	20	2008	2522	2750	2920
	7	7	1868	2511	2877	2964
1981	8	22	1600	2128	2378	-
	9	9	2030	2706	3004	3502
1982	10	8	1791	2315	2718	3065
Weighed Mean			1889	2379	2636	2810
Increase over control				25.9%	39.5%	48.8%

Response to P and K: Long-term trials evaluating the effect of N alone; N and P; and N, P and K were set up at four points on the swamp catena at Rokupr, representing the range of soil conditions and water regimes in the mangrove swamp. Five seasons' results show no response to potassium and an occasional response to phosphorus. The Application of 20-40 kg P per ha as Single Superphosphate effect of N and increased grain yield significantly.

Mechanical cultivation : The single axle tractor has been used for ploughing and puddling of the swamos and has been shown to be practical in most areas of the swamp.

Trials over the past four years have shown that the effect of mechanical cultivation on grain yield has been consistently superior to the farmers method (manual digging with hoe). However, the effect of mechanical cultivation on soil properties and its long term effect on soil fertility in the mangrove swamps needs study

WEED SCIENCE

Weed Surveys and Crop Loss studies: A weed survey conducted during 1976-79 showed that Paspalum vaginatum or "Kire Kire", a salt-tolerant grassy weed is the dominant weed in the mangrove swamp, while in the associated swamps a broad spectrum of weeds occur, including grasses, sedges, and broad leafed weeds. The occurrence and intensity of various weed species are summarised in table 3.6. A weed survey in the mangrove swamp rice growing belt of Guinea revealed a similar spectrum.

Cultural and chemical control: On the mangrove swamps, trials conducted from 1979 to 1981 have shown that good ploughing and puddling with a single axle tractor before transplanting can adequately suppress Paspalum vaginatum for the duration of the rice crop. In the soft soil areas with a vary dense population of the weed, June is the best time for land preparation. March cultivation results in regeneration of the weed

was after the time of transplanting. Irrespective of the cultivation method used, all cultivations done in June had highly significant lower weed infestation than the cultivations done in March. Mechanical cultivation had the lowest weed weights and highest rice yields than all the other cultivation methods used in both March and June.

In the associated swamps, grasses and sedges pose serious problem. Weed control trials conducted from 1978 to 1981 have shown that the herbicide, Stam F 34T (Propanil + Fenoprop), is promising in controlling these weeds and increasing rice yields.

Effect of duration of weed control in the Associated Grass Swamp

Results of experiment initiated in 1981 indicate that the critical period to keep the rice crop free from weed competition in order to obtain reasonable yields is the first four weeks after transplanting.

Effect of cultivation and weed control with and without nitrogen

Application of fertilizers without adequate weed control measures usually results in severe weed infestation and reduced rice yields. A trial was conducted in the 1981 season to evaluate the effect of different cultivation and weed control methods with and without nitrogen. Urea was applied at the rate of 60kg N/ha three weeks after transplanting It appears that when nitrogen is applied weed control is much more important in manual cultivation plots than mechanically cultivated plots where weeds are suppressed due to the better ploughing and puddlings.

TABLE 3/5 SUMMARY OF THE WEEDS FOUND IN THE MANGROVE AND ASSOCIATED GRASS OF NORTH-WESTERN AND SOUTHERN SIERRA LEONE.

Scientific name	Local or Common name	Intensity in N.S.	Intensity in A.S.
Paspalum vaginatum	Kire..Kire (Temne)	++	
Panicum repens	Kawire (Temne) Wild rice	+	++
Oryza barthii	An Tek-Tek (Temne)	+	+
Panicum laxum			++
Panicum sp.			++
Ischaemum rugosum	Wrinkle grass, Rice grass		++
Rhynchospora corymbosa	An wor-woran (Temne)	+	+
Cyperus articulatus	An kolma (Temne)	++	
Fuirena stricta	Ka yaba (Temne)	+	++
Fuirena sp.			++
Eleocharis quicis	An kolma katar (Temne)+		
Fimbristylis aphylia			++
Fimbristylis sp.			++
Cyperus diffonnis			+
Cyperus sphacelatus			+
Cyperus sp.		+	++
Alternanthera sessilis	Ka Guanthan (Temne)	++	
Sphenoclea zeylanica		++	
Commelina sp.			++
Ipomoea sp.			++
Jussiaea sp.			++

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TRAINING AND SUPPORT TO NATIONAL PROGRAMME

Strengthening of national research programmes on mangrove swamp rice is one of the important objectives of the Special Research Project. This is accomplished through various activities including training of young scientists and technicians, exchange visits to encourage familiarity with various activities and conducting collaborative trials. These activities are considered below on a country by country basis.

Sierra Leone

For each of the past three years, several students from Njala University College have worked at Rokupr during the July - September vacation for their final degree dissertation under the supervision of project staff. Selected topics were related to the project's programme of activities and served to train the students in rice research methodology. Since this scheme started ten students have been trained. Some of the subjects covered were :

(a) The Effect of Iron Toxicity on the yield components of Rice - M.S. Jusu

(b) Some Variation in Soil Properties in Mangrove and Associated Grass Swamps at Rokupr in Sierra Leone - M. Kekura

(c) Resistance of Rice varieties to crab damage - L. Wurie

(d) A study of Agricultural Extension services in the Great Scarcies Mangrove Swamps - H.M.S. Kargbo

Research activities on Mangrove swamp rice in Sierra Leone are mainly carried out by the WARDA Project. Other collaborations with the Rice Research Station takes the form of frequent exchange of materials, idea and experience through informal discussions and research seminars organised by the project. In addition, project staff help in maintaining the

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national programme by supervising work in their areas of specialization during the absence of national staff. In particular, project staff have been involved in the planning and execution of the Upland Rice Storage Project conducted by the national programme with funding from Sierra Leone Government and IDRC.

Other bodies with whom the project co-operates in Sierra Leone include the Adaptive Crop Research and Extension (ACRE) project which the project supplies with promising varieties for testing in national trials; ACRE is evaluating the effect of injection nitrogen in inland valley swamps and riverain flood plains. The National Seed Multiplication Project is supplied with seed and some small scale multiplication is done on their behalf.

the Gambia

During 1981 and 1982, three young research scientists and technicians from the national programme spent 1-2 weeks with the project at Rokupr to familiarize themselves with various aspects of work and methodologies related to mangrove swamp rice cultivation.

The project is collaborating with Freedom from Hunger Campaign (FFHC) in the Gambia in an attempt to reclaim Beretto swamp (250 ha) which has over recent years accumulated very high levels of salt due to the combined effect of empoldering and low precipitation. The project scientists are providing assistance by monitoring the salt concentrations and distribution in the soil. Collaborative fertilizer trials are also being conducted with FFHC.

Other collaborative work in The Gambia included the installation of a light trap at Sapu to monitor insect pests; participate in surveys and monitoring of pests, diseases and weed problems; to supply short duration salt tolerant varieties

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and medium duration varieties for further testing by FFHC at Bureng and Beretto and by the national programme at Jenoi.

Guinea

A number of members of staff of the World Bank financed ONADER Project, which aims to develop a national network for rice research in Guinea, have spent various periods at Rokupr to gain experience in practical aspects of rice research. In 1980, five young research officers spent one week familiarizing themselves with the conduct of field trials. Other members of staff of ONADER's Koba Station which is concerned with mangrove swamp rice research, have visited for several shorter periods to learn from Rokupr's longer experience in the field. In 1982, training was given in soil and water sampling and the use of pH and conductivity metres for monitoring pH and salinity levels to establish safe periods for rice cultivation at Rokupr involving 5 trainees.

Socio-economic surveys of mangrove swamp rice farmers have been started in Coyah and Conakry districts. On-farm variety trials to establish the duration of varieties favoured by farmers and on-farm trials to determine the response of rice to application of nitrogen by injection and bradcast methods were conducted in the same districts.

Other activities in Guinea included surveying of pests, diseases and weeds in Koba, Sonfonia and Coyah area, collection of mangrove swamp rice germplasm in the Coyah area and supply of promising varieties to be screened for suitability for Guinea conditions.

Guinea Bissau

In 1983, two members of staff of the Department of Hydrology spent two weeks at Rokupr to familiarize themselves with traditional and improved water management for saline mangrove areas and fertilizer management of mangrove soils.

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Diseases and pests were surveyed at Caboxanque and Contuboel in 1978 and 1979. A number of varieties have been made available for local testing to identify adapted short duration materials. The national programme has assisted the Rokupr project to obtain samples of the most commonly grown traditional mangrove rice varieties.

Senegal

The Djibelor research station in the Casamance region is actively engaged in mangrove swamp rice research and is therefore one of the strongest programme in the region. In collaboration with national scientists, F_2 and F_3 generation materials from Rokupr have been evaluated for salt tolerance under Djibelor conditions. A collection of Senegalese rice varieties is being made available to the Rokupr project for salinity tolerance testing.

Nigeria

The area of mangrove swamp rice currently grown in Nigeria is small. Considerable interest has been expressed in expanding the area but this is still at the very early planning stage. The project liaises with two organisations, National Cereals Research Institute (NCRI) and the University of Port Harcourt with particular interest in mangrove swamp rice research and development. A number of promising varieties have been conducted in Warri mangrove swamp.

TRANSFER OF TECHNOLOGY TO FARMERS

The ultimate measure of the success of the project lies in the extent of adoption of its improved materials and mmethods by farmers. Although responsibility for transfer lies with the national extension authorities, it is incumbent on the project to do its utmost to ensure that farmers with whom it comes directly in contact and relevant research,

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extension and development agencies are fully aware of available improved varieties and cultural practices.

Direct contact with farmers: Through on-farm trials, farmers field days, socio-economic survey activities and adaptive trials the project has come in contact with a large number of farmers. This has mainly been in the Scarcies region of Sierra Leone but particularly due to survey work and adaptive trials it is rapidly spreading to other areas - namely. Guinea, Guinea-Bissau and The Gambia. The following section deals almost wholly with direct farmer contact in Sierra Leone.

Over the past six years, trials of promising varieties have been carried out on farmers' fields under simulated farmers' conditions. Rok 5 has been shown in these trials and other on station trials to be superior in yield to the best local varieties by a margin of about 25 percent; in saline areas its yield advantage has been greater - approximately 45 percent - due to Rok 5's slightly shorter duration allowing it to escape salt damage better than local varieties. Farmers in areas close to the sea who have seen Rok 5 have shown much interest in it, particularly because of its earliness. Several bushels lots of Rok 5 have therefore been made available on an exchange basis to a number of co-operating farmers along the Scarcies River. This has generated considerable demand for Rok 5 which the project has been unable to meet fully. Small quantities of Rok 5 continue to be exchanged each year, however. In 1983, approximately 60 new farmers have been given Rok 5 to bring the total involved to approximately 120 farmers, mainly in the village of Kibanka, Moribaia and Tongbaia. The socio-economic survey and on-farm trials conducted in Guinea in 1982 have also led to farmer interest in Rok 5, particularly in the Sonfonia area, and small quantities have also been exchanged with farmers there.

Project research activities have shown that the use of single axle tractor in the mangrove swamp reduces labour,

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controls weeds and increases yields. By use of power tillers, on project trial sites, their usefulness has been demonstrated to farmers along the Scarcies and considerable demand stimulated. In 1981, to try in part to meet this demand and to test further the capabilities of power tillers under farmers conditions the project provided two power tillers operated by trained operators to work for farmers on a limited scale in the eight villages who participated in the WARDA socio-economic survey and four other cooperating villages. In 1982, approximately 0.4 ha each was ploughd for 44 farmers in 14 villages. The farmers involved in this scheme in 1982 paid the full estimated economic cost of using the tiller.

In 1983, three experimental farmers' associations to own and operate a tiller have been set up in three villages in the Scarcies area. Each group comprises approximately 30 farmers with land holding of approximately 40 ha. Credit to purchase the tillers has been arranged by the special project and will be repaid over four years. By monitoring the working of these associations, it is hoped to identify a viable mechanism for tiller ownership and operation which can be recommended to interested development projects.

The importance of nitrogen fertilizer and the injection application technique for its efficient utilization have been demonstrated to farmers. Each year, a limited number of farmers are assisted to obtain fertilizers and are educated in the use of the injection technique.

Contact with research, extension and development agencies :

National extension services in the mangrove areas are generally weak. However, several development projects are now active or about to become active in predominantly mangrove swamp areas and the project has attempted to contact them to provide the vehicle for transfer of new technology to the farmers.

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In Sierra Leone, the Kambia Integrated Agricultural Development Project has just been established, and has heavily on project findings in mapping out its work programme.

In The Gambia, the FFHC is engaged in developing a saline associated swamp area at Beretto (250 ha) and on abondoned tidal mangrove swamp at Bureng (400 ha). This project is at present evaluating varieties and fertilizer practices recommended by Rokupr with the aim of identifying practices which can be passed on to the farmer. The results of fertilizer trials at Beretto have been particularly interesting.

In Guinea, the ONADER station at Koba is similarly evaluating materials and cultural practices developed by Rokupr.

In Senegal, SOMIVAC is engaged in development of mangrove areas. Contact between SOMIVAC and Rokupr has been fairly limited so far but it is hoped to develop closer collaboration in future.

In 1983, adaptive trials of Rokupr-developed technology will be initiated in Guinea and The Gambia and a socio-economic survey started in Guinea-Bissau. This will bring the project in direct contact with farmers in these areas and assist in identification of problem there. The results of the adaptive trials will also identify promising technology which can be recommended to national extension and development authorities.

RELATIONSHIP WITH INTERNATIONAL CENTRES

Both IRRI and IITA have assisted in the training of staff members of the Rokupr project. H.M. Bernard and M.P. Jones attended six-month Rice Production training courses at IRRI followed by six-month specialist training in Weed Science and Plant Breeding respectively. C.A. Dixon, S.N. Fomba and S.J. Fannah were trained at IITA for six-months in research methodologies in soil science, plant pathology and entomology respectively.

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IRRI has been and continues to be the main source of new varieties tested by the project. These are supplied through IRTP nurseries and screening sets and direct requests to the Germplasm Bank for varieties with specific characteristics. IITA has also supplied materials for screening.

Traditional mangrove swmp rice varieties collected by the Rokupr project have been transmitted to IITA and IRRI for long term conservation. The first nominations of varieties for IRTP screening sets for saline conditions have been made in 1983.

RELATIONSHIPS WITH SPECIAL RESEARCH PROJECTS

A collaborative project on azolla is being run with the Richard-Toll project to attempt to develop the use of azolla as an alternative source of nitrogen fertilizer. Work conducted at Rokupr over the past two years has involved collection of native strains of azolla and comparison of their growth rates with those of imported strains. Various methods of production and preservation of azolla during the dry season have been investigated and the effect of azolla as a source of nitrogen in lowland rice evaluated.

Salt tolerant local rice varieties identified in salinity screening at Rokupr have been sent to Richard-Toll, which shares an interest in salinity tolerance under irrigated conditions for further testing.

Tall statured, thick stemmed, photoperiod sensitive selections from the Rokupr hybridization programme are being forwarded to the Mopti project for screening for adaptation to deep water conditions.

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RELATIONSHIP WITH SUB-REGIONAL CO-ORDINATORS

The bulk of the project's work is concentrated in The Gambia, Senegal and Guinea-Bissau and in Guinea and Sierra Leone. Thus contact is greatest with the Sub-regional Co-ordinators in Zones I and II. The Sub-regional Co-ordinators assist the project in making initial contacts with the national research and extension organisations and with development projects involved with mangrove swamp rice. They are involved with transmission of materials and messages between the project and national programmes and vice versa and are active in follow-up of project activities in their zones.

TRANSFER OF TECHNOLOGY

The research area for the socio-economic study in Sierra Leone is the Great Scarcies region. Eight villages were selected along the river and sample of 13-18 farmers was taken from each village.

In Guinea, the socio-economic study started in July/August 1982, is still in progress and covers two mangrove swamp rice regions, Coyah and Sonfonia. Three villages and a sample of 15-21 farmers were selected in each region.

Initial steps are being taken to start a socio-economic survey in Guinea Bissau.

Some of the preliminary results for the socio-economic study in Sierra Leone are presented below.

Farm size (in number of bushels)

Table 3.7 indicates the distribution of farmers by size.

The average mangrove rice farm size within each area increases as one gets closer to the sea. This might be due to the fact that the farmers upstream tend to have more upland farming activities than nearer to the sea.

The number of bushels nursed to the hectare is estimated at 3-5 bushels, but this is yet to be confirmed by the survey results.

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Table 3.7 : Distribution of farmers by farm size

Enumeration area	# bushels nursed 0.1-5	5.1-10	10-15	Above 15	Total
1	21	15	5	5	46
2	138	101	13	19	271
3	71	49	12	14	146
All villages	230	165	30	38	463

Farming Systems

About 45% of households combined mangrove swamp rice farming with other types such as inland swamp rice, upland rice, or other crops especially cassava and potatoes. About 35% concentrated on mangrove swamp farming only. Thus roughly 80% of the households listed had mangrove swamp rice farms.

The variety mostly grown in the long duration areas (areas 1 and 2) are Zorokent, Bundu, Dambaya and White sorro in that order of importance. Other varieties grown in the long duration area include P'fant, Bluestick, and CP4. In the short/medium duration area (area 3) Minique is predominant followed by Marisa and Mayeni.

Yield on Farmers Farms

A total of 260 yield plots (4m x 4m) were demarcated on 130 farms. The plots were carefully harvested, threshed, winnowed and weighed. All the weighings were standardised at 14% moisture content. Most varieties averaged above 2000kg/hectare. Areas 1,2 and 3 averaged 1808, 2371 and 2589 kg/ha. respectively. ./.

Adaptive trials under the TAT programme were initiated in Sierra Leone in the 1982 cropping season and are expected to run for two seasons. Similar trials are to be initiated in Guinea and Gambia in the 1983 season.

The trials in Sierra Leone (40 in all), were conducted in five zones covering the whole of the Great Scarcies Mangrove Swamp rice growing area from the mouth of the river close to the sea to the tidal limit, 23 miles inland. Each zone comprised three villages with eight trials per zone conducted by one Field Assistant. The first and second zones covered the short duration areas i.e. areas with free periods not exceeding 3-4 months. The remaining three zones covered the long duration areas i.e. areas with salt-free periods of 6 months and above.

The trials were conducted on plots 4000m2 in area divided into equal plots of 2000m2. These large plots were intended to create visual impact of the technological package on the farming community. On one plot was tested the improved package while the farmers' traditional practice was tested on the other.

The type of trials and results are presented in Table 3.8

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Table 3.8

Types of Trial - Grain Yields of Improved Variety Vs Traditional Variety

Location	Ecology	VARIETIES: Improved	VARIETIES: Traditional	YIELD IN kg/ha: Improved	YIELD IN kg/ha: Traditional	% increased improved over traditional
Moribaia	P.M.S.**	ROK 5	"ROK 5*"	1300	515	152
Moribaia	P.M.S.	ROK 5	Minique	1000	1325	-32
Balancera	A.M.S.***	ROK 5	Minique	1622	284	471
Balancera	P.M.S.	ROK 5	Maseray	1751	656	166
Katema	P.M.S.	CP4	Pa Fant	951	1419	-49
Katema	A.M.S.	CP4	Pa Sorro	910	690	32
Katema	A.M.S.	CP4	Pa Fatumalike	1384	934	48
Rosinor	P.M.S.	CP4	Gbantoke	1360	638	-22
Rosinor	A.M.S.	CP4	Blue stick	715	1115	-56
Robat	P.M.S.	CP4	Pa Panel	1466	1330	10
Robat	P.M.S.	CP4	Pa Panel	1181	1357	-15

* "ROK 5" Contaminated ROK 5

** P.M.S. - Pure Mangrove Swamp

*** A.M.S. - Associated Mangrove Swamp

ROK 5, in 3 out of 4 trials conducted in both ecologies of the short duration areas of Moribaia and Balensera out yielded the traditional varieties.

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In the case of CP4 in the long duration area, there were decreases in yield of 4 out of 7 trials. This could be attributed to the low spikelet fertility of the variety coupled with iron toxicity problems to which the traditional varieties show greater tolerance.

Table 3.9 shows the performance of ROK 5 and CP4 under mechanical land preparation as compared to the traditional varieties under manual land preparation . The results more or less confirm research findings that increase in yield due to mechanical land preparation alone is in the region of 10%.

Table 3.9 - Grain Yields of Improved Variety + Mechanical Ploughing vs Traditional Variety + Manual Ploughing

Location	Ecology	VARIETIES: Improved	VARIETIES: Traditional	YIELD IN: Improved	YIELD IN: Traditional	% Increased of Improved over Traditional
Moribaia	A.M.S.	ROK 5	"ROK 5"	300	274	9
Moribaia	P.M.S.	ROK 5	Pa Lamina	1863	1738	7
Balensera	A.M.S.	ROK 5	Minique	1779	2437	-37
Balensera	A.M.S.	ROK 5	Minique	2922	1843	58
Katema	P.M.S.	CP4	Black Soro	828	731	13
Rosinor	A.M.S.	CP4	Bundu	2022	1894	7
Rosinor	A.M.S.	CP4	Best rice	1940	1797	8
Robat	A.M.S.	CP4	Bundu	1992	1839	8
Robat	P.M.S.	CP4	Pa Brima	1695	2230	-30

The trials with Improved varieties plus fertilizer by injection compared with traditional varieties under no fertilization showed yield increase of the former over the latter with a range from 31% 87% in 9 out of 10 trials (Table 3.10). The exception was due to high weed infestation and iron toxicity problems.

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Table 3.10 - Grain Yields of Improved Variety + Fertilizer Injection vs Traditional Variety + No Fertilizer

Location	Ecology	VARIETIES: Improved	VARIETIES: Traditonal	YIELD IN kg/ha: Improved	YIELD IN kg/ha: Traditional	% Increase Improved over Traditional
Moribaia	P.M.S.	ROK 5	Minique	2688	1813	48
Moribaia	P.M.S.	ROK 5	Minique	1350	895	51
Balansera	P.M.S.	ROK 5	Minique	2149	1627	32
Balensera	P.M.S.	ROK 5	Minique	2741	1964	39
Katema	A.M.S.	CP4	Pa Kamara	1779	1099	62
Katema	A.M.S.	CP4	Pa Fant	1985	1510	31
Rosinor	P.M.S.	CP4	Blue Stick	3901	2686	45
Rosinor	A.M.S.	CP4	Bundu	3408	2311	47
Robat	A.M.S.	CP4	White Soro	1954	2176	-11
Robat	P.M.S.	CP4	Red Soro	2389	1274	87

Results of the complete package trials in Table 3.11 showed yield increase in 7 out of 10 cases. However it is necessary to determine the economic viability of the package before drawing conclusion.

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Table 3.11 - Grain Yield of Improved Variety + Mechanical Ploughing + Fert. Injection vs Traditional Variety Manual Ploughing + No Fertilizer

Location	Ecology	VARIETIES Improved	VARIETIES Traditional	YIELD IN kg/ha Imrpoved	YIELD IN kg/ha Traditional	% Increa-
Moribaia	P.M.S.	ROK 5	Bathurst	3163	1644	92
Moribaia	A.M.S.	ROK 5	Pa Nylon	418	1475	-252
Balensera	P.M.S.	ROK 5	Pa Korima	4030	2668	51
Balensera	P.M.S.	ROK 5	Minique	3530	2391	41
Katema	A.M.S.	CP4	Pa Sorie Sanko	2613	1125	132
Katema	P.M.S.	CP4	Pa Fant	1648	1120	47
Rosinor	P.M.S.	CP4	White Soro	2688	1528	76
Rosinor	A.M.S.	CP4	Kamsar	2439	1037	135
Robat	A.M.S.	CP4	White Soro	2940	2927	0.4
Robat	P.M.S.	CP4	Matis	2127	2184	-3

Post Production Loss Studies

a) Storage Loss Assessment in Farmers' Stores : This study was started in 1981 to determine the losses of rice due to insect damage. Monthly samples were collected from the storage boxes (Kuma) of 38 farmers in the research area and the losses due to insect damage analysed by (a) the count and weight method and (b) the volume and weight method.

The percentage losses increased from 1.65 in April to 3.86 in July for the volume/weight method and from 1.10 to 1.68 during the same period for the count and weight method.

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b) The effect of delayed harvest on yields of mangrove rice :The aim of the study was to measure and compare the effects of delaying the harvest of a selection of mangrove swamp rice varieties beyond maturity.

Nine trials were conducted, using five varieties (ROK 9, Adny 301, CP4, Bundu and Zorro fera). Three were on farmers field and six on seed multiplication plots at the Rice Research Station, Rokupr. Samples were harvested on the day that the crop was estimated to have reached maturity, then after delays of one, two and three weeks.

The yield of ROK 9 remained reasonably constant over the three week harvesting period. Bundu and Zorro ferra showed a relatively gentle decline as did Adny 301 from the second week. CP4 suffered the most and the rate of decline increased markedly after the second week.

c) Threshing Losses : Losses due to the two main alternative methods, foot threshing and stick treshing, are being determined under farmers' conditions.

The field study was preceded by the assessment of the relative "yields" of the two methods per unit time, at the Rice Research Station. Using equal weights of 40 kg of unthreshed paddy and six replications, the results indicated a greater loss of grain in the stick method than with the foot method.

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J. INFRASTRUCTURE :

Laboratories and offices : Two blocks of building (103.0 x 39.0 ft per block) were completed by October 1976. Furniture was all locally made. Present office accommodation is inadequate for the expended activities.

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Stores and fenced-in areas: Size 180 x 80 ft. including Nine stores units, total area 1302 sq. ft., at one side of fenced area. At the oppositie side is a Cold Room, 25 x 18 ft., with four unit stores and a carpenters shed. A Rice drying floor (80 x 30 ft.,), greehouse (543 sq. ft.,) and screenhouse (547 sq. ft.,) are also within the fenced area. All project cars are parked within the area at night and it is also used to conduct bucket (pot) experiments without fear of theft or distrubance by goats and sheep.

Senior staff quarters: Seven 3-bedroomed houses have been built and furnished.

Guest House: Under construction.
Equipment store: (20x 30ft.,)

All building work within the project has been done by local artisans and labour under immediate supervision of station personnel and overall supervision of project staff.

Laboratory equipment: The laboratories - Breeding, Entomology, Weed Science, Pathology and Soil Science keep a wide range of equipment - for example, moisture meters knapsack sprayers, ovens, pH meters, thermometers etc.

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Transport:

Vehicles - long-wheel-base Land Rover
Peugeot 504 Familial
Long-wheel-base Land Rover
Peugeot 404 Pick-up
Peugeot 504 Pick-up
Peugeot 504 Familial

Outboard Motors: Johnson 6hp
Johnson 20 hp
Yamaha 20 hp
(2) Mercury 20 hp
Boats- (3) Wooden boats (8 seater)
(2) Aluminium (4-5 seater)
(1) Fibreglass (3-4 seater)

Electrical generator - A generator (75 KVA Morrison) has been supplied to the Sierra Leone Electricity Corporation for use in the Rokupr power house.

Agricultural equipment (2) Honda Water Pumps
(5) Honda Tiller F800

FUNDING:

The mangrove swamp rice project is supported by several donors. The United States Agency for International Development contributes the bulk of funds for development and capital equipment as weel as the work in Entomology, Pathology, Weed Science . Administration and the newly established Extension Liaison Function.

The Consultative Group for International Agriculture Research supports the position of the Team Leader.

The Overseas Development Administration of the United Kingdom finances the current cost of Varietal Improvement and Soil Sciences as weel as providing capital equipment for these disciplines. ./.

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The European Economic Community funded the Agricultural Economics programme up to October 1982.

The Government of Sierra Leone, contributes in kind with some housing, security and land for experiments.

The member states of WARDA, through the Special Fund, contributes to specific capital items required by the project.

The Azolla work is supported by Government of Belgium.

Table 3.12 gives list of donors by project activities since 1976 and proposals to 1985

RESEARCH PROGRAMMES - 1983 - 1988

Table 3.27 shows the list of donors and project activities since 1976 and proposals to 1985.

The research approach will continue to be multidisciplinary as before but greater emphasis will be placed on regional activities i.e. in Guinea, Guinea Bissau . The Gambia, Nigeria and Senegal. Thus, collaborative work with national mangrove swamps programmes, training of young scientist/technicians in research methodologies and direct involvement with extension and rural development agencies will be stressed in the hope of speeding up the transfer of improved techniques to farmers. Table 3.13 shows the overall future plan of work.

For simplicity, each research discipline is discussed separately.

VARIETAL IMPROVEMENT

The main theme of the programme will remain unchanged with introduction of varieties, collection and evaluation of local varieties and hybridization continuing to play major roles.

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Varietal Introduction: Emphasis will be on identification of shorter duration varieties (110-130 days) and salt tolerance for non-tidal mangrove areas in the north of the region with low rainfall and short growing season.

Collection of local cvarieties from southern Senegal and strengthening of existing collections from Guinea and Guinea Bissau. Study of local germplasm for pureline selections and hybridization will be initiated. Characterization of new accessions will continue.

Efforts to select improved long duration varieties of intermediate height (120-130cm) for tidal mangrove swamp areas with shallow tides and for increased fertilizer responsiveness will continue. Great stress will be placed on breeding short duration varieties with tolerance to blast, iron toxicity and acid soil conditions.

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Table 3.12

List of donors by project activities and projections

Donor and Activities	Years									
	76	77	78	79	80	81	82	83	84	85
Overseas Development Adm. (UK)										
Project Manager	X	X	X	X	X	X				
Varietal Improvement	X	X	X	X	X	X	X	X	X	X
Soils/Agronomy	X	X	X	X	X	X	X	X	X	X
Training					X	X		X		
Capital equip. & Transport	X			X						
USAID										
Entomology, Pathology, Weed Sc.	X	X	X	X	X	X	X	X	X	X
Administration	X	X	X	X	X	X	X	X	X	X
Capital Equip. & Transport	X	X	X	X	X	X	X	X	X	X
Infrastructure	X	X					X	X		
Training							X	X		
Technology Assessment and Transfer							X	X	X	X
Government of Sierra Leone										
Experimental land, houses and security	X	X	X	X	X	X	X	X	X	X
EEC										
Socio-economic & post harvest surveys					X	X				
Belgium Government										
Azolla					X	X				
Italian Government/UNDP										
Mechanization							X	X	X	
C.G.I.A.R.										
Project Manager						X	X	X	X	X
WARDA Special Fund										
Transport and infrastructure					X	X	X			

x - existing or confirmed support.

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Exchange of segregating materials with co-workers in the region will be increased. The bhybridization programme will be supplemented through special arrangement with IRRI and other centres.

ENTOMOLOGY

Work programme in entomology aims at identifying major pests in mangrove swamp, evaluating their economic importance and developing an integrated programme of control. A start has been made in Sierra Leone and this will be continued over the next five years in WARDA member countries with mangrove swamp ecology. The research efforts to be undertaken will include:

1. Surveys of insect pests, distribution, and identification of major pests in the different ecosystems of the mangrove swamp.
2. Studies of population changes of major mangrove swamp rice pests to determine major biotic and abiotic mortality factors regulating pest abundance in farmers field .
3. Crop loss assessments and establishment of economic thresholds of the different major pests in farmers field.
4. Development of practical, cultural and chemical pest control methods will be continued in Sierra Leone and promising techniques and chemicals will be tested as widely as possible in the region.
5. Attemps will be made in collaboration with breeders to develop screening techniques for tolerance to major pests.
6. Formulate, demonstrate and evaluate on farmers' fields prototype integrated pest management systems that farmers can understand and implement themselves.

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on Crabs will include:

(i) Studies of the distribution and seasonal abundance of crabs in tidal mangrove swamps in member countries either than Sierra Leone;

(ii) Assessment of crop losses caused by crab in member countries;

(iii) Screening for varieties tolerant to crab damage at Rokupr and

(iv) Development of control systems.

Disease surveys will be extended to other mangrove swamp rice areas of WARDA member countries.

Screening of varieties for their tolerance to major diseases will be continued.

Ecological and biological studies of blast and brown spot will be a subject of a special study.

Chemical and cultural control methods will be investigated and attempts made to develop integrated management systems for suppressing rice diseases.

WEED SCIENCE

As has already been done for Sierra Leone the occurrance of and distribution of weeds in the tidal and associated mangrove swamps of the other WARDA member countries will be studied and their economic importance determined.

Herbicide screening will continue at Rokupr and further testing will be carried out in member countries.

Studies of biology of the weed, Paspalun vaginatum will be initiated.

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Work to-date indicates that mechanical cultivation of the swamp achieves good control of Paspalum vaginatum, the dominant and most noxious weed. Future work will concentrate on the supplementation of mechanical cultivation with chemical control for more efficient weed suppression in associated swamps.

Studies on the effect of canopy development on weed suppression and on weeds as alternate hosts of pest and diseases will be initiated in collaboration with the other appropriate disciplines.

Studies of the long term effects of controlling weeds on yields, and composition of the weed flora will be carried out. Similarly studies of the effects of mechanical cultivation and removal of kire kire on soil fertility and structure will be conducted in collaboration with the Soil Science section.

Stree will be placed on rapid development of integrated weed management through an appropriate combination of control methods suitable and economical to small farmer.

SOIL SCIENCE

Over the next five years, the Project will help the member countries, where necessary, to determine salinity and acidity levels and nutrient toxicities and deficiencies of their mangrove swamps and develop corrective measures that will increase yield per unit area.

Further tests of the injection technique and other methods of applying nitrogen will continue and the efficiency of slow release forms of nitrogen suitable for bradcast will be evaluated. The effects of different phosphatic fertilizers on the growth and grain yield of rice in different parts of the region will also be assessed.

The long term effects of mechanical cultivation on soil fertility and structure will monitored in collaboration

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with the weed scientist.

In collaboration with WARDA Project at Richard Toll, Senegal investigations will continue into the adaptability and use of azolla as an alternate source of N in rice culture.

A chemistry laboratory equipped to conduct soil and plant analyses and to monitor fluctuations in the seasonal cycle of build up and clearance of salt from mangrove swamp soils will be established.

AGRIC. ECONOMICS

Socio-economic studies, adaptive trials and post production studies undertaken or going in the Scarcies region of Sierra Leone will continued. Similar work started in Guinea will also continue and to be extended to other member countries.

A pilot study of Group Ownership of Capital equipment will be undertaken. The operational activities of the groups will be monitored to determine the economic and social feasibility of the use of power tillers.

In collaboration with all the disciplines in the Project the section will be evaluating the detailed economics of technology packages developed. In addition the impact of technological packages transferred to the farmers will be monitored.

MECHANISATION

A new section is being established to carry out investigations and research into appropriate mechanization of rice on small farms in the mangrove swamps and valley bottom. It will also provide training facilities for development of rice mechanization in mangrove swamps.

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Table 3.13 : Future activities

	1983 1984	1984 1985	1985 1986	1986 1987	1987 1988
Varietal Improvement	X	X	X	X	X
Introduction of exotic varieties	X	X	X	X	X
Collection and characterization	X	X	X	X	X
Hybridization and selection	X	X	X	X	X
International Rice Testing	X	X	X	X	X
Entomology					
Pest survey, identification and distribution of pests	X	X	X	X	X
Yield loss and threshold assessment	X	X	X	X	X
Insect pest ecology	X	X	X	X	X
Varietal resistance	X	X	X	X	X
Cultural and chemical control	X	X	X	X	X
Development and implementation	X	X	X	X	X
of integrated control		X	X	X	X
Crab studies	X	X	X		
International Rice Testing	X	X	X	X	X
Pathology					
Disease surveys	X	X	X		
Screening varieties	X	X	X	X	X
Horizontal resistance studies of blast and brown spot	X	X	X	X	X
Chemical - cultural control	X	X	X	X	X
Development of integrated control system		X	X	X	X
International Rice Testing	X	X	X	X	X
Weed Science					
Surveys of weeds distribution	X	X	X		
Biology of weeds -e.g. P.vaginatum	X	X			
Crop loss studies	X	X	X		
Cultural and chemical control	X	X	X	X	X
Development and implementation of integrated weed management	X	X	X	X	X

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	1983 1984	1984 1985	1985 1986	1986 1987	1987 1988
Soil Science					
Identification of soil problem	X	X	X		
Monitoring salt and water regime	X	X	X	X	
Nitrogen response and application	X	X	X	X	X
Response to other nutrients	X	X	X	X	X
Azolla as alternate source of nitrogen	X	X	X		
Water control studies	X	X	X	X	X
Chemistry lab.activities	X	X	X	X	X
International Rice Testing	X	X	X	X	X
Agric. Economics					
Socio-economic studies	X	X	X	X	
Post production studies	X	X	X		
Ownership capital equipment	X	X			
Evaluation of developing technology	X	X	X	X	X
Adaptive trials	X	X	X	X	X
Monitoring impact of tech. package		X	X	X	X
Mechanization					
Appropriateness of mechanization in mangrove	X	X			
Training in mechanization	X	X	X		

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F ture requirements

The mangrove swamp rice project at Rokupr has been operational for about six years. During this period, the basic infrastructure necessary for the project to function has been established at Rokupr where most work has been done.

Owing to the diversity in the ecosystems of the mangrove swamp, there is a need to develop different pachages suitable for the different swamp conditions. Thus, in order to implement the proposed programme on regional bases, the project will need further financial, technical and infrastructural support.

ROKUPR (SIERRA LEONE)

Office accommodation/staff houses: The activities of the project have increased considerably since the original pla. The present office and laboratories are crowded and the soil Science section is still without proper accommodation because the original laboratory has not yet been completed. The addition of Agricultural Economics section in 1980 and enlargement of its Extension liaison activities in 1982 combined with the proposed Mechanisation unit will make office extension inevitable. Also with the increase in the regional activities proposed for the next five years, the staff at Rokupr will have to be increased and this will require additional office space and staff houses.

Chemistry laboratory: The project requires analytical facilities for :

- Routine plant analysis of a range of nutrients
- Routine water analysis
- Simple soil physical measurements

The shell of the laboratory building already exists but it requires :

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- Completion of internal fittings
- Purchase of laboratory equipment and chemicals
- An experienced Senior Laboratory Technician to set up and run routine analyses.

Senegal (Casamance), The Gambia (Jenoi), Guinea Bissau Region

From the previous experience of the project, pre-extension/package trials conducted in this region have met with little success mainly due to lack of effective co-operation and supervision from the national scientists. The limited number of trained technicians and the Project's inability to pay for supervisory work done have also contributed. Co-ordinated Varietal Trials, IETs and on-farm trials funded from WARDA Headquarter in the region have, however, succeeded.

The area has diverse mangrove swamp conditions which differ markedle from those around Rokupr particularly in the low rainfall and highly salty nature of the soils. Experimental results obtained at Rokupr therefore need to be tested thoroughly in this area where mangrove swamp rice production is of high priority.

It is proposed that two scientists, an agronomist and agricultural economist should be stationed at Djibelor. They should be assisted by four Field technicians who will be stationed two in Guinea-Bissau, one in Casamance and the other in The Gambia. This team, in collaboration with scientists at Rokupr, will be responsible for basic data collection, and implementation of pre-extension activities for all disciplines, socio-economic studies and adaptive trials for the mangrova swamp rice programme.

Guinea

Q In Guinea the constraints of the mangrove swamp rice farmer include low yielding varieties, salinity, fertility and pest problem. Research efforts in the country are limited.

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Since Guinea is near to Rokupr (Sierra Leone), the Project scientists will be able to travel frequently to trial sites to conduct /supervise experiments. However, it is proposed that two field Technicians be stationed at Sonfonia/Koba and Koba Districts to assist with the programme of activities.

Nigeria

Of late Nigeria has shown interest in utilising the potentials of 800,000 ha of the mangrove swamp ecology for rice production,. However, only about 5000 ha of the swamps are currently under cultivation. Initial research programme may include:
Reclamation of mangrove swamps
Monitoring of salt level to determine salt free periods
Trials for appropriate varieties

For the time being, project scients will limit themselves to liaison and collaboration with the interested Nigeria Institutions e.g. NCRI, River Basin Authorities, with regular visits and the possibility of longer visits for as long as 3 - 4 months, where necessary, to help solve specific problems.

CHAPTER FOUR

SPECIAL RESEARCH PROJECT - DEEP WATER AND FLOATING RICE

MOPTI, MALI

Staff

S. Koli, Ph.D.	- Agronomist and Acting Head
D. Guindo, B.Sc	- Research Assistant - Entomology
F.J. Bangura, Ph.D	- Breeder
G.C. Nyoka, Ph.D.	- Weed Scientist
M. Goïta, M.Sc	- Assistant Breeder
A. Diarra, M. Sc.	- Assistant Weed Scientist
A. Touré, Ing. Agronome	- Assistant-Agronomist
A. Dembélé, Ing.Agronome (Dev. Department)	- Extension Officer

Posthumous

Late Charles Dembélé BSc.	- Research Assistant - Entomology (1975 - 1980)

BACKGROUND

The first deep water and floating rice research station in Mali was established in 1952 by the French as a subsidiary of a parent rice research station at Kankan, Guinea. The Station in Mali was sited at Ibetimi, a village 8 kilometres north of Mopti on the opposite bank of River Niger. Work was concentrated mainly on selection of improved local glaberrima varieties and new introductions from Guinea. In 1962, the Ibetemi Station was formally taken over by IRAT, the Tropical Agronomic Research Institute of France. For the ensuing fifteen years, IRAT worked on improvement of introduced sativa varieties from Asia, made crosses and experimented with improved cultural practices. However, it was soon found out that Ibetemi was not an ideal location mainly because of its relatively high elevation and improperly designed experimental polders and that Mopti was a more suitable location.

In 1972, the WARDA Governing Council approved of Mopti as site for development as the regional research station for deep-water and floating rice. By 1976, IRAT had pulled out of Ibetemi in favour of WARDA. Infrastructural development in Mopti was started and by 1977 Research Assistants seconded by the Malian Government to WARDA were at post. In July 1979, a Deputy Director was appointed. Major infrastructural development were completed by September, 1979, and thus, the Station was formally inaugurated on September 15, 1979.

The main objective of the deep water floating rice project is to solve problems limiting rice production in that ecology. Table 4.1 shows the area under deep water/floating rice in West Africa.

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The ecology accounts for about 16% of total rice area in the region.

Table 4.1 : Areas under Deep Water (Floating Rice in the WARDA Region - 1982 in hectares

Country	Area	% of National Rice Area
Benin	2,200	20
Gambia	1,000	3
Guinea	150,920	28
Mali	161,000	69
Niger	16,341	78
Nigeria	105,000	16
Senegal	2,000	3
Sierra Leone	6,000	2
Togo	6,250	23

PRODUCTION CONSTRAINTS

1. Niger river valley:

-uneven rainfall distribution, drought and water stress at the beginning of the cropping season

- poor plant stand per unit area due to inadequate land preparation
- unpredictable arrival of flood water and depth of flooding and short flooding period (1 to 2 months)
- lack of yield response to fertilizer application

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- heavy weed infestation
- disease (leaf blast before the arrival of flood water), and at some locations bacterial leaf blight and insect pest (stem borer) infestation
- lack of high yielding varieties
- lack of incentive due to uncertainty
- losses at harvest

2. High rainfall areas (boli land and riverain grassland):

- great variation in texture and native fertility of soil (poor in N, P and Zn)
- flush flooding of varying depth
- excessive weed infestation
- inadequate seed bed preparation, dry seeding and poor stand of crop
- disease and pest damage
- losses at harvest
- lack of high yielding varieties, seed supply and effective extension services.

STRATEGY

The Mopti Station is located in the middle of the inland delta at the estuary and confluence of Rivers Niger and Bani where there are vast flood plains and majority of farmers cultivate deep water and floating rice. The Government of Mali also has rice development projects (Operation Rice Mopti and Operation Rice Seed Multiplication) very close to the Station. These coupled with the experience gained from the Ibetemi Station make the WARDA Special Research Project in Mopti strategically and geopolitically located as a regional research centre on deep-water and floating rice.

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The major objective is to find solutions to the production constraints listed above. These solutions include the introduction and selection of high yielding varieties and development of improved cultural practices.

To meet the objective, five disciplines of research have been set up. These are varietal improvement, agronomy, weed control, entomology and technology assessment and transfer.

RESEARCH PRIORITIES

The research priorities for the various disciplines are as follows :

Varietal Improvement

- Screening of varieties collected from West Africa and other parts of the World, particularly Asia, for drought and submergence tolerance and resistance to insect pests and diseases. Growth duration and other major agronomic characters are important selection criteria.

- Evaluation of Yield Potentials under Different Depths.

- Multilocation Yield Trials.

- Hybridization : promising deep water and floating rice varieties are being crossed with high yielding varieties.

- Germplasm Collection

Agronomy

- Land Preparation : The objective is to compare the effectiveness of the available tillage implements, i.e. native hand hoe, animal drawn plough and the reversible tractor

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plough in seed bed preparation. Their effectiveness will be compared in terms of the enhancement of good seed germination, reducing weed infestation and yield increase.

- Cultural Practices : Studies are conducted on optimum seeding date, methods of sowing variety and spacing interaction, time and depth of ploughing.

- Fertilizer Management: There is need to find solutions to problems of N-P application and availability; fertilizer rates and profitability, and also the suitability of different sources of nitrogen.

Weed control

- Weed Identification : The identification of problem weeds in the various countries where deep water and floating rice is grown and the search for methods of their control. At the moment efforts are being concentrated on the control of the wild rices.

- Cultural Practices : A joint study will be undertaken with the Agronomist, on cultural methods of weed control. This will include the evaluation of useful farming operations such as row sowing, plant density, and minimum or zero tillage.

- Herbicide screening and testing of application devices.

Entomology

- Insect Identification.

- Insect Population : Studies of the population dynamics of the rice stemborer.

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- Varietal Screening for insect resistance.

- Cultural Practices in Relation to Insect Pests: In collaboration with the Agronomy and Weed Control Divisions to study the effect of different cultural practices on the build-up of insect pest.

- Estimation of yield losses due to insect pests.

- Insecticide Screening.

- Farmers' field trial to determine profitability of insecticide application

Technology Transfer

- Carrying out the on-farm trials in collaboration with national extension agencies to transfer research results to farmers.

SUMMARY OF RESULTS 1978-82

Varietal Improvement

Work started in 1977 with the arrival of the Research Assistants towards the end of the previous season. The following variety improvement scheme has been adopted.

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DEEP-WATER RICE (DWR) IMPROVEMENT SCHEME - MOPTI

INTRODUCTION OF HYBRID

HYBRIDIZATION	AFRICAN DWR GERMPLASM	INTRODUCTION OF FIXED BREEDING LINES
		a) IET b) IRDWON
INTRODUCTION OF HYBRID PROGENIES	PURE LINE SELECTION	c) Materials from Bangladesh, India and Thailand
PROGENY SELECTION		
IDENTIFICATION OF SUPERIOR STRAINS		IDENTIFICATION OF SUPERIOR STRAINS

Observational Trials

Preliminary Yield Trials

WARDA Coordinated Trials

Multilocational (Mali and other Countries)

Advanced Yield Trials in Farmers' Fields

PRODUCTION AND SUPPLY

OF BREEDER SEED

RELEASE OF VARIETY

BY NATIONAL PROGRAMME

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In 1978, an observational trial was carried out with materials introduced from South-cast Asia. DA 29 was elected for comparative trials.

The results of the shallow and medium zone trials in 1979 showed that the BKN varieties could produce higher yields under shallow water conditions than existing varieties. The introduced Thai varieties, BKN 6986-38-1 and DKN 6323 were promising for shallow and medium zones respectively. The variety DA 29 from Bangladesh was promising for shallow zone while DM16 was promising for beth shallow and medium zones. The results of 1980 at all water levels confirmed those of 1979 with BKN 6986-38-1 giving the highest yields in the shallow zone compared to the check variety D52-37. Yields of the varieties BKN 7022-6-4, BKN 6986-105-P and BKN 7022-1-4 also seemed promising.

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TABLE 4.1.: GRAIN YIELDS OF DEEP-WATER/FLOATING VARIETIES UNDER VARIOUS WATER REGIMES

(1978 - 1981)

VARIETIES	GRAIN YIELD KG/HA												2-3 Yrs.Average		
	1978			1979			1980			1981					
	Shallow Zone	Medium Zone	Deep Zone	Shallow Zone	Medium Zone	Deep Zone	Shallow Zone	Medium Zone	Deep Zone	Shallow Zone	Medium Zone	Deep Zone	Shallow	Medium	Deep Zone
1.BKN 6986-38-1	-	-	2522	4217	-	-	4524	3494	-	2215	1855	-	3652	2675	2522
2.D52-37	-	-	-	4059	-	-	3339	2777	-	2301	2089	-	3233	2433	-
3.DA 29	-	-	1890	3852	2697	N.R	3591	3668	-	2232	2482	-	3225	2949	1890
4.BKN 7022-6-4	-	-	1555	3755	-	-	4373	3687	-	2099	2571	-	3409	3129	1555
5.DM 16	-	-	2079	3755	3263	N.R	3894	3403	3051	2504	2806	3044	3384	3157	2725
6.DM 17	-	-	-	3754	-	-	4265	3137	-	2378	2572	-	3466	2856	-
7.BM2	-	-	-	3677	-	-	3954	3286	-	2476	2952	-	3369	3119	-
8.BKN 6986-105-P	-	-	2203	3632	-	-	4774	4396	-	2931	2568	-	3779	3482	2203
9.T442-36	-	-	-	3625	-	-	4070	3778	-	2367	3299	-	3354	3539	-
10.BKN 7022-10-1-4	-	-	1719	3034	-	-	4298	3548	-	2203	2024	-	3178	2786	1719
11.BKN 6986-81-5	-	-	1734	-	1396	N.R	-	2169	1813	-	2602	1625	-	2056	1724
12.BKN 6986-167	-	-	1694	-	1937	N.R	-	2858	2475	-	2879	1725	-	2558	1965
13.BKN 6986-108-3	-	-	1800	-	1877	N.R	-	2674	2632	-	2669	1794	-	2473	2073
14.Kha Gaew Check	-	-	2032	-	2122	N.R	-	3250	2921	-	3227	2320	-	2533	2424
15.BKN 6323	-	-	-	-	2585	N.R	-	3392	2997	-	3024	2961	-	2970	2979
16.Nang Kiew	-	-	-	-	1933	N.R	-	2836	2664	-	3407	2162	-	2725	2413

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TABLE 4.1.: Continued

17. MSP 11	-	-	-	-	1914	N.R	-	2868	2449	-	2708	1877	-	2497	2163
18. Mali Sawn	-	-	-	-	1548	N.R	-	3208	1934	-	2874	2060	-	2543	1997
19. Cula	-	-	-	-	-	-	-	3301	2980	-	4219	2646	-	3760	2813

In 1981 persistent drought conditions immediately after sowing gave rise to poor germination. As a result, sowing had to be repeated several times in some trials. This seriously affected yields in all zones. In the deep zone trials, the varieties DM 16 and BKN 6323 gave the highest yields while the variety Cula gave the highest yield from the medium zone.

Results obtained from 1978 to 1981 reveal several promising varieties which yield over 3 t/ha. under shallow condition. These varieties are BKN 6986-38-1, BKN 6986-105-P, BKN 7022-6-4, BKN 7022-10-1-4, DA 29, T442-36, DM 16 and DM 17. Under medium zone conditions some varieties, such as BKN 6986-105-P, BKN 6323, BKN 6986-10-1-4, DA 29, Cula and DM 16 gave promising results. DM 16 showed good adaptability to all water levels and gave a better 3-year average yield, compared to Khao Gaew. Other promising varieties are BKN 6323 and Cula.

Table 4.1. shows the summary of the results of trials conducted between 1978 and 1981.

A hybridization programme started in 1977. Since then, the progenies from previous 6 crosses have been studied.

Agronomy :

Animal drawn plough B2 and harrowing (1.5 t/ha) is equally effective in increasing yields as the reversible plough drawn by tractor (1.5 t/ha). Preparing land with the native hand hoe produced lowest yield (0.8 t/ha) and was least effective in reducing weed infestation.

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Perennial wild rice is effectively controlled and rice yields significantly increased when ploughing and harvesting are done either with animal or tractor at the end of harvest and then are planted at the beginning of the sowing season. Ploughing and h rrowing only at the beginning of the sowing season is less effective (1.8t/ha). The former requires less subsequent weeding and hence is more economical than the latter.

Summary of sowing date studies for the past four years revealed the unpredictability of the commencement and distribution of rainfall under Sahelian conditions (see Appendices 4.1 to 4.5). The exact optimum sowing dates will depend upon the particular year taking into account when the precipitation started.

Despite the unpredictability of the commencement and distribution of rainfall it would appear that sowing from second week in July to the second week in August can produce better yields . The July sowing seems to be most suitable for deeper zones which become inundated first.

Experiments in two seasons have shown that there is no significant difference in yields between line, drill and broadcast sowing. However, the drilling produced higher yields as it afforded easy manual weeding.

Spacing experiments, started in 1981, indicated that 20 cm spacing produced highest yield (3.4t/ha) while 30 and 40 cm spacings produced 2.7 and 2.5t/ha respectively.

Experiments were conducted in 1979 at the Station to determine if the residual soil moisture after harvest in January could support any field crop. The crops tested were rice, millet, sorghum, okra, cowpea and Flusine corocana. All the crops germinated within 7 to 10 days. But in February, the soil cracked

badly and by the middle of that month,the crops died due to low soil moisture and prevailing hot, dry wind.

Studies on sources and time of nitrogen application in 1979 and 1980 revealed that there were no significant differences between yields from Ammonium sulphate, Ammonium phosphate and urea; nor were there any differences between a) 60 kg N/ha at 3 weeks after seeding and b) 40 kg N/ha at 3 weeks after seeding and 20 kg N/ha at 2 weeks before flooding. There was no yield response to nitrogen.

Nitrogen phosporus placement studies on clayey soil in 1979 and 1980 showed the following :

(a) there was significant yield response to nitrogen applied as ammonium sulphate.

(b) The effect of phosphorus applied as single super-phosphate was negligible. However, in 1981 and on a sandy soil, the nitrogen response as well as phosphorus response were both non significant.

The fact that soil test showed available phosphorus to be low on that sandy soil and yet there was no significant positive response to the phosphorus fertilizer application, underlines the complex dynamics of chemical nutrient status and reactions under floating rice conditions.

In 1981, in collaboration with IRRI, trials were conducted at two sites to compare the efficiency of urea, sulphur coated urea and urea supergranule under floating rice conditions. There were no significant differences between any of the treatments. Even though at both sites the trial was sown the same week, the average yield at the WARDA Station (clayey soil) was 3.3 t/ha while that of Mopti South (Sandy soil) was 2.0t/ha.

WEED CONTROL

Estimate of Crop loss Due to Weeds: An appraisal of the weed problem in farmers' fields was conducted in 1977 and 1978 in farmers' plots around Mopti. Weeds in general, and wild rice in particular, were the most important constraints in deep water rice production. Studies conducted in farmers' field showed that yield loss due to weeds varied between 9 and 82 %. The mean loss for ten locations was 32 %.

In the survey mentioned above, farmers regarded *Oryza barthii* and *O. longistaminata* as the most troublesome weeds. Other species often mentioned were: *Brachiaria* and *Echinochloa* species. *Oryza glaberrima* was not regarded as a weed, while sedges were unimportant due to their inability to withstand floods.

Systematic weed identification started in 1976 at Mopti. By 1977, 22 species were identified including those mentioned by local farmers (Table 4.2). All specimens are preserved in the herbarium at Mopti.

TABLE 4.2 Weeds of Floating and Deepwater Rice at Mopti Identified betweeb 1976 and 1981.

FAMILY	SPECIES
Gramineae	Brichiaria
	Echinochloa staginata
	Echinochloa lelievrei
	Oryza barthii
	Oryza longistaminata
	Oryza glaberrima
	Oryza stapfii
	Panicum anabaptistum
	Paspalum scrobiculatum
	Sociolepis cymbiandra
	Vossia cuspidata
Cyperaceae	Cyperus sp.
	Heleocharis plantaginaea
	Pycreus sp.
	Scirpus praelongatus
Papilionaceae	Aeschynomene sensitive
	Aechynomene nilotica
	Sesbania sesban
	Alteranthera sessilis
	Sesbania sesban
Amaranthaceae	Alteranthera sessils
	Achyranthes aspera
Euphorbiaceae	Caperonia aptustus
	Caperonia sp.
Sterculiaceae	~~Melochia corchorifolia~~
Tiliaceae	Corchorus fascicularis
Polygonaceae	Polygonum mildbredii
Convolvulaceae	Ipomoea Aquatica
Bymphaeaceae	Mymphaea lotus
Manyanthaceae	Nymboides sp.
Rubiaceae	Borreria filifolia
Lentibulariacaceae	Utricularia stellaris
Minosae	Neptunia oleracea

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During the 1978 growing season, weed identificaton was extended to segou and Gao. The weed flora in these localities are similar to those at Mopti but the dominant species differed.

In 1979, a trip was made to deep water rice areas in Nigeria. The important weeds recorded at Benin Kebbi were: Oryza logistaminata, Sesbania sesban, Melochia, Commelina and Jussiaea spp.

During 1977 and 1978, studies on seed dormancy and viability of important weeds were carried out in order to identify those features that could be used to plan control measures. Results showed that seeds of O.longistaminata had a dormancy period of about two months while those of O. barthii needed only a few weeks of dormancy. Seeds of O. glaberrima and O. stapfii germinated almost immediately after they were harvested. Viability tests revealed that seeds of O.longistaminata. O. barthii and O.stapfii could remain viable for about 12 months after they are shed.

The effect of depth of burial on the germination of wild rice was studied using seeds of O.barthii during the 1978 growing season. It was noted that placing seeds on soil surface or below 7.0 cm in the soil significantly reduced the germination of O.barthii. The best germination percentage was obtained at the depth of 2.5 cm.

During 1978, the growth habits of O.longistaminata, O.barthii, O.glaberrima and O. stapfii were compared with cultivated rices, T442-36 and BH2. It was shown that when placed at an ideal depth,

seeds of the cultivated rices emerged first, followed by O.stapfii, O.glaberrima ,O barthii and O.longistaminata.

Oryzae barthii had the highest number of tillers and shortest days to maturity (Table 4.11). Oryzae longistaminata grew slowly at first but after two months, overtook all other species in height.

A trial was initiated in 1979 and repeated in 1980 to find a better weeding period and frequency. The results indicate that although weeding 35 and 63 days after rice emergence (DARE) produced the highest rice yields there was no significant difference between this treatment and one weeding 35 DARE, one weeding 49 DARE, two weedings 21 and 63 DARE. However, one weeding 21 DARE and one weeding 63 DARE were each significantly inferior to the four treatments above.

A trial was initiated in 1977 and repeated in 1978 to evaluate the effectiveness of ploughing, mowing and glyphosate application in the control of O.longistaminata. The two years results indicate that glyphosate at 2.5 kg./ha or two mowings under water (50-100 cm) or one ploughing just before floods followed by one mowing under water (50-100 cm) could achieve over 90% weed control. Further tests indicated that mid-August is a better time for glyphosate application than at the beginning of August.

Trials on the control of Oryza barthii started in 1978, indicated that rates of less than 1 Kg.a.i./ha of both glyphosate and paraquat could not significantly reduce O. barthii populations. In a subsequent trial using higher rates, it was demonstrated that glyphosate at 1.92 Kg.a.i./ha and paraquat at 1.6 and 2.4 kg a.i./ha resulted in over 70% weed reduction. Velpar 90 at 0.9 and 1.8 kg a.i./ha respectively achieved 80% and 93% weed reduction. Velpar 90 was very toxic resulting in zero rice yields. Zorial was also toxic. Paraquat, glyphosate and MSMA were not toxic to rice. A group of herbicides was tested in 1978-1979. Pre-emergence herbicides appeared less effective than post emergence herbicides.

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ENTOMOLOGY

The most important insects of deep water and floating rice are the stemborers : Chilo zacconius, Maliarpha separatella, and Scirpophaga subumbrosa. Leaf eating insects encountered are: Meterographis convexella. Two parasites, Bracon Sesamiae found on larvae of Chilo zacconius and another Telenomus benefactor, found or egg masses of Scirpophaga subumbrosa, have been identified by CERDAT in Montpellier France.

The Commonwealth Institute of Entomology also identified the following insects for the Station: Segatella nigeriensis Toya tuberculosa, Baletutha eremica and Sterellus sp.

Apart from the above, the Division maintains a large collection of other insects found on the rice field.

Weekly light traps of adult stemborers have shown that Scirpophaga sumbumbrosa, was found in the largest numbers. The populations of maliarpha separatella and Chilo zacconius were lower. For all three insects populations rose sharply from low levels in August to a peak in November then dropped sharply again to low levels in December.

Weekly dissections of rice stems to evaluate the degree of infestation in relation to the population dynamic s of the insects showed that the larvae of Maliarpha separatella was most predominant accounting for about 80% at all observations. Some Chilo sp.were also present particulary after flowering stage. It could also be deduced that even though the adult of Scirpophaga subumbrosa occurred in the light trap, it did not constitute a threat as far as rice stem infestation was concerned.

Weekly dissections of three rice varieties Mali Sawn, Nang Kieu and Khao Gaew growing on the Seed Multiplication Farm and also at the WARDA Station were made to [illegible] the degree of resistance to infestation.

Highest percentage of infested stems was observed on Mali Sawn.

Among the granular insecticides screened, Furadan 3 G, Birlan 10 G and Miral 10 G appear to be most promising. Furadan 3 G applied at 1 kg a.i./ha days after rice emergence controlled stemborer and produced the highest yields (3.1 t/ha) as control yield of 1.8 t/ha) as control yield of 1.8t/ha.

Among liquid insecticides, Azodrin 55.2 EC and Sumithion 50 EC seem most promising but did not produce as high a yield as Furadan treated plots. It has been observed that application of liquid insecticides using the application of liquid insecticides using the apparatus, Tecnoma T 15 during flood is cumbersome and impractical. Other apparatus such as Solo and Ultra Low volume sprayers are yet to be tried.

Transfer of Technology

To speed up the transfer of research results to farmers, a programme of multilocation trials was started in 1980. It was designed to compare the yields of new promising varieties on farmers' fields with locally recommended ones. This was done in collaboration with "Opération Riz Mopti" in Mali and the National Institute of Agronomic Research (INRAN) in Niger. The results for the shallow zone are shown in Table 4.3. Out of ten trials conducted in 1980, only five were harvested as the others were either damaged by flood or failed due to early recess of flood waters.

TABLE 4. 3. Yields of selected varieties on farmers' fields.

VARIETIES	YIELDS KG/HA AND SIGS					AVERAGE MEAN FOR	
	Sofara		Bougoula		Kole (Niger)	Bougoula	Sofara
	1980	1981	1980	1981	1981		
1. BKN 6986-38-1	–	1191	4743	3462	3906	4113	1191
2. DM 17	3221	1399	4363	3156	3562	3760	2310
3. DM2 (check)	3197	833	4327	2712	3875	3855	2015
4. DM 16	3104	1012	3991	3382	–	3687	2098
5. BKN 6986-105-P	–	1175	–	2678	3281	2678	1175
6. D52-37 (check)	– NS	– NS	– NS	– NS	3104 NS	–	–

NS = Significant

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Under medium zone, the water level varied from 0.8 to 1.3 depending on the year. In 1979 and 1980, MSP 10 and MSP 11 were tested against the standard varieties Khao Gaew and Mang Kieu at six locations. In 1979, the comparison was made on fertilized as well as non-fertilized fields. All cultural practices were done by the farmer who made his own observations. Supervision was in collaboration with the extension agent for the particular location.

Results from six sites in 1979 showed that the two test varieties produced more yield than the standard when fertilizer was applied. But under unfertilized condition, Khao Gaew, produced higher yield than the varieties. The mean yields under non-fertilized conditions for MSP 10, MSP 11 Nand Khao Gaew were 1.7 , 1.6 and 1.9 t respectively. In 1980, more farmers were included and the programme extended to Segou. Results in the Mopti Region showed that MSP 10 and Khao Gaew produced almost equal yields slightly higher than MSP 11. However, in Segou region all the varieties gave similar yields.

Nevertheless, in the two localities, farmers were prepared to try MSP 10 and MSP 11 again because of their longer panicles and the good appearance of the grains.

In four zones (Konodimini, Sorobasso,, Kouniana and Bougoula) where floods recede quite early, DM 16 and DM 17 which are early maturing were demonstrated against the long duration Khao Gaew.

The DM 16 and DM 17 varieties with a growing cycle of about 137 days were harvested in the last week of November giving higher yields. On the contrary, Khao Gaew, the variety normally grown and which has about 156-day growing

cycle, failed at most locations. DM 16 (0.4-1.3 t/ha) DM 17 (0.2-1.7 t/ha) outyielded Khao Gaew which failed at five locations and only yielded 0.6 t/ha at one location.

Some recommended cultural practices evolved as a result of past work by IRAT at Ibetemi. These were being extended to farmers by Operation Riz Extension Agents. It was therefore decided to investigate how successfully these practices were being adopted.

The practices investigated were:

- ploughing after harvest to control wild rice.
- Seeding with the "Nodet Gougis" Seeder in 40 cm rows to facilitate weeding.
- weeding before arrival of floods.
- application of 100 kg/ha ammonium phosphate at sowing and 100 kg/ha of urea just before flooding

Many of the farmers were unable to adopt the practices recommended for the following reasons:

- most farmers lacked oxen and other farm implements to plough at the right time.
- some of the farmers live far away (15 to 25 Km) from the polders.
- the 40 cm rows were too wide.
- broadcasting gives higher yield compared to 40 cm rows.
- many farmers give priority in weeding upland crops (millet, sorghum, cotton) and also in weeding non-governmental polders.
- the remoteness of the fields retards weeding.
- difficulties encountered in controlling some noxious weeds (O. barthii) and Eleocharis plantaginea).

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Other troublesome weeds are: O.longistaminata, Brachiaria sp., and Ischaemum rugosum. Reasons for non-using of fertilizers by farmers:

- Lack of capital;
- Non-profitability of the investment; and
- uncertainty of soil moisture and floods.

Economic analysis of the land preparation treatment on farmers' fields at Mopti South was made. Ploughing with oxen at the end of the harvest as well as the beginning of the sowing season was most profitable. Ploughing only once at the beginning of the sowing season was least profitable.

Infrastructure

The infrastructure consists of a station with laboratories and offices, experimental polders and a housing compound.

The Station has four laboratories, seven offices, a library which can be used as a conference room and photocopying room. It has also a storage shed, a workshop shed for agricultural equipment, threshing floor, cold room, screenhouse and a house for the farm manager. A net-house for breeding purposes is to be constructed soon.

The experimental farm which consists of 46 hectares, is subdivided into four polders:

- Polder 1 (11 ha) maximum water level 1.70 m
- Polder 2 (5 ha) maximum water level 1.30 m
- Polder 3 (14 ha) maximum water level 1.00 m
- Polder 4 (16 ha) maximum water level 1.70 m for seed multiplication purposes.

In addition there is a special small polder (tank) which is 0.8 ha built for the screening of newly introduced rice varieties. It has 3 terraces for water levels varying from 1 to 2.5 m. The entire experimental area is fenced.

The Housing Compound is located at Sevare, 13 Km from the experiment Station. It comprises seven houses for the Director, Deputy Director and other scientists. There is also a four-bed room guesthouse with a kitchen, a generator room and a two-room guardhouse. The entire housing compound is fenced.

Funding

The Government of Mali has contributed land for the development of the infrastructure at Mopti and Sevare. In addition, it has donated the following buildings: a house for the farm manager, a laboratory and office for the breeder, a three-room storebuilding, generator room, garage and workshop.

The Government of Saudi Arabia provided funds for the construction of the Office Building.

The development of the experimental polders, the construction of the staff houses at Sevare and the overall operating budget of the Station is funded principally by United States Agency for International Development (USAID).

WARDA provided funds for the purchase of three cars, construction of a coldroom and purchase and maintenance of oxen.

Future programme 1983-1988

Varietal Improvement

- Germplasm Collection has been, and will be a continuous process at the Station.

- The Station will introduce fixed breeding lines through WARDA IET and IRDWON. Rapid Generation Advanced (RGA) will be introduced from IRRI. Varieties will be introduced from Bangladesh, India and Thailand.

- The WARDA Coordinated Trials will be continued.

- Observational trials of new lines selected from IET, IRDWON, RGA materials and from the Germplasm will be continued.

- Variety X Fertilization Interaction Trials: This is a joint trial in collaboration with the agronomy and weed control divisions.

- On-farm or out-station trials will be extended to more villages in collaboration with "Opération Riz" Mopti and "Opération Riz Sorgho", Gao. Trials are also planned for Kolo (Niger) and Birnin Kebbi (Nigeria) in the 1983 programme.

- The Study of hybrid progenies of previous crosses will be continued. A new hybridization programme is being made to meet the breeding demands of the region.

- The search for drought tolerant highyielding varieties will continue.

- Pure line selections will be started for oryza glaberrima varieties.

Agronomy

- Land preparation experiments will be conducted to find better means of enhancing plant stand.

- On-farm demonstrations of the usefulness and profitability of land preparation both at the end of the harvesting season and at the beginning of sowing season will continue.

- New low-cost implements available on the market and suitable especially for the peasant farmer will be screened in land preparation operations.

- Sowing date studies which have gone on for some time now will be concluded.

- Investigations on row sowing with regard to variety and water depth will be continued.

- On-farm trial on row and broadcast sowing to determine the relative convenience in weeding operations and the profitability of each method will receive attention.

- Efforts will be made to relate fertilizer recommendations to specific soil types.

- On-farm trials determining the profitability of fertilizer recommendation will be carried out in collaboration with National Extension Agencies in various countries.

- The usefulness of the local rock phosphate (Phosphate of Tilemsi) on farmers field in Mali will be examined.

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- Collaboration with IRRI on the use of different nitrogen sources such as sulphur-coated and supergranule will continue.

Weed Control

- The appraisal of the weed problem in farmers' fields, which has already been conducted at Mopti will be extended to other parts of Mali and all other countries where deep water and floating rice is grown.

Weed Identification: The collection and identification of weeds causing economic losses in deep water and floating rice will continue and be extended to those countries where no such identification has been done.

- Studies of the biology of important weeds will deal with:

a) Methods of propagation
b) The mechanisms of seed dispersal
c) Viability and dormancy studies
d) The degree of establishment and the rate of growth.
e) Morphological characteristerics of both juvenile and mature weeds to aid in identifications.
f) Physiological features such as allelopathy, nutrient requirements and uptake, and other competition relationships.

- The weed control programme will be divided into two categories: the control of wild rices and the control of other weeds. Attemps will be made to evaluate the role of zero and minimum tillage, the use of cover crops, the effect of fallow, and the use of herbicide antidotes in post-emergence control of wild rices. Research on the control of

other weeds will cover the determination of efficient cultural practices and the screening of herbicides.

Entomology

- Collection and identification of insects of deep-water and rice will continue.

ii) Light trap will continue to be used to studdy the insect population dynamics.

- Study of the biology of Scirpophaga subumbrosa and Maliarpha separatella.

- Investigations on biological insect control of insects.

- On-farm investigation of infestation of rice varieties by stemborers and the degree of crop loss that can be ascribed to it.

- On-farm evaluation of the economics of Furudan 3G application to control stemborers.

- Screening of liquid insecticides to control grasshoppers.

APPENDIX 4-1 Rain fall distribution and flood arrival during (1978-1982) Growing Seasons Mopti Station.

MONTH	ANNUAL AND MONTHLY TOTAL (MM)						NUMBER OF RAINY DAYS				
	1978	1979	1980	1981	1982	Average 1970-81	1978	1979	1980	1981	1982
March	-	-	-	-	0.4	-	-	-	-	-	1
April	10.5	8	-	4.3	10.1	2.9	3	-	-	2	1
May	19.2	16.2	3.8	13.6	14.1	31.6	6	4	1	2	2
June	44.3	61.9	71.5	17.2	29.5	55.4	5	9	7	5	6
July	153.0	65.8	172.9	223.3	81.5	132.0	15	8	14	12	8
August	81.4	179.8	206.4	94.1	63.6	131.0	14	13	15	9	11
September	216.3	70.2	85.4	24.2	32.1	87.2	11	9	8	7	6
October	59.2	10.2	8.3	-	5.4	20.6	5	3	2	-	3
November	-	-	9.3	-	-	1.0	-	-	1	-	-
Total (mm)	583.9	404.1	557.6	376.7	236.7	461.7	59	46	48	37	38
Above/below 10 yrs Average	+122.2	- 57.6	+95.9	-85.0		-225.0					
Date of opening of flood gate or field	2/9	8/9	12/9	14/9	25/9						

APPENDIX 4.2 Characteristics of the soil samples collected in the Agronomic trial sites

Characteristics **	1	2	3	4
C %	0.8	0.86	0.77	0.16
Total N %	0.107	0.07	0.07	0.02
PH (H_2O)	5.40	4.91	4.91	5.82
PHKOL	4.03	3.56	3.31	4.22
Total P ppm	300.0	-	-	-
Available P ppm	2,10	0.42	2.31	3.15
Exchangeable K ppm	175.0	195.0	130.0	110.0
C.E.C meq/100 g	14.50	15.0	10.50	1.45
Na meq/100 g	0.17	1.63	-	-
Ca meq/100 g	1.20	0.25	0.64	0.32
K meqq/100 g	4.50	6.:5	4.0	1.0
K meq/100 g	2.00	6.0	-	-
Clay %	64.5	49.5	47.7	9.6
Fine silt %	7.1	18.3	19.5	1.8
Coarse silt %	25.2	5.4	25.5	11.6
Very fine sand %	1.6	8.7	3.9	26.1
Fine sand %	0.6	8.4	1.5	28.1
Coarse sand %	0.7	9.1	1.5	22.2

* 1 Fertilizer management Expt. 3 (sources of N)

2. Land preparation (I)

3. International trial on nitrogen fertilizer efficiency Expt.

4.

4. Fertilizer management Expts. 1, N-P studies, and 2, Rate and time of fertilizer application

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