WARDA
Research Department

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West Africa Rice Development Association
P.O. Box 1019, Monrovia, Liberia

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CONTENTS

WEST AFRICA RICE DEVELOPMENT ASSOCIATION (WARDA)

Rice is a staple food of growing importance in West Africa. An estimated 700,000 farmers grow rice in this region, but yields are generally low. Despite the tremendous potential in physical and ecological resources available for growing much larger quantities of rice, West African countries spend large amounts of their scarce foreign exchange resources to import rice to supplement local production.

The West Africa Rice Development Association (WARDA) is a cooperative intergovernmental regional organization aimed primarily at making the region self-sufficient in rice. It was started in December, 1971. Its members are: Benin, Gambia, Ghana, Guinea, Guinea Bissau, Ivory Coast, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo and Upper Volta.

WARDA is financed by member countries as well as by many donor countries and international organizations. The aim of WARDA is to promote and increase the quantity and quality of rice produced in West Africa through carefully planned research, development and training programmes. The Scientific and Technical Committee of WARDA as well as donor agencies review the Associations's programmes, while the Governing Council formulates its policies.

RESEARCH ACTIVITIES

WARDA's research projects are aimed at providing useful information and improved plant material which can be used for increasing rice productivity. The overall programme includes:

- Coordinated varietal and crop protection trials at various locations in the region;
- Special research projects for reinforcing existing research work and for filling existing gaps in rice research in the region, backstopped by available knowledge and experience at the international level;
- Research coordination which involves planning, project formulation, negotiation for funding, and the implementation and supervision of the approved programme and budget;
- Support to national research programmes;
- Cooperation with oher international agricultural research centers.

WARDA's coordinated trials have provided opportunities for testing local and introduced varieties throughout West Africa. A sound programme of coordinated trials and effective links between WARDA and the national programmes has led to the introduction of improved varieties and better cultural practices among the rice farmers.

To speed up the introduction of rice materials into the region, WARDA extends financial and logistic support to the Regional Plant Quarantine Station, Ibadan, Nigeria. A nusery farm where new introductions are multiplied before entering them into the coordinated trials has been established at Suakoko, Liberia as well as a Seed Laboratory at Fendall, also in Liberia.

In 1976, WARDA, IRAT, IRRI, member states of WARDA and Tanzania arrived at a collaborative understanding for germplasm collection in Africa. WARDA has initiated its germplasm programme which, when fully functional, will have a capacity for about 12,000 accessions under medium term storage.

WARDA conducts a rice review meeting every year, at which research reports incorporating all the results obtained from the coordinated trials, special research projects and national programmes are presented and discussed.

In supporting national institutions, WARDA aims to assist in establishing capable national institutions, providing adequate facilities to local scientists, establishing a strong working relationship with national teams, solving local agronomic production problems and in strengthening particular aspects of national research programmes that have regional value. WARDA also backstops specific local research projects through its regional scientists and exchange of research information and through assistanse to countries trying to identify and draw up national research programmes. WARDA continues to strengthen national research facilities by supplying needed laboratory and field equipment. An integrated training programme to assist in the training needs of member states for research personnel is run yearly.

The programmes of other international centres such as IRRI and IITA, and that of WARDA, are linked together with mutual benefit. WARDA helps make the research findings of the international centres effective among its member states, while the international centres benefit from feedback from WARDA. In this light, WARDA has cooperative agreements with these centres in the area of training, research and exchange of staff.

DEVELOPMENT ACTIVITIES

Since it is primarily a development association, WARDA has assembled a team of agronomists, irrigation engineers, economists and loan specialists, rice storage and processing engineers and extension specialists, as well as statisticians and data processing experts. The major activities of the Department can be summarized as follows:

- Participation with other departments in the development, assessment and transfer of appropriate technology;
- Provision of technical assistance to member countries and financial institutions in rice development, planning (including project identification, preparation , appraisal and evaluation) and implementation;
- Collection, analysis and dissemination of information on the rice industry of member countries, including the conduct of sectoral and socio-economic studies.

WARDA is helping to implement viable rice development projects; helping member states find funds for new projects; monitoring improvements in on-going projects as regards better cultural practices, water management, storage and processing as well as marketing, both within and among member countries; and technology assessment and transfer.

Since the exchange of ideas among field workers in member states is very important, the development team undertakes case studies of specific projects for dissemination among member states; it also arranges seminars on specific issues in development, and helps personnel from one country to visit projects in another. Member countries often call on WARDA for consultancy services in specialized areas of projection, production, processing and marketing.

TRAINING ACTIVITIES:

One of the major drawbacks in increasing rice production in West Africa is shortage of trained personnel who can quickly convert accumulated research findings into rice production. WARDA's Training Centre became fully operational in 1976 at the farm of the University of Liberia, Fendall. All courses are given in both English and French. The Training Centre conducts the following courses among others:

- Rice Production Specialist Course: A six-month course designed to produce specialists who return to member countries to organize, manage and conduct training courses for extension workers, and who in turn assist rice farmers to increase their yields. The long training period allows for adequate emphasis on all aspects of rice cultivation and processing as practised at the farm level;
- Research Assistant Course: This is closely linked with the successful implementation of WARDA's coordinated trials. This programme ensures standardization of observations and data collection while it strengthens the research capabilities of member countries;
- Specialised Rice Courses: These are designed to meet training requirements of member countries in seed technology, processing, storage and marketing.

Between 1973 and 1982, the Training Department trained 826 students from member states in various aspects of rice production.

DOCUMENTATION SUPPORT

The Documentation Division is one of the support divisions aimed at providing information on all aspects of rice in the region to the governments of member states, WARDA projects and personnel, research institutions, universities, other organizations and individuals concerned with rice.

Activities in the Division include the following:

- publication of rice literature (e.g. indexes, bibliographies, abstracts of rice journals) and a quarterly accessions and periodicals list;
- selective dissemination of information to individuals or parties interested in rice research and development within and outside the region;
- production of microfiches from selected literature and documents relevant to rice research and development from within and outside the WARDA region;
- operation of a Question and Answer Service whereby researchers and developers can obtain information on their fields of activity;
- compilation of relevant literature on rice production from the reference journal "World Reference on Rice in West Africa" in collaboration with IITA, IRAT, IRRI and TFI;
- cooperation with various information centers and data banks;
- photography (slides, documentaries etc.);
- information exchange with world institutions like AGRIS, CARIS, AFLINET, UNISIST, etc.;
- publication of "World Reference on Rice" of interest to West Africa; and
- short in-service training of librarians from West African national and regional organizations.

COMMUNICATION SUPPORT

The Communication Division is another support division of WARDA set up to pursue the following services:

- translation of documents from one of English and French to the other;
- editing of documents;
- printing and distribution of documents;
- public relations;
- operation of a language class and laboratory;
- occational interpretation at meetings, etc.

FINANCE AND ADMINISTRATION SUPPORT

The Department of Finance and Administration is responsible for providing financial and administrative services to the technical departments and divisions. The services include personnel, conference services, procurement, stores, transportation, security, liaison and welfare, accounting, budget control and financial reporting.

PROFESSIONAL STAFF LIST FOR 1982
RESEARCH DEPARTMENT

A. HEADQUARTERS

Research Coordination

B. A. C. Enyi, Ph.D., F.L.S., F.R.S.A., F.I.Biol., L.F.I.B.A.	- Director of Research
G. A. Paku, Ph.D.	- Agronomic Statistician
G. Varango, B.Sc., D.P.L.G.	- Architect

Technical Support Services

M. A. Choudhury, Ph.D.	- Senior Rice Breeder
A. O. Abifarin, Ph.D.	- Senior Rice Breeder & IITA Liaison Scientist
D. K. Das-Gupta, Ph.D.	- Senior Rice Agronomist
V. A. Awoderu, Ph.D.	- Senior Rice Pathologist
E. A. Akinsola, Ph.D.	- Rice Entomologist
A. K. Koroma, Ph.D. +	- Assoc. Rice Breeder
N. S. Bangura, M.Sc.	- Assoc. Rice Pathologist
M. A. Larinde, M.Sc.	- Seed Technologist
L. Kandakai (Mrs.) B.Sc. *	- Asst. Seed Technologist

B. SUB-REGIONAL COORDINATION

Zone I

R. B. Kagbo, Ph.D.	- Sub-Regional Coordinator
K. M. Shambuyi, M.Sc. +	- Asst. Sub-Regional Coordinator

Zone II

S. Diatta, Ing. Pedologue, DEA	- Sub-Regional Coordinator
S. D. Bangura, Ing. Agronome	- Asst. Sub-Regional Coordinator

Zone III

S. Assegninou, Ing. Agronome, DEA	- Sub-Reg. Coordinator
M. Diakite, Ing. Agronome, DEA	- Asst. Sub-Reg. Coordinator

Zone IV

J. O. Olufowote, M.Sc.	- Sub-Regional Coordinator
D. C. Pankani, M.Sc.	- Asst. Sub-Regional Coordinator

Zone V

O. Koffi-Tessio, Ing. Pedologue	- Sub-Reg. Coordinator
M. Daffe, Ing. Agronome	- Asst. Sub-Regional Coordinator

Notes:
* On study leave
+ Left during 1982

C. SPECIAL RESEARCH PROJECTS

Mangrove Swamp Project - Rokupr, Sierra Leone

E. Jones, M.Sc. *	- Soil Scientist & Team Leader until May 1982
M. Agyen Sampong, Ph.D.	- Entomologist & Team Leader from June 1982
J. Stenhouse, Ph.D.	- Rice Breeder
M. Jones, M.Sc.	- Assoc. Rice Breeder
C. A. Dixon, M.Sc.	- Assoc. Soil Scientist
S. N. Fomba, M.Sc.	- Assoc. Pathologist
S. J. Fannah, B.Sc.	- Asst. Entomologist
H. M. Bernard, B.Sc.	- Asst. Weed Scientist

Irrigated Rice Project - Richard-Toll, Senegal

H. Van Brandt, M.Sc.	- Soil Scientist & Team Leader until May 1982
A. Coly, Ing. Agronome, Ph.D.	- Rice Breeder & Team Leader from June 1982
T. Diop, BAC (Agricole) *	- Asst. Entomologist
I. Camara B.S.P. *	- Asst. Soil Scientist
A. M. Diop, Ing. Agronome	- Asst. Weed Scientist
J. Dome, Ing. Agronome	- Asst. Breeder
H. F. Diarra, Ing. Agronome, M.Sc.	- Azolla Specialist

Deep Water/ Floating Rice Project - Mopti, Mali

S. Koli, Ph.D.	- Agronomist & Acting Team Leader
F. J. Bangura, Ph.D.	- Rice Breeder
C. Nyoka, Ph.D.	- Weed Scientist
M. Goita, M.Sc. *	- Asst. Rice Breeder
A. Diarra, M.Sc. *	- Asst. Weed Scientist
M. Toure, Ing. Agronome	- Asst. Agronomist

Upland Rice Project - Bouake, Ivory Coast

J. Dallard, D.F.A.	- Agronomist

Notes:
* On study leave
+ Left during 1982

FOREWORD

Over the past five years, WARDA has been able to identify several high yielding stable rice varieties through the Initial Evaluation Tests and Coordinated Varietal Trials for both the humid and Sahelian ecologies within its member states. Some of these varieties have shown promising results under farmers' conditions and are being multiplied by WARDA member states for distribution to farmers by means of extension services.

One of the bottlenecks in the distribution of improved rice seeds to farmers is the lack of adequate seed production and processing facilities beyond the foundation seed stage.

Although high yielding varieties have been identified for the irrigated rice ecology, there is the need to select those that are resistant to cold injury, and wind and bird damage, especially in the Sahelian zone.

The efficiency of water use is a crucial factor in rice production in the Sahelian zone considering the high rate of evaporation. As a result, a water management research programme at Richard-Toll was initiated by WARDA in 1981 to determine ways of increasing the water use efficiency in the Sahelian zone under farmers' field conditions.

To ensure high yield of irrigated rice, nitrogenous fertilizers have to be used. These fertilizers are so costly that most farmers cannot afford to purchase them. If high yield has to be maintained without considerable increase in cost of production, then some form of cheap nitrogenous sources have to be found.

The programme on Azolla research, launched by WARDA in 1980, has put forth very promising results. With the use of Azolla only, it is possible to increase the yield of irrigated rice by 40%, thereby saving the cost of artificial nitrogenous fertilizer. During the 1983-84 growing seasons, the work on Azolla will be extended to farmers' fields.

The expansion of area under new and improved rice varieties has led to the incidence of new diseases (Xanthomonas oryzae) and insect pests (Orseolia oryzae, and mites). In order to halt the rapid spread of these new diseases and pests, new varieties resistant to them will have to be produced through breeding or introduction of new resistant varieties.

Although upland rice accounts for about 60% of the area under rice in West Africa, the yield per hectare is still very low (0.5 - 0.8 t/ha). Research work is now in progress to improve the yield of upland rice through judicious application of fertilizer, breeding for high yield, drought and disease resistance and improved cultural practices. A study on the appropriate farming system for the maintenance of soil fertility under upland rice cultivation is also in progress.

In the mangrove rice ecology, effort is being made through rapid generation advance to produce varieties that outyield the current ones. By 1984, some of these new varieties will be released and it is anticipated that these new varieties will increase yield by about 15%.

In the deep water/floating rice ecology, attempt is being made through hybridization to produce new varieties that can give higher yields than the current ones. Prior to the release of these varieties, emphasis will be placed on improvement of agronomic practices which limit grain yield under this ecology.

With the prevailing financial constraints, emphasis will be placed on breeding and selection of high yielding varieties for mangrove swamp and upland rice. In the latter case, drought and disease resistance will be important criteria for selection.

In the irrigated rice ecology, efficiency of water use, use of Azolla as a source of nitrogen, and the control of new diseases and insect pests through selection of resistant varieties will be emphasized.

In the deep water and floating rice ecology, a minimum amount of hybridization will be undertaken. However, more emphasis will be placed on developing improved agronomic practices, and the efficient use of water for cultivation of rice and other food crops.

The coordinated varietal trials will continue with emphasis on upland, mangrove, rainfed lowland, shallow flooded and deep flooded ecologies, especially with the introduction of new varieties from outside West Africa. 1984 will bring in the scaling down to two categories of irrigated trials instead of four.

I wish to thank the staff of WARDA for their dedication, industry, and the progress they have made in this task and also the national scientists of member states for their continuous collaboration.

Sidi Coulibaly
Executive Secretary

RESEARCH HIGHLIGHTS

Initial Evaluation Tests (IET)

The initial Evaluation Tests were conducted to screen a wide range of rice germplasm. In 1982, two IETs, one each for upland and irrigated conditions, were carried out in the WARDA region. These involved 348 rice varieties at 30 locations. Varieties with high yields, suitable maturity period, desirable plant heght and disease resistance were identified from the IETs for further tests.

Coordinated Variety Trials (CVT)

Coordinated variety trials were conducted at various locations in the WARDA region with the aim of direct introduction of superior varieties to different rice ecologies in a reliable and faster way. In 1982, nine sets of CVTs (three for upland, four for irrigated, one for mangrove swamp and one for deep flooded conditio ns) were conducted in the region. Most sets of trials consisted of 14 entries. Useful results were obtained from a total of 88 individual tests. A total of 54 locations were involved in this programme.

Onfarm trials

Onfarm trials were conducted in all five zones of the region in 1982. Fifty-two of the trials were based on the assessment of promising varieties with high yielding ability observed in the CVTs.

In some countries, the trials also included farm agronomic trials such as weed control, varietal response to fertilizers and cultural practices.

The varieties nominated from the WARDA CVTs continue to show superiority in field performance and yield.

Technical Support Services

Seed Nursery Farm

The Seed Nursery Farm continued to perform its vital role in varietal introduction, improvement and seed production. In 1982, a total of 673 plant selections were made from eight crosses introduced from IRRI. Sixteen new crosses were introduced for plant selection. A total of 1506 new varieties were introduced and tested. During the year, 957 varieties were grown for seed increase and observation. A total of 377 varieties were multiplied, including 167 at Richard-Toll for the coordinated variety trials of 1983.

Seed Laboratiory

For the year under review a total of 1807 varieties were processed out of which 252 were selected for use as entries in the WARDA 1982-83 trials.

Results of experiments carried out with freshly harvested seeds of wild rices suggested that dormancy in these species is probably due to the impermeability of the hull-pericarp complex to oxygen. Only scarification was effective in breaking the dormancy of the seeds.

Agronomy

In a yield constraints study using LAC 23, it was found that in a fallow-rice-rice-rice system, upland rice yields could be increased by 200% over the traditional yield by a package of line sowing + fertilizer + weeding + insect pest control. In the second and third rice crops in a bush-fallow-rice system, high dose of nitrogen (60-90kg N/ha)is needed to obtain grain yield between 1.5 and 2.0 t/ha.

Under lowland conditions, compound fertilizer (15-15-15) was the least effective source of nitrogen. One application of urea super granule or sulphur coated urea of various disolution rates at transplanting could give similar grain yield as commercial urea applied three times in lowland swamps.

As far as direct effect on grain yields is concerned, Tunisia and Jordan phosphate rocks are as effective as triple super phosphate, while Morocco and Togo phosphate rocks are less effective.

Yield response to residual phosphorus was highest in Jordan phosophate rock and lowest in triple super phosphate under lowland swamp conditions.

In a collaborative experiment between IITA and WARDA during the 1982 dry season, it was found that some rice cultivars such as ITA 239, ITA 243, ITA 245, ITA 250 and ITA 254 gave significantly higher grain yields (yields varied between 5.0 and 5.3 t/ha) than the local check Suakoko 8 (3.8 t/ha) which is tolerant to iron toxicity. Leaf blast incidence increased with increase in the levels of applied nitrogen from 60 to 120 kg N/ha for most of the rice cultivars. There was no significant difference in grain yield between 60 kg and 120 kg N/ha.

Entomology

Two major monitoring trips were organized to investigate problems of rice cultivation in two WARDA member countries, Mali and Upper Volta. A multidisciplinary team visited Gao, Mali on account of a malady of deep flooded rice described as drying up of leaf tips and floating rice straws. The trip to Bobo-Dioulasso investigated the problem of gall midge on irrigated rice in Upper Volta. Recommendations were made towards solving these problems.

Pathology

Tours were made during the 1982-83 season to monitor the incidence of rice diseases in Ivory Coast, Mali, Niger, Sierra Leone, Guinea, Nigeria and Senegal. Observations made from these trips plus reports from sub-regional coordinators were used in updating the geographical distribution of rice diseases in West Africa.

Varietal resistance or susceptibility to bacterial leaf blight and other diseases was determined in Niger, Mali and Senegal. Effects of different levels of nitrogen on the susceptibility of rice varieties to rice blast and baterial blight was assessed at Suakoko (Liberia) and Richard-Toll (Senegal) respectively. The efficiency of Benlate, FP389 and Kocide in reducing blast incidence on C22 rice variety was determined at Suakoko (Liberia).

Germplasm Programme

In 1982, emphasis was placed on the development of the germplasm bank. A total of 1500 cultivars were registered and stored in the bank. Characterization of the cultivars has been initiated.

International Rice Testing Programme (IRTP)

In 1982, 157 sets of 23 different nurseries were dispatched to cooperators in West Africa. Promising cultivars have been identified from these nurseries. Several of the cultivars have been nominated into WARDA trials and some selected by national programmes for further testing or for hybridization.

Special Research Projects

Deep Flooded and Floating Rice - Mopti, Mali

The Mopti Project is engaged in developing improved varieties and cultural practices in the form of packages for deep water rice farmers in West Africa.

Due to severe drought in 1982 in the Mopti area and unusually low flooding, most experiments failed at seedling stage. Some trials survived the drought but failed due to short flooding.

Mangrove Swamp Rice - Rokupr, Sierra Leone

Materials screened in initial evaluation trial during 1982 were obtained through IRTP and consists of 94 lines from IRLRONL, 27 lines from IRSATON and 10 lines from the Acid Sulphate Soils Screening Test. In addition to these, short and medium duration rice varieties were tested in observational and replicated yield trials. Three replicated yield trials were also conducted on long duration varieties under tidal swamp. Six varieties (Haji Haroun, Bay Banh, Randen Mas, IR 5677-17-3-1-1, ROHYBG-WAR-6-2-B-2 and ROHYBI-WAR-5-2-B-1) were nominated for coordinated trials.

Fifty-one new accessions (34 from Guinea and 17 from Sierra Leone) were added to the germplasm collection and by end of 1982, 639 accessions were recorded. In the hybridization programme twelve new crosses were made.

In Entomology, activities concentrated on incidence of rice insect pests in different ecosystems of the mangrove swamp. Progress was made in studies on the occurrence and distribution of stemborers and their natural enemies. The tolerance of improved varieties to stemborer infestation was compared with traditional varieties.

Crab damage in farmers' fields was assessed and varietal tolerance to crab damage was studied.

In pathology, research activities included disease surveys and monitoring, crop loss assessment due to fungal pathogens and determination of varietal resistance to major diseases.

The research activities on chemical, cultural and mechanical weed control in the mangrove and associated swamps continued. A weed survey of rice farms in Koba, Koya and Sonfonia districts of Guinea was conducted.

The efficiency of mineral fertilizer (NPK) was compared with biological fertilizer (Azolla) both on experimental sites and on farmers' fields in Gambia, Sierra Leone and in Guinea.

Production packages developed by the multidisciplinary team enumerated above were tested on farmers' fields vis-a-vis the socio-economic problems facing the farmers.

Upland Rice - Bouake, Ivory Coast

Upland rice improvement work continued at Bouake in collaboration with IRAT/IDESSA/DEV. In evaluation studies, short duration varieties IRAT 144, IRAT 109 and IRAT 142 and medium duration varieties IRAT 104, IRAT 13, IRAT 170 and 949 M were found to be the most outstanding for upland. The best choice of variety however depends on the rainfall regime and cropping calendar.

Irrigated Rice - Richard-Toll/Fanaye, Senegal

A varietal yield trial conducted to identify short and medium duration varieties adapted to local conditions identified BR 161-2B-54 as the most promising together with a few others.

Application of phosphorus to the rice nursery during the cold dry season improved plant growth considerably. The formulation of 130-100-100 and 130-100-0 NPK produced the highest yield while K application had no effect on yield. Studies on the effect of seeding and fertilizer application methods on irrigated rice growth during the cold dry season showed that broadcast seeding was better and more adapted to cold than the traditional nursery in terms of root development, leaf area index and subsequent yield. A comparison of four seeding rates, 80, 100, 120 and 140 kg/ha and six nitrogen doses, 0, 80, 100, 120, 140 and 160 kg N/ha showed the optimum seed rate to be 120 kg/ha and the application of 0 and 80 kg N/ha gave significantly less yield than other doses.

Results of long-term NPK fertilization indicated that vertisols are not fertile enough as shown by the gradual decrease in paddy yields over the seasons. Nitrogen is important in obtaining high yields and phosphorus became important during the third cropping season. With hydromorphic soils, there was a drop in fertility in the third cropping season which was improved by ploughing in of rice straw. The positive effect of compost on rice yield especially at the low level (60 kg N/ha) of N application was confirmed in a study using harvest residues. The best combination was 90 kg N/ha + 5 tonnes of compost/ha. In another experiment, it was shown that regardless of the type of irrigation, the water intake response curve for rice was sigmoidal. There were variations at different growth stages with the maximum occurring at panicle initiation and flowering stages.

In direct seeded rice, hand weeding and the use of the rotary tiller produced significant increases in grain yield. Two runs of the rotary tiller followed by hand weeding produced yields comparable to those obtained with two hand weedings.

Studies on frequency of application of granular insecticide, Firadan 3G, showed that between applications at 10, 30, 50 and 70 days after sowing (DAS) the application at 50 DAS gave the highest yield. Population dynamics studies have shown that it is possible to avoid stemborer attack through manipulation of planting dates. Among rice varieties screened for their resistance to stemborers, entries meriting further observervation were IR 2823-399-5-6, IR 9782-144-3-3-3, IET 4247, B 2360-8-9-5, FH 109, IR 2071-586-5-6-3, IR 442-165-1-3-2 and Vijaya.

The results of urea supergranule trials showed that it is possible to save 50% nitrogen particularly at high doses. Supergranule treatments topped the list in terms of grain yield followed by two urea treatments applied in three split doses. In variety trials I Kong Pao remained the best variety followed by IR 3941-86-2-2-2 and Sri Malaysia. Results of NPK trials during the hot dry season showed significant positive effects of nitrogen application on grain yield. The economic analysis indicated that when fertilizers are subsidized, the 240-96-0 NPK formulation gives the highest gross profits of 261,539 CFA at Nianga and 225,077 CFA at Haere Lao. During the hot wet season, double dose of N (240 kg N/ha) in general gave higher yields compared with single dose (120 kg N/ha). Significant effects of P2O5 and K2O application were observed.

The combination of 50% Azolla Nitrogen + 50% Urea Nitrogen produced yields equal to those obtained with the application of 100% Urea Nitrogen. In other Azolla trials, there was indication that the application of about 40 t/ha of Azolla produced the same effect as the application of 30 kg N/ha. On the average, 40 x 10cm spacing gave significantly higher grain yield than 20 x 20 cm spacing. From results obtained, it can be concluded that Azolla can grow in the hot and dry Sahelian as well as in the wet tropical zone provided moisture is available to conserve them throughout the year.

RESEARCH ACTIVITIES

INITIAL EVALUATION TESTS (IET)

Upland IET

The upland IET of 1982 was sent to 14 locations in the WARDA region. Results from 12 locations were useful. The test was composed of 97 entries of varied duration, plant height, plant type and drought tolerance.

Grain yield: Only two varieties, BW 248-1 and IR 52 produced yields over 3.0 t/ha. ITA 117, IR 5201-63-1-3, ITA 133, IRAT 142, BW 170 and IRAT 146 produced yields over 2.75 t/ha. Ten other varietes gave grain yields over 2.5 t/ha. A total of 50 varieties produced yields over 2.0 t/ha.

Maturity: Among the varieties giving yields over 2.5 t/ha, IRAT 146 flowered in 77 days and IRAT 142 in 81 days. Two other entries, DJ 11-541-1 and DJ 11-307-3-1-5, flowered in less than 90 days. Among the other varieties, IRAT 110 and IRAT 112 flowered in 76 days.

Plant height: The following good yielding (over 2.0 t/ha) varieties showed desirable plant height (95-120 cm):

C 171-136	BW 248-1	C22
IET 2980-6	IRAT 138	ITA 142
ITA 143	IRAT 156	ITA 118
ITA 165	ITA 182	M18
MARICHBATI	IRAT 132	IRAT 168
ITA 116	IRAT 144	IRAT 104
ITA 174	ITA 162	CMBP 217

Leaf blast (<u>Pyricularia oryzae</u>): Among the good yielding varieties, DJ 4-135, DJ 11-307-3-1-5, DJ 11-541-1 and ITA 117 were highly resistant to leaf blast. Other resistant varieties were DJ 11-509, IRAT 147, IRAT 168, IRAT 169, ITA 135, ITA 138, ITA 174 and ITA 225.

Neck blast (<u>Pyricularia oryzae</u>): The following entries showed high resistance to neck blast:

IRAT 104	IRAT 132	Tox 718-1-23
ITA 141	ITA 158	Tox 494-SLR
Tox 502-13-SLR	ITA 116	Tox 906-67-3-1
Tox 936-267-1-1	Tox 936-354-2-1	

Leaf scald (<u>Rhyncosporium oryzae</u>): Among the good yielders, DJ 11-307-3-1-5, DJ 11-539-2, IET 2980-6 and M18 were highly resistant to leaf scald disease. Other resistant varieties were IRAT 132, ITA 135, Tox 502-13-SLR and Tox 77-1-1.

Brown spot (<u>Drechslera oryzae</u>): Only two good yielding varieties, DJ 11-307-3-1-5 and DJ 11-539-2, were found to be highly resistant to brown spot disease. Other resistant varieties were IET 4090, ITA 162, ITA 183 and Tox 936-150-3-1.

Irrigated IET

The irrigated IET of 1982 was sent to 16 predetermined locations in the WARDA region. Results from 12 locations were useful. The test was composed of 251 entries of varied duration, plant height, plant type and disease and pest reaction.

Yield: Only one variety, Tox 475-1-1-1-1 produced average grain yield over 5.0 t/ha. BR 51-91-6 gave yield over 4.5 t/ha. Out of 251 entries, a total of 16 entries produced average yields over 4.0 t/ha. The following varieties produced yields of 8.5 t/ha or more at certain locations:

BR 51-91-6	IR 8192-166-2-3	CR 1023
IR 13146-41-3	IR 13427-40-2-3-3	IR 8192-242-3-2-1
IR 9288-B-B-244-2	CR 1030	IR 13358-73
IR 13146-41-1	CR 263-506	IR 11248-148-3-2-3-3
BR 20-29-2	IR 13146-23-3	IR 10781-143-2-3
IR 13146-13-3-3-3	IR 10199-128-2	IR 13358-16-3-2
IR 36	BR 161-2B-58	IR 17525-114-2-1-1
Tox 915-102-2-1	IR 19743-25-2-2	

Maturity: Among the varieties giving over 4.0 t/ha of yield, 32XUAN-5-B was earliest, flowering in 89 days. Among other fairly good yielding varieties (over 3.75 t/ha) the following flowered within 95 days:

B541b-KN-19-3-4	75-4830	B 2039C-KN-7-2-5-3-1
IR 4547-14-3-1	M12C-34-3	IR 13426-9-2-1
BW 100	IR 13427-40-2-3-3	AD 9246
CR 263-506	BR 20-29-2	IR 11248-248-3-2-3-3
IR 3483-180-2	BKNLR 1031-7-5-4	

Among the lower yielders, the following varieties flowered within 85 days:

BR 161-2B-53	MRC 603	BG 276-5
BG 367-4	Taichung Sen 10	IR 13429-196-1-2-1-1
IR 1976-2-3-3	IR 5260-1	TNAU 13613

The earliest variety was BG 367-4 which flowered in 77 days.

Plant Height: Most of the entries were of desirable plant height for irrigated or inland swamp conditions. Among the entries giving over 3.75 t/ha, the following had plant height of 100 to 112 cm:

B 2360-11-3-2-9	CR 1030	BR 51-91-6
IR 3483-180-2	BR 51-74-61-J1	BKNLR 1031-7-5-4
BW 248-1	B 2039C-KN-7-2-5-3-1	BR 51-315-4
BW 100		

All the varieties were of non-lodging type. Out of 251 entries, only 21 varieties had plant height less than 80 cm. 120 varieties had plant height from 80 to 100 cm.

Leaf Blast (<u>Pyricularia oryzae</u>): The disease was quite severe at all locations. The following varieties were identified as resistant to leaf blast:

IR 42	IR 4442-165-13-2	ITA 249
ITA 252	IR 9782-144-3-3-3	IR 9852-53-2
ITA 253	Tox 711-2-2-1-1	ITA 233
ITA 237		

Neck Blast (<u>Pyricularia oryzae</u>): The following varieties showed resistance to neck blast:

Bouake 189	B 2489b-PN-1-76-8	BKNBR 1036-28-1-5
BR 51-46-5	CR 1015	CR 1030
FH 109	IET 5854	IET 6058
IR 42	IR 54	IR 14632-2-3
IR 14753-49-2	IR 14753-72-1	IR 14753-89-2
IR 14753-133-2	IR 15529-253-3-2-2-2	ITA 233
ITA 239	ITA 243	ITA 245
ITA 247	ITA 248	ITA 249
ITA 250	KAU 1734-2	KAU 1925
IR 2928-7-3-1-1	IR 3259-P5-160-1	IR 3259-166-2-2-3
IR 8192-242-3-2-1	IR 9575 Sel	IR 9782-44-3-3-3
IR 9846-18-3	IR 10199-128-2	IR 11248-148-3-2-3-3
IR 13426-9-2-1	IR 13146-13-3-3-3	IR 13146-23-3
IR 13146-41-1	IR 13146-41-3	IR 17525-278-1-1-2
IR 17525-283-2-3-1	IR 19660-131-333	Tox 711-2-2-1-1
Tox 711-2-2-4-1	Tox 711-6-2-1-1	Tox 711-19-7-5-1
Tox 711-19-7-5-1	Tox 755-102-2-1-2	Tox 899-29-201-1
Vijaya Sel	Tox 915-102-2-1	Tox 938-101-2-2
X-3-D-T		

Leaf Scald (<u>Rhynchosporium oryzae</u>): The following varieties were resistant to leaf scald: 30-TV, BR 24-2-1, BW 248-1, IR 17525-278-1-1-2, KAU 1925

Brown Spot (<u>Drechslera oryzae</u>): The following varieties were identified as resistant to brown spot:

30-TV	32-XUAN-5-C	BR 24-2-1
BR 40-300-2-1	BR 161-2B-58	BW 248-1
CNM 31	CP2-C11	CR 131-3-1
CR 263-506	CR 1022	IET 4506

IET 7812	IR 36	IR 40
IR 42	IR 2823-399-5-6	IR 13535-21-2-3-3-2
IR 13540-56-3-2-1	IR 13564-95-1	MRC 301
MRC 603-303	Mutant	Nam Sagui
Ratnagiri 9-5-3-2	IR 2928-7-3-1-1	IR 3859-P5-160-1
IR 3275-P339-2	IR 330423	IR 3646-9-1-1
IR 4422-98-3-6-1	IR 4442-165-13-2	IR 4547-14-3-1
IR 5179-2-2-A1	IR 8192-166-2-2-3	IR 9411-5-3-3
IR 9782-144-3-3-3	IR 9846-18-3	IR 13426-9-2-1
IR 13358-73-1-1	IR 13429-196-1	IR 13440-6-3-3-1
RPW 1064-14-2-1	Taichung Sen Yu 129	Taichung Sen 10
TNAU 9478-6	TNAU 13613	UPR 103-44-2
UPR 830-8-1		

COORDINATED VARIETY TRIALS (CVT)

Dry Season Sahel Irrigated Short Duration trial

The dry season Sahel irrigated short duration trial of 1981-82 was conducted only at Korhogo (Ivory Coast). By design the entries of the 1981 main season trial were used. The trial was very well conducted and the yields were very high. 75-4830 showed the highest yield of 9.2 t/ha. This was followed by BR 13-47-3 and IR 2823-399-5-6, which gave 8.9 and 8.4 t/ha respectively. This yield pattern agreed with the results of the main season trial. It appears that these three varieties are equally good in the main and the dry seasons in the Sahel. In this test the local check variety Bouake 189 occupied fourth place giving 8.2 t/ha. The yield and other major characteristics are shown in Table 1.

Dry Season Moist Zone Irrigated Short Duration Trial:

The dry season moist zone irrigated short duration trial of 1981-82 was conducted at Sapu (Gambia) and Contuboel (Guinea Bissau) only. The entries of 1981 main season trial were used. IR 3273-P339-2 produced the highest average yield of 5.3 t/ha and was closely followed by MRC 505. In the main season trial of 1981, MRC 505 gave the highest yield and IR 3273-P339-2 produced the second best yield. IR 2042-178-1 occupied third position in yield in both main and dry seasons. It appears that these varieties are suitable in both main and dry seasons. Grain yields and other characteristics of the varieties are shown in Table 2.

Dry season Moist Zone Irrigated Medium Duration Trial:

The dry season moist zone irrigated medium duration trial of 1981-82 was conducted at 3 sites only and entries of the 1981 main season trial were used.

Three varieties namely, Nizersail, FARO 15 and FAROX 188A gave yields of 4.0 t/ha while IR 2071-586-5-6-3 and ITA 212 each produced yield of 3.9 t/ha. IR 4422-98-3-6-1 which gave highest yield of 5.0 t/ha in the main season of 1981 occupied sixth position in the dry season with a yield of 3.8 t/ha. ITA 212 which occupied second position in the main season was in fifth place in the dry season trial. These varieties, therefore, reacted diffently in the two seasons. The grain yield and other major characteristics are shown in Table 3.

Cold Tolerance Trial, 1981-82

The cold tolerance variety trial of 1981-82 dry season was sent to eight sites. The trial was well conducted at Kou (Upper Volta), Kamboinse (Upper Volta) and Kogoni (Mali). At Kou and Kamboinse, the daily mean temperature in December 1981 and January 1982 was not low enough to induce cold injury at the seedling stage. The yields of the varieties are however given in Table 4.

Table 1: Dry Season Sahel Irrigated Short Duration, 1981-82

Varieties	Grain yield (t/ha)	Maturity (days)	Plant height (cm)	# Panicles (per m2)
75-4830	9.2	130	98	251
BR 13-47-3	8.9	123	90	283
IR 2823-399-5-6	8.4	136	89	283
Bouake 189 (check)	8.3	131	111	275
B2360-11-3-2-9	7.9	124	110	292
B2360-8-9-5	7.8	124	109	257
IR 1529-430-3	7.8	124	100	276
IET 4247	7.1	118	95	309
IR 5179-2-2-A1	6.2	113	95	258
IR 9782-144-333	6.2	104	91	375
KN 361-1-8-6	5.8	106	140	265
Tos 4688	5.6	104	115	266
RASHT 448	5.6	116	93	245
B9C-MD-3-3	4.4	-	67	426
Tox 504-21-120-BB	4.3	116	127	198

Table 2: Dry Season Moist Zone Irrigated Short Duration Trial, 1981-82

Varieties	Grain yield (t/ha)	Maturity (days)	Plant height (cm)	# Panicles (per m2)
IR 3273-P339-2	5.3	157	87	423
MRC 505	5.2	155	87	467
IR 2042-178-1	5.0	150	89	490
Bouake 189	4.9	153	100	434
IET 3137	4.8	134	76	511
KN 144	4.7	148	92	381
B 541b-KN-19-3-4	4.7	151	98	432
CNM 31	4.4	138	75	477
Tox 514-16-101-1	4.2	142	92	428
MTU 8431	4.1	154	96	585
BR 168-2B-23	4.1	155	86	372
IR 2798-107-3	4.0	151	101	500
Tox 504-21-120-B-B	2.0	140	95	241

Savanah Upland Short duration Trial, 1982

In 1982, the Savannah Upland Short Duration Trial was conducted at nine locations in the short rainfall areas of the region. The performance of the trial and the yields of the varieties were good at almost all locations.

IRAT 144 gave the highest average yield of 3.2 t/ha, and matured in 100 days. Other entries showing high yields were: IRAT 142, IRAT 109 and DJ 12-539-2, each yeilding 3.1 t/ha.

IRAT 110 produced 3.0 t/ha. It is interesting to note that the IRAT varieties continued to maintain their superiority in yield in both the 1981 and 1982 seasons. IRAT 147 and ITA 150 were the earliest varieties, maturing in 94 days. IRAT 112 took 95 days to mature. Except DJ 12-539-2, which showed blast susceptibility at several locations, all other entries showed generally acceptable plant height. ITA 116, ITA 118, ITA 150 and ITA 235 showed lodging tendency at certain sites.

Table 3: Dry Season Moist Zone Irrigated Medium Duration Trial, 1981-82

Varieties	Grain yield (t/ha)	Maturity (days)	Plant height (cm)	# Panicles (per m2)
Nizersail	4.0	152	103	449
FARO 15	4.0	160	104	314
FAROX 188A	4.0	165	90	366
IR 2071-586-5-6-3	3.9	155	93	330
ITA 212	3.9	149	94	391
IR 4422-98-3-6-1	3.8	162	95	335
BW 248-1	3.7	138	87	349
ITA 123	3.6	137	83	336
B 2360-8-9-5	3.5	143	93	331
BG 375-1	3.4	143	102	350
BR 51-118-2	3.3	152	99	350
IR 13429-57-1	3.3	132	91	385
IR 9782-144-3-3-3	2.7	128	95	260
BR 13-47-3	2.5	135	104	260

Table 4: Cold Tolerance Trial, 1981-82

Varieties	Grain yield (t/ha)	Maturity (days)	Plant height (cm)	# Panicles (per m2)
IR 7176-33-2-3	4.1	133	109	202
Calrose 76	4.0	148	82	245
KN 1b-361-BLK-2-5	3.7	133	131	188
Fujisaka 5	3.7	146	83	223
Vijaya (check)	3.5	171	80	248
KN 998	3.3	148	93	265
IR 5467-2-2-2	3.3	148	114	225
KN 1b-361-179	3.2	145	112	177
IR 3941-86-2-2-1	3.2	145	105	230
IR 5867-45-2	2.9	142	109	221
KN 1b-361-BLK-13-9	2.8	147	118	155
KN 1b-BLK-13-6	2.7	148	116	181
KN 1b-361-8-6-9-2-6	2.6	145	119	168
KN 14-351	2.6	148	116	198
IR 7167-33-2-4	1.7	161	111	226

On the basis of yield, plant height, maturity, duration and phenotypic acceptability, IRAT 144 is considered the best adapted variety to Savannah conditions among the varieties tested so far.

The grain yield and other major characteristics of the entries are shown in Table 5.

Moist Zone Upland Short Duration Trial, 1982

The moist zone upland short duration trial of 1982 was conducted at 16 sites. The performance was good at 12 locations.

The average yield of varieties was low in 1982 due to poor yields at some sites. IRAT 109 gave the highest yield of 2.7 t/ha while DJ 12-539-2, IRAT 144, IRAT 133 and IRAT 110 produced yields of 2.6, 2.6, 2.7 and 2.5 t/ha respectively. The plant height of DJ 12-539-2 is probably not acceptable for upland.

ITA 132 and M55 slightly lodged at two sites while IRAT 109 and IRAT 144 slightly lodged at one site, probably because of their weak straw. DJ 12-539-2 and IRAT 133 were susceptible to leaf and neck blast at places where disease pressure was high, namely: Man, Odienne, Sagbovi-Dome, Rokupr and Suakoko. High grain sterility was observed at Man, Sotouboua, Sagbovi-Dome and Suakoko. Damage caused by birds and rodents was considerable at Sagbovi-Dome.

Variety x site analysis showed superiority of IRAT 109. The grain yield and other major characteristics are shown in Table 6.

Moist Zone Upland Medium Duration Trial, 1982

In 1982 the moist zone upland medium duration trial was conducted at 15 locations. The performance of the trial was good at 11 sites.

The average yield of varieties in 1982 was low. IRAT 104 gave the highest yield of 2.5 t/ha and was followed by IRAT 156 and IRAT 170, giving yields of 2.4 and 2.3 t/ha respectively. Five varieties, Sel. IRAT 19 4/1/2, IRAT 132, IRAT 162, IRAT 138 and IRAT 168 each produced 2.2 t/ha. With the exception of sites at Rokupr, Nyankpala, Sagbovi-Dome, Kenema and Ibadan, all these varieties gave yield over 3 t/ha.

Table 5: Savanna Upland Short Duration Trial, 1982

Varieties	Grain yield (t/ha)	Maturity (days)	Plant height (cm)	# Panicles (per m2)
IRAT 144	3.2	100	105	194
IRAT 142	3.1	101	01	202
IRAT 109	3.1	103	97	196
DJ 12-539-2	3.1	107	80	249
IRAT 110	3.0	98	92	200
IRAT 133	2.8	98	90	207
IRAT 146	2.8	96	97	197
M18	2.6	109	106	181
IRAT 112	2.6	95	102	175
IRAT 147	2.6	94	97	170
ITA 235	2.5	108	107	195
ITA 150	2.4	94	115	184
ITA 117	2.4	109	89	171
ITA 116	2.4	114	111	184

Table 6: Moist Zone Upland Short Duration Trial, 1982

Varieties	Grain yield (t/ha)	Maturity (days)	Plant height (cm)	# Panicles (per m2)
IRAT 109	2.7	103	97	178
DJ 12-539-2	2.6	107	80	222
IRAT 144	2.6	100	105	160
IRAT 133	2.5	100	89	166
IRAT 110	2.5	100	91	189
M55	2.4	112	105	151
IRAT 146	2.3	100	93	165
IRAT 112	2.3	99	98	167
ITA 117	2.3	105	90	195
ITA 132	2.2	112	108	148
Tox 502-13-SLR	2.0	109	118	158
DJ 11-541-1	1.8	111	64	224

IRAT 104, IRAT 156 and IRAT 168 showed lodging tendency at some sites probably due to their weak straw. The height of DJ 11-509 is too short for most upland areas. Also, DJ 11-509, C22 and R9-1-6-1-3-1-1 were susceptible to leaf blast. Several varieties showed susceptibility to brown spot and leaf scald diseases. The disease pressure was very high in 1982 at most sites.

Variety x site analysis showed the overall superiority of IRAT 104. The grain yield and other major characteristics of entries are shown in Table 7.

Table 7: Moist Zone Upland Medium Duration Trial, 1982

Varieties	Grain yield (t/ha)	Maturity (days)	Plant height (cm)	# Panicles (per m2)
IRAT 104	2.5	123	113	150
IRAT 156	2.4	121	112	154
IRAT 170	2.3	118	102	141
Sel.IRAT 194/1/2	2.2	121	56	154
IRAT 132	2.2	122	103	144
ITA 162	2.2	119	107	143
IRAT 138	2.2	117	98	148
IRAT 168	2.2	113	115	145
IRAT 169	2.1	116	107	166
IRAT 136	1.9	126	99	147
C22	1.8	126	100	195
ITA 256	1.7	124	87	145
DJ 11-509	1.5	107	63	215
R9-1-6-1-3-1-1	0.9	131	79	174

Table 8: Sahel Irrigated Short Duration Trial, 1982

Varieties	Grain yield (t/ha)	Maturity (days)	Plant height (cm)	# Panicles (per m2)
IR 2823-399-5-6	5.7	135	86	282
75-4830	5.7	138	97	245
84312	5.6	129	99	253
B 2360-8-9-5	5.5	135	106	269
IR 1529-430-3	5.2	128	94	269
IET 4247	5.1	124	89	289
IR 40	4.6	128	92	297
IR 9782-44-3-3-3	4.3	113	83	348
RASHT 448	3.9	122	88	243
C22	3.8	129	122	236
KN 361-1-8-6	3.6	128	125	242
BR 13-47-3	3.6	123	121	202
TOS 4688	3.1	120	101	230

Sahel Irrigated Short Duration Trial, 1982

The sahel irrigated short duration trial was conducted at eight sites in 1982. The trial was well conducted and the yields were good.

IR 2823-399-5-6 and 75-4830 gave the highest yield of 5.7 t/ha. This was followed by 84312 and B 2360-8-9-5 giving yields of 5.6 and 5.5 t/ha respectively. In 1981 also, 75-4830 gave the highest yield while IR 2823-399-5-6 ranked third in yield. IR 2823-399-5-6 gave a minimum yield of 3.4 t/ha and a maximum yield of 13.1 t/ha. The minimum and maximum yields for 75-4830 were 2.8 and 11.7 t/ha respectively. On the basis of yield, maturity and plant height, 75-4830 is probably a very good variety for the Sahel.

C22, KN 361-1-8-6, BR 13-47-3 and B 2360-8-9-5 are tall and showed lodging tendency at some sites. IR 1529-430-3 was susceptible to both leaf and neck blast. 75-4830 was moderately susceptible to leaf and neck blast. B 2360-8-9-5 was susceptible to neck blast. BR 13-47-3, C22, IET 4247 and IR 2823-399-5-6 were moderately susceptible to neck blast. All the entries showed resistance to brown spot and leaf scald diseases.

Variety x site analysis showed the superiority of IR 2829-399-5-6 and 75-48300 under different management levels or environmental conditions. The grain yield and other major characteristics are shown in Table 8.

Sahel Irrigated Medium Duration Trial, 1982

The trial was conducted at eight sites in the Sahel. The trial was very well conducted at most sites. IR 3273-P339-2 which ranked second in 1981 produced the highest average yield of 6.0 t/ha. ITA 230 which gave the second highest yield of 5.7 t/ha topped the list in 1981. The yield of IR 3273-P339-2 ranged from 3.1 to 13.7 t/ha, and that of ITA 230 from 2.7 to 11.2 t/ha. On the basis of yield, life cycle and plant height, these two can be considered as good varieties for the Sahel. BW 170 and BR 51-91-6 each produced 5.6 t/ha.

IR 3273-P339-2 showed susceptibility to leaf blast at Dapaong. Vijaya (selection) was susceptible to neck blast at Vallee du Kou. BW 170, IET 6496 and B 541B-PN-58-5-3-1 were moderately susceptible to neck blast at Vallee du Kou. ITA 230, BW 170 and ITA 232 showed moderate susceptibility to brown spot at one site. B 541B-PN-58-5-3-1, BR 51-46-5, BR 51-91-6, BR 51-319 and Improved Mahsuri lodged at certain sites. ITA 230 and ITA 232 showed lodging tendency. Disease incidence was higher in 1982 than in 1981.

Variety x sites analysis showed the superiority of IR 3273-P339-2 over other varieties under different conditions. The grain yield and other major characteristics of the entries are shown in Table 9.

Table 9: Sahel Irrigated Medium Duration Trial, 1982

Varieties	Grain yield (t/ha)	Maturity (days)	Plant height (cm)	# Panicles (per m2)
IR 3273-P339-2	6.0	137	95	288
ITA 230	5.7	133	96	263
BW 170	5.6	138	91	308
BR 51-91-6	5.6	140	117	272
BR 51-319-9	5.5	132	108	264
IET 6496	5.5	132	89	290
IET 6496	5.5	132	89	290
Vijaya (Selection)	5.4	136	90	264
COL 38	5.4	136	90	320
BR 51-46-5	5.4	133	106	272
IR 2072-586-5-6-3	5.2	136	92	302
ITA 232	5.2	132	101	245
B 541b-PN-58-5-3-1	4.9	142	108	270
Improved Mahsuri	4.6	138	121	256
IR 4442-165-1-3-2	4.4	129	88	262

Moist Zone Irrigated Short Duration Trial, 1982

This trial was sent to 13 locations and was well conducted at all places. The grain yield in general was good. B 541-KN-19-3-4 and Tox 526-19-SLR gave the highest grain yield of 5.1 t/ha. The yield of B 541-KN-19-3-4 ranged from 2.4 t/ha at Badeggi to 7.7 t/ha at Mission-Tove

Disease intensity in general was very high at most sites. B541-KN-19-3-4 was moderately susceptible to neck blast at Mission-Tove and to leaf scald at Suakoko. It showed resistance to other diseases at other sites. Varieties that were resistant to blast and brown spot at all sites are: IET 6056, Tos 103 and Tox 516-19-SLR. All entries except KN 144 showed some susceptibility to leaf scald at least at one site. Varieties which were moderately susceptible to brown spot at one site only are: BR 24-2-1, CR 1022, IET 3137 and IET 4506. These and other entries were resistant at other sites. BR 508-B2-9 lodged badly at five sites due to its weak straw. Stemborer damage was high at seven sites. BR 508-B2-9 gave high sterility of grains at two sites. The grain yield and other major characteristics of the entries are shown in Table 10.

Moist Zone Irrigated Medium Duration Trial, 1982

This trial was conducted at 13 locations. The grain yield in general was good. ITA 212 poroduced the highest yield of 5.6 t/ha and was closely followed by IR 4422-98-3-6-1 with yield of 5.5 t/ha. BW 248-1 and ITA 123 produced yields of 5.3 and 5.2 t/ha respectively. In 1981, IR 4422-98-3-6-1 gave the highest yield while ITA 212 and BW 248-1 ranked second and third respectively. The yield of ITA 212 ranged from 4.0 to 7.8 t/ha, and that of IR 4422-98-3-6-1 from 3.8 to 8.4 t/ha. ITA 212 showed moderate susceptibility to leaf and neck blast, brown spot and leaf scald diseases at few places but showed resistance at most sites. IR 4422-98-3-1 also showed resistance to diseases at most places.

The disease pressure was high at most places. All the entries showed moderate to high susceptibility to diseases at few places, but resistance at most places. BR 13-47-3, BW 248-1 and ITA 231 lodged at least at two places. Several varieties (ITA 212, BW 248-1, Bouake 189, FAROX 188A, IR 2071-586-5-6-3, ITA 245 and Nizersail) showed resistance to problem soil, particularly iron toxicity. The grain yield and other major characteristics of the entries are shown in Table 11.

Table 10: Moist Zone Irrigated Short Duration Trial, 1982

Varieties	Grain yield (t/ha)	Maturity (days)	Plant height (cm)	# Panicles (per m2)
B 541b-KN-19-3-4	5.1	123	99	287
Tox 516-19-SLR	5.1	127	94	282
BR 20-29-2	5.0	125	94	290
B 2360-8-5-LR-43	5.0	125	93	304
KN 144	4.9	121	99	269
CR 1022	4.8	131	93	307
BR 24-2-1	4.8	121	86	290
Tos 103	4.6	118	83	266
IR 2928-7-3-1-1	4.6	135	105	265
IET 6056	4.5	133	97	295
IET 4506	4.5	117	89	302
CNM 31	4.4	122	89	276
IET 3137	4.4	117	82	302
BR 508-B2-9	2.5	116	115	251

Table 11: Moist Zone Irrigated Medium Duration Trial, 1982

Varieties	Grain yield (t/ha)	Maturity (days)	Plant height (cm)	# Panicles (per m2)
ITA 212	5.6	126	95	285
IR 4422-98-3-6-1	5.5	132	103	278
BW 248-1	5.3	125	115	253
ITA 123	5.2	117	93	268
B 2360-8-9-5	5.1	127	104	289
BR 168-2B-23	5.0	127	95	269
ITA 231	5.0	124	103	280
Bouake 189	4.8	124	99	272
IR 2071-586-5-6-3	4.8	128	90	299
ITA 245	4.5	136	97	295
Nizersail	4.4	129	101	298
FAROX 188A	4.4	134	97	260
BR 13-47-3	3.6	115	116	251
IR 9782-144-3-3-3	3.4	107	86	308

Table 12: Mangrove Swamp Trial, 1982

Varieties	Grain yield (t/ha)	Maturity (days)	Plant height (cm)	# Panicles (per m2)
Moyamban 1	5.2	155	153	210
SL 22-617	5.1	153	153	230
Warkaiyo 1	4.9	151	152	208
ROHYB 12-4	4.8	131	149	223
Sentral Merah	4.7	148	172	183
Djabon	4.7	132	160	200
ROHYB 1-1	4.6	117	133	225
Kuatik Kundur	4.5	158	156	179
Kuatik Jambi	4.4	157	143	189
Padi Mentul	4.4	155	163	173
IR 3259-PS-1-10-1	3.9	136	89	191
IR 2797-125-3-2-2-2	3.5	140	100	205
IR 4712-113-3-1-2	3.3	126	98	270
IR 4707-148-1-3	3.0	125	93	194

Mangrove Swamp Trial, 1982

The mangrove swamp variety trial of 1982 was conducted at four sites, one each in Sierra Leone, Guinea Bissau, Guinea and Gambia. The grain yield was good. Moyamban 1 gave the highest average yield of 5.2 t/ha, followed by SL 22-617 and Warkaiyo 1 with yields of 3.1 and 4.9 t/ha respectively. The yields and other characteristics of the entries are shown in Table 12. The entries identified from local germplasm showed better yielding ability and general adaptability than the introduced varieties.

Deep Flooded Trial, 1982

In 1982, eight varieties were tested in the trial at six locations. At one site, there was not enough standing water to facilitate plant elongation. At the other sites, plant elongation was satisfactory. The grain yield and other performance were good at five sites. BKN 6323, which has been showing very good performance for the last two years, produced yield of 3.9 t/ha. BKN 6987-161-1-2 was found to be susceptible to leaf blast and gave the lowest grain yield of 2.3 t/ha. The yields of other entries were fairly good. BKN 7022-10-1-4 showed least elongation ability and therefore may not be suitable for deep flooded conditions. All other entries showed elongation ability under increasing water depths. The grain yield and other major characteristics of the entries are shown in Table 13.

Table 13: Deep Flooded Trial, 1982

Varieties	Grain yield (t/ha)	Maturity (days)	Plant height (cm)	# Panicles (per m2)
BKN 6986-38-1	4.0	145	115	211
ADNY 301	4.0	163	172	190
BKN 6323	3.9	148	117	205
BKN 6986-17	3.6	147	120	186
Baligrodak	3.4	142	152	189
BKN 6986-105-P	3.4	155	115	194
BKN 7022-10-1-4	3.2	146	99	202
BKN 6987-161-1-3	2.3	173	144	192

ON-FARM TRIALS

Each country was allowed a maximum of 10 trials to be funded by WARDA. Trials were conducted in all five zones. Four of the entries at each site were from WARDA coordinated variety trials while a local variety was used as the check.

ZONE I: (Gambia, Guinea-Bissau, Senegal)

In an upland trial at Jambeijelly, Gambia, the highest grain yield of 1120 kg/ha was obtained from the farmer's plot planted with Abdulai Mano (Table 14). The farmers however preferred DJ 11-34 because of its grain quality, panicle size and height over the IRAT varieties. The variety 144B/9 which is currently the recommended variety for upland condition in Senegal gave the highest yield in Bandeme, Senegal.

Other on-farm trials were conducted in the Gambia and Senegal under low land fresh water conditions.

At Jibanack and Kitty in the Gambia, the variety DJ 11-509 gave the highest yield of 5612 kg/ha and 2250 kg/ha respectively. The check variety in Jibanack and Kitty gave yields of 2954 and 0 kg/ha respectively.

In the Pa Kaliba trial (Gambia), the Chinese variety Peking came top with a yield of 2250 kg/ha. Although this variety and the IRAT varieties produced reasonable yields under lowland conditions where there was low standing water, the farmers still preferred the variety DJ 11-508 because of its high yield, short duration and medium size grain.

At Djitoukubon (Senegal), the variety I Kong Pao gave the highest yield of 5600 kg/ha, compared with the check variety yield of 2400 kg/ha. The farmers were impressed with the performance of the improved varieties, especially because of their earlier maturity.

Trials conducted at Delinabe (Mauritania) under irrigated conditions showed that, on the average of three sites, variety IR 1561-228-3 (average yield 5826 kg/ha) outyielded the check variety Taichung No.1 by 980 kg/ha. Management of irrigated plots was quite good and environmental conditions were conducive for high grain yield.

Table 14: Performance in 1982 On-farm Upland Trials at Janbeijelly (Gambia) and Bademe (Senegal)

Varieties	yield kg/ha	kg/ha/day	Increase over Farmer's plot kg/ha	Duration (days)
Janbeijelly, Gambia:				
DJ 8-341	1002	10.32	-	97
IRAT 110	869	9.41	-	95
IRAT 112	702	7.16	-	98
Abdullai Mano	1012	10.32	-	98
Abdullai Mano *	1120	11.09	-	101
Bandeme, Senegal:				
144B/9	2980	31.04	1800	96
IRAT 112	2120	22.08	940	96
IRAT 133	2280	23.50	1100	97
DJ 8-341	1060	10.93	-	97
144B/9 *	1180	12.16	-	96

* Farmer's own plot.

ZONE II: (Guinea, Sierra Leone, Liberia)

In 1982, ten on-farm trials were conducted in Guinea. In Sierra Leone, Zonal trials were conducted, and in Liberia, National Coordinated trials using WARDA coordinated variety nominations were conducted.

Results of the on-farm trials conducted in Guinea were not reliable and therefore are not presented in this report.

In Sierra Leone, Zonal trials were conducted by the Adaptive Crop Research and Extension Project (ACRE), in collaboration with the National Research Programme, using WARDA coordinated variety nominations. There were five trials conducted in four areas within the country.

The mangrove rice trials in the Rokupr area showed that two varieties, ADNY 301 (2464 kg/ha) and CP 4 (2096 kg/ha) from WARDA coordinated trials outyielded the local check (2086 kg/ha). Yield differences between improved (M1) and local (M2) management were 886 and 680 kg/ha for ADNY 301 and CP 4 respectively.

Results of the rainfed trials at Rokupr (Table 15) showed that ROK 16 and ROK 3 from WARDA Coordinated Variety Trials maintained their superiority over the check and other varieties. At Makeni ROK 3 and ROK 16 topped the varieties tested with yields of 1796 and 1254 kg/ha repsectively under improved management condition.

Results of the Kenema Zone are shown in Table 16. Improved management was superior to local management for all the varieties tested.

Results from the inland Valley Swamp in Kenema zone showed that Djabon and Mashuri, entries from WARDA coordinated trials, topped the yields with 3980 kg/ha and 3900 kg/ha respectively (Table 16). The Improved management gave yield increases of above 1,000 kg/ha for each of the three top yielding varieties.

Results of the trials in Kabala zone differed from those in Kenema. Variety Rohyb and the local check outyielded all other test varieties with yields of 2874 and 2836 kg/ha respectively. At this location improved management increased the yield of Rohyb, Mashuri and Djabon by 970, 1016 and 882 kg/ha respectively.

In Liberia, the National Programme conducted coordinated trials in place of on-farm trials. Many entries came from the WARDA coordinated variety trials.

The first type of trial evaluated yields and reaction to iron toxicity. Sixteen varieties were tested. Yields ranged between 2828 kg/ha for IET 3137 to 5164 kg/ha for CMBP 217. These two varieties and nine others were from WARDA CVT.

BG 90-2 which is one of the outstanding cultivars in WARDA trials ranked a poor

12th in yield. CMBP 217 which topped the list showed susceptibility to iron toxicity. Almost all the varieties showed iron toxicity score of above 2.

Yields were impressive in the medium duration trial. However one of the promising varieties from WARDA CVT, IR 2071-586-5-6-2, ranked a disappointing 15th out of 16 varieties. Four other varieties from WARDA CVT, BW 248-1, B 5426-BPN-68-9-2-2, ITA 123 and Suakoko 8 were tolerant to iron toxicity.

In an early duration upland wet season trial only five varieties gave grain yields of above 2000 kg/ha four of which had gone through WARDA coordinated trials (DJ 12-539-2 (2760 kg/ha), IRAT 13 (2603 kg/ha), IRAT 110 (2571 kg/ha) and IRAT 144 (2491 kg/ha)).

In a medium duration upland trial, six cultivars gave yields of above 2000 kg/ha. The top five varieties were entries from WARDA CVT. IRAT 138 topped the list with a yield of 3001 kg/ha.

Table 15: Grain Yields of Upland Varieties under two Levels of management - Rokupr, Sierra Leone

Varieties	Improved management kg/ha	Local management kg/ha	Difference kg/ha
ROK 16	2450	1618	832
ROK 3	2428	1643	783
Local check	1816	1536	280
Tox 502	1810	1202	680
Tox 737	1546	1068	478

Improved management = drilling, line planting, fertilizer application and pest control.
Local management = random planting, no fertilizer and no pest control.

Table 16: Grain Yields of Varieties in Inland Valley Swamp

Varieties	Improved management kg/ha	Local management kg/ha	Difference kg/ha
Djabon	3980	2688	1292
Mahsuri	2900	2152	1748
TOS 78	3736	2396	1340
Local check	3200	2628	168
Rohyb	3076	2508	568
Baligrodak	2832	2664	572

ZONE III: (Ivory Coast, Mali, Upper Volta)

The yields of upland on-farm trials obtained at Adzope, Ivory Coast, were rather low because of inappropriate fertilizer application and bird damage. Lodging was also observed in the case of IRAT 109. IRAT 144 tested by two farmers suffered from poor seedling emergence.

The on-farm irrigated trial yields were very satisfactory in the Ivory Caost, and yields were close to experimental results obtained at Korhogo, Dabu and San Pedro stations.

At Ferka and Korhogo, BG 90-2 yielded 8455, 8215 and 7420 kg/ha in three farmers' fields. Its lowest yield was 3932 kg/ha in a single field. Bouake 189B was appreciated by farmers because of its yield (7307 kg/ha) and its early maturity. The lowest on-farm trial yield was 3168 kg/ha.

Two new varieties identified from the WARDA coordinated trials at Korhogo, BR 13-47-3 and 75-4830, were tested for the first time in farmers' fields. Their performances were considered good. BR 13-47-3 produced a yield of 7542 kg/ha.

In Mali, only irrigated rice trials were suscessful. The deep flooded and floating rice trials failed due to inadequate rainfall and flood.

Lowland trials were conducted in Klela and Tien and the results are shown in Table 17. BH2 confirmed its susceptibility to water stress and leaf blast in the Klela trial.

Results for rice with partial water control, are shown in Table 18. The best 3 varieties, H15-23DA, IET 2885 and IET 2911, were those recently identified and recommended for short duration by the Agronomic Department of Mali. IET 2911, being susceptible to water stress and leaf blast, would be better suited to full water control conditions.

The 1982 results (Table 19) for the irrigated on-farm trials in Upper Volta were in line with those of the previous years. Varieties adapted to irrigated cultivation were used in developed and undeveloped lowlands where problems of water could be a limiting factor.

IET 1996 was of short duration (120 days), but was susceptible to blast, especially in the wet season. This could be a limiting factor for extension in the lowlands. Where there is lack of water at the beginning and at the end of the growth cycle, the extension agent might recommend for slightly flooded lowlands, the use of high yielding strictly upland varieties such as IRAT 144 and IRAT 147 which were recently recommended by CERCI extension agents. These two very early maturing varieties, which performed satisfactorily under short duration flooded conditions, also performed perfectly well under partly flooded lowland conditions, on constantly wet soil. Their yields are by far better (not less than 2.7) than the others because of better tillering and their resistance to lodging.

Table 17: Results of On-farm Trials at Klela and Tien in Mali

KLELA		TIEN	
Varieties	Yield kg/ha	Varieties	Yield kg/ha
IET 2885	3552	BH 2	1049
Gambiaka	3480	IET 2885	994
H15-23DA	2768	IET 2911	976
IET 2911	1472	Gambiaka	953
BH 2	736	H15-23DA	297

Table 18: Results of On-farm Trials at Mono, Kolongo and San in Mali (kg/ha)

	NONO				KOLONGO				SAN
Varieties	1980	1981	1982	Mean	1980	1981	1982	Mean	1982
IET 2885		3684	4112	3898		3100	2907	3003	2249
IET 2911	4000	4381	4016	4132	4876	4544	2878	4099	1482
H15-23DA	1792	4096	3760	3216	5160	3080	3626	3955	1116
Gambiaka		3738	3004	3371		2800	3312	3056	1996
BH 2	3562	3882	3251	3567	3772	2624	2500	2965	1718

Table 19: Yields of Irrigated On-farm Trials in Upper Volta

Sites	Varieties and Yields in kg/ha			
	BR 51-319-9	IR 1569-680-5	IET 1996	Local Variety
Bougouriba				
Sibera	4093	3886		3026
Holy	3223	5798		4446
Dolo		2110	2627	4155
Comoe				
Dakoro Plain		3652	4228	2736
Banfora		990	2040	1780
Hauts Bassins				
Banwoly	1456	625		416
Tondogosso				1200
Peni		1600	1535	
Central West				
Tensobentenga		3220	4330	
Baonere		4314	3452	3999
Central				
Kabouda		5500	5100	1110
Mean yield	2924	3169	3330	

ZONE IV: (Ghana and Nigeria)

Both irrigated and rainfed on-farm trials, were conducted in Ghana. There were eight irrigated sites and four rainfed sites. The varieties were selected from past WARDA coordinated trials and have been confirmed to be high yielding and resistant to pests and diseases.

The results for irrigated trials in Ghana are shown in Table 20. The four test varieties produced high grain yields at various locations. At the two sites at Vea, IR 42 topped in yield (4.20 and 4.12 t/ha respectively); at Tono IR 42 topped at the first location (4.02 t/ha) while IR 3273-P339-2 topped at the second location (6.40 t/ha). At Asutsuare, IET 2885 topped at the first location (7.28 t/ha). In the two locations at Ashiaman, BR 51-118-2 topped the varieties in yield (7.82 and 7.72 t/ha respectively).

At Vea I and Vea II, IR 42 was best preferred by farmers because of its high yield and good grain size, followed by IET 2885, IR 3273-P339-2 and IR 442 in that order. At Asutsuare I, the farmers preferred BR 51-118-2 because of its earliness.

The Rainfed on-farm trials in Ghana were conducted at four sites in two locations - Nabogo I, Nabogo II, Zuo I and Zuo II. Varieties chosen from the WARDA Coordinated Variety Trials were IRAT 110, IRAT 112, IRAT 13, IRAT 113, IB 99, MALAJ II and 4418.

At Nabogo I, IB 99 gave the highest grain yield of 2.4 t/ha while at Nabogo II, MALAJ II gave the highest grain yield of 2.4 t/ha. Both varieties performed considerably better than the check variety, IR 1820-210-2, which gave grain yields of 1.66 t/ha and 0.70 t/ha at Nabogo I and Nabogo II respectively

At Zuo, four varieties were tested at each of the two sites. MALAJ II and 4418 were common to both sites, while IRAT 13 was tested at Zuo I and IB 99 at Zuo II. At Zuo I, MALAJ II produced the highest grain yield of 1.32 t/ha, followed by the check variety IR 1820-210-2 and 4418, giving grain yields of 1.08 and 1.02 t/ha respectively.

Surprisingly the yield from the farmer's plot (1.0t/ha) was higher than the grain yields of IB 99 (0.74 t/ha) and IR 1820-210 2 (0.7 t/ha). Farmers at Zuo ranked 4418 as the best because of its good grain quality.

In Nigeria, there were National Rice Zonal Trials in which, by mutual agreement, 4-5 entries were WARDA nominations from the WARDA coordinated trials.

Irrigated Short Duration Zonal Trials were conducted at Badeggi and Edozhigi. Two entries from the WARDA Coordinated trials were among the top yielders. These were BR 51-46-5 and ADNY 11. BIPLAB topped the yield table at Badeggi (6.4 t/ha) and ITA 121 emerged as the best yielder at Edozhigi with 4.4 t/ha.

The mean grain yield showed BIPLAB (5.1 t/ha), BR 51-46-5 (5.0 t/ha), ITA 122 (5.0 t/ha) and ADNY 11 (4.9 t/ha) to be the top yielders. ADNY 11 was the earliest. ITA 212 was the only variety rated susceptible to gall-midge in a screening exercise at Edoz'igi.

The results of the Irrigated Medium Duration Zonal Trial at Badeggi and Edozhigi showed that the highest grain yielders were BG 90-2 (6.7 t/ha) at Badeggi and BR 51-118-2 (3.7 t/ha) at Edozhigi. On the average the best grain yielders were BR 51-118-2 (4.8 t/ha), IR 944-1023-2-3-2 (4.5 t/ha), BR 512-46-5 (4.3 t/ha) and BG 90-2 (4.3 t/ha).

Results of the National Short Duration Upland Zonal Trials conducted at Ibadan, Akure and Ikenne show that the top yielders at the various locations were Tox 86-1-3-1 (2.0 t/ha) at Ibadan, IR 1746-226-1-2 (3.49 t/ha) at Akure, IR 1746-226-1-2 (3.40 t/ha) at Ikenne, IR 30 and IR 1746-226-1-2 (4.08 t/ha) at Amakama. The best overall yielder was IR 1746-226-1-2 (3.03 t/ha). The variety 144B which came next to the highest yielder (3.3 t/ha) at Ikenne and Akure also has high potential because of its short duration.

Results of the National Medium Duration Upland Trials conducted at Ibadan, Akure, Ikenne and Amakama showed that the top yielders at various locations included Tox 4090-3-14-1-1 (2.33 t/ha) at Ibadan, Tox 4090-3-108-1-1 (3.69 t/ha) at Akure, Tox 4090-3-108-1-1 (3.67 t/ha) at Ikenne, and IR 2035-108-2 (4.85 t/ha) at Amakama.

Two varieties noted for drought tolerance at booting/flowering stage were IR 1529-430-3 and Tox 475-1-1-1 and gave average yields of 2.83 and 2.44 t/ha respectively.

ZONE V: (Niger, Benin, Togo)

In 1982, on-farm trials were not as successful as those of 1981. Out of 30 trials planned, only 19 produced satisfactory results due to various reasons, e.g. germination failure at Niaouli and Grand Popo in Benin, poor rainfall distribution and high incidence of blast at Sotouboua in Togo, and late floods at Kolo Moli in Niger. The results reported therefore relate to irrigated and upland trials with the latter being seriously affected by moisture stress.

In this Zone the local checks, which were invariably improved varieties, performed as well as the varieties being tested.

During coordinated trials in Niger, all the tested varieties produced yields averaging between 5 to more than 6 tonnes per hectare. In the on-farm trials the check, IR 1529-680-3 gave the highest yield at N'Douga I with 4.9 t/ha. The variety BR 51-46-5 gave the highest yield (5.7 t/ha) at N'Douga II. Considering the performance in the coordinated trials of IET 2885 across the region, its yield of 2.6 t/ha at N'Douga I was disappointing. BG 90-2 gave low yield at both sites.

Table 20: Performance of Varieties in Irrigated On-farm Trials in Ghana, Main Season 1982.

Varieties	Plant Height (cm)	Duration (days)	Yield (t/ha)	Per Day Yield (kg/ha)	Farmer's ranking
Vea I & II.					
IR 42	73	140	4.20	30.00	1
IET 2885	74	135	4.00	29.63	2
IR 3273-P339-2	76	130	3.28	25.23	3
IR 442 (check)	92	125	3.12	24.95	4
IR 42	74	142	4.12	29.01	1
IET 2885	74	132	3.90	29.55	2
IR 3273-P339-2	75	130	3.50	26.92	3
IR 442 (check)	94	125	3.16	25.28	4
Farmer's plot			3.22		
Tono I & II.					
IR 42	72	135	4.02	29.78	2
IET 2885	73	130	3.74	28.77	1
IR 3273-P339-2	78	135	3.44	25.48	3
IR 442 (check)	90	130	3.24	24.92	4
Farmer's plot			3.04		
IR 3273-P339-2	76	120	6.40	53.33	1
IET 2885	77	120	5.70	47.50	2
IR 42	79	130	4.70	36.15	3
IR 442 (check)	80	130	33.90	30.00	4
Farmer's plot			2.66		
Asutsuare I & II.					
IET 2885	92	135	7.28	53.93	2
BR 51-118-2	90	128	6.30	49.22	1
Thailand (check)	96	132	5.84	44.24	3
IR 42	86	139	5.62	40.43	4
Farmer's plot			3.84		
BR 51-118-2	+	127	3.90	30.71	
IET 2885	+	122	3.24	26.58	
Thailand (check)	+	124	2.76	22.26	
IR 42	+	120	2.26	18.83	
Shiaman I & II.					
BR 51-118-2	90	130	7.82	60.15	
IR 42	95	132	7.46	56.52	
IR 3273-P339-2	85	132	6.72	50.91	
DS 3 (check)	75	130	2.64	20.31	
Farmer's plot (DS 3)			2.60		
BR 51-118-2	90	125	7.72	61.76	
IR 3273-P339-2	92	127	7.64	60.16	
IR 42	90	127	6.64	52.28	
DS 3 (check)	87	125	6.54	52.32	
Farmer's plot (DS 3)			3.12		

TECHNICAL SUPPORT SERVICES

Seed Nursery Farm

The Seed Nursery Farm continued to perform its vital role in varietal introduction, improvement and seed production. The results and achievements during the period May 1982 to April 1983 are presented in this report.

In 1981, eight RGA (Rapid Generation Advance) crosses were introduced from IRRI and planted at Suakoko for plant selection. From these, 225 progenies were selected for inland swamp condition. These progenies were planted in 1982 and further plant selections were made (Table 21)

Table 21: RGA crosses and plant selections, 1982-83

RGA #	Generation in 1982	Parentage	# Progenies selected
2	F5	Aswina/IR 4432-103-6	82
13	F5	Fulkari/IR 4422-164-3-6	107
17	F5	Habiganj DW1/IR 4422-164-3-6	132
30	F5	Sungwala/IR 4818-70-1	118
33	F5	Nonasail/IR 2071-105-4	87
36	F5	IR 2307-217-2-3/BKN 6986-147-2	68
189	F4	Digha 489/BR 4	17
202	F4	Nizersail/BR 51-74-6	62
Total lines			673

In 1982, sixteen RGA crosses were introduced from IRRI and planted at Suakoko. The crosses were bulked since plant selection could not be made due to low numbers of populations in each cross. Seven crosses were in F4 and nine crosses in F5 generations. Twelve crosses involved rainfed lowland varieties and irrigated varieties and 4 crosses had an upland variety crossed with an irrigated variety.

In 1982, new varieties (539 upland and 967 irrigated) from IITA, IRRI and Bangladesh were introduced.

Varieties (97 upland, and 860 irrigated) selected from earlier introductions were planted for observation and seed increase.

Table 22: Number of varieties under seed increase, 1982-83

Location	Upland	Irrigated	Others	Total
Suakoko	56	126	28	210
Richard Toll	42	97	28	167
Total	98	223	56	377

From earlier observations a number of varieties were selected for seed increase for nomination to the IETs and CVTs. The number of varieties grown in large plots (100 sq.m each) at Suakoko and Richard-Toll are shown in Table 22. A total of 183 varieties were nominated to the trials. These comprised 60 for upland IET, 104 for irrigated IET and 19 for the CVTs.

Seed Laboratory

Over the past nine years the emphasis of the seed laboratory has been on the supply of high quality seed for various WARDA activities. However, the strategy of the laboratory in the year under review shifted more to seed quality diagnosis and control.

In 1982, a total of 1,807 varieties were processed out of which 252 varieties were selected for use as entries in the WARDA 1982/83 trials.

A total of 2,403 samples of rice were tested for viability prior to their selection and packaging for use in the various WARDA activities. For the 1982/83 trials alone, 12,692 packages of seed samples comprising about 1.2 tons of improved varieties were prepared and dispatched to 179 trial sites located in 16 countries in West Africa.

Results of experiments carried out with freshly harvested seeds of wild rices (O. longistaminata, O. barthii and O. staphii) suggest that dormancy in these species is probably due to the impermeability of the hull-pericarp complex to oxygen. Of all the treatments, nitric acid, hot-water soak, heat treatment and scarification, only the last was effective in breaking the dormancy. Amongs the various scarification methods tried, the combination comprising seed dehulling and scratching of the pericarp near the embryo gave the best result.

Also, under laboratory condition, the wild rices appeared to exhibit some resistance to the attack of a major storage insect, Sitophilus oryzae.

Table 23(a): Effect of Various Agronomic Practices on Grain Yields Under Upland Continuous Rice Cultivation At Suakoko, Liberia (High Rainfall Zone)

Agronomic Practices	Grain yield (t/ha)		Yield reduction from IP (%)	
	1981	1982	1981	1982
1. Complete Pakage (CP)	1.31	1.05	-	1
2. Intermediate Package (IP)	1.25	1.06		
3. IP-fertilizer	0.64	0.53	49	50
4. IP-weeding	0.65	0.56	48	47
5. IP-line sowing	1.26	0.91		14
6. IP-insect control	1.26	0.85		20
7. Traditional (control)	0.55	0.34	56	68
8. Traditional + bunding	0.60	0.36	52	66
LSD (p=0.05)	0.08	0.11		
CV (%)	5.80	10.4		

Table 23(b): Effect Of Various Agronomic Practices On Weed Population Under Upland Continuous Rice Cultivation At Suakoko, Liberia (High Raifall Zone)

	Number of various weeds at harvest per m2							
	Grasses		Sedges		Broadleaf		Totals	
	1981	1982	1981	1982	1981	1982	1981	1982
1. Complete Package (CP)	100	152	2	0	56	75	158	227
2. Intermediate Package (IP)	116	166	2	0	44	60	162	226
3. IP-fertilizer	108	150	2	0	61	54	171	204
4. IP-weeding	220	315	10	1	101	104	331	419
5. IP-line sowing	126	210	6	0	72	74	204	284
6. IP-insect control	114	154	3	1	43	75	160	230
7. Traditional (control)	206	293	9	3	59	78	274	374
8. Traditional + bunding	192	244	18	1	46	92	256	337

Agronomy

In a yield constraints study, using LAC 23, it was found that in a fallow-rice-rice-rice system, upland rice yields could be increased 200% over the traditional yield by a package of line sowing + fertilizer + weeding + insect pest control (IP). In the second and third crops in a bush-fallow-rice system, a high dose of nitrogen (60-90 kg N/ha) is needed to obtain grain yield between 1.5 and 2.0 t/ha.

In 1982, CP (CP = IP + water conservation by bunding) and IP treatments had significantly higher grain yields than the IP-insect control and IP-line sowing.

In both years, the yield reduction was highest in traditional method (56 to 68%) followed by IP-fertilizer (49 to 50%) and IP-weeding (47 to 48%), when compared with the yield of IP treatment. This showed that fertilizer application and weed control had maximum contribution to the grain yield (Tables 23a and 23b).

Results of trials on yield response of rice varieties to nitrogen levels in upland showed that yield of rice was highest in the first year of cropping and decreased in the second and third years of cropping despite the application of nitrogenous fertilizer (Table 24).

Using LAC 23 the following yield response surface curves were obtained in 1980, 1981 and 1982 respectively, where Y is grain yield in kg/ha and N is nitrogen level in kg/ha:

$Y = 1648.0 + 48.87N - 0.33N2$

$Y = 798.7 + 17.01N - 0.10N2$

$Y = 715.9 + 15.96N - 0.01N2$

The above three equations indicate that the yield response to applied nitrogen is almost linear in the range of nitrogen to applied nitrogen is almost linear in the range of nitrogen levels tested.

Table 24: Yield Response To Nitrogen in Upland Bush Fallow Rice Cropping Systems At Suakoko, kg/ha

Varieties	Nitrogen levels (kg/ha N)						
	0	20	30	40	60	90	Means
1980							
1. LAC 23	1648	2495	-	3081	-	-	2408
2. 4418	1019	2805	-	3567	-	-	2464
3. MRC 172-9	1090	3114	-	3257	-	-	2487
4. IR 2035-108-2	1128	2517	-	3024	-	-	2224
5. ROK 3	1462	1809	-	2381	-	-	1884
Means	1269	2548	-	3062			
1981							
1. LAC 23	789	1127	-	1285	1458	-	1165
2. 4418	989	1260	-	1449	1685	-	1346
3. C22	706	944	-	1386	1698	-	1183
4. IRAT 132	732	802	-	1053	1337	-	981
Means	804	1033	-	1293	1544		
1982							
1. LAC 23	720	-	1178	-	1667	2106	1418
2. Sel IRAT 194/1/2	735	-	1019	-	1485	1932	1293
3. LS(1)-19-1-1	542	-	939	-	1485	1909	1219
4. Tox 502-2SLR-LS2-5B	489	-	841	-	1212	1879	1105
Means	621	-	994	-	1462	1956	

Under lowland conditions, compound fertilizer (15-15-15) was the least effective source of nitrogen (Table 25). One application of Urea super granule or sulfur coated urea of various disolution rates at transplanting could give similar grain yield as commercial urea applied three times in lowland swamp.

Table 25: Effect of Various Sources of Nitrogen on Grain Yield of Suakoko 8 under Lowland Swamp Conditions at Suakoko, Liberia (1981 and 1982 Wet Seasons).

Sources of Nitrogen	1981			1982		
	Yield	Yield increase over control		Yield	Yield increase over control	
	kg/ha	kg/ha	%	kg/ha	++kg/ha	%
1. Control (no nitrogen)	2161	-	-	2037	-	-
2. SCU 14.8 DR, 36.7% N	3805	1644	76	3114	1017	53
3. SCU 22.0 DR, 36.7% N	3847	1686	78	3279	1242	61
4. SCU 34.5 DR, 37.8% N	3420	1259	58	3105	1068	52
5. SCU 20.7 DR, 38.6% N	3408	1247	58	3002	965	47
6. SCU 35.5 DR, 39.1% N	3387	1226	57	3035	998	49
7. Supergranule 1g, 46% N	3395	1234	57	3010	973	48
8. Supergranule 2g, 46% N	3408	1247	58	3014	977	48
9. Commercial Urea	3408	1247	58	3238	1201	59
10. (15-15-15) Fertilizer	2778	617	28	2534	497	24
LSD (p=0.05)	536			434		
CV (%)	11			10		

DR = dissolution rate

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 lowland swamp.

As far as direct effect on grain yield is concerned, Tunisia and Jordan phosphate rocks are as effective as triple super posphate, while Morocco and Togo phosphate rocks are less effective (Tables 26a, 26b, 26c and 26d).

Yield response to residual phosphorus was the highest in Jordan phosphate rock and lowest in triple super phosphate under lowland swamp conditions.

Table 26(a): Direct And Residual Effect Of Sources And Rate Of Phosphorus On Grain Yield Of IR 5 Under Lowland Swamp Conditions At Suakoko, Liberia. (1981 Wet And 1982 Dry Seasons)

Sources of phosphorus	p205 level kg/ha	Direct Effect (1981) wet season: Yield kg/ha	Direct Effect (1981) wet season: Yield increase over control kg/ha	Direct Effect (1981) wet season: Yield increase over control %	Residual Effect (1982) dry season: Yield kg/ha	Residual Effect (1982) dry season: Yield increase over control kg/ha	Residual Effect (1982) dry season: Yield increase over control %
1. Control	0	2819			3679		
2. Tunisia PR	20	3169	350	12	4600	921	25
3. Tunisia PR	40	3657	838	30	4709	1030	28
4. Tunisia PR	60	4556	1737	62	4751	1072	29
5. Jordan PR	20	3200	381	13	4529	850	23
6. Jordan PR	40	3550	731	26	4924	1245	34
7. Jordan PR	60	3916	1097	39	5062	1383	37
8. Morocco PR	20	3108	289	10	4691	1012	27
9. Morocco PR	40	3489	670	24	4811	1132	31
10. Morocco PR	60	3657	838	30	4829	1150	31
11. Togo PR	20	3108	289	10	4356	+677	18
12. Togo PR	40	3246	427	15	4607	+928	25
13. Togo PR	60	3520	710	25	4652	+973	26
14. TSP	20	3124	305	11	4201	+522	14
15. TSP	40	3505	686	24	4638	+959	26
16. TSP	60	3912	1093	39	4691	1012	27
LSD (p=0.05)					433	479	
CV (%)		8.7			7.3		

Table 26(b): 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 Season).

Sources of Phosphorus	Levels of phosphorus (kg/ha P205): 20		40		60		Means	
	1981	1982	1981	1982	1981	1982	1981	1982
1. Tunisia PR	3169	4600	3657	4709	4556	4715	3794	4687
2. Jordan PR	3200	4529	3550	4924	3916	5062	3555	4838
3. Morocco PR	3108	4691	3489	4811	3657	4829	3418	4777
4. Togo PR	3108	4356	3246	4607	3520	4652	3291	4583
5. TSP	3124	4201	3505	4638	3912	4691	3514	4510
Means	3142	4475	3489	4738	3912	4797		

LSD (p=0.05):

1981 source = 250 kg/ha
1982 source = 277 kg/ha

1981 levels = 194 kg/ha
1982 levels = 214 kg/ha

Table 26(c): Direct Effect Of Sources And Rate Of Phosphorus On Grain Yield Of IR 5 Under Lowland Swamp Conditions At Suakoko, Liberia. (1982 Wet Seasons)

Sources of phosphorus	p205 level kg/ha	Yield kg/ha	Yield increase over control kg/ha	%
1. Control	0	2898	-	
2. Tunisia PR	20	3151	253	9
3. Tunisia PR	40	3520	622	22
4. Tunisis PR	60	4348	1450	50
5. Jordan PR	20	3201	303	10
6. Jordan PR	40	3520	622	22
7. Jordan PR	60	3934	1036	36
8. Morocco PR	20	3134	236	8
9. Morocco PR	40	3387	489	17
10. Morocco PR	60	3569	671	23
11. Togo PR	20	3089	191	7
12. Togo PR	40	3267	369	13
13. Togo PR	60	3511	613	21
14. TSP	20	3159	261	9
15. TSP	40	3478	580	20
16. TSP	60	3892	994	34
LSD (p=0.05)		328		
CV (%)		7		

Table 26(d): Direct Effect Of Sources And Levels Of Phosphorus On Grain Yield Of IR 5 IN Lowland Swamp at Suakoko, Liberia. (1982 Wet Season).

Sources of	Levels of phosphorus (kg/ha P205) 20	40	60	Means
1. Tunisia PR	3151	3520	4348	3673
2. Jordan PR	3201	3520	3934	3552
3. Morocco PR	3134	3387	3569	3363
4. Togo PR	3089	3267	3511	3289
5. TSP	3159	3478	3892	3510
Means	3147	3434	3851	

LSD (p=0.05): Source means = 189 kg/ha
Level means = 147 kg/ha

Considering the mean grain yield of the 1981 and 1982 wet seasons, the effectiveness (direct effect) of sources of phosphorus could be arranged in the following descending order:

- Tunisia and Jordan phosphate rocks and triple super phosphate;
- Morocco and Togo phosphate rocks.

The two years' results showed, as far as direct effect on grain yield is concerned, that Tunisia and Jordan phosphate rocks are as effective as triple super phosphate while Morocco and Togo phosphate rocks are less effective.

The economics of direct and residual effects of various sources and levels of phosphorus are still to be worked out. The residual effect trial of phosphorus on grain yield in the 1983 dry season is in progress.

In a collaborative experiment between IITA and WARDA during the 1982 dry season, it was shown that some rice cultivars such as ITA 239, ITA 243, ITA 245, ITA 250 and ITA 254 gave significantly high grain yields (yields varied between 5.0 and 5.3 t/ha) than the local check Suakoko 8 (3.8 t/ha) which is tolerant to iron toxicity. Leaf blast incidence increased with increase in the level of applied nitrogen from 60 to 120 kg N/ha for most of the rice cultivars. There was no significant difference in grain yield between 60 kg and 120 kg N/ha (Table 27).

It may be inferred from the above studies that in iron toxic swamp, a moderate level of nitrogen application (40 to 60 kg N/ha) may be needed for higher grain yield.

Further field trials using some cultivars (especially ITA series) which exhibited better yield performance than Suakoko 8, an iron toxicity tolerant cultivar, will be conducted in the 1983 wet season.

Table 27: Effect of Nitrogen On Grain Yield Of Rice In The Dry Season Under Lowland Iron Toxic Swamp Conditions At Suakoko, (1982).

Varieties	Days to 50% flowering	Blast scores		Yields in kg/ha		Mean yield kg/ha
		At 60 kg/ha N	At 120 kg/ha N	At 60 kg/ha N	At 20 kg/ha N	
1. BG 90-2 *	93	2	3	2741	4206	3473
2. FARO 15	115	1	1	5095	5264	5179
3. ITA 234	95	3	4	1561	1545	1553
4. ITA 236	98	1	2	2529	4005	3267
5. ITA 237	99	1	3	3651	3688	3669
6. ITA 239	112	1	1	5545	5021	5283
7. ITA 241	121	1	3	4905	4640	4772
8. ITA 242	117	1	1	4931	5635	5283
9. ITA 243	115	1	3	4677	4672	4674
10. ITA 245	117	1	2	5127	4873	5000
11. ITA 247	125	1	3	4995	4979	4987
12. ITA 250	115	1	2	5169	4788	4978
13. ITA 252	121	1	3	4915	5090	5002
14. ITA 253	118	1	3	4936	4587	4761
15. ITA 254	118	1	1	4730	5333	5031
16. Suakoko 8 **	105	1	2	3899	3799	3849
Means				4338	4508	

* Check

** Local check

Table 28: INCIDENCE OF RICE DISEASES IN THE REGION (Up-dated from Anon, 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		x		
Leaf blast	" "	x		x	x	xx	x	xx	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
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	x	x	
VIRUS AND BACTERIAL DISEASES																
Bacterial leaf Streak	*Xanthomonas translucens* f.sp. *oryzicola*		x		x	x	x	x	x	x				x		
Bacterial blight	*Xanthomonas oryzae*				x		x		x	x	x	x				
Plae yellow mottle	Virus		x		x							x	x			
NEMATODE DISEASES																
White tip	*Aphelenchoides besseyi*	x		x	x					x	x	x	x			x
Stained Root Rot	*Hirschmanniella oryzae*									x		x				
Rice Root Cyst	*Heterodera* sp.				x											
Rice stunt	*Tylenchorynchus* sp.									x	x					

Entomology

In collaboration with technicians at the Special Research Projects, activities were carried out in the area of planning and implementing rice entomology programme, data collection, processing and analyses of experimental results at Richard-Toll (Senegal); Mopti (Mali) and Bouake (Ivory Coast). Results of the research activities are detailed in relevant sections in the report of each of the Special Research Project Centres.

A monitoring tour to Gao, Mali, identified the following problems affecting rice in the area:

- a floating rice straw phenomenon probably caused by stemborer
- drying of leaf tips probably caused by bacterial leaf blight
- white heads probably caused by Chilo zacconius
- bird damage.

A trip to Bobo-Dioulasso, Upper Volta, revealed that the gall midge, Orseolia oryzae, was the most serious insect pest of rice in the area, with about 70% of tillers affected. Since insecticides were not effective in controlling the midge a set of IRRI gall midge nursery, containing 190 entries, was handed over for screening in a joint WARDA/National Research collaborative work. 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 midge.

Pathology

The incidence of rice diseases was monitored in Ivory Coast, Mali, Niger, Sierra Leone, Guinea, Nigeria and Senegal. Observations made from these trips plus reports from the Sub-regional Coordinators were used in updating the geographical distribution of rice diseases in West Africa shown in Table 28.

In Sadia (Niger), bacterial blight (Xanthomonas oryzae) was found on the rice variety Tchounchen 22 with the seedlings badly affected and giving rise to the Kresek stage. In Fadama about 2 hectares were badly affected.

Variety D52/37 developed for the shallow flooded ecosystem and adapted to the irrigated ecosystem did not exhibit any symptoms of infection.

In Kirikisoi and Saga, a similar trend of infection was observed.

Bacterial blight was also found to be severe in Libore and Tilleberi on dwarf varieties, especially at the seedling stage (Kresek). The varietal reactions to diseases are shown in Table 29.

Table 29: Reaction Of Some Rice Varieties To Bacterial Blight And Other Major Diseases In Libore And Tilleberi, Niger.

Varieties	BB	LSC	LB	NR	BS
D52/37	HR	HR	HR	HR	HR
IET 22	HR	HR	HR	HR	HR
IR 1529	HR	HR	HR	HR	HR
Sintane Diofor	MR	HR	HR	HR	HR
Tchounchen 22	S	HR	HR	HR	HR
IET 15	HR	HR	HR	HR	HR
IR 15	MR	HR	HR	HR	HR
IR 22	MS	HR	HR	HR	HR

BB = Bacterial Blight
LSC= Leaf Scald
LB = Leaf Blast
NR = Neck Rot
BS = Brown Spot

HR = Highly resistant
R = Resistant
MR = Moderately Resistant
MS = Moderately Susceptible
S = Susceptible

It is suspected that the primary source of infection was from the seed-borne bacterium. At Fadama infection was found to have spread from a heavily infected area through a field planted to the resistant cultivar D52/37 to another plot planted to a susceptible variety, Tchounchen 22, where infection progressed from the point of entry of water to the centre of the field.

Eight varieties selected for multiplication from the 1977 trial at Libore and Tilleberi were assessed for disease incidence and were rated as resistant to leaf blast, leaf scald, neck rot, and bacterial blight. These were BR 51-46-5, BW 78, ADNY 11, BG 90-2, BKN 6986-59P, IR 3273-3392-12, H5 and IR 1529-680-3.

In the Gao region of Mali, a progressive death of leaf tips followed by whitish symptoms associated with bacterial leaf blight (Xanthomonas oryzae) was also observed.

No fungal disease was found on any of the varieties grown in both Nianga and Fanaye (Senegal). However, varying levels of bacterial infection were observed on the rice variety I Kong Pao which was being grown under different doses of fertility (Table 30).

Table 30: Reaction of I Kong Pao to Bacterial Blight Under Different Nitrogen:Compost Ratios

Nitrogen Compost Ratio	Bacterial Blight Score	Host Reaction
0:10	2	R
120:20	4	MS
120:0	4	MS
180:0	5	S
180:10	5	S
180:20	5	S
120:10	4	MS
0:0	2	R
60:0	3	MR
60:20	3	MR
60:10	3	MR
0:20	2	R

Results of a joint study by WARDA, IITA and the National Research Programme of Liberia at Suakoko, to assess the performance of 16 rice cultivars obtained from IITA for their reaction to diseases at 2 different levels of nitrogen application showed that most of the varieties had increased rice blast disease incidence as the level of nitrogen increased from 60 to 120 kg N/ha (Table 27). All the varieties exhibited highly resistant to resistant reactions, except ITA 234 which exhibited only moderately resistant reaction at 60 kg N/ha.

The fungicides PP 389, Kocide and Benlate were tested for their efficiency against blast disease at Suakoko using the rice variety C 22.

The effect of treatment on grain yield was significant. PP 389 gave significantly higher yield (5,255 kg/ha) than Kocide (4,775 kg/ha), Benlate (4,362 kg/ha) and the control (2,725 kg/ha) but the yield difference between Kocide and Benlate was not significant. PP 389, Kocide and Benlate showed neck blast effeciency of 66.7, 44.5 and 33.3% respectively (Table 31).

Table 31: Efficiency of PP 389, Kocide and Bellate on the incidence of Neck Blast on C22 Rice Cultivar.

Treatments	Grain Yield kg/ha	Increase over Control kg/ha	Increase over Control %	Average No. Of tillers per m2	Average No. Of tillers with neck blast / m2	Neck blast Control efficiency (%)	Neck blast rating (0-9)
PP 389	5925	3200	117	121	6	66.7	3
PP 389	5925	3200	117	121	6	66.7	3
Kocde	4775	2050	75	119	10	44.5	4
Benlate	4362	1637	60	120	12	33.3	5
Control	2725			120	18	-	7
LSD (.05)	146						

Two hundred and fifty-six rice varieties from IRRI were screened for their resistance to blast in the seed nursery farm at Suakoko. Ninety varieties exhibited a highly resistant reaction.

Germplasm Programme

In 1982, emphasis was placed on the development of the germplasm bank. A total of 1500 cultivars were registered and properly stored in the germplasm bank. Characterization of the cultivars has been initiated.

International Rice Testing Programme (IRTP)

In 1982, 157 sets of 23 different types of nurseries were dispatched to cooperators in West Africa. However the majority of the nurseries planted in 1982 were the 1981 nurseries. Many promising cultivars have been identified from these nurseries. Some have been selected by national scientists for further yield trials or for hybridization. Several have been nominated into WARDA trials.

The yield nurseries, IRYN-VE and IRYN-E were reported from NCRI, Badeggi, Nigeria and IRYN-M were reported from Badeggi and Rokupr, Sierra Leone. At Rokupr, four entries were selected for local testing (BG 400-1, BIET 360, BR 51-282-8 and IR 54). IR 42 was selected as a parent for hybridization.

Results of IURYN 1981 were reported from Bouake, Ivory Coast. There was severe neck blast. Local check was IRAT 13. Nine entries gave higher yield than the local check IRAT 13 (2.6 t/ha).

As in the previous years only a limited number of the 1982 nurseries were planted during the same year.

The results of the nurseries obtained through WARDA and IRRI/Africa Liaison Office up to April 8, 1983 are briefly reported.

Results of IRYN-VE 1982 were reported from two locations, Badeggi and IITA (Nigeria). At IITA, IR 50, IR 9752-71-3-2 and BG 276-5 gave significantly higher yields than local check TOS 78 (IR 269-26-3-3-3), which has been named FARO 26 in Nigeria.

Results of IRYN-E 1982 were reported from two locations, Badeggi and IITA (Nigeria). In IITA and Badeggi the average yields of the top five entries were 5.4 and 2.8 t/ha respectively.

Results of IRYN-M 1982 were reported from two locations, Badeggi and IITA (Nigeria). At IITA, IR 54 gave significantly higher yield than the local check ITA 212. IR 54, IR 19670-263-3-2-2-1 and BG 400-1 were among the top five yielders at the two locations.

Results of IRON 1982 were reported from 2 locations, Suakoko (Liberia) and IITA (Nigeria). At both locations several promising entries have been selected for further evaluation.

Results of IRLRON 1982 were reported from IITA, Nigeria. There was severe incidence of leaf blast.

The results of Iron Toxicity Screening (1982) were received from 2 locations, Suakoko (Liberia) and Itoikin (Nigeria). At Itoikin, scores were taken at flowering stage only, but at Suakoko scores were taken at 4, 8, 10 and 12 weeks after transplanting. At Suakoko all the entries were less resistant than the local check Suakoko 8.

SPECIAL RESEARCH PROJECT FOR UPLAND RICE AT BOUAKE, IVORY COAST

Upland variety improvement work continued at Bouake in collaboration with IRAT/IDESSA/DEV. The one WARDA staff (French Technical Assistance) was engaged in the conduct of WARDA's network of trials and IRTP nurseries in Ivory Coast.

Other activities included:

- Yield stability studies;
- Varietal evaluation in low fertility areas;
- Relative productivities of upland short and medium duration varieties; and
- Screening for grain discoloration.

Results of WARDA trials and IRTP nurseries are discussed elsewhere.

Yield Stability Studies

WARDA's network of coordinated varietal trials provided a rich source of information for this study which was based on homogeneous rainfall and cropping regime. Four zones were defined as follows:

- Zone I: Short monomodal rainy season. It is likely that drought period which sets in at the end of the growth period would affect long duration varieties;
- Zone II: Long monomodal rainy season. It is not likely that moisture stress would pose a problem;
- Zone III: Bimodal rainfall regime. Rice is sown during the first rainy season and heads during the second rainy season. Drought might affect the crop particularly during the tillering to booting stages;
- Zone IV: Bimodal rainfall regime. Rice is sown and heads in the first rainy season. Moisture stress would more likely not be serious, but could affect the crop towards the end of the growth period.

Coordinated trials results over several locations and years in Ivory Coast provided the data for this study.

For each zone, the yields of varieties were regressed on environmental indices derived from a composite check (i.e. means of the varieties that were present in all the trials involved). Rigorous standards were maintained for the inclusion of a trial or variety in the analysis: e.g. all trials included were under strictly upland conditions, of acceptable management and precision and furnished the composite check. Furthermore, a variety was included only if it was tested in a sufficient number of trials.

The following varieties demonstrated a high degree of yield stability:

	Zone I	Zone II	Zone III	Zone IV
Short duration	IRAT 144 IRAT 142	IRAT 144 IRAT 109	IRAT 144 IRAT 109	IRAT 109
Medium duration		IRAT 104 IRAT 13	IRAT 104 949 M	

Lodging as a Function of Yield

A study was conducted to relate lodging to yield. Lodging indices for IRAT 13 and IRAT 170 varied little from 0 to 4, on a 0-9 scale, for yields between 3 to 5 t/ha. Lodging index for IRAT 156 varied across the entire 0-9 scale for yields between 3 to 4.5 t/ha while that of IRAT 104 varied from 2 to 7 for yields between 3 to 5 t/ha.

Varietal Evaluation in Low Fertility Areas

The objective of this study was to evaluate promising varieties under conditions which are typical of present day peasant farmers of West Africa. Expected yields were around 1 t/ha. This low yield was however not due to unforeseen circumstances but was simply a result of low level cultural practices, vis: no fertilizer, no insecticide, inadequate weed control etc.

Five low fertility trials were conducted in 1982 in Ivory Coast for promising early and medium duration varieties. Results shown in Tables 32 and 33 were subjected to yield stability analysis using the means of the indicated reference varieties as composite check.

The factors which contributed to low yields were:

- poor soil chemical properties and acidity at Man II; and
- Acidity, moisture stress and especially incidence of termites at Bouake I and Bouake II.

Among the early maturing varieties IRAT 144 and IRAT 109 maintained their superiority.

Table 32: Grain Yield (t/ha) of Short Duration Entries in Low Fertility Trials

Varieties	Bouake I	Bouake II	Man I	Man II	Odienne	Means
IRAT 144*	0.80	1.17	0.89	0.68	1.63	1.04
IRAT 109*	0.61	0.93	0.81	0.53	2.09	0.99
IRAT 112*	0.51	0.63	0.63	0.31	1.72	0.76
Dourado Precoce	0.51	0.42	0.44	0.17	1.65	0.64
Reference mean	0.64	0.91	0.78	0.51	1.81	

* Reference varieties.

Table 33: Grain yield (t/ha) of Medium Duration Entries in Low Fertility Trials

Varieties	Bouake I	Bouake II	Man I	Man II	Odienne	Means
IRAT 104*	0.48	0.62	2.69	1.19	1.83	1.36
IRAT 156*	0.46	0.49	2.09	1.35	1.64	1.21
IRAT 13	0.18	0.35	1.52	1.28	1.62	0.99
IRAT 170*	0.27	0.44	1.69	0.87	1.80	1.01
IR 3646-8-1-2	0.81	0.64	2.41	0.76	0.90	1.10
949 M	0.25	0.45	1.65	0.84	1.59	0.96
Iguape Cateto	0.38	0.39	1.93	0.94	1.66	1.06
Reference mean	0.40	0.55	2.16	1.14	1.76	

* Reference varieties.

In the medium duration trials IRAT 104 and IRAT 156 demonstrated a high degree of yield stability. However the best variety in Bouake was IR 3646-8-1-2. It was termite "tolerant" because of its high tillering. It also performed well at Man but was poor at Odienne where blast incidence was heavy. 949 M whose performance is generally equal to that of IRAT 104, without lodging, produced low yields.

The new varieties being recommended to farmers performed better than the old, Iguape Cateto and Dourado Precoce, under good management. It would be noted here that even under low fertility conditions these varieties performed at least equally well or better than the varieties they are replacing.

Relative Productivities of Short and Medium Duration Varieties in West Africa

Early maturing or short duration varieties have generally been considered as being less productive than the long and medium duration varieties. This opinion which is frequently expressed verbally is also found in documents on extension.

Results obtained with new upland rice varieties developed in West Africa did not always agree with this opinion. Results of multi-locational trials conducted over 3-4 years were analysed to ascertain the fact especially for the benefit of extension agents.

Medium duration varieties used were: IRAT 104, IRAT 13 and IRAT 170. Their maturity duration from seeding was about 130 days. The short duration varieties included were: IRAT 144, IRAT 109 and IRAT 110 with about 105 days duration.

Table 34: Yield Differences (yield of medium duration varieties minus yield of short duration varieties), t/ha

Years / Locations	1979	1980	1981	1982
Zone I:				
Contuboel	-2.17	-2.57	-0.82	
Sefa			-1.83	
Farako-Ba		-2.77	-1.59	
Zone II (Forest Savannah):				
Odienne	-0.08, -0.09	-0.35	+0.40	-0.60, -0.11
Touba	+0.43	+1.19	-0.39	
Boundiali	-0.90	-0.47		
Man		+0.88	+0.64	+1.63, +0.81
Zone II (Wet Forest):				
Rokupr	-0.36	+0.15	+0.56	
Kenema	+0.51	+0.08		
Suakoko	+0.98	-0.43	-0.03	
Zone III:				
Bouake	+0.64	-0.57	+0.56	-0.40, -0.59
Beheke	+0.28	-0.15	+0.31	
Dianra	-0.27	-1.10		
Katiola	+0.71	-0.46		
Niakaramandougou		+0.70		
Tienigboue		+1.60		
Zone IV:				
Ibadan	-0.74		+0.34	
IITA	-2.65	+0.37	+0.22	
Ikenne	+0.24	-1.20		

This study was also based on homogeneous rainfall and cropping regimes as described earlier.

Results were obtained from 3 trials networks, namely:

- Savannah Institute, Ivory Coast - IDESSA network covering Zones II, III and IV;
- Ivorian Textile Development Corporation - CIDT network covering Zones I, II and III in Ivory Coast; and
- WARDA network covering all the zones in many countries.

Pairs of mean value were obtained from trials in which varieties of the two durations (early and medium) were grown in the same location and year. It was verified that the agent conducting the trial in a location sowed the seeds under conditions favourable for each type of variety especially with respect to the seeding date and that there were no problems relating tc soil fertility and cultural practices.

Sometimes many trials were conducted at the same location and in the same year. In this case, the mean of all results was used excluding results of trials conducted under highly different conditions. At times, there were only one or two of the selected varieties used in a trial. In that case, results obtained were used, nevertheless, since yield differences between the three selected varieties were small, about 5 to 10%. Results are shown in Table 34.

One finds two situations where:

- Early maturing varieties perform better than medium duration varieties; and
- Medium duration varieties perform better than early maturing varieties.

1) Where early maturing varieties performed better than medium duration varieties: This was observed in Zone I (Sefa in Senegal, Contuboel in Guinea Bissau and Farako-Ba in Upper Volta). For all six pairs of results, the early maturing varieties performed better than those of medium duration. Yield differences between durations were significant by a t-test. This was expected. It is known that in the regions with short rainy season, varieties with growth duration exceeding 110 days would not have time to complete their growth period before drought sets in.

The yields of short duration varieties were more often higher than those of medium duration varieties in Zone IV represented by sites in Nigeria. The difference in this case was not significant.

Conclusions are similar to those obtained in Zone I. Varieties used during the first rainy season need to mature between 90-120 days. This is long enough for the development of short duration varieties but may be inadequate for medium duration varieties.

2) Where medium duration varieties performed better than short duration varieties: This was the case in Zones II and III and it is what was expected. However, the differences were very small and not significant: about 200 kg or 8% on the average.

A bigger difference was expected in Zone III. In the bimodal rainfall zone, there is a fairly severe moisture stress corresponding to the short dry season which coincides with the tillering stage. Since the tillering stage of medium duration varieties is twice longer than that of short duration varieties, it is believed that this long period makes it possible for medium duration varieties to tolerate moisture stress. This effect is perhaps less important than previously thought.

The rainy season in Zone II is sufficiently long and the rains abundant so that drought is not a limiting factor. This zone covers two series of fairly different conditions:

- Odienne, Touba, Man, and Boudiali, located in the transitory forest-savannah zone with a relatively moderate rainfall, where average yield of medium duration varieties was 3.15 t/ha, while average yield of short duration varieties was 3.95 t/ha; and
- Rokupr, Kenema, and Suakoko, located in the very wet forest zone where average yield of medium duration varieties was 2.01 t/ha and average yield of short duration varieties was 1.87 t/ha.

Given varieties presently available, the notion that medium duration varieties produce higher yields compared with short duration varieties does not seem to be true for all sites and rainfall zones. On the other hand, these results indicate the need for plant growth to be well adapted to the rainfall regime.

Results obtained in Zones II and III have shown that if a medium duration variety could not be seeded in time, a short duration variety should be sown in place. For cases where the yield difference between different growth periods is small, two possibilities arise:

- Allow heading to coincide with the period when rain is most likely to fall;
- Select varieties on the basis of the organization of work on the farm, availability of equipment, weather conditions, etc.

For instance in Zone III, it is certainly advisable to sow a short duration variety at the end of June instead of hurrying land preparation to sow a medium duration variety under less than optimum conditions at the beginning of June. The possibility of growing 2 crops a year could also be considered.

In Zone II, the advantage of medium duration varieties is that they make it possible to undertake land preparation activities, se.ding and harvest under favourable conditions at the beginning and at the end of the rainy season.

Screening for "Stained Grain"

A study conducted in 1982 showed that "stained grain" had considerable effect on yield at least when there was a large number of grains affected.

Screening results of trial IURYN 1981, conducted in Bouake in 1982 are presented below.

One hundred grains of each variety were examined in 2 replications and the number of stained grains was recorded.

Varieties	% Stained grains	Varieties	% Stained grains
Seratus Walam	57	B 2493-KN-10-1-1-1	32
IR 9671-1-4-6-8	55	IR 5931-110-1	30
IR 52	51	IR 9101-124-1	30
B 733C-167-3-2	47	ITA 117	27
IR 6115-1-1	46	ITA 235	25
IR 4505-4-1-2	45	IR 9782-111-2-1-2	24
UPL RI-3	39	IR 3646-8-1-2	22
Sein Talay	37	IR 6023-10-1-1	18
CR 165-5021-207	37	BPI RI-6	11
UPL RI-5	34	ITA 225	11
IR 43	32	ITA 118	9
IR 5260-1	32	ITA 116	6

SPECIAL RESEARCH PROJECT FOR DEEP WATER
AND FLOATING RICE, MOPTI, MALI

The broad objective of deep water and floating rice research project at Mopti in Mali is to develop improved varieties and cultural practices in the form of production packages which are adapted to the West African environment and can profitably enhance farmers' yields.

The emphasis has been on adaptive research comprising programmes in varietal improvement, agronomy, weed control, entomology and research extensioin on farmers' fields.

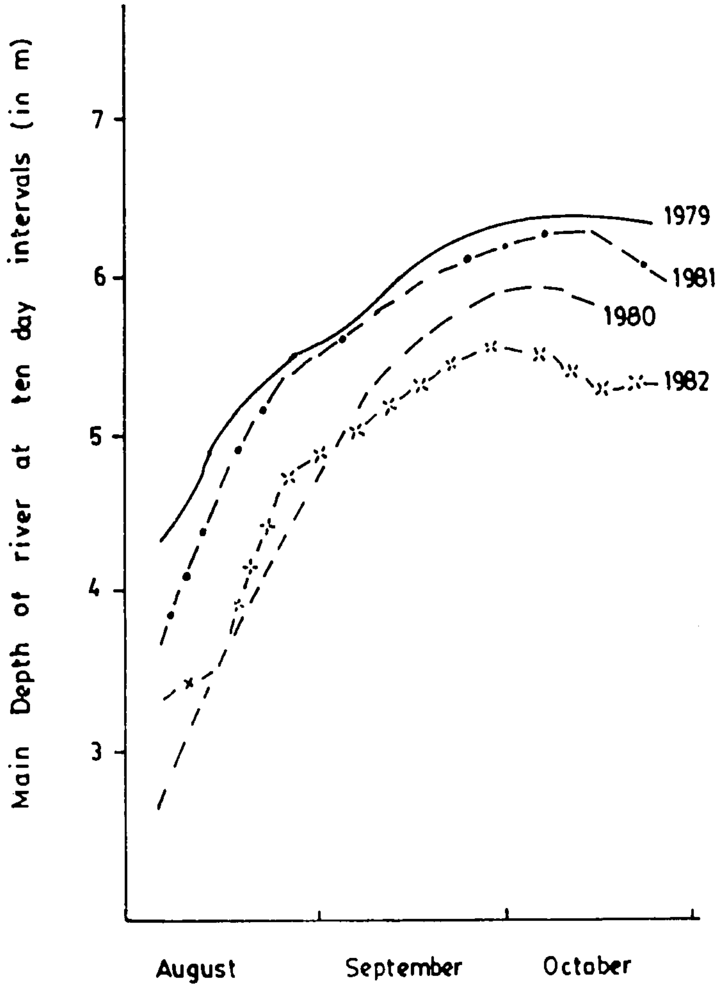

Fig. 1: FLOOD FLUCTUATIONS OF RIVER BANI IN MOPTI (Source: Escale Company)

During the year, rainfall of 236.7 mm was recorded as against 461.7 mm, the average for the previous twelve years. This represents a 48% decrease on the average and 37% decrease when compared with the previous year. The months of July and August, the crucial period for sowing and crop establishment, saw little rain. There were 38% and 51% reductions in precipitation for the two months respectively, when compared with the previous 12-year average.

Monthly records of the depth of the river showed that there was a reduction in the volume of water from river Bani which floods polders at the Station and Mopti South. (Fig. 1). Other polders outside Mopti in Operation Riz fields such as Bougoula and Sofara where the Station carries out on-farm trials were equally affected.

Most of the experiments attempted in 1982 failed due to inadequate rainfall during or after sowing or due to inadequate flooding. Sowing was done from late June to second week of August depending on elevation and type of experiment. Some experiments failed at germination stage, some at seedling stage while others failed at reproductive stage. Attempts were made to irrigate some important experiments particularly breeding materials without satisfactory results. Some experiments were replanted without success.

In order to protect experiments and experimental materials from severe drought and or inadequate flooding that may occur in future, certain remedial measures have been taken:

In case of severe drought at germination or seedling stages, sprinkler irrigation will be used. Water for sprinkler irrigation will be supplied by canal through mobile pumps. Two lister pumps of 0.0283 m3/s which are already available at the Station will be used for this purpose. Pipes are also available while 20 sprinklers are being procured for possible use in 1983.

In case of inadequate flooding or severe drought, a bigger pump will be used to soak or flood the experimental fields as needed. A 10 HP pump with 150 m3/h discharge capacity is being procured for possible use in 1983. The pump will be mobile and mounted on a cart to be drown by tractor. If necessary, the pump will be used to draw water from Bani River to fill the canals. It can also be used to soak or flood the polders by drawing water from the canals. A tractor is also being procured for the purpose. Flooding by irrigation would be used only to protect the breeding materials and important experiments.

In order to control water in polders efficiently, sluice gates for entry and exit of water have been renovated or reinforced. Regular maintenance measures for the gates have been taken to stop leakage of water.

SPECIAL RESEARCH PROJECT FOR IRRIGATED RICE
RICHARD TOLL - SENEGAL

Varietal Improvement

A trial was conducted to identify, with particular reference to yield and life cycle, short and medium duration varieties most adapted to local conditions. Twenty-two varieties were tested with IR 8 as the control. Results (Table 35) showed BR 161-2B-54 as the highest yielder. A few other varieties also performed well.

Table 35: Grain yields and Duration of some Varieties in the Wet Season, 1982 at Richard-Toll.

Varieties	Yield kg/ha	Duration (days)
BR 161-2B-54	8330	128
PR 103-190-R35-2874	7667	135
IAA 232 (PM)	7667	127
BP TRI-1	7460	122
RAJENDRA DAHNA	7367	127
BW 170	7233	119
PNR 24-263	7067	125
BR 7-73	7067	117
IR 2071-685-3-5-4-3	6800	120
BR 51-91-6	6667	115
PAU MUTI-40-4-1-IRP-504	6667	130
IR 8	6633	127
LSD (5%)	901	

Agronomy

Results obtained from a study of the effect of NPK fertilizer on rice yield during the cold dry season (Table 36) showed that phosphorus application to the nursery improved plant growth considerably and subsequently resulted in high grain yield. The combinations of 130-100-100 and 130-100-0 NPK produced the highest yields while K application had no effect on yield.

Table 36: Effect of NPK in the Nursery on Grain Yield of KH-998 in the Cold Dry Season, 1981/82 in Richard-Toll.

N-P-K	Yield kg/ha
0-0-0	6500
0-100-0	7190
0-0-100	6650
0-100-100	7790
130-0-0	6860
130-100-0	8390
130-0-100	7190
130-100-100	8540

The effect of seeding and fertilizer application methods on irrigated rice growth was studied during the cold dry season. Using rice variety KH-998, fertilizer (120 kg N/ha, 60 kg P/ha and 60 kg K/ha) was applied as follows:

(1) deep ploughing-in of NPK by a power tiller before transplanting;
(2) surface ploughing-in before transplanting; and
(3) application of P and K before transplanting and split application of N as 40% of the dose at 10 days after transplanting, 30% at maximum tillering and 30% at panicle initiation. (Transplanting was done using the modified dapog seedlings (broadcastable seedlings)).

Roots of broadcast seedlings were longer than those of seedlings from the traditional nursery at different growth stages, but differences were significant only at 55 DAT. Broadcast seedlings flowered 7 days before those from the traditional nursery. Roots of rice plants in plots where fertilizer was deeply ploughed in or applied in split application were longer than those of plants in plots with surface ploughing-in.

Table 37: Effect of Seeding and Method of Fertilizer Application on Grain Yield of KH-998 in the Cold Dry Season, 1981/82 at Richard-Toll.

Methods	Yields (kg/ha) TN	BS	Means
Deep ploughing in	4263	7363	5788
Surface ploughing in	4300	4488	4394
Split N	3713	5638	4675

TN = Traditional nursery
BS = Broadcast seedlings

The leaf area index (LAI) of broadcast seedlings was higher than that of the traditional nursery at 69 DAT. Regardless of the method of fertilizer application, broadcast seedlings produced more fertile tillers than seedlings from the traditional nursery. Plants from broadcast seedlings significantly outyielded those from the traditional nursery (Table 37).

Table 38:
Effect of Seeding Rate on Grain Yield of Direct Seeded IR 3941-86-2-2-2

Seed rate kg/ha	Yield kg/ha
80	3118
100	4140
120	4966
140	4554

Table 39:
Effect of Nitrogen on Grain Yield of Direct Seeded IR 3941-86-2-2-2

Doses of N kg/ha	Yield kg/ha
0	1933
80	2727
100	5158
120	5117
140	5304
160	5370

Results of this study indicated that during the cold season, plants from broadcast seedlings were more adaptable to cold than those from traditional nursery.

Results obtained from a similar study during the wet season differed from those of the cold season. Differences in the effect of seeding and method of fertilizer application on morphological characters were not significant. There was a significant interaction between seeding and fertilizer application methods on yield.

A study of seeding rates and nitrogen doses in direct seeded rice was conducted with rice variety IR 3941-86-2-2-2 using four seeding rates (80, 100, 120, and 140 kg/ha) and six nitrogen doses (0, 80, 100, 120 and 160 kg N/ha). The results showed the optimum seeding rate to be 120 kg/ha (Table 38).

The application of 0 and 80 kg N/ha gave significantly less yields than other doses (Table 39). Application of 120, 140 and 160 kg N/ha, significantly increased plant height. However high doses of N delayed maturity. Results of the effect of increased nitrogen doses in direct seeding using three improved varieties (IR 3941-86-2-2-2 with short and slender straws, Tatsumimochi which is an improved Japonica type with short and strong straws, and KN-1h-350 with tall straws) showed significant increases in grain yield with increasing N doses up to 160 kg N/ha.

The best response was from Tatsumimochi, followed by IR 3941-86-2-2-2. These preliminary results showed that varieties with short, strong straws had the best response to increasing nitrogen doses. Varieties with tall straws lodged easily when nitrogen is applied at the rate of 120 kg N/ha and above.

Agropedology

Results of a long-term NPK fertilization trial on vertisols (Table 40) indicated that: these soils are not fertile enough as shown by the gradual decrease in paddy yields over the seasons; nitrogen is important in obtaining high yields; and phosphorus is very important during the third cropping season.

Table 40: Effect of Long Term NPK Frtilizer on Rice Yield in an Intensive Rice-rice System on Vertisol.

N-P-K kg/ha	Grain Yields (kg/ha) 1981 Wet Season	1982 Hot Dry Season	1982 Wet Season
0-0-0-	1900	1500	1000
0-60-0	2500	2200	2200
0-0-60	2000	1300	1200
0-60-60	2000	1800	2100
130-0-0	5400	4300	3000
130-60-0	5900	5400	4200
130-0-60	5300	5700	2900
130-60-60	6300	6100	4900

With the hydromorphic soils (Table 41) there was a drop in fertility of the soils in the third cropping season which was improved by ploughing in of rice straw. The application of nitrogen greatly increased grain yield. A minor effect of phosphorus was observed from the first season as well as little interaction among N, P and K.

Table 41: Effect of NPK Fertilizer on Rice Yield in an Intensive Rice-rice System on Hydromorphic Soil

N-P-K kg/ha	Grain Yields (kg/ha) 1981 Wet Season	1982 Hot Dry Season	1982 Wet Season
0-0-0	1500	1900	1700
0-60-0	2900	2300	2200
0-0-60	2000	1900	1800
0-60-60	2400	2300	2800
130-0-0	6000	7900	4500
130-60-0	5500	6000	3800
130-0-60	4600	5700	4000
130-60-60	5300	9000	4300
65-30-30 + Straw	4600	5300	4900
130-60-60 + Straw	6200	8300	5500

The effect of mineral nitrogen fertilizer in the presence of compost on irrigated rice yield was studied to find out how harvest residues can partially substitute for inorganic nitrogenous fertilizer and improve the organic matter content of the soil. The experiments were conducted during the 1981 hot dry and wet seasons, and 1982 hot dry season. Results obtained during the second and third seasons (Table 42) confirmed the positive effect of compost on rice yield especially at the low level of N (60 kg N/ha) application.

The best nitrogen and compost combinations are 90 kg N/ha + 5 tonnes of compost/ha, and 60 kg N/ha + 10 tonnes of compost/ha.

Table 42: Effect of Nitrogen and Compost on Grain Yield (kg/ha) of Rice Variety JAYA on Vertisol.

Doses of N kg/ha	Tonnes of Compost/ha		
	0	10	20
	1981 Wet Season		
0	2700	4200	3700
60	5400	6900	6300
120	7400	8500	8800
180	10400	9800	9700
	1982 Hot Dry Season		
0	3000	3800	3800
60	5000	5800	5900
120	5900	6800	6900
180	7700	7600	8000

A study of the effect of different water regimes on water intake and yield response to compost and mineral nitrogen application was undertaken.

The irrigation systems used were as follows:

- continuous flooding with 5 cm water depth (W1)
- field capacity throughout growing season (W2)
- field capacity during vegetative phase and flooding during reproductive phase (W3)
- flooding during vegetative phase and field capacity during reproductive phase (W4).

Nitrogen was applied in 3 split (50%, 25% and 25%, one day before transplanting, at tillering and at panicle initiation respectively). Compost was added at the rate of 15 t/ha. Phosphorus and potassium were applied in the form of triple super phosphate (46% P_2O_5) and KCl (60% K_2O) at the rate of 60 kg/ha each. Twenty-one day old seedlings of variety Kwan She Shung (KSS) were transplanted at a spacing of 20 x 20 cm.

Table 43: Effect of Water Regime on Water Requirement on Vertisol and Hydromorphic Soil in the Warm Dry Season.

	Water requirement (mm)	
	Vertisol	Hydromorphic
Continuous flooding	1333	1566
Field capacity (FC)	599	759
FC + flooding	1132	980
Flooding + FC	1117	1185

Regardless of the type of irrigation, the water intake response curve was sigmoidal. There were variations at the different growth stages with the maximum occurring at panicle initiation and flowering stages (33 to 45% of total requirement in vertisol and 25 to 26% in hydromorphic soil depending on the water regime). Table 43 shows the effect of water regime on water requirement. On vertisol, compost application resulted in a slight increase in the quantity of water by 16%, 12%, 17% and 4% in treatments W1, W2, W3 and W4 respectively.

Weed Control

IN a study of methods of land preparation and the effect of herbicides on weed development in rice plots at Fanaye, the herbicide Glyphosate was tested in combination with up to 3 runs of a rotovator.

The main weed species were Cyperus difformis, Cyperus rotundus, Cyperus sp. and Eclipta prostrata. Sedges were dominant especially in plots with or without minimum land preparation. The treatments did not produce any significant differences in the dry weights of weeds nor in grain yields.

With direct seeded rice (Table 44) hand weeding and the use of a rotary tiller produced a significant increase in grain yield. Two runs of the rotary tiller followed by hand weeding produced yields comparable to those obtained from two hand weedings.

The main weed species encountered in this trial were Ammania auriculata, Cyperus iris, Echinochloa colona, and the prominent weeds were Jussiaea erecta and J. Perennis.

Table 44: Effect of Rotary Tiller With or Without Hand Weeding on Direct Seeded Rice.

Treatments	Grain kg/ha	Straw kg/ha	Number of tillers/m2
Control	1199	5340	178
2 Hand weedings (HW) at 3 and 6 WAS	4369	6140	375
1 Rotary tiller + HW at 3 WAS	2596	5740	300
2 Rotary tillers at 3 and 6 WAS	2002	5460	272
2 RT + 2 HW at 3 and 6 WAS	4253	6120	419
CV (%)	29	11	16

Table 45: Effectiveness of Furadan 3G in Control of Stemborers

DAS	Percent infested stems: Without borers	With borers	Borers/ 10 hills	Yield kg/ha
10	3.9	5.5	6.4	8500
30	3.5	5.1	5.4	9400
50	4.3	4.0	4.4	9950
70	5.5	5.0	7.8	9250
Control	7.9	10.9	11.6	8550
LSD (5%)	3.8	4.8		610
CV (%)	19	22		9

Entomology

The frequency of application of Furadan 3G for the control of Stemborers was investigated. The experiment was planted sequentially and repeated five times in order to obtain comparative information on stemborer infestation in relation to time of planting.

Results obtained showed that the first crop (November 1981 - July 1982) had very low incidence of stemborers. The level of attack ranged from 0.6 to 1.3%. There was however, a progressive increase in the level of stemborer attack on subsequent crops. Results of the fourth experiment are presented in Table 45. Early application of Furadan 3G significantly reduced percentage infested stems with and without borers. The numbers of borers inhabiting the stems were also reduced. Yields were generally high. The highest yield (9950 kg/ha) was obtained with Furadan 3G applied at 50 days after sowing (DAS).

Studies on population dynamics of rice stemborers were confined to actual presence of borers in the rice fields. Results (Fig.2) showed that rice crops planted between November and March could escape from borer damage almost completely. An experiment planted in July was most heavily attacked by stemborers. Infestation started 30 days after transplanting and reached peak population between 72 and 86 days after transplanting. It is possible, therefore, to avoid stemborer attack through manipulation of planting dates.

Infestation by Maliarpha separatella, which is the predominant stemborer started in the month of June (Fig. 3) and progressively increased. Pupation occurred in July and extended to November. Although generations overlapped considerably, it seemed that two major generations existed between the months of June and November.

Short and medium duration varieties nominated for the coordinated irrigated trials were subjected to evaluation for their reactions to stemborer infestation.

Results (Tables 46 and 47) indicate that there was no clear cut distinction in the reactions of tested varieties.

Table 46: Evaluation of Short Duration Irrigated Rice Varieties for Reaction to Stemborers, 1981.

Varieties	Percent infested stems: Without borers	Percent infested stems: With borers	Borers/ 10 hills
BR 13-47-3	10.0	12.9	13.5
IR 1529-430-3	7.1	10.7	13.0
IR 9872-144-3-3-3	5.1	3.6	7.7
IR 40:	6.7	10.0	14.5
TOS 4688	9.7	12.3	13.0
RASHT 448	10.6	12.1	14.7
C 22	8.4	11.5	13.7
75-4830	6.9	20.2	23.2
IET 4247	6.4	9.6	14.0
B 2360-8-9-5	5.7	15.1	18.2
84312	7.3	13.9	17.2
KN 1h-361-1-8-6	13.8	12.7	14.2
IR 2823-399-5-6	4.2	8.2	10.5
LSD (5%)	5.9		1.1
CV (%)	26.3		21.7

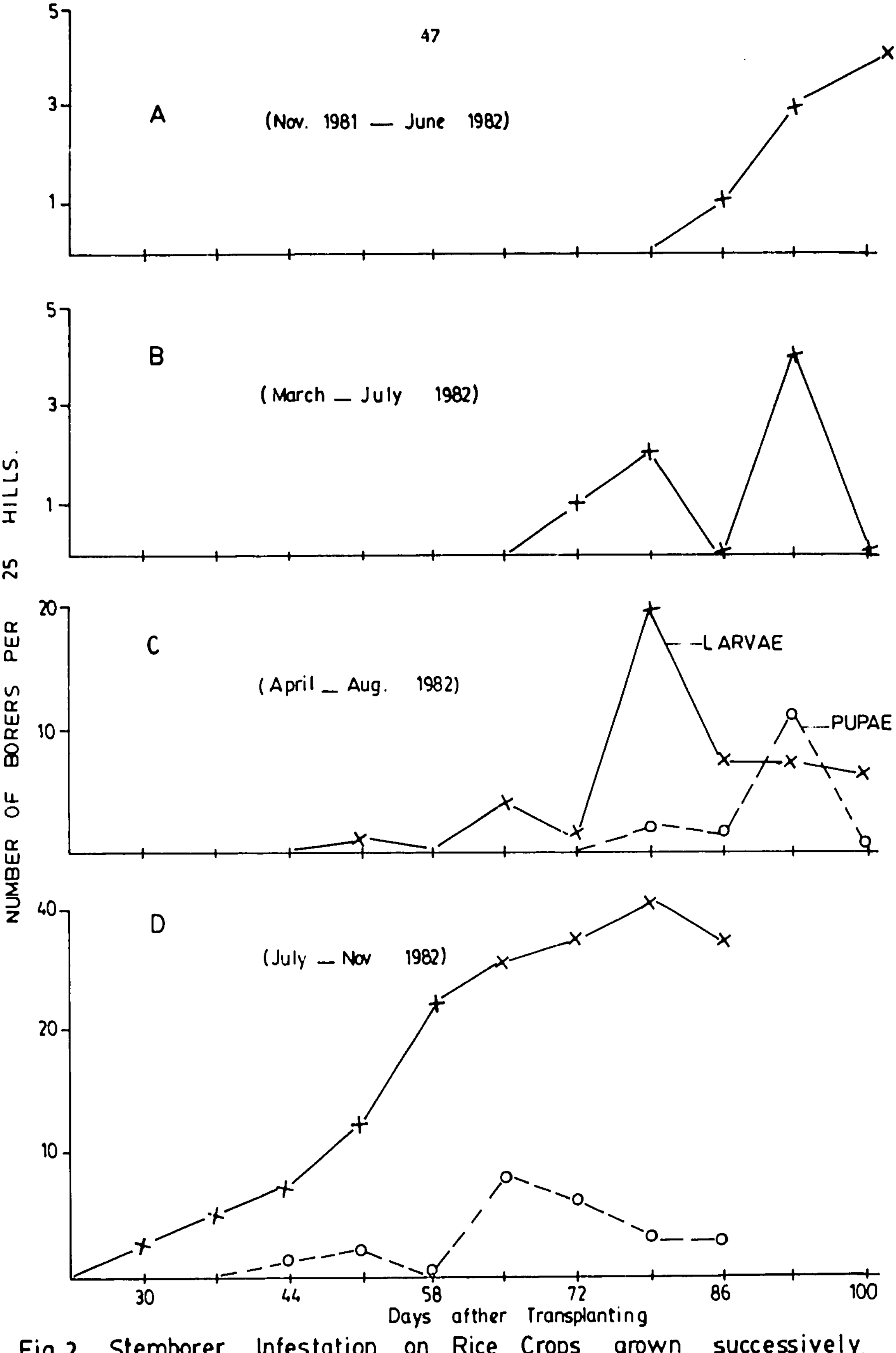

Fig.2. Stemborer Infestation on Rice Crops grown successively.

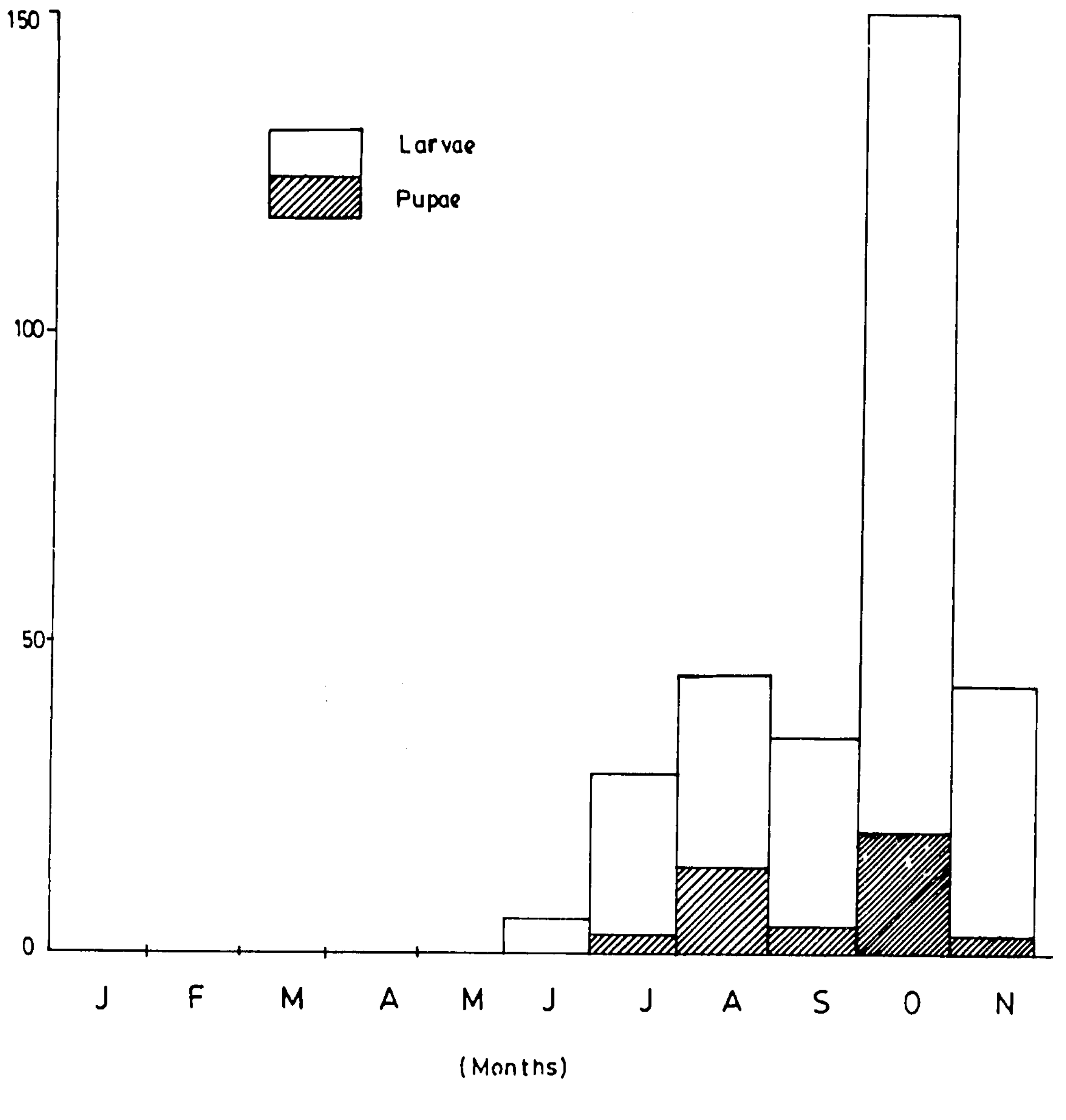

Fig. 3. Occurrence of M. Separatella (larvae and Pupae) in Rice stems. Jan.–Nov. 1982.

Table 47: Evaluation of Medium Duration Irrigated Rice Varieties for Reaction to Stemborers

Varieties	Percent infested stems: Without borers	With borers	Borers/ 10 hills
B 541b-PN-585-3-1	8.3	11.7	14.2
BR 51-46-5	6.5	11.1	12.7
BR 51-91-6	5.6	7.7	8.7
BR 51-319-9	6.0	8.3	10.0
BW 170	9.8	14.4	19.0
FH 109	5.6	5.0	6.2
IET 6496	9.1	7.0	8.2
Improved Mahsuri	6.5	10.0	11.7
IR 2071-586-5-6-3	6.4	7.1	6.5
IR 3273-P339-2	7.4	11.1	14.0
IR 4442-165-1-3-2	4.9	6.6	8.0
ITA 230	5.7	11.3	13.5
ITA 232	7.9	15.1	19.5
Vijaya (selection)	3.8	5.3	6.5
LSD (5%)	5.2	5.9	1.1
CV (%)	24.7	24.1	22.9

Farmers' Field Trials

A total of 15 farmers participated in an Urea super granule trial in the 1982 hot dry season but only 8 furnished reliable results. Statistical analysis showed that the variances were not homogeneous among the 8 farmers and so, the farmers were divided into two groups, the first made up of 5 farmers, the other comprising 3 farmers. For both groups, supergranule treatments topped in yield, followed by two urea treatments applied in three split doses (Table 48).

Table 48: Results of SCU Trials in the Hot Dry Season 1982

Group 1 Treatments	Yield kg/ha	Group 2 Treatments	Yield kg/ha
S 172	8689	S 172	8995
S 86	7551	S 86	7130
U 172	7549	U 172	6971
U 86	6278	U 86	5431
U 120	5534	U 120	4718
Control	3800	Control	3638
CV (%)	11.4	CV (%)	28.0

Further analysis showed that when fertilizers are subsidized, U 172 is less economical than S 86 because of the higher cost of application.

The results of the trials at Fanaye are shown in Table 49. These results showed that it is possible to save 50% nitrogen particularly at high doses. It is absolutely necessary to provide simple mechanical application equipment to enable farmers accept this technology.

Table 49: Results of SCU Trials in the Hot Dry Season at Fanaye

Treatments	Yield kg/ha	Treatments	Yield kg/ha
S 290	10854	U 290	9538
S 232	10267	U 232	7958
S 174	8384	U 174	7128
S 116	7027	U 116	5346
S 58	4433	U 58	3929

The results of variety trials (Table 50) showed that on the average, IKP remained the best variety followed by IR 3941-86-2-2-2 and Sri Malaysia. Under good management conditions these two varieties produced the highest yields while IKP gave the best "minimum" yield under unfavourable cultivation conditions. The two Japanese varieties, particularly Yoseshiro, have very short duration and suffered extensive bird damage at maturity.

Table 50: Results of Varietal Trials at Nianga in the Hot Dry Season, 1982

Varieties	Duration (days)	Average yield kg/ha	Lowest yield kg/ha	Highest yield + kg/ha	Number of farmers involved
KSS	105	4794	1671	7797	14
IKP	116	6364	4293	9191	13
Yoneshiro	80	2830	1929	3469	5
Tatsumimochi	96	3825	2553	6514	8
KN 1h-350	119	4109	2615	6064	10
IR 3941-86-2-2-2	117	5564	2771	9242	14
Sri Malaysia	131	5412	3190	9219	11
Farmers' plot (IKP)		5812	3173	7234	

Jaya and Sri Malaysia both gave the best yields for the first two sowing dates. On the other hand, KH-998, BG 90-2, IR 2823-399-66-7 and IR 3941-86-2-2-2 gave high yields for the third sowing date (Table 51). KSS and Tatsumimochi produced low yields at all the three sowing dates.

Table 51: Yields (kg/ha) of Varieties on Farmers' fields at Three Sowing Dates in the Hot Dry Season at Nianga

Varieties	Sowing dates 28/7/82	12/8/82	26/8/82
Sri Malaysia	6105	5342	3983
Jaya	5532	6118	2478
IR 3941-86-2-2-2	4304	3833	5590
KH-998	4171	3521	5945
IR 2823-399-66-7	4102	4522	5691
KSS	3697	2836	3530
BG 90-2	3527	5102	5935
Tatsumimochi	2115	3093	3288

Table 52: Results of Moist Hot Season Variety Trial at Ndiaye, 1982.

Sowing date	Varieties	Duration (days)	Yield kg/ha
27/8	IR 2823-399-66-7	111	7010
	KSS	98	6494
	IKP	105	6018
	BG 90-2	113	5800
	KH-998	108	5582
	Sri Malaysia	119	5233
	KN 1h-350	103	5100
	Tatsumimochi	87	Bird damaged
9/9	Tatsumimochi	92	6851
	KSS	113	2806
17/9	Tatsumimochi	95	5608

Results of the variety trial conducted in the Delta area are shown in Table 52. Among the varieties tested, those that need further confirmation are Sri Malaysia, IR 2823-399-6-7, BG 90-2, KH-998 and IR 3941-86-[illegible]-2-2.

Table 53: Effect of NPK on Grain Yield in the Hot Dry Season, 1982.

Nianga		Haere Lao	
NPK Dose	Yield kg/ha	NPK Dose	Yield kg/ha
220	7756	220	7973
212	7732	202	7891
211	7604	211	7618
222	7519	222	7600
202	7485	212	6940
221	7154	221	6666
200	6923	110	6293
111	5707	200	6188
112	5627	112	6070
110	5550	121	5979
122	5448	122	5827
101	5409	101	5458
121	5316	111	5256
011	2356	000	3205
022	2281	011	3093
000	2280	022	2179
LSD (5%)	708	Lsd (5%)	1170
CV (%)	15.7	CV (%)	22.7

The following formulations and NPK fertilizer doses were used in an NPK trial in the hot dry season of 1982:

000 = 0-0-0	200 = 240-0-0	110 = 120-48-0	220 = 240-96-0
011 = 0-48-40	101 = 120-0-40	111 = 120-48-40	121 = 120-96-40
211 = 240-48-40	221 = 240-96-40	022 = 0-96-80	112 = 120-48-80
122 = 120-96-80	202 = 240-0-80	212 = 240-48-80	222 = 240-96-80

Twelve farmers conducted trials in the large plots in the Middle Valley (Nianga), and 10 farmers in the small plots at Haere Lao. Results obtained in the two trials are presented in Table 53.

Nitrogen application produced significant positive effect on grain yield. Economic analysis of the fertilizer formulations showed that when fertilizers are subsidized, the 220 formulation gives the highest gross profit of 261,539 CFA at Nianga and 225,077 CFA at Haere Lao.

Results obtained in the NPK trials in the 1982 hot wet season showed that double doses of N (240 kg N/ha) in general gave higher yields compared with single doses (120 kg N/ha). Significant effects of P and K were observed.

The 1982 NPK trials therefore confirmed results obtained in previous years. There was a greater response to nitrogen in the hot dry season. The subsidy policy is one of the most important factors to be considered in making recommendations for fertilizer formulations. The nitrogen in ammonium phosphate can be substituted with nitrogen from urea, thus making it possible to separate the N and P application operations. The current practice among farmers is to apply ammonium phosphate 7 to 10 days after sowing or transplanting. This evidently makes the application of P2O5 less profitable.

Azolla Project

An evaluation of Azolla pinnata on rice yield with and without inorganic nitrogen, made during the 1982 hot dry and wet seasons, had the following treatments:

1) Control (no nitrogen);
2) 120 kg N/ha (50% during transplanting, 25% during tillering and 25% at panicle initiation;
3) 1 Azolla crop ploughed in before transplanting (40 t/ha);
4) 2 Azolla crops ploughed in before transplanting (40 t/ha);
5) 2 Azolla crops ploughed in before transplanting and a 3rd azolla crop not ploughed in after transplanting;
6) 60 kg N/ha (urea) during transplanting and an Azolla crop, seeded after transplanting rice and not ploughed in;
7) 2 Azolla crops ploughed in before transplanting and 60 kg N/ha (urea) applied during tillering and panicle initiation;
8) 2 Azolla crops ploughed in before transplanting and 30 kg N/ha (urea) during tillering;
9) 2 Azolla crops ploughed in before transplanting and 30 kg N/ha (urea) at panicle initiation;
10) Same treatment as in 8), plus a 3rd Azolla crop, seeded after transplanting rice and not ploughed in.

Some designations in Tables 54 and 55 are explained as follows:
Azolla I = One Azolla crop ploughed in before transplanting.
Azolla II = Two Azolla crops ploughed in before transplanting.
Azolla III = One Azolla crop, not ploughed in, after transplanting.
60kg N/ha = Urea applied as basal dressing before transplanting.
30A = 30 kg N/ha Urea applied at tillering.
30B = 30 kg N/ha Urea applied at panicle initiation.

Table 54: Effect of Azolla on Yield (kg/ha) of I Kong Pao in the Hot Dry and Wet Seasons, 1982 at Fanaye.

Treatments	Dry season	Wet season	Mean	Yield index
Control (no N)	1883	3028	2455	100
120 kg N/ha Urea	6025	7295	6660	271
Azolla I	2635	4893	3764	153
Azolla II	2299	6043	4171	170
Azolla II + Azolla III	3347	7392	5319	217
60 kg N/ha Urea + Azolla III	2531	5190	3860	157
Azolla II + 30A + 30B	5908	7205	6556	267
Azolla II + 30A	3499	6521	5010	204
Azolla II + 30B	4987	6495	5741	234
Azolla II + Azolla III + 30A	3508	7625	5565	227
Standard error	475	434		
CV (%)	20.5	11.1		

Table 55: Effect of Azolla and Inorganic Nitrogen on Rice Yield.

Treatments	Spacing (cm)	1981/82 cold dry season	1982 hot dry season	1982 hot wet season	Mean	yield index
Control (no N)	20x20	2324	1699	3217	2413	100
60 kg N/ha	20x20	4201	5417	4662	4760	197
60 kg N/ha	40x10	5654	5151	6369	5725	237
Azolla I + 30 kg N/ha	20x20	3309	5624	4934	4622	191
Azolla I + 30 kg N/ha	40x10	4900	4792	5344	5345	221
Azolla I + 2 Azolla	20x20	3508	5310	4580	4466	185
Azolla I + 2 Azolla	40x10	4107	5106	6861	5358	222
Azolla I + 2Azolla	40x10	4458	5350	6501	5436	225
120 kg N/ha	20x20	5906	8223	5310	6815	282
120 kg N/ha	40x10	7226	7725	8229	7727	320
Standard error		490	372	469		
CV (%)		16.9	10.8	11.4		

The current results (Table 54) confirm previous results as follows:

- The combination of 50% Azolla nitrogen + 50% Urea nitrogen produced yields equal to those obtained with the application of 100% Urea nitrogen. This is exemplified in treatment 7) compared with treatment 2). In both cases, there was 180% increase in yield compared with control during the two seasons.
- Interesting results, but less promising, were obtained with treatments 8) and 9) which combined the ploughing in of 2 Azolla crops before transplanting with the application of 30 kg N/ha (urea) either at tillering or panicle initiation.

A comparative study of the effect of azolla and inorganic fertilizer on rice yield (variety IKP) and effect of spacing on azolla growth was conducted in Fanaye. The treatments were as follows:

1) Control (without urea or azolla at spacing of 20 x 20 cm);
2) Split application 60 kg N/ha (1/3 + 1/3 + 1/3) with spacing of 20 x 20 cm;
3) Same as treatment 2) but with spacing of 40 x 10cm;

4) 1 Azolla crop (20tons of fresh matter per hectare) ploughed in before transplanting + 30 kg N/ha (1/3 + 1/3 + 1/3) and spacing of 20 x 20cm;
5) Same as treatment 4) but with spacing of 40 x 10cm;
6) 1 Azolla crop ploughed in before transplanting + 2 crops seeded and ploughed in successively after complete coverage of plot with spacing of 20 x 20cm;
7) Same as treatment 6) but with spacing of 40 x 10cm;
8) 1 Azolla crop ploughed in before transplanting + 2 crops ploughed in after transplanting with spacing of 20 x 20 cm;
9) 120 kg N/ha (1/2 + 1/4 + 1/4) and with spacing of 20 x 20 cm;
10) Same as in treatment 9) but with spacing of 40 x 10 cm.

The Azolla crops were seeded at the rate of 0.2 kg/m2. Specific fertilization, made up of 15 kg P2O5/ha (in the form of triple super phosphate) in 3 equal applications with 10-day intervals, was used for each azolla crop.

The results presented in Table 55 showed that there was no effect of spacing on the rate of growth of azolla crop. At a spacing of 20 x 20 cm treatments 2, 4 and 6 did not produce significantly different effects on yield but these were superior to the control except during the 1981/82 cold season when azolla application (treatments 2 and 4) gave significantly lower yield than the application of 60 kg N/ha only.

There is indication from these results that application of about 40 t/ha of azolla produced the same effect as the application of 30 kg N/ha. On the average the 40 x 10 cm spacing gave significantly higher grain yield than the 20 x 20 cm spacing. At the spacing of 40 x 10 cm treatments 3, 5, 7 and 8 (wet season and hot dry season) did not produce significantly different effects on yield but these were signficiantly superior to the control. In the cold dry season the use of azolla alone produced significantly lower yield than the application of 60 kg N/ha alone.

From the results of the Azolla trials presented in this report, it can be concluded that azolla can grow in the hot and dry Sahelian as well as in the wet tropical zone, provided that moisture is available to conserve it throughout the year and that when used as an organic nitrogen fertilizer can substitute in an appreciable proportion inorganic nitrogen fertilizer such as urea.

It must be pointed out that the successful production of Azolla requires phosphorus fertilizer and that the ploughing in and harvesting of Azolla is time consuming and labour intensive. Also once the Azolla is fully established in the field, it is very difficult to control its spread.

SPECIAL RESEARCH PROJECT ON MANGROVE SWAMP RICE
ROKUPR, SIERRA LEONE

The principal objective of WARDA's Special Research Project on Mangrove Swamp Rice, Rokupr, is to develop, in collaboration with national programmes, new technology at the farm level for the small scale rice farmers of the mangrove swamp in West Africa. In order to meet the above objective, the programme of activities in 1982 included:

a) Approximately 100 research trials conducted at the Rice Research Station, Rokupr, and on farmers' fields along the Scarcies in saline areas at Kiabanka and Moribaia, and at Rotifunk in southern Sierra Leone;
b) A socio-economic survey of mangrove swamp farmers in Guinea;
c) Adaptive trials along the Scarcies of packages of technology developed by the project;
d) Training of young scientists and technicians from national programmes on rice research methodologies; and participating in training of technicians in courses related to rice production, e.g. rice seed multiplication courses in Sierra Leone;
e) Collaborative adaptive research with scientists of national programmes and rural development agencies, e.g. Integrated Agricultural Development Projects (IADPs) and Adaptive Crop Research and Extension (ACRE) in Sierra Leone, and Freedom From Hunger Campaign (FFHC) in the Gambia.

Varietal Improvement

Materials introduced and screened in the initial evaluation trial during 1982 were all obtained through IRTP and comprised 94 lines from the 4th IRLRON-L (1981), 27 lines from the 6th IRSATON (1981), and 10 lines from the Acid Sulphate Soils Screening Set. From the IRLRON-L trials, lines suitable for Guinea Bissau and Southern Senegal were selected. These include: B922C-Mr-118, BR 111-140-1-1, BR 50-90-2, IR 4829-89-2, CR 1030, IR 13419-113-1, IR 10781-143-2-3, IR 10781-75-3-2-2, IR 13564-95-1, IR 19431-72-2, IR 5857-64-1E-1-6, 7-CANUTO, IR 17494-32-2-2-1-3, IR 11288-B-B-288-1, IR 11388-B-B-445-1, IR 14753-86-2, BR 51-91-6, IR 19256-88-1, IR 13358-16-3-2 and BKN 6990-63. Most of the selections were short statured with short growing period.

The materials from the IRSATON were planted on a tidal site and evaluated for ability to withstand tidal inundation at Rokupr, Sierra Leone. All the lines showed poor adaptation to tidal conditions as compared to local check materials and most died during the vegetative phase.

As a continuation of the testing of varieties selected in previous seasons, a number of observational yield trials, replicated yield trials and farmers' field trials, were conducted during 1982.

Observational Yield Trials (OYT)

(a) Performance of Short Duration Varieties in Associated Swamp:

The sixty varieties tested, which ranged in duration from two weeks to a few days shorter than ROK 5, were selections from 1979 and 1980 IRLRONs. The trial site was a swamp edge of low natural fertility with marked iron toxicity problems. A basal application of 20 kg P2O5/ha was given and 60 kg N/ha was injected 3 weeks after transplanting.

A further 10 varieties were selected on the basis of their appearance in the field. The durations (93 to 103 days) of the selections were shorter than ROK 5 (106 days to 50% flowering), several of them by margins of over two weeks. Their earliness coupled with their short stature (71 to 116 cm) suggests these materials for use in non-tidal swamps in the short rainy season areas of northern Guinea Bissau and southern Senegal. The yield also ranged between 2.6 - 3.9 kg/ha. These include Kau 2036, Kau 2037, IR 9784-142-1-3-2, IR 13240-6-3-3-b, IR 8608-82-1-3-1-3, IR 3404-23, IR 9846-2-3-2, B 981d-Si-35-1, B 2360-6-7-1 and IR 9675-Sel.

(b) Performance of Medium Duration Rice Varieties in Associated Swamp.

Fifty-one lines, mostly selected from 1980 IRLRON, were tested against ROK 5 on an iron toxic associated swamp site. Fertilizer application was the same as for the previous trial.

Twelve varieties which outyilded their adjacent ROK 5 plots were selected as well as a further eight varieties which had good appearance in the field. These selections ranged from 105 to 119 days to 50% flowering and were about two weeks longer in duration than ROK 5. They were all short statured, 75 to 119 cm tall. They are therefore most suited for shallow flooded swamps in areas with long rainy season. Varieties selected for yield ranging from 1.8 to 3.4 metric tons/ha are:

IR 10781-175-1 (2.6)	BR 51-46-3 (3.4)	IR 14753-120-3 (2.6)
IR 9852-53-2 (2.9)	IR 8192-242-3-2-1 (2.7)	IR 8192-166-2-2-3 (3.3)
IR 13358-16-3-2 (3.4)	PANKAJ (2.1)	IR 13358-73-1-1 (3.1)
IR 4570-83-3-3-2 (1.8)	INTAN (3.1)	BKN 7022-10-1-4 (2.3)

Those selected for phenotipic acceptability are:

RATNAGIRI 9-5-3-2 (IET 4693) (3.2)

IR 14632-2-2 (2.2)	RD 15 (2.2)	IR 13146-41-3 (2.1)
IR 4683-54-2-2-3 (1.6)	IR 9288-B-B-244-2 (2.2)	BW 78-7 (3.0)

IR 4683-54-2-2-3 (1.6) IR 9288-B-B-244-2 (2.2) BW 78-7 (3.0)

RP 975-109-2 (IET 5656) (3.1)

(c) Performance of Medium Duration Varieties in Tidal Swamp:

Forty-one entries, selected mainly from 1979 and 1980 IRLRONs on the basis of intermediate height, were tested without fertilizer on a site subject to deep tidal flooding. The yields recorded for the trial were low with ROK 5 averaging 1514 kg/ha.

Replicated Yield Trials (RYT)

(a) Performance of Medium duration Varieties in Associated Grass Swamp:

The two associated swamp RYTs both tested medium duration varieties, shorter than and comparable in duration to ROK 5. Four-week old seedlings were transplanted. A basal dressing of 20 kg P205/ha was given and 60 kg N/ha was injected as a solution of urea at 20 cm depth 3 weeks after transplanting.

The results of the first trial are shown in Tables 56(a) and (b). The entries included five varieties nominated for coordinated trials in 1982, namely: IR 3259-PS-160-1, IR 4707-140-1-3, IR 2797-125-3-2-2-2-1, IR 4712-113-4-1-2 and IR 5677-17-3-1-1; four varieties advanced from OYTs in 1981: Segon Mega, Setra, Merak and Lead (7798); and the check variety, ROK 5. ROK 5 significantly outyielded all other entries (Table 56(b)). It is likely that its intermediate height and droopy growth habit allowed it to compete more effectively with weeds than the short statured, erect entries. IR 3259-PS-160-1 showed immunity to blast while IR 4712-113-3-1-2 and IR 5677-17-3-1-1 showed low incidence of blast at the seedling stage.

(b) Performance of Medium Duration Rice Varieties under Tidal Swamp conditions

Eleven varieties were tested against ROK 5 in a RYT sited on tidal mangrove swamp. The entries included 3 new varieties advanced from OYTs - Bahagia, Mas 2401 (3627) and Lead (5411); 4 lines from the hybridization programme - ROHYB 4-WAR-1-1-1-B-1, ROHYB 4-WAR-1-3-B-2, ROYB 6-WAR-6-2-B-2 and ROHYB 15-WAR-3-3-B-2; and 4 varieties which have performed consistently well in previous yeares - Bali Grodak, Djabon, Haji Haroun and Sentral Merah.

Blast incidence in the nursery was severe for all varieties and a shortage of seedlings was experienced at transplanting. Subsequent crab damage and disease incidence resulted in the elimination of varieties Djabon, Bali Grodak and Lead (5411) from the trials. Yield and other characteristics of the remaining varieties are shown in Tables 57(a) and (b).

The varieties were all poor from the point of view of blast tolerance with the exception of Sentral Merah which showed some resistance. Poor blast tolerance appears to be a problem in this duration category and it should be a priority to identify more resistant varieties.

Table 56(a): RYT of Medium Duration Varieties Associated Swamp.

Varieties	Tillers/m2	Effective tillers/m2	No. of filled grains/ panicle	Sterility (%)
ROK 5	182	179	82	24.1
IR 3259-P5-160-1	254	243	57	22.8
SEGON MEGA	215	215	74	27.3
IR 2797-125-3-2-2-2-1	270	237	55	20.2
SETRA	216	211	67	32.9
IR 5677-17-3-1-1	179	164	79	26.4
IR 4712-113-3-1-2	243	228	51	34.3
MERAK	195	186	81	31.3
LEAD (7798)	213	210	62	27.0
IR 4707-140-1-3	200	176	66	21.6
LSD (p=0.05)	47	47	17	ns

Table 56(b): RYT of Medium Duration Varieties Associated Swamp.

Varieties	1000 grain weight (g)	Height (cm)	50% Flowering (DAS+)	Yield (kg/ha)
ROK 5	32.4	121	104	4674
IR 3259-P5-160-1	31.4	91	111	3824
SEGON MEGA	29.1	137	125	3561
IR 2797-125-3-2-2-2-1	26.6	88	+99	3409
SETRA	29.8	153	127	3261
IR 5677-17-3-1-1	28.3	115	123	3200
IR 4712-113-3-1-2	29.3	93	101	2780
MERAK	25.4	166	123	2713
LEAD (7798)	28.6	124	104	2661
IR 4707-140-1-3	27.9	82	95	2190
LSD (p=0.05)	1.8	7	ns	770

Table 57(a): RYT of Medium Duration Varieties - Tidal Mangrove Swamp

Varieties	Tillers/m2	Effective tillers/m2	No. of filled grains/ panicle	Sterility (%)
ROHYB 6-WAR-6-2-B-2	138	138	93	15.7
ROHYB 4-WAR-1-3-B-2	182	177	60	18.2
HAJI HAROUN	158	153	82	11.4
ROHYB 15-WAR-3-3-B-2	149	141	70	13.1
MAS 2401 (3627)	189	189	63	18.6
SENTRAL MERAH	150	147	91	16.8
ROK 5	182	178	73	14.4
BAHAGIA	161	161	79	23.6
ROHYB 4-WAR-1-1-B-1	142	139	68	15.2
LSD (p=0.05)	33	33	21	ns
CV (%)	12	12	16	30.0

Table 57(b): RYT of Medium Duration Varieties - Tidal Mangrove Swamp

Varieties	1000 grain weight (g)	Height (cm)	50% Flowering (DAS+)	Yield (kg/ha)
ROHYB 6-WAR-6-2-B-2	30.0	153	140	3185
ROHYB 4-WAR-1-3-B-2	30.9	122	115	3089
HAJI HAROUN	28.0	133	125	2931
ROHYB 15-WAR-3-3-B-2	30.3	113	117	2907
MAS 2401 (3627)	27.7	125	137	2882
SENTRAL MERAH	27.7	149	141	2753
ROK 5	30.0	111	118	2605
BAHAGIA	25.2	128	138	2348
ROHYB 4-WAR-1-1-B-1	30.4	111	116	1937
LSD (p=0.05)	1.5	11	4	546
CV (%)	2.9	5	2	12

Table 58(a): RYT of Very Long Duration Varieties - Tidal Mangrove Swamp.

Varieties	Tillers/m2	Effective tillers/m2	No. of filled grains/ panicle	Sterility (%)
ROK 10	132	129	158	8.4
MAUNG NYO B24-72	103	103	176	12.6
Pulut Rambutan	177	175	81	11.3
Kuatik Putih	148	146	107	9.3
Raden Jawa (Gundil)	152	150	89	6.5
CP 4	129	127	145	24.8
TOMA 112 (4914)	174	170	105	8.5
Mentong	175	171	79	8.6
Raminad Str. 3	150	148	94	5.9
Pukui Lang Sat	156	150	106	16.8
LSD (p=0.05)	27	29	21	3.0

Table 58(b): RYT of Very Long Duration Varieties - Tidal Mangrove Swamp.

Varieties	1000 grain weight (g)	Height (cm)	50% Flowering (DAS+)	Yield (kg/ha)
ROK 10	21.9	165	147	4141
MAUNG NYO B24-72	20.2	162	152	3486
Pulut Rambutan	28.9	175	139	3428
Kuatik Putih	26.2	171	138	3266
Raden Jawa (Gundil)	25.2	174	148	3238
CP 4	20.3	163	149	3141
TOMA 112 (4914)	25.9	157	136	3100
Mentong	21.8	160	139	2997
Raminad Str. 3	25.0	165	145	2769
Pukui Lang Sat	23.4	177	139	2750
LSD (p=0.05)	2.1	6	1	463

+ DAS = days after sowing

Table 59(a): RYT of Long Duration Varieties - Tidal Mangrove Swamp.

Varieties	Tillers/m2	Effective tillers/m2	No. of filled grains/ panicle	Sterility (%)
Bay Danh	113	109	120	9.9
Raden Mas	120	118	103	10.2
Kuda Hirang	118	113	92	12.6
ROHYB 1-WAR-5-2-B-1	134	129	100	24.4
RH 2	132	127	102	28.3
Padi Koran	102	93	102	13.2
Gamut	119	115	75	16.1
Neang Chok	113	107	109	17.2
Sambegeury	133	129	72	21.6
LSD (p=0.05)	ns	ns	23	5.3

Table 59(b): RYT of Long Duration Varieties - Tidal Mangrove Swamp.

Varieties	1000 grain weight (g)	Height (cm)	50% Flowering (DAS+)	Yield (kg/ha)
Bay Danh	26.7	156	142	2612
Raden Mas	23.8	166	145	2393
Kuda Hirang	30.7	165	143	2298
ROHYB 1-WAR-5-2-B-1	25.3	156	138	2271
RH 2	23.1	145	143	1889
Padi Koran	26.8	161	145	1742
Gamut	24.9	165	144	1725
Neang Chok	26.3	146	146	1454
Sambegeury	31.4	149	134	1390
LSD (p=0.05)	2.6	8	2	510

+ DAS = days after sowing

Table 60(a): RYT of Long Duration Varieties - Tidal Mangrove Swamp.

Varieties	Tillers/m2	Effective tillers/m2	No. of filled grains/ panicle	Sterility (%)
Kuatik Kundur	103	101	89	8.4
RH 2	131	127	91	28.9
Serayap	120	120	94	16.5
Kuatk Bene	113	107	89	11.0
Kuatik Jambi	125	123	89	11.6
Padi Mentul	112	112	96	16.9
PARN A 191	106	96	98	13.0
Sokotera	135	134	94	19.8
Ebandioul (6196)	139	136	90	17.1
LSD (p=0.05)	ns	24	ns	6.8

Table 60(b): RYT of Long Duration Varieties - Tidal Mangrove Swmp.

Varieties	1000 grain weight (g)	Height (cm)	50% Flowering (DAS+)	Yield (kg/ha)
Kuatik Kundur	24.9	148	148	2878
RH 2	22.9	139	146	2417
Serayap	24.9	146	158	2410
Kuatik Bene	27.3	147	147	2396
Kuatik Jambi	22.8	140	146	2305
Padi Mentul	24.4	153	150	2294
PARN A 191	26.4	154	146	2271
Sokotera	22.6	147	134	1918
Ebandioul (6196)	31.7	138	146	1731
LSD (p=0.05)	1.8	7	2	441

+ DAS = days after sowing

(c) Performance of Long Duration Varieties in Tidal Swamp

Three RYTs to test long duration varieties were conducted during the year. There were two categories according to duration, 180 to 190 days and 170 to 180 days respectively.

In the longer duration category (180 to 190 days), eight varieties were compared with CP 4 and ROK 10 as checks. The trial was established on a fertile site with moderately deep tidal flooding and was fertilized at a rate of 40 kg N/ha.

The duration to 50% flowering of the varieties were in general shorter than the 180 to 190 days used as criterion for their inclusion in the trial (Table 58(b)). Only one variety, Maung Nyo B24-92, had a duration of more than 180 days and several were less than 170 days. This deviation from results obtained in previous years is probably attributable to the photoperiod sensitivity of the materials and late planting in 1982. Delay in flowering in 1981 due to effects of iron toxicity may also have contributed.

ROK 10 gave significantly higher yield than the 8 test varieties among which there was little difference in yield. None of the 8 varieties significantly yielded higher than CP 4. All the varieties were tall sturated and lodged at late maturing stage. Other characteristics worth noting were the blast tolerance of Raminad Str. 3 and and the large panicles of Maung Nyo B24-92. Spikelet sterility was less than 10% for ROK 10 and several other varieties but was 25% for CP 4. Results of other long duration trials are presented in Tables 59(a), 59(b), 60(a) and 60(b).

On the basis of the results of the RYTs reported in 1980 and 1981, six varieties: IR 5677-17-3-1-1, ROHYB 6-WAR-6-2-B-2, Haji Haroun, Bay Danh, Raden Mas and ROHYB 1-WAR-5-2-B-1 were nominated for inclusion in the mangrove swamp coordinated trial for 1983.

Farmers' Field Trials

Medium durtion Varieties

Three sets of six varieties were tested in multi-locational trials on farmers' fields during 1982. Each set comporised six varieties which have shown potential in previous trials. ROK 5 and ROK 8 are currently recommended for mangrove cultivation in Sierra Leone.

ROK 5 significantly outyielded all the varieties except ROK 8. It was notable that there was a distinct yield gap between ROK 5, ROK 8 and Lead (Table 61) which have identical durations to 50% flowering of approximately 120 days under cultural practices used, and MAS 2401 (3627) Sentral Marah and Djabon which are longer by 14 to 20 days. The late maturity of these three varieties exposed them to salt damage which resulted in increased spikelet sterility and consequent reduction in grain yields.

Table 61: Performance of Medium Duration Varieties on Farmers' Fields

Varieties	Yield kg/ha
ROK 5	3298
ROK 8	3072
LEAD (5411)	2681
MAS 2401 (3627)	1995
Sentral Merah	1738
Djabon	1725
LSD (5%)	511

Germplasm Collection and Evaluation

During the year, 51 accessions (34 collected from Guinea and 17 from Sierra Leone) were added to the collection. The Guinean varieties came from different ecologies but those from Sierra Leone all came from mangrove swamp areas in the south of the country. At the end of the year, the collection stood at 639 accessions.

Thirty-one varieties from Guinea were characterized for morphological and agronomic characters during the main season. This brought the total number of accessions characterized to 571.

Hybridization

Three hundred and sixty-five F5 lines from 18 crosses were evaluated and 163 lines from 15 crosses were retained for observational yield testing. Eight hundred and seventy-nine F4 lines from 23 crosses were also grown and selections made from 237 of them. Both these sets of materials consisted mainly of tall statured lines for tidal mangrove conditions. The durations of the F5 selections ranged between 165 and 190 days and those of the F4 selections between 150 and 170 days.

Eighteen F2 populations and a small number of F3 lines were grown on saline and non-saline sites and selections made from them. A number of these selections are being grown under irrigation during the off season in an attempt to speed up generation turnover.

Entomology

Incidence of Pests

Monitoring of incidence of rice pests was done in farmers' fields in three mangrove swamp districts of Guinea during the heading/flowering stage of the crop growth.

Table 62: Rice Pests Collected at Coyah, Sonfonia and Koba in Guinea

Pest	Number per Sample of 10 sweeps		
	Coyah	Sonfonia	Koba
Nephotettex modulatus	19.5	2.9	0.0
Chaetocnema spp.	178.9	28.3	258.1
Epilachna similis	2.1	3.1	33.0
Aspavia armigera	11.6	7.6	18.8
Cofana spp.	5.8	11.1	0.0
Diopsis theracica	68.2	48.4	2.1

Mangrove swamp pests in Guinea appeared to be similar to those of Sierra Leone. There were no differences in the diversity of pest species in the three districts but Koba had more numerous pests than the other two (Table 62)

Stemborer infestation was assessed by collecting rice hills at random and splitting each tiller. Infested stems were noted. Maliarpha separatella was recorded as the most dominant stemborer in the mangrove swamp of Guinea as in Sierra Leone.

In Koba district, the total stem infestation was about 30 percent while at Sonfonia and Coyah, the attacks were 10 and 12 percent respectively. Goniozus sp was the only parasite recorded and it was reared from M. separatella.

Ecological Studies

Light trap studies showed successive increases in the population of Chilo sp, M. separatella and Scirpophaga sp of about 4, 3, and 4 fold respectively at Mapotolon. This upsurge in adult populations was found to be positively correlated (r = 0.8) to stemborer infestation in the field.

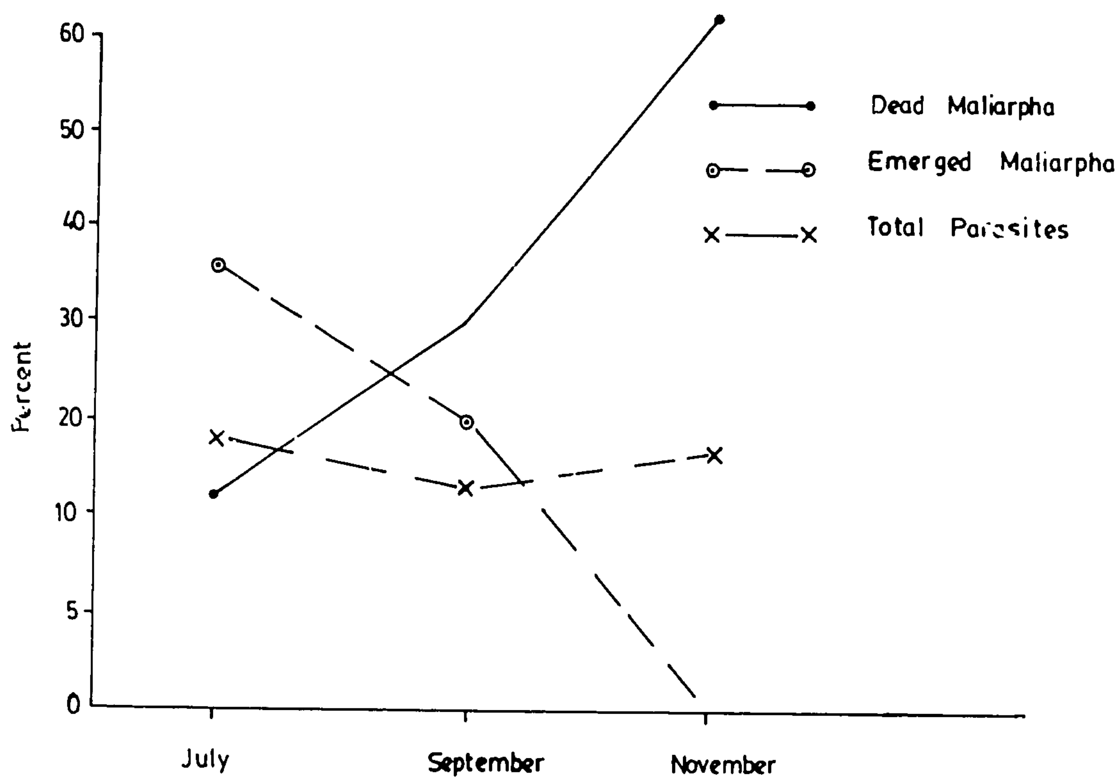

Fig. 4 Relationship between time of transplanting and hibernation of Maliarpha.

Distribution of maliarpha parasites

Eight larval parasites of M. separatella have been recorded in northern Sierra Leone. The dominant parasite, Phanerotoma major, is a solitary larval endoparasite which is widely distributed in mangrove swamps of northern Sierra Leone. Phanerotoma major formed about 75 percent of all larval parasites reared from M. separatella, followed by V. crassicaput which is fairly common in rice farms about 15 miles upstream from the sea. Rhaconotus scirpophagae, the third dominant parasite, is evenly and widely distributed. Goniozus sp. was found mainly in saline areas near the sea. Longevity of unfed P. major after emergence from hibernation averaged 4.6 days (ranged from 1 - 19 days) while those fed on honey lived for about 1.5 days. Since emergence from hibernation started in May, time of limited food supplies and numbers of hosts, longer life of unfed parasites may provide adequate time to search for suitable food and host.

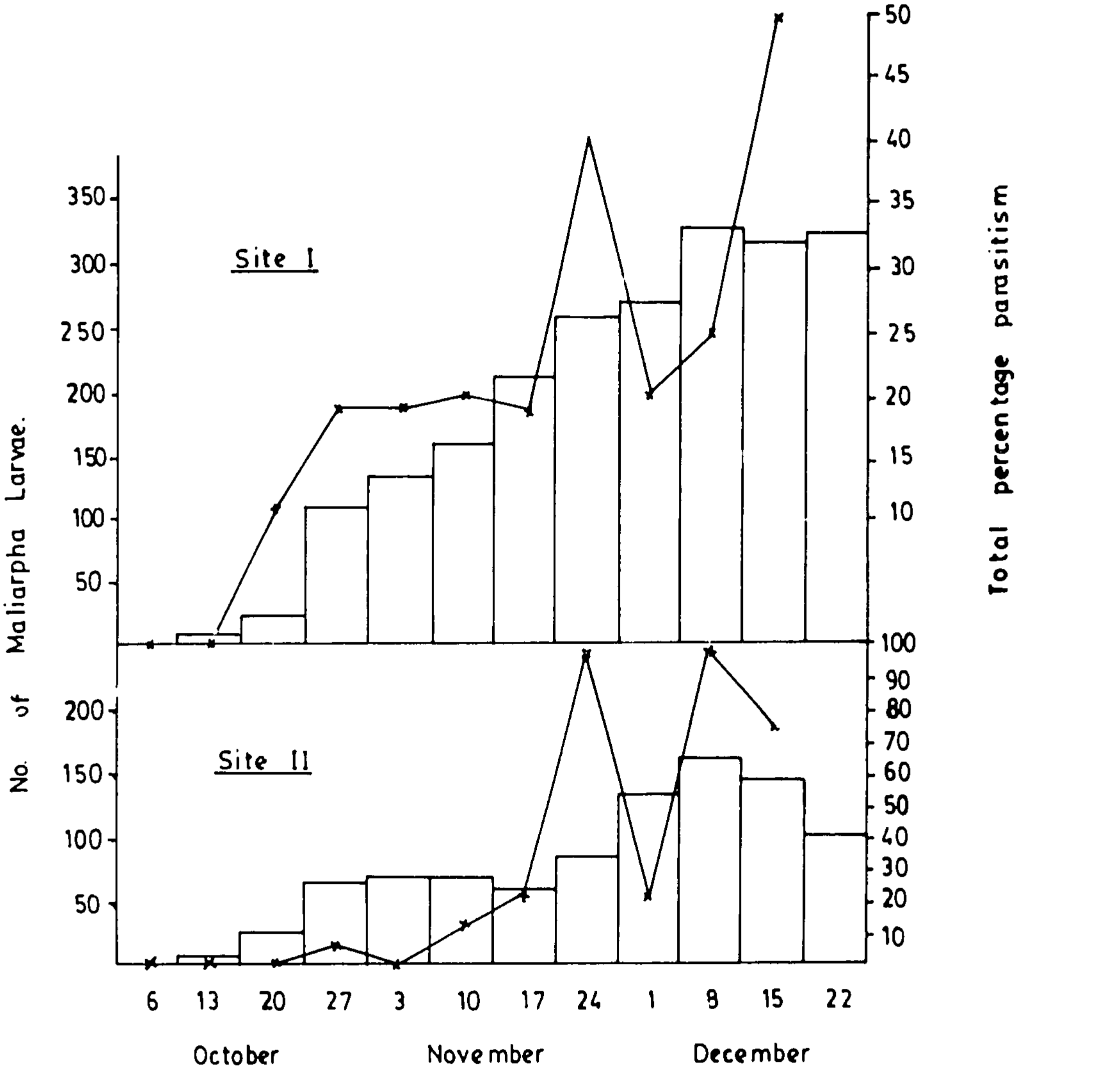

Fig. 5 Parasitism of Maliarpha Larvae in northern Sierra Leone

Time of Seedling Transplanting and larval Hibernation

In northern Sierra Leone, it has been found that hibernation of *Maliarpha* larvae generally starts in October and intensity of diapausing increases sharply in November and reaches a peak in December. July transplanted crops have lower stemborer infestation and higher yield than rice crops transplanted later than July.

Results on the effect of time of transplanting on larval hibernation (Figure 4) showed that July transplanted crop had lower stemborer infestation but a greater number of the infesting larvae underwent hibernation than in the crop transplanted in September and November. The high percentage of dead larvae recorded for September and November crops might have been due to a high number of non-diapausing larvae starved to death.

Of the larval parasites, *Venturia crassicaput* (48.1%) was slightly more numerous than *P. major* (42.9%), and *Rhaconotus sp.* formed about 9 percent. The range of parasitism from July to November transplanted crops was 23 to 28 percent.

Population Studies in Rice Fields

Studies on biotic and abiotic factors which influence the pest populations in farmers' rice continued during the 1982 cropping season.

At Robomp, *M. separatella* larvae population increased gradually from first week after transplanting (1 stemborer/hill) until harvest (3 stemborers/hill). The percentage of infestation (Figure 5) was due to the hibernation of the larvae which started at the end of October and reached a peak in December. *Phanerotoma major* was the major parasite reared from *M. separatella* larvae. Larval parasitism of non-diapausing larvae commenced two weeks after hosts appeared (i.e. third week in October) and reached first peak during the last week of November, and major peak four weeks later. *Phaconotus sp*, the second important parasite, started to parasitize *M. separatella* three weeks after the appearance of *P. major*.

At Mawirr, the *Maliarpha* larval population was relatively low. The percentage of stem infestation at harvest was 40.8. The dominant parasite at Mawirr was *Venturia crassicaput*.

The impact of parasitism appeared to increase as stemborer population densities increased. Thus, parasites are capable of regulating the population in all situations and act as an important suppressant in northern Sierra Leone. The eggs of *Borbo fanta* and *Pelopidas mathias*, rice defoliators, were rare at both sites and were effectively parasitized (75 percent) by *Telonomus sp* and *Pediobius telonomi*.

Pest Management and Crop Loss Assessment

Results in Table 63 show that under insecticidal protection, Pa Kenema gave the highest increase of about 25 percent while in Kuatik Jambi and Warkaiyo, yield decreased. Although Kuatik Kundur was highly attacked by stemborers, it yielded more than all the varieties suggesting that the variety was tolerant to stemborer infestation.

Table 63: Stemborer Infestation at Harvest and Grain Yield

Varieties	Stemborer Infestation		Grain Yield		Yield Increase (%)
	Protected (%)	Unprotected (%)	Protected kg/ha	Unprotected kg/ha	
Pa Kenema	0.6	46.1	2826	2262	24.9
Warkaiyo	0.3	20.2	3817	3553	7.4
Kuatik Jambi	0.3	27.6	3404	3258	4.5
Kuatik Kundur	0.1	61.1	3947	3558	10.9

Table 64: Relation of Crab Damage and Grain Yield with Variety, Seedling Age and Seedling Number/hill.

	ROKUPR		KAGBANHA		TOMBO		KYCHUM		BALANSERA	
	Damage (%)	Yield kg/ha	Damage (%)	Yield kg/ha	Damage (%)	Yield kg/ha	Damage (%)	Yield kg/ha	Damage (%)	Yield kg/ha
Varieties										
CP 4	30.1	2466	48.2	2347	41.3	1682				
ROK 5							50.6	4394	58.3	4792
Pa Kenema	22.3	2326	51.7	1654	45.1	1437	61.1	5541	56.2	5625
LSD (5%)	5.2	ns	ns	305	ns	219	ns	610	ns	787
Seedling age										
40 days	34.7	2272	63.7	1783	56.9	1460	64.0	4828	64.7	5281
60 days	17.2	2519	36.2	2219	29.4	1659	47.4	5105	44.9	5135
LSD (5%)	8.8	ns	9.3	333	11.2	180	11.2	ns	9.6	ns
No. Seedlings/hill										
6	23.2	2345	52.8	1850	38.2	1681	53.5	4903	54.1	5206
10	29.2	2446	47.1	2151	48.2	1438	58.3	5030	55.4	5210
LSD (5%)	ns	ns	ns	280	8.1	227	ns	ns	ns	ns

DAT = Days after transplanting.

Crabs

The assessment of crab damage was done at 12 days after transplanting by counting the damaged and undamaged tillers and grain yield.

Highly significant differences were found between crab damage to older and younger seedlings at all sites (Table 64). Ten seedlings per hill gave significantly higher grain yield than six seedlings at some sites. At ten seedlings per hill and spacing of 15 cm, crab attack left a higher number of seedlings per unit area than that of six seedlings per hill, thereby resulting in higher yields.

Although Pa Kenema gave significantly higher yield than ROK 5, (improved variety) at Kychum and Balansera, its lodging trait makes it unacceptable.

Simulation of Crab Damage

The pattern of seedling damage in the rice field by Sesarma huzardi, the major crab pest of the tidal mangrove, is very characteristic - attack of seedlings starts either along the bunds and creeks and progressively proceeds into the field or seedlings are distroyed randomly in the field.

To determine the importance of these two different patterns of damage, a simulation experiment was conducted in two farmers' fields.

The results indicated that higher yields were obtained where higher number of hills per unit area were planted. Presumably, this was due to increased number of productive tillers than at lower hills per unit area. There were no significant differences in yields between the same levels of percentage damage at 15 hills and 30 hills/sq.m of scattered loss. However, yields from scattered loss were significantly higher than that of the block loss of similar percentage damage levels. These differences may be attributed to higher tillering ability of the fewer number of seedlings per hill.

It may be concluded that the visible crab damage along bunds and creeks are of greater economic importance than the randomized damage in the rice fields. Farmers transplant on the average of 15 hills/sq. m. using 10 - 40 seedlings/hill.

It may also be inferred from this experiment that crab damage could be minimized if farmers reduced the seedling number per hill and increased the number of hills per unit area.

Varietal Resistance

Studies on mass screening for resistant varieties against crab damage were carried out by evaluating 221 mangrove swamp varieties including three from IRRI.

Twenty-six entries exhibited high tolerance to crab damage (0 - 10% damage), and half of the entries evaluated were attacked to the extent of 30 percent; only about 11 percent of the entries suffered crab damage of more than 50 percent. The entries, mainly traditional varieties which were generally tolerant to crab attack included Blue Stick, Banjul Bai, Nyabo I, Pa Compound Toma, Warkaiyo, Tima, Nyabo, Pa Minkween, Boloing Bolo, Nyabo II, Sorro Kent, Pa Doma Soya, Rok 5, Djambarla and Pa Lahiri.

The three IRRI bred varieties (IR 3259-P5-1, IR 4712-113-3-1-2, IR 4707-140-1-3) were highly susceptible to crab attack, possibility due to their short stature. The mechanism of resistance appeared to be morphological. Toughness of cell walls and large size of tissues physically interfered with feeding mechanism of crabs and prevented tolerant varieties from being destroyed.

Soil Science

The Soil Science programme concentrated on fertilizer response and agronomic practices to improve rice production in the mangrove swamp catena. Promising results from earlier trials were tested over a wide range of farmers' field conditions in Sierra Leone, Gambia and Guinea. The effect of Azolla on rice production in the associated swamps was also investigated.

Nitrogen Responses

The long term trial initiated in 1976 at four points on the mangrove swamp catena (deep flooded, tidal limit, river edge and seepage swamps) continued. The trial was conducted in a 4 x 4 Latin square design with 0, 20, 40 and 80 kg/ha of nitrogen as urea applied by the injection technique. Prior to 1982, all nitrogen was applied at early tillering, i.e. four weeks after transplanting. During the last cropping season, the treatments were modified by applying the 80 kg N/ha treatment in two equal spits at early tillering and booting.

The application of nitrogen was beneficial to grain yield of rice on all sites of the swamp catena with the exception of the seepage site. At the river edge, the application of 20 kg N/ha increased grain yield significantly over the Control (Table 65). The grain yield response to 40 kg N/ha at river edge was superior to that of 20 kg N/ha but was not significantly different from the response to 80 Kg N/ha. This may be attributed to lodging at the higher level of nitrogen. The application of 80 kg N/ha at the deep flooded site was superior to all treatments. At the tidal limit, the application of 80 kg N/ha significantly outyielded all other treatments with the exception of 40 kg N/ha (Table 65).

Table 65: Grain Yield (kg/ha) of CP4 Showing Response to Nitrogen on the Mangrove Swamp Catena.

Nitrogen kg N/ha	Mangrove River edge	Swamp Deep flooded	Associated Swamp Tidal limit	Seepage swamp
0	2381	2089	2326	2524
20	2779	2727	2585	2976
40	3181	3176	2700	2939
80	3465	2744	3050	3128
LSD (5%)	383	485	403	773

Effect of Nitrogen Supply on the Swamp Catena:

A trial was conducted at two points on the mangrove swamp catena, along the river edge and deep flooded, to determine the effect of nitrogen applied in one dose and in splits at different physiological stages of crop growth on the grain yield of CP 4.

The application of nitrogen had significant effect on grain yield at both sites. With the exception of nitrogen applied at early tillering or booting stage at river edge, the single application of 60 kg N/ha was as effective as the split application of nitrogen in increasing the grain yield of rice at both sites (Table 66).

Broadcast versus Deep Placement of Nitrogen:

Soils on the tidal limit of mangrove swamps are subjected to the movement of considerable quantities of water in run off and seepage through the profile during the cropping season. The effect of this water movement on applied nitrogen is thought to be the cause of the inconsistent responses to injected nitrogen in this part of the mangrove swamp ecology over the years. The results of trials conducted in 1979 and in 1980 indicated a significant response to split application of N in this part of the ecology. The data in Table 67 indicate that split application of nitrogen, whether by broadcast or deep placement methods is of no benefit at the sites on which the trial was conducted. Deep placement has no advantage over broadcast of nitrogen at tidal limit but as a once only method of application it has an edge over broadcast in other areas of the ecology.

Response to Depth of Nitrogen Application in the Associated Swamp:

A trial conducted in the tidal mangrove swamp at Rokupr during the 1981 cropping season confirmed the superiority of deep placement over broadcast application of nitrogen and showed that the response to nitrogen in this part of the ecology increased with increasing depth of application.

An experiment was conducted to evaluate the efficiency of deep-placed nitrogen and determine the appropriate depth of nitrogen application in the associated swamps.

The grain yield data presented in Table 68 indicate a significant increase in grain yield with the application of 60 kg N/ha. The grain yield response to broadcast and injected nitrogen in this part of the ecology was similar, suggesting that the additional cost of labour involved in deep placement of nitrogen is not justifiable.

Table 66: Effect of Nitrogen Application at Different Physiological Stages of CP4 on Grain Yield.

Rate of Application (kg/ha)				Mean Grain Yield	
Et	Lt	Pi	Bt	River edge	Deep flooded
0	0	0	0	2466	1860
60	0	0	0	3072	2709
0	60	0	0	3638	2728
0	0	60	0	3405	2859
0	0	0	60	3024	2680
40	0	20	0	3631	3053
40	0	0	20	3723	3082
40	0	10	10	3346	3183
30	0	30	0	3510	2974
30	0	0	30	3422	2635

Et = Early tillering
Lt = Late tillering
Pi = Panicle initiation
Bt = Booting.

Table 67: Effect of Method and Time of Nitrogen Application on Grain Yield of CP4 in the Associated Swamp

Treatments	Grain Yields	
	Tidal limit	ABST farm
Control (no nitrogen)	2190	1630
N 60 injected at Et	2272	2928
N 60 broadcast at Et	2887	2563
N 30 injected at Et and Bt	2153	1689
N 30 broadcast at Et and Bt	1829	2145
N 15 injected at Et, Lt, Pi and Bt	2505	1802
N 15 broadcast at Et, Lt, Pi and Bt	2603	2396
LSD (5%)	1234	862

Table 68: Grain Yield of ROK 5 in Relation to Depth of Nitrogen Application using Urea in the Associated Swamp.

Application method	Yield kg/ha
Control (no nitrogen)	2021
N 60, broadcast	2895
N 60, injected 5 cm deep	3210
N 60, injected 10 cm deep	2989
N 60, injected 15 cm deep	3393
N 60, injected 20 cm deep	2943
LSD (5%)	766

Varietal Response to Nitrogen

Six varieties, namely: Sokotera, Serayap, Parn A 191, Kuatik Kundur, CP 4 and ROK 5 in the tidal mangrove swamp; and IR 3259-P5-160-1, IR 4707-1-3, IR 2797-125-3-2-2-2, IR 4712-113-3-1-2, IR 5677-17-3-1-1 and ROK 5 in the associated swamp were used in this trial.

In the tidal mangrove swamp, interaction between varieties and nitrogen was significant (Figure 6). The application of nitrogen increased grain yield significantly in all varieties and this increased with increasing levels of nitrogen for most of the varieties. Grain yield increased with increasing levels of nitrogen for ROK 5 but response to 80 and 120 kg N/ha was not significantly different.

ROK 5 performed well under all levels of fertility and was distinctly superior to the other varieties under high fertility conditions. The performances of Serayap and Kuatik Kundar were comparable to ROK 5 under high fertility conditions in the tidal mangrove swamps.

At all levels of applied nitrogen, ROK 5 was superior to the other varieties with the exception of Parn A 191 at 40 kg N/ha.

The response to nitrogen of the varieties cultivated in the associated swamp is presented in Table 69. In the associated swamp, the application of nitrogen produced significant increases in average grain yield but the differences in response to the different levels of nitrogen were not significant. IR 3259-P5-160-1 produced the highest grain yield but this was superior only to IR 4712-113-3-1-2. ROK 5 ranked fourth in this environment and the average grain yield was much lower than the average yield obtained in the tidal mangrove swamp.

Most of the varieties grown in the associated swamp, including ROK 5, succumbed to brown spot. This may be a reflection of iron toxicity problems experienced in this area. The symptoms of brown spot were not manifest on IR 5677-17-3-1-1 but this variety did not respond to nitrogen. The poor response to nitrogen in this area may be attributed to nitrogen losses due to leaching.

Alterate Sources of Nitrogen

Three trials were conducted to evaluate the effect of Azolla, as an organic source of nitrogen, on grain yield in lowland rice production.

1. Effect of Azolla as a Green Manure: This trial, in its second season, compared the effect of fresh Azolla incorporated as a green manure with mineral nitrogen on the grain yield of rice in the associated swamp.

The results showed that the incorporation of fresh Azolla increased grain yield significantly over the control and was as effective as mineral nitrogen. (Table 70)

2. The Effect of Different Dates of Azolla Incorporation: Fresh Azolla is known to decompose rapidly and release 50 to 80% of its mineralized nitrogen mostly as urea within 3 to 6 weeks of incorporation. Newly traansplanted rice has a recovery period of about two weeks. Owing to the large volume of water seeping through soils in the associated swamp, nitrogen mineralized from decomposing Azolla is subjected to leaching losses and may not be effectively utilized by the crop. It was therefore necessary to evaluate the effect of time of Azolla incorporation in relation to transplanting on the grain yield of rice in the associated swamp.

The grain yield response to mineral nitrogen and the incorporation of fresh Azolla two weeks after transpplanting were similar. Both treatments significantly outyielded the control (Table 71). Azolla treatments in this trial also suffered from wash-off and drift resulting from heavy rains and flooding after incorporation.

3. Comparison of the Effect of Fresh, Dried and Composted Azolla: The uncontrolled water movement in most lowland rice farms during the cropping season does not facilitate in situ production of large quantities of Azolla for incorporation into the soil. This necessitates the development of ponds, where water is available, for production of Azolla in the dry season. Azolla produced in the fallow period can be composted or dried and composted and incorporated in the following cropping season.

The effect of these Azolla materials on the grain yield of rice was compared with fresh Azolla and mineral nitrogen in a trial conducted in the associated swamp. The following quantities of the different Azolla materials were used: 20 tons/ha of fresh Azolla, 4 tons/ha compost two weeks before transplanting or at transplanting. The treatments also included urea nitrogen at 40 kg/ha applied at 15 cm depth two weeks after transplanting; a control without nitrogen or any of the Azolla materials. Phosphorus at 20 kg P/ha was applied uniformly as basal treatment.

The incorporation of fresh Azolla had the same effect on grain yield as mineral nitrogen. Both increased grain yield significantly over the control. With the exception of the earlier application of dried Azolla, the effect of the other materials was comparable to mineral nitrogen (Figure 7). Time of incorporation of the Azolla materials may not be critical but Azolla incorporation at transplanting had an edge over the earlier incorporation.

Azolla materials incorporated in these swamps have the advantage of being slowly decomposed and in addition to nitrogen, other nutrients especially phosphorus are probably mineralized and made available to the crop directly from the Azolla materials and from the soil as a result of organic matter incorporation. The effect of the different Azolla materials on availability of nutrient was not determined. It is presumed to be different and this probably accounts for their different effects on grain yield.

Fresh Azolla has a better effect on grain yield than the dried and composted materials but these too can benefit grain yield in lowland rice production. It is evident from the results obtained that the incorporation of Azolla supplements the nitrogen required and presumably provides other nutrients for rice growth in the associated swamp. However, the adoption of Azolla by farmers is being hindered by ignorance of the benefits to be derived from its use and lack of a suitable technology for large scale, in situ production and effective incorporation of Azolla into the soil.

Table 69: Varietal Response (kg/ha) to Nitrogen in the Associated Swamp.

Varieties	kg/ha of nitrogen			
	0	40	80	100
IR 3259-P5-160-1	2730	3087	2836	3419
IR 4707-140-1-3	1532	2588	2582	3123
IR 2979-125-3-2-2-2	1986	2818	2687	2775
IR 4712-113-3-1-2	1460	2401	2288	2160
IR 5677-17-3-1-1	2468	2619	2804	2933
ROK 5	2023	2472	2694	2962

LSDs (5%)
Between nitrogen levels = 338 kg/ha
Between varieties = 553 kg/ha
Between varieties at fixed nitrogen level = 1106 kg/ha

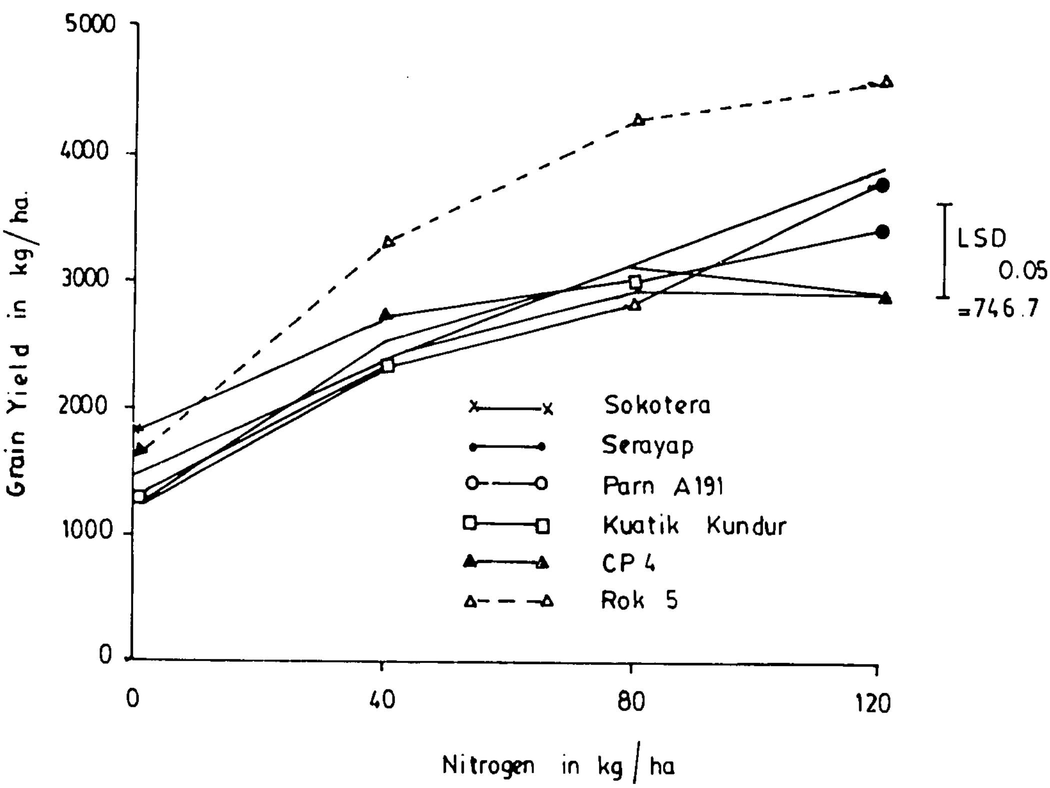

Fig. 6 VARIETAL RESPONSE TO NITROGEN IN THE TIDAL MANGROVE SWAMP

Table 70: Effect of Azolla

Treatments	Yield kg/ha
No nitrogen or Azolla	1181
60 kg/ha urea nitrogen	2704
20 t/ha of Azolla	1940
40 t/ha of Azolla	2051
LSD (5%)	747

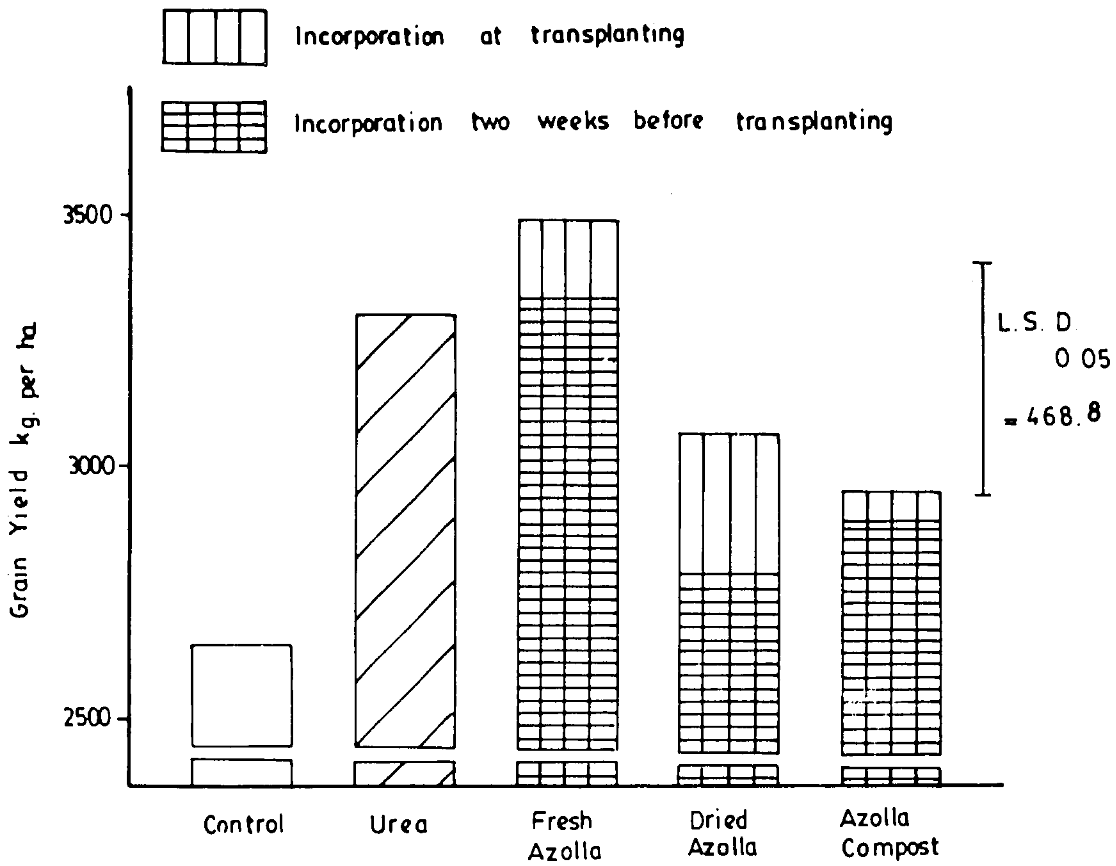

Fig. 7 The Effect of Fresh and Composted Azolla on Grain Yield of ROK 5 in Associated Swamp.

Table 71: Yield of ROK 5 as influenced by time of Azolla Application in the Associated Swamp

Treatments	Yield kg/ha
No nitrogen or Azolla	2050
40 kg N/ha Urea at 2 WAT	2783
20 t/ha of Azolla at 2 WBT	2687
20 t/ha of Azolla at transplanting	2222
20 t/ha of Azolla at 2 WAT	2773
LSD (5%)	712

Interaction of Nitrogen with Other Nutrients

Response to Nitrogen, Phosphorus and Potassium: Evaluation of the long-term effect of nitrogen, phosphorus and potassium on the yield of CP 4 at the river edge, deep-flooded, tidal limit, and seepage zone on the swamp catena, was carried out during the cropping season.

The results showed a significant response to nitrogen at all sites with the exception of the seepage swamp and the new farm site (Table 72) on the river edge. The addition of phosphorus increased the grain yield of CP 4 significantly at tidal limit, seepage and the new farm site.

These results suggest that nitrogen may be limiting for rice production in the tidal areas of the swamp but in areas of the swamp where the soil becomes oxidized and soil reaction is adverse at the start of the cropping season, phosphorus is probably the major limiting nutrient for rice production.

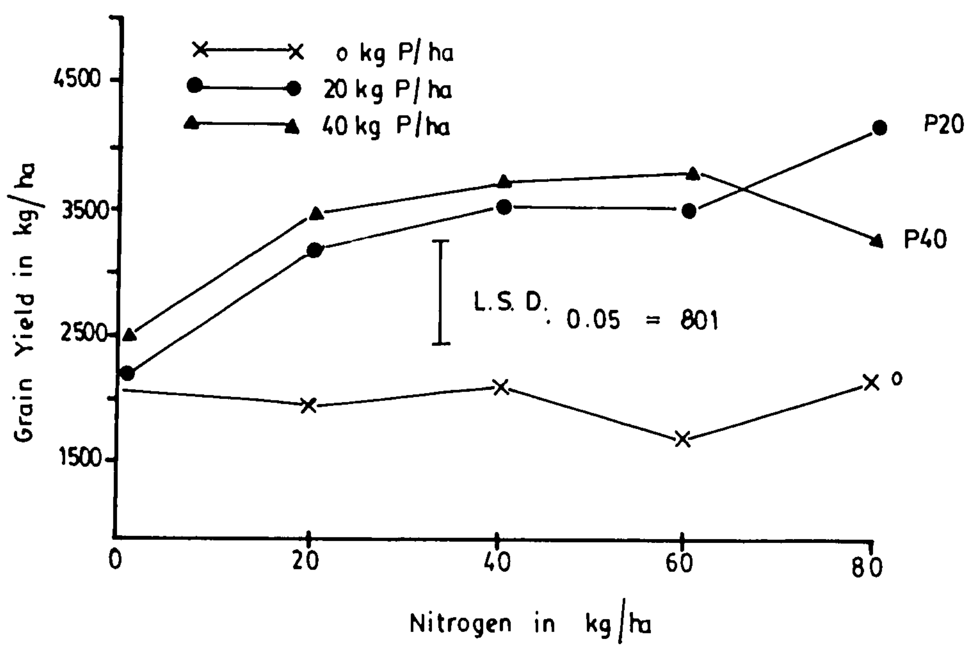

Fig. 8. YIELD RESPONSE OF CP 4 TO NITROGEN AND PHOSPHORUS ON THE TIDAL LIMIT ZONE OF THE MANGROVE SWAMP CATENA AT ROKUPR.

Response to Nitrogen and Phosphorus in the Associated Swamp: Application of phosphorus in addition to nitrogen has produced positive though non-significant interactions. The effect on grain yield of three levels of phosphorus, 0 20, and 40 kg P/ha was evaluated in a factorial experiment at the tidal limit of the swamp catena during the cropping season to determine possible nitrogen x phosphate interactions.

Analysis of the grain yield data showed a significant nitrogen phosphate interaction. Response to nitrogen at the different levels of phosphorus is shown in Figure 8. Addition of 20 kg P/ha produced a response to nitrogen and increased grain yield significantly. At 80 kg N/ha, significant yield differences were obtained between the different levels of phosphorus.

The results indicate that phosphorus is the first limiting nutrient for rice production in this area of the swamp and a balanced application of moderate levels of nitrogen and phosphorus would be beneficial to grain yield in such areas of the associated swamp.

Agronomy

Effect of Plant Spacing and Nitrogen Supply on the Grain of Medium and long duration Mangrove Swamp Rice Varieties:

A trial was established on the main farm at Rokupr to investigate the effect of plant spacing and determine the effect of early and late application of nitrogen on the grain yield of medium duration (ROK 5) and long duration (CP 4) mangrove swamp rice varieties.

It was found that an application of 60 kg N/ha increased grain yield significantly over the control and at all nitrogen supply regimes, ROK 5 produced a higher grain yield than CP 4 (Table 73). Higher grain yields were obtained when nitrogen was applied early for ROK 5 and late for CP 4.

Since there was no effect of plant spacing on the grain yield of the two rice varieties at the levels of nitrogen used in this trial, it would therefore be more economical in terms of seedling requirement and labour to transplant at the lower density in the mangrove swamps.

The indications are that nitrogen could be more effectively used by the rice crop if the time of application was related to the duration of the rice varieties. A plant density of 50 hills/m2 did not produce significantly higher grain yields than 12 hills/m2 at the levels of nitrogen used irrespective of variety.

Farmers Field Trials

Effect of cultivation methods on nitrogen response: The response of rice to nitrogen under manual and mechanical cultivation and the long-term effect of cultivation methods on crop performance was evaluated for the fourth consecutive season on farms in the Scarcies area.

The results show that the effect of mechanical cultivation on grain yield was superior to the farmers' manual method of land cultivation. With the exception of 60 kg N/ha, the grain yield produced under mechanical cultivation was significantly higher than under manual cultivation at all levels of nitrogen (Figure 9). The response to nitrogen was significant and grain yield increased significantly with successive 20 kg/ha increments of nitrogen. The response to nitrogen under manual cultivation was linear but under mechnaical cultivation the response to nitrogen levelled off at 40 kg N/ha.

The effect of mechanical cultivation in increasing the grain yield of rice in farmers' fields has been consistent over the years. Its immediate effect has been beneficial to rice cultivation on mangrove swamps. However, the long-term effect of mechanical cultivation on soil constituents, particularly the status of organic matter in the soil is to be carefully monitored as this is the major source of plant nutrient in the mangrove swamp and sustained productivity requires soil management practices that would preserve the organic matter.

Table 72: Effect of N, P and K Application on Grain Yield (kg/ha) of CP4 in Mangrove Swamp

Treatments	Mangrove River edge	Swamp Deep flooded	Associated Swamp Tidal limit	Seepage swamp	ABST site
Control	2230	2200	1117	2900	1747
N	3021	3309	1795	3370	2211
NP	3412	3265	2641	3793	2824
NPK	3228	3609	2383	3906	2794
LSD (5%)	460	662	315	532	844

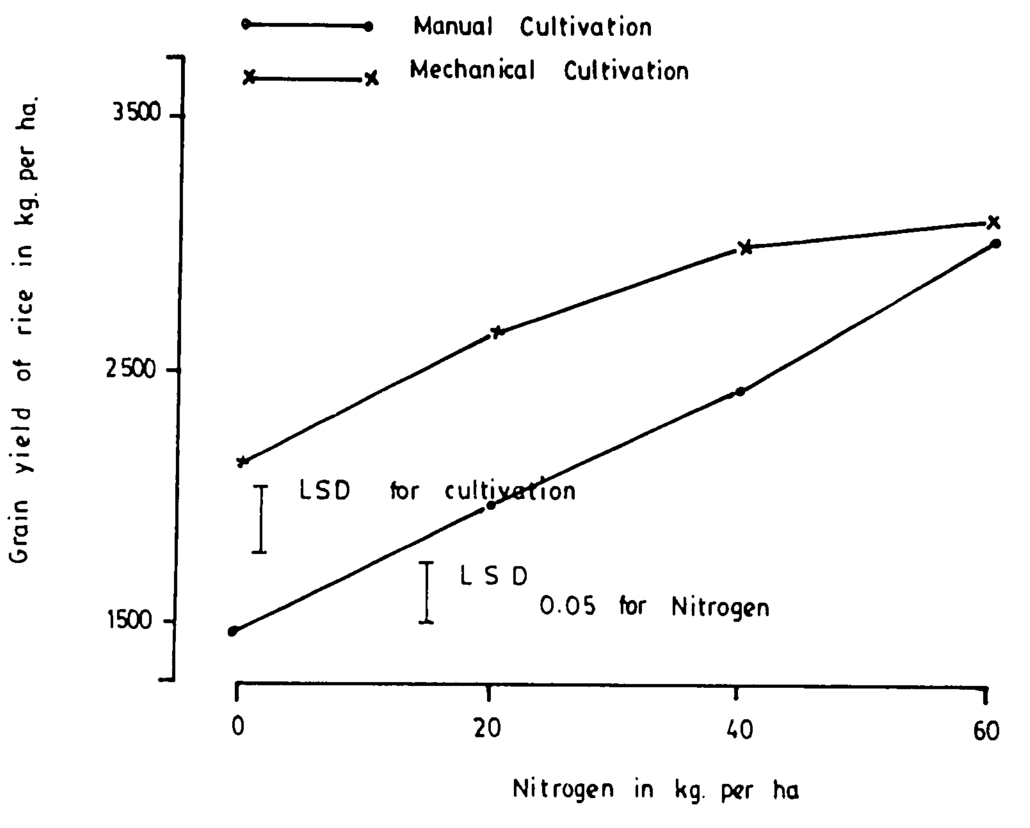

Fig. 9. The response to nitrogen under manual and mechanical cultivation on farmer's fields.

Table 73: Effect of Spacing and 60 kg N/ha on the Grain Yield of ROK 5 and CP4.

Treatments	Plant Spacing cm x cm 30x25	20x20	20x15	20x10
	CP4 (long duration)			
No nitrogen	1718	1858	1821	1845
Early nitrogen	2578	2885	2714	2919
Late nitrogen	3036	2099	2019	3341
Early + Late nitrogen	3209	3065	3341	3202
	ROK 5 (medium duration)			
No nitrogen	1913	2175	2347	2194
Early nitrogen	3448	3676	3457	3542
Late nitrogen	3522	3353	3616	3549
Early + Late nitrogen	3336	3158	3590	3168

Weed Science

Introduction

The research activities in 1982 included work on chemical, cultural and mechanical weed control in the mangrove and associated grass swamps. Experiments on weed control on farmers' fields were continued while those on the biology of Paspalum vaginatum were initiated. A survey was also conducted in the Koba, Koya and Sonfonia regions of Guinea.

Weed Survey

In the pure mangrove swamp of Guinea, the most dominant weed was 'kire-kire' (Paspalum vaginatum) and to a less extent Alternanthera sessilis. In the associated mangrove swamps, the sedges, Fuirena sticta and Cyperus difformis; the grasses, Panicum repens and Ischaemun rogosum; and the broad leaves, Jussiaea sp. and Sesbania sp., were the most dominant. The weed occurrence is therefore similar to that of Sierra Leone; thus, any weed control measure found successful in Sierra Leone could be made applicable to the Guinea situation.

Weed Control in Mangrove Swamp

Long Term Effects of Paspalum vaginatum Control Methods: The trial has been repeated for four consecutive seasons from 1979 - 1982 on the same site to evaluate the long term effects of different cultivation methods at different times on the growth of kire-kire and yield of rice.

The yields of all cultivation done in June were slightly higher than the cultivation done in March, but the differences were not significant (Table 74). This might be attributed to severe crab damage after transplanting in some plots. However, mechanical cultivation done in June gave the highest yield. All cultivation treatments had significantly lower kire-kire infestation than manual digging only (farmers' practice). All cultivation done in June had lower kire-kire population than the cultivation done in March which confirms earlier findings that in soft soil areas with a very dense kire-kire population, June is the best time for land preparation. March cultivation results in regeneration of the weed before the time of transplanting.

Effect of Manual and Mechanical Cultivation Methods on Cyperus articulatus and Rice Yield: The sedge, C. articulatus, is gradually becoming a problem in the mangrove swamps.

A trial was therefore initiated to evaluate the effect of manual and mechanical cultivatiom methods using the spade, hoe and power tiller respectively, in suppressing the growth of the sedge.

Table 74: Effect of Different Cultivation Methods at Different Times on Yield (kg/ha) of CP 4 in the Mangrove Swamp at Rokupr

Date of cultivation	CULTIVATION METHODS				Mean
	Manual digging only	Brushing Non removal Manual digging	Brushing Removal Manual digging & Puddling	Brushing Removal Mechanical ploughing & Puddling	
March	1104	767	1190	1283	1086
June	1077	1304	1191	1481	1263
Means	1091	1336	1191	1382	

LSD (5%): Date of Cultivation = 249 kg/ha
Cultivation method = 352 kg/ha
Treatment means = 498 kg/ha

Table 75: Effect of Manual and Mechanical Cultivation Methods on Grain Yield of CP 4 and Population of C. Articulatus at Harvest.

Treatment	Yield kg/ha	Weed Population/m2
1. Manual ploughing and puddling	1967	264
2. Manual ploughing and puddling with rhizomes removed from soil	1753	23
3. Mechanical ploughing and puddling	1803	25
4. Mechanical ploughing and puddling with rhizomes removed from soil	2061	7
5. Manual ploughing (Control)	1853	343
LSD (5%)	793	85

Table 76: Effect of Cultivation and Weed Control Methods on Yield (kg/ha) of Rice in Mangrove Associated Grass Swamp at Rokupr (1978-1982 Wet Seasons)

Cultivation and weed control methods	1978	1979	1980	1981	1982	Mean
Manual ploughing + no weeding	1919	1472	2175	2074	2967	2121
Manual ploughing + weeding 20 & 40DAT	2904	3457				
Manual ploughing + weeding 40DAT			2881	3023	3804	3214
Manual ploughing + weed free	3056	3575				
Manual ploughing + weeding 20 & 40DAT			3177	2860	3897	3313
Manual ploughing + Stam F34T	2629	3863	2880	3063	4082	3303
Mech. ploughing + no weeding	2800	2965	2831	2558	3551	2941
Mech. ploughing + weeding 20 & 40DAT	3381	4007				
Mech. ploughing + weeding 40DAT			3346	2931	3651	3463
Mech. ploughing + weed free	3364	4229				
Mech. ploughing + weeding 20 & 40DAT	2851	3210	3835	3498		
Mech. ploughing + Stam F34T	3555	4028	3445	3194	3631	3571
Means	2951	3450	2948	2864	3677	

Table 77: Effect of Herbicides on Yield of Rice and Weed Population in Associated Mangrove Swamp.

Treatment	Rate	Time of Application	Yield kg/ha	Weed Count/m2 Grass	Sedge	Broad Leaved
Herbamix-PM410	5L/ha	10DAT	2019	53	229	47
Herbamix-PM410	6L/ha	10DAT	2204	67	217	29
Herbamix-PM410	8L/ha	21DAT	2628	80	193	51
Herbamix-PM410	10L/ha	21DAT	2628	33	361	26
Herbamix-PM410	5L/ha	10DAT + weeding 30DAT	2598	44	455	64
Herbamix-PM410	8L/ha	21DAT + weeding 40DAT	2562	27	330	27
Stam F34T	3.0 kg a.i./ha	21DAT	1974	79	371	38
Stam F34T	4.0kg a.i./ha	21DAT	1816	49	435	41
Stam F34T	3.0 kg a.i./ha	21DAT + weeding 40DAT	2265	56	343	77
Handweeding twice		21 & 35DAT	2410	49	476	32
Weed free		Whenever necessary	2545	13	101	21
No weeding			1921	43	486	33

Table 78: Effect of Cultivation and Weed Control Methods on Yield (kg/ha) of CP 4 on Farmers' Fields in Associated Grass Swamp.

Site No.	MANUAL CULTIVATION No weeding	Handweeding at 25 & 40DAT	Stam F34T+	MECHANICLAL CULTIVATION No weeding	Handweeding at 25 & 40DAT	Stam F34T+
1.	1463	1895	1688	2631	2752	2324
2.	596	1228	1474	1462	2470	2372
3.	1241	1707	2415	1488	1842	1605
4.	2470	2845	3236	2137	2443	2406
5.	1001	1063	1228	698	1097	1403
6.	977	1146	1253	1046	1325	1334
7.	886	1100	1307	1029	1365	1428
8.	307	978	1368	526	822	1516
Means	1118	1495	1746	1377	1765	1799

LSD (%) : Cultivation methods = 333 kg/ha
Weed control methods = 149 kg/ha

+ Stam F34T was applied at the rate of 3.24 kg a.i./ha
DAT = Days after transplanting.

Although there were no significant differences in yield between treatments, all treatments except manual ploughing and puddling, had significantly lower infestation of C. articulatus than the control (Table 75). Mechanical cultivation gave the best control. The results further show that for manual cultivation to adequately control the weed, the stem and root cuttings should be removed after ploughing and puddling to avoid regeneration of the rhizomes. But for mechanical cultivation, the weed can be adequately controlled after ploughing and puddling even if the stem and root cuttings are not removed.

Effect of Kire-Kire (Paspalum vaginatum) Competition on Growth and Development of CP 4 Rice Variety: The results show that plots without kire-kire infestation had significantly higher production of tillers (113/0.6m2) than the kire-kire infested plots (90/0.6m2) for all the dates of sampling which shows that tiller production by the rice crop can be reduced by kire-kire competition.

Weed Control in Mangrove Associated Grass Swamp

Effects of Cultivation and Weed Control Methods: This trial was initiated during the 1977 season and has been conducted for the past six seasons. The trial has been repeated on the same site to determine the long-term effect of the treatments on yield and the weed flora. The test variety was CP 4.

The results presented in Table 76 for grain yield show that for both methods of cultivation, all weed control methods yielded significantly higher than the no weeding control but did not differ significantly from each other. Mechanical cultivation did not significantly differ in yield from manual cultivation. This can be due to the fact that after six seasons of cultivation, on the same site, the weed population had been drastically reduced as reflected in the weed count and weed weight results. All weed control methods under manual and mechanical cultivation adequately controlled the grasses, sedges and broad leaves.

Effect of Herbicides on Rice Yield in Associated Swamp:

The yield results from 1978 to 1982 (Table 78) show that herbicide STAM F 34T (propanil + fenoprop), is very promising in controlling weeds and increasing rice yields. The results further show that mechanical cultivation with the single axle tractor is superior over manual cultivation in controlling weeds and increasing rice yields.

Effects of Cultivation and Weed Control Methods on Grain Yield of CP 4 in Associated Swamps: The trial was conducted on eight sites on farmers' fields in the associated grass swamps within a radius of six miles from Rokupr. The results in Table 78 show that hand weeding (at 25 DAT and 40 DAT) with the application of STAM F 34T gave significantly higher yield than the no weeding control, regardless of the method of cultivation.

For both manual and mechanical cultivation, the population of sedges was significantly less in the hand-weeded and STAM F 34T plots than in the no-weeding control plots.

At all the trial sites, sedges were dominant over grasses and broadleaves but STAM F34T proved to be an effective broad spectrum weed killer. the poor grain yields might be attributed to iron toxicity and other nutrient deficiencies which occurred in most of the trial sites.

Pathology

Incidence of Disease

Disease Survey in Guinea Mangrove Swamp: A general disease survey of mangrove swamp rice conducted in three regions of Guinea (Koya, Sonfonia and Koba) showed the occurrence of the following dieases: Leaf blast (Pyricularia oryzae), brown leaf spot (Cochliobolus miyaleanus - Helminthosporium oryzae), narrow brown leaf spot (Cercospora oryzae), leaf scald (Rhynchosporium oryzae), a presumptive stack burn disease (Alternaria padwickii), sheath blotch (Pyrenchaeto oryzae), sheath rot (Acrocylindrium oryzae), dirty panicle (C. miyabeanus, etc.), sugary disease, cattail fungus or udbatta (Ephilis pallida), panicle blast (P. oryzae) and pale yellow mottle virus. The intensity of fungal diseases observed varied with the ecology.

Disease Monitoring in Varietal Improvement Plots at Rokupr: Some 1,600 varieties/lines were scored for seedling blast in the nursery and other diseases occurring in the field after transplanting. Twenty-five varieties/lines recorded immune reaction to seedling blast; another 84 were rated highly resistant followed by 271 resistant lines. The intermediate class had 430, followed by 371 susceptible and 433 highly susceptible. Seedling blast incidence was observed to be more severe during the season than was apparent in the previous year. This was probably due to a combination of favourable weather conditions and abundant susceptible germplasm.

At Rokupr, udbutta (E. pallida) was recorded on 20 varieties which included ROK 5, IR 4712-38-1-2-3, IR 5677-17-3-1, Kautik Putih, Toma 112, Raminad Str. 3 and Djabon.

Table 79: Reactions of some Rice Varieties to Seedling Blast and other Diseases under Mangrove Swamp Conditions - 1982

	ROKUPR					ROTIFUNK				
	SB	BS	LSc	LSm	DP	SB	BS	LSc	LSm	DP
ROK 4	S	I	I	HS	R	S	I	I	S	HR
ROK 5	S	R	HR	HR	HR	I	I	I	I	HR
ROK 7	S	I	I	HS	HR	R	R	I	S	R
ROK 8	HS	R	HR	S	HR	I	S	I	HS	R
ROK 9	HS	R	R	HR	HR	I	I	I	S	R
BD 2	HS	I	HR	HR	HR	I	I	R	HS	R
CP 4	I	R	I	I	HR	R	R	I	S	HR
RH 2	HS	I	HR	R	HR	I	I	R	I	HR
SR 26	HS	R	HR	HR	R	R	I	I	I	R
Pa Konday 48B	R	I	I	S	HR	HR	I	I	I	HR
Pa Yenke Yanka 114	R	I	HR	HR	HR	HR	I	R	S	R
Kaolaka 106a	I	I	I	I	HR	HR	I	I	S	R
Segon Mega	HR	I	I	HS	R	HR	R	I	S	HR
Murungakayan	I	R	I	I	HR	R	I	I	R	R
Raminad Str. 3	HR	I	HR	I	HR	HR	I	I	S	HR
23-3-1-B-3	HR	I	I	I	HR	HR	I	I	S	HR
23-2-F5-1	HR	I	HR	S	R	HR	I	R	S	R
IR 4712-38-1-2-3	R	HR	HR	HR	HR	HR	R	R	S	R
IR -3-231-3-3	HR	I	HR	HR	HR	HR	R	R	I	HR
IR 9782-111-2-1-2	HR	R	HR	HR	HR	HR	I	R	HS	HR

SB = Seedling blast (Pyricularia oryzae)
BS = Brown spot (Cochliobolus miyabeanus)
LSc= Leaf scald (Rhyncosporium oryzae)
LSm= Leaf smut (Entyloma oryzae)
DP = Dirty panicle (C. miyabeanus, etc.)

HR = Highly resistant
R = Resistant
I = Intermediate
S = Susceptible
HS = Highly susceptible

Horizontal Disease Resistance Nursery: Some 150 varieties/lines of recommended mangrove swamp varieties, local varieties, introduced varieties and advanced breeding lines of related ecology and 10 monogenic Japanese blast differential varieties were sown in horizontal resistance field plot design at Rotifunk and Rokupr.

It is evident from the results that considerable varietal differences in reaction to seedling blast and other diseaases in the field occurred. However, some varieties indicated stable resistance to blast and other disease at both locations (Table 79). Lesion number per leaf was observed to be high on susceptible varieties and low on resistant varieties.

Seedling Blast in Nursery and Crop Stand in Tidal Mangrove Swamp: Some 60 seedling blast resistant or tolerant viarieties/lines were re-selected after the first nursery was transplanted and nursed in larger plots. the spread of disease along a gradient at 0.5 m intervals up to 2.5 m long was monitored. The materials were then transplanted in tidal mangrove swamp.

Table 80: Reactions of some Mangrove Swamp Rice Varieties to Pale Yellow Mottle Virus

Variety	Disease reaction	(% Stunting)	Other Reaction
A. Recommended Varieties:			
ROK 4	S/MR	12.2	
ROK 5	S/S	30.4	Oranged
ROK 7	S/S	22.2	
ROK 8	S/I	17.9	Oranged, blasted
ROK 9	S/S	33.9	Oranged
ROK 10	S/I	16.3	Blasted
BD 2	S/S	31.4	
RH 2	S/S	29.2	
SR 26	S/S	40.7	Scalded
CP 4	S/S	25.3	
Gantang	S/S	31.0	Oranged
B. Farmers' varieties and introductins:			
Nyowai 298	I/MR	7.9	Scalded
Anghata	I/MR	7.8	Scalded
Pa Konday 48B	I/MR	15.4	
Pa Sorro Bullo 115b	I/I	17.1	Scalded
Pa Sorro 104	I/I	19.6	Blasted
Pa Sorro White 9	I/I	17.2	Scalded
Pa Miniki 33	I/MR	10.1	Blasted
Bolo 108 (5789)	I/I	16.6	Blasted
Bali Grodak	I/I	16.5	Scalded
Bong Sen Den 2R10	I/I	14.9	
Getu	I/I	15.2	Scalded
Gissi 27	I/MR	10.5	Scalded
IET 6137	I/MR	9.9	
IR 13299-96-2-2	I/I	19.0	scalded
Mahsuri	I/MR	12.1	Blasted, scalded
Mas 2401 (6020)	I/MR	16.0	Scalded
Setra	I/I	19.4	
Tox 516-11-SLR	I/MR	9.2	Oranged
Tjempo Bentan	I/MR	10.0	
55-K-70	I/I	19.2	Blasted

* The designation to the of the stroke refers to chlorosis; right of the stroke refers to stunting.

MR= Moderately resistant
I = Intermediate
s = Susceptible

Results on lesion count along a gradient revealed three classes of resistant or tolerant varieties for seedling blast in the nursery (Figure 10). The first class of varieties was represented by Sentral Merah or 4-1-1-B-1, ROHYB 4-WAR-1-1-B-1. This class had relatively high lesion count per leaf but maintained more or less a steady level of disease along the gradient. This would indicate efficient buffering capacity, probably due to high level of horizontal resistance. Class two varieties were characterized by high initial lesion count which gradually dwindled along the

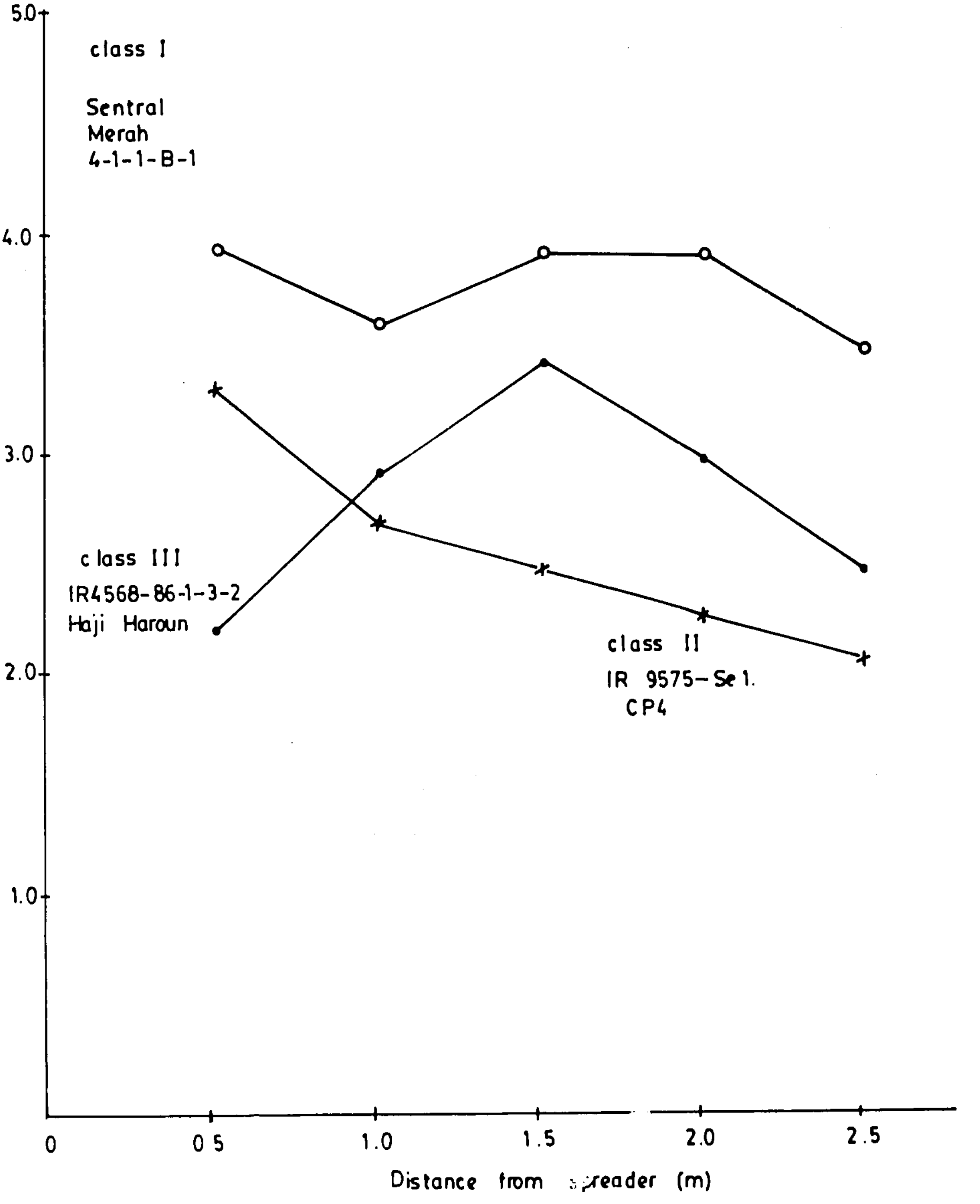

Fig. 10 Pattern of lesion distribution in three classes of resistant varieties in a horizontal blast resistance nursery along a gradient

gradient away from the spreader, for example, CP 4 or IR 9575-Sel. This was probably due to vertical resistance or susceptibility in which disease built up rapidly when it was initiated.

Table 81: Effect of D. Oryzae (Brown spot) on the yield of 2 Rice Varieties at 3 Stages of Crop Growth

Variety	Stages at which inoculated	Grain yield (g/panicle)	Lesion count	% yield increase Over control
CP 4	Control	2.4	0	-
	Booting/heading	1.8	*	-25.0
	Milk/dough	2.5	21	4.2
Pa Sorro 125	Control	2.5	0	-
	Booting/heading	2.3	*	-8.0
	Milk/dough	2.7	47	8.0

* Brown spot lesions were too small in size to count accurately.

Table 82: Grain Yield of ROK 5 and Disease Incidence under Two Levels of Nitrogen in a Date of Transplanting Experiment in a Tidal Mangrove Swamp at Rokupr

Date of Transplanting	Grain Yield at 0 kgN kg/ha	Grain Yield at 40 kgN kg/ha	% yield increase with fertilizer	Leaf Damage Brown Spot 0 kgN (%)	Leaf Damage Brown Spot 10 kgN (%)	Leaf Smut 0 kgN (%)	Leaf Smut 40 kgN (%)
24 July	3062	3273	6.9	6.2	4.2	65.0	65.0
22 August	2405	3337	38.7	4.2	4.2	65.0	65.0
19 September	2178	3484	60.0	24.2	30.8	65.0	65.0
16 October	1466	3413	132.8	37.5	37.5	65.0	65.0

DAT = Days after transplanting.

Pale Yellow Mottle Virus (PYMV)

Screening for resistance: Disease readings were taken two weeks after inoculation, followed by another a fortnight later. It is evident from the results (Table 80) that all recommended mangrove swamp varieties tested were susceptible to the disease in varying degrees. However, some traditional and introduced varieties were moderately infected. It was also noted that leaf scald was recorded on almost all the varieties in varying degrees.

Alternative Hosts of Rice Pathogens in Mangrove Swamps

Alternative weed hosts of important rice pathogens were recorded in and around the mangrove swamp ecosystem. Udbatta (Ephelis pallida) was recorded on two new alternative grass hosts, namely: 'lalang' (Imperata cylindrica) in Rokupr and Rottboellia exaltata at Kibanka, in associated swamps. Presumptive symptoms of the disease were also observed on the flag leaf and culm of wild rice (Oryza longistaminata) at Rokupr. Brown leaf spot was also recorded on this host and 'lalang', 'kawaya' (Panicum repens) and 'kire-kire' (Paspalum vaginatum), an obnoxious weed dominant in tidal mangrove swamps. Narrow brown leaf spot and leaf blast were recorded on O. longistaminata, particularly in associated swamps. Leaf smut was observed on P. repens and R. exaltata.

Crop Loss Assessment

Growth Stages of rice and Effect of Brown Spot on Yoeld of Rice in the screen house: Studies on crop loss assessment under field conditions are complicated by the interference of non-target diseases and variable environmental conditions. Therefore to obtain definitive results on losses caused by D. oryzae, studies were carried out under controlled environment.

Two varieties, CP 4 (improved) and Pa Sorro 125 (local) were used for this study.

Experimental plants were sprayed with spore suspension at booting/heading and milk/dough stages of crop development.

When the crop matured, five panicles were harvested and weighed per treatment per replicate. The unsprayed plants served as control.

Yields of both varieties were reduced when inoculated at booting/heading stage and brown spot lesions counts were very low (Table 81). CP 4 suffered greater decrease (25%) in yield than Pa Sorro 125 (8.0%), suggesting that the former variety was more susceptible to brown spot disease. Although higher lesion counts were recorded on the varieties inoculated at the milk/dough stage, yields were high possibly due to grain development being complete before infection was achieved.

Date of Planting and Disease Incidence

The trial was established at the river edge of Rokupr experimental farm in a split-plot design with date of transplanting in main plots and with nitrogen or without nitrogen as sub-plots. The unfertilized plots simulated farmers' field conditions. Diseases were scored at regular intervals.

The results (Table 82) indicated that brown spot was not serious in the July to August transplanted crops but began to assume damaging proportions at later transplanting. In the July and August transplanted crops, application of nitrogen appeared to suppress brown spot while September transplanting increased it.

Agricultural Economics and Extension

The activities of the Agricultrural Economics/Extension Section came under one broad heading Technology Assessment and Transfer (TAT). The main components include socio-economic studies in Sierra Leone and Guinea for the period 1982/83, and adaptive trials in Sierra Leone during the same period.

Socio-Economic Study in Guinea

Selection of Villages and Enumerators: The Conakry region (around Sonfonia) which is typical of the general mangrove ecology and the Coyah region, representing the mangrove fringes, were selected for the study. The availability of potential enumerators; accessibility of villages all the year round to facilitate supervions; the pre-disposition of the people to accept the studies; and representativeness of the mangrove ecology were deciding factors in selecting the region.

In the Conakry region, Sonfonia, Yattaya and Kobaya were selected while in the Coyah region, Tonguiron, Yelimangaya and Donia were selected.

Enumerators were appointed and trained for one week in Conakry and 10 days in Rokupr. A supervisor was appointed for each region. An overall supervisor was appointed for the regions to ensure intensive supervision of the enumerators. Each enumerator carried out listing of households and participated in the random selection of 15 to 21 farmers in his village. Precoded questionnaires were used to record general information as well as cost route data.

The farm Family: The household farm labour force is made up of family members usually numbering 2 or 3 in the Coyah region, and 3 or 4 in the Conakry region. Adult family sizes of up to 8 was recorded in some instances. Family children below 16 years assist in farm activities especially in uprooting of seedlings, harvesting, threshing, winnowing and manual milling of rice. Usually 2 or 3 children may contribute to household farm labour. Women participate in almost all farm operations but may not do ploughing or threshing. Picking of individual panicles, winnowing and manual milling are women's normal activities.

Non-family household members comprise an average of 11.2 percent of the total household labour force in the Coyah region (Table 83). The high percentage of non-family household members in the Conakry region may be attributed to rural urban migration. Since Sonfonia, Yattaya and Kobaya are almost suburban to Conakry, they can more easily draw on the unemployed labour force in Conakry.

Farming Systems:

a) Cropping System: The farmers in the study regions mainly do multi-cropping. They generally own mangrove swamp rice farms, rice in other ecologies, and other crops such as potatoes, cassava, vegetables and fruits. The households in the above category comprise about 51.7% of a total of 346 households interviewed. About 13.9% have mangrove swamp farms solely, 7.5% have mangrove swamp farms plus rice in other ecologies, 3.5% have only crops other than rice, and 22.54 households are non-farming. The non-farming households are often traders or artisans. The percentage distribution is fairly similar for both regions except for a greater number of households in the Conakry region engaged in mangrove farming only, than those in the Coyah region. The percentage in the Conakry region is 21.3% compared with the overall percentage of 13.9.

b) Farm Size: Most farmers in the two regions nurse two bushels of rice or less. Those in the Koya region may nurse to 5 bushels while those in the Conakry region may go up to 10 bushels though usually between 2 and 6 bushels are nursed. The number of bushels nursed only gives an indication of relative farm sizes. The actual farm sizes have been measured and are being computed.

c) Yield: Yields range from about 400 kg/ha to about 2,800 kg/ha though the upper limit is rare. The yields in the Coyah region tend to be higher than the Conakry region (Figure 11). The former is often between 800kg/ha and 2000 kg/ha while the latter is usually between 400 and 1200 kg/ha at 14% moisture content.

d) Storage: Sacks and boxes are the main storage units in the study area. About 31.4% and 20.9% of farmers interviewed store their rice in sacks and boxes respectively. A lot more use the combination of both (20.1%) while about 10% store their rice in barrels.

e) Crop Use: The average farmer in the two regions grows rice principally for household consumption but part of the produce is often sold to meet financial needs. Some fraction of it may also be used in kind to pay off loans. The results from a supplemental survey indicates that farmers may use up to 10 bushels of their produce to pay off loans. The number of bushels for repayment average 4.40 bu. in the Conakry region agains 3.30 in the Koya region. An average of 2.05 bushels is used on social customs and alms in the two regions. the percentages of the total output will be determined for individual regions when the farm size results become available.

f) Land Tenure: The land tenure systems in the two regions are basically similar. The farm lands belong to individual family heads but the ultimate right to the land rests with the Government of Guinea and is exercised through the chiefs. Thus, family heads cannot pledge their farm lands without the consent of the chiefs. Renting out of farm land may sometimes be done without the consent of the chief but only occasionally. Out of 60 farmers interviewed from the sample villages, only 10% indicated they need to seek the consent of the chief. The farmer can make a gift of portions of his farm land to other relatives although it is his children who inherit his property. Socio-economic Study in Sierra Leone

Farming Calendar: The following section contains a description of the farming calendar in different areas along the Great Scarcies River. Land clearing in the nursery commences around the first week of March for both areas but finishes early in short duration areas in early June compared to the long duration areas where it finishes in mid July. The ploughing of nursery lands continues after the land is cleared, and in both areas, nurseries are ploughed and ..dy for seeding which takes place between late May and the end of July. The uprooting of seedlings takes place from July to early October for both areas. Seedlings are transported, often over considerable distances, from the nursery to the field after uprooting. Land clearing in the swamps appears to begin in early March but finishes later in the long duration areas compared to short duration areas where it ends in July. Ploughing commences around the middle of March and extends to October in some long duration villages. In short duration areas, ploughing begins in April and ends begore October. The puddling of land is greatly facilitated by the rains and as such the majority takes place in mid July and ending in early October in both areas. Transplanting commences from the first week in July to mid October.

Harvesting of mangrove rice commences in late November in short duration areas and early December in long duration areas. It finishes at the end of January in areas close to the sea because of salt incursion and in long duration areas, it can continue until mid march. From flowering until maturity, rice in the field and the harvested crop are guarded against pests and watched regularly particularly in short duration areas. After cutting, it may be a considerable period of time before rice is completely threshed, though small amounts are continually threshed for consumption. Threshing can take place in the field as early as mid December or can be transported to a different site, stacked and then threshed right up until April and occasionally May, in the case of long duration areas. Winnowing is usually carried out at the same time as threshing.

In each village, data on the amount of time spent on each activity was collected, averaged for the whole village and displayed as a proportion. Though concealing a large amount of inter-farm variations, it does indicate broad trends in labour input, and the relative time spent on these activities through the year. Land preparation, nursery and planting activities demand high labour input from May to September. Harvest activities also demand high labour input from early December to early February. It is clear that certain activities continue throughout the year but place a smaller demand on labour. Animal feeding is a good example. Other crop activities occurring in the associated swamps such as potato and cassava cultivation place demands on labour at times of the year when rice is not being cultivated. Several other activities such as repairing buildings and fencing attract labour at non-peak periods.

Household activities (mainly done by females) decline in peak agricultural periods as do social and religious activities. Travelling time (away from the farm) was only recorded for the household head in the survey but it is an extremely large proportion in off-peak periods. A similar trend in undetermined activities was observed.

Differences between areas in terms of proportion of time spent on activities in each month can be discerned by taking a high demand activity such as ploughing. In Kata-Kera (the long duration areas analyzed), the highest proportions of time spent on this acvtivity occurs in June. In Kychum (the short duration area), the peak is in July. Similar trends were observed with other activities. For example, a greater proportion of harvesting is done in December in short duration areas, compared to a greater proportion in January (in long duration areas).

The Division of Labour in Mangrove Rice Farming: Farming households in the Scarcies utilize all the labour available to them although certain operations are predominatly done by one age or sex group. For the purpose of the socio-economic survey, the labour force was divided into the household head, the wife (or wives), males and females between 10 and 60, males and females over 60 years, and children younger than 10 years old. (Children between 10 to 15 were regarded as full working adults).

The major activities performed predominantly by males (including household heads and males from 10 to 60) are land clearing, ploughing, puddling, ridge/mound making, earthing-up, manuring, guarding and watching, bird scaring and uprooting. Eighty percent of the time on these activities are exclusively male though activities such as uproooting have a higher proportion of female input. Winnowing, carrying, parboiling, watering, selling and household activities, majority of which occur around the household compound, are done mainly by women.

Adaptive Trials in the Great Scarcies Mangrove Swamp Area of Sierra Leone:

The trials were conducted on parcels 4000 m2 in area divided into two equal plots of 2000 m2 with exceptions where the farmers' field could not accomodate the total 4000 m2. On one plot, the improved package was tested with the farmers' traditional practice on the other. There were 40 trials in all, distributed between pure mangrove swamp (PMS) and associated mangrove swamp (AMS).

The test packages were derived from the combination of improved variety, fertilizer injection and mechanical ploughing. Trials were carried out for:

- Improved variety vs Traditional variety;
- Improved variety, Mechanical ploughing vs Traditional variety, Manual ploughing;
- Improved variety, Fertilizer injection vs Traditional variety, No fertilizer; and
- Improved variety, Mechanical ploughing, Fertilizer injection vs Traditional variety, Manual ploughing, No fertilizer.

Results and Discussion

Varietal: Results on the varietal trials conducted in both ecologies of the short duration areas of Miribaia and Balansera showed that the variety ROK 5 outyielded the traditional varieties in 3 out of 4 trials.

Variety + Fertilizer Injection: The trial with improved varieties plus fertilizer by injection compared with traditional varieties under no fertilization showed higher yield increases of the former over the latter, ranging from 31% to 87% in 9 out of 10 trials.

Complete Package: Results of the complete package in Table 84 showed yield increases in 7 out of 10 cases. However, it is necessary to determine the economic viability of the package before drawing conclusions.

Table 83: Distribution of Household Farm Labour Force According to Family and Non-family Members

Village	No. of household interviewed	Family members %	Av. for region %	Non-family members %	Av. for region %
Coyah Region			88.78		11.22
Yelimangaya	20	92.81		7.19	
Tonguiron	19	75.00		25.00	
Donia	20	98.53		1.47	
Conakry Region			76.90		23.10
Sonfonia	18	71.11		28.89	
Yattaya	19	73.39		26.61	
Kobaya	18	86.12		13.79	

Table 84: Advantage of Improved Technology over Traditional Technology

Locations		Varieties Im-proved	Tradi-tional	Yields in kg/ha Im-proved	Tradi-tional	% increase
Moribaia	PMS	ROK 5	Bathurst	3162	1644	92
	AMS	ROK 5	Pa Nylon	418	1475	-252
Balensera	PMS	ROK 5	Pa Kenema	4030	2668	51
	AMS	ROK 5	Minique	3530	2391	+48
Katema	PMS	CP4	Pa Sorie Sanko	2613	1125	132
	AMS	CP4	Pa Fant	1648	1120	47
Rosinor	PMS	CP4	White Sorro	2688	1528	76
	AMS	CP4	Kamsar	2439	1037	135
Robat	PMS	CP4	White Sorro	2940	2927	0.4
	AMS	CP4	Matis	2127	2184	-3

Net Revenues Obtained From the Adaptive Trials

Both the variable costs (Table 85) and the net revenues in Le/ha of the various adaptive trials (Tables 86 and 87) were classified according to the ecologies and zones. The proportion of labour the farmer was assumed to hire and the output price were varied to introduce an element of sensitivity into the analysis. The net revenues were obtained by multiplying the yield of each trial (in kg/ha) by the output price (Le/ha). The variable costs for each trial were then deducted from this figure to obtain those shown in Tables 87 and 88. All costs were regarded as variable, including capital charges for equipment, which would be included in rental charges when the farmer used the item. Payment for seed rice was Le 37 and Le 23 per ha (local varieties), Le 55.5 and Le 34.5 (improved varieties) for short and long duration varieties respectively. Application of fertilizer in the nursery cost Le 1.9 and Le 0.9 per hectare for short and long duration varieties respectively. The cost of field application was Le 19.4 per hectare regardless of the duration of the varieties. Use of the injector and power tiller costs Le. 4.0 and Le 172.0 per hectare respectively for short and long duration varieties.

Determination of labour costs was based on the labour data collected from the trials. The labour rate used was Le 2.50/day and the rate of Le 1.00/day was considered to be appropriate for bird scaring.

Costs differed considerably between short and long duration areas and betwee pure and associated swamps (Table 86). The higher costs for short duration areas reflected the higher seed rate and in turn the higher nursery fertilizer rate, as well as the cost involved in bird scaring which only took place in this area. The differences between ecologies mainly reflected the higher labour input in pure mangrove swamps.

It was observed and generally agreed that the adaptive trial sites were not truly representative of the land that farmers generally use for cultivation and indeed were marginal in many cases. Sites were often heavily weed infested, had soil fertility problems or were subject to pest damage. Most farmers had ploughed their good land in May when the researchers started site selection, and others were cautious about permitting the use of their land for trials. In several cases the trials were outyielded by the control plots. It is with these factors in mind that one is in a position to interprete the net revenues calculated in Tables 87 and 88.

The overall tendency was for net revenue to be higher on pure mangrove swamps compared to associated swamps. The exceptions to this were the fertilizer trials where the situation was reversed. In general, the yields of the pure mangrove swamps were higher than those of the associated swamps and this could account for some of the differences. The average net revenues of the varietal trials were lower than those of the control plots when classified by ecology. However, with reference to Table 88, it can be seen that the poor performance of CP 4 in long duration areas is the cause of the low averages. Reference to the table indicates that varietal trials still fall short of controls in terms of revenue and the difference can be attributed to cost differences outlined in the section on variable costs. When all labour is costed, the varietal trials break even at a product price of between Le 10 to 15/bushel whereas all other trials on the average break even between Le 6 to 10/bushel. Where only 25% of labour is costed, all trials break even at the lowest price level.

The mechanical ploughing trials provided informative results. The net revenue figures indicate that mechanical ploughing by itself may not increase net revenues above that of traditional practice though it certainly reduces the drudgery of hand digging and may break a seasonal labour bottleneck. The fertilizer trials were extremely promising. The average net revenues were superior to those of the complete package in associated swamps and in pure mangrove swamps at lower price levels. Fertilizer injection coupled with improved varieties produced high yields without having high variable costs. It also indicates that improved varieties should be combined with fertilizer to fully exploit their advantages. The complete package trials consistently outyielded the control plots and as a consequence, the revenues were highest for all trials except fertilizer trials in associated swamps.

Table 85: Summary of Total Variable Costs (Le/ha)

	100% Labour Costed				25% Labour Costed			
	PMS	PMS	AMS	AMS	PMS	PMS	AMS	AMS
Traditional Practice	460	396	453	381	180	116	179	115
Variety	543	472	496	424	216	145	205	133
Mech. Ploughing	549	478	577	506	332	261	339	268
Fert. Injection	559	487	485	413	238	166	220	148
Complete Package	659	587	640	568	377	305	372	300

Table 86: Average Revenues (Le/ha)

		% of Labour Hired									
		100					25				
		Output Price (Le/kg)									
		0.22	0.37	0.55	0.75	1.10	0.22	0.37	0.55	0.75	1.10
Traditional Practice	PMS	-76	164	451	771	1329	204	445	731	1071	1609
	AMS	-89	127	387	675	1179	185	401	661	949	1453
Variety	PMS	-219	-26	205	463	913	108	301	532	790	1240
	AMS	-188	-14	195	427	932	104	278	486	718	1113
Fertilizer Injection	PMS	1	381	834	1315	2175	334	702	1145	1636	2496
	AMS	110	468	897	1372	2205	376	732	1161	1637	2470
Mechanical Ploughing	PMS	-99	178	510	881	1528	118	395	728	1098	1745
	AMS	-206	22	296	601	1134	32	260	534	893	1372
Complete Package	PMS	7	437	953	1525	2528	289	719	1205	1807	2810
	AMS	123	192	570	1727	1727	145	460	838	1259	1995

Table 87: Average Net Revenues (Le/ha)

		% of Labour Hired									
		100					25				
		Output Prices (Le/kg)									
		0.22	0.37	0.55	0.75	1.10	0.22	0.37	0.55	0.75	1.10
Traditional Practice	ROK 5	-135	86	351	646	1160	144	365	630	924	1439
	CP 4	-45	193	477	794	1348	233	470	755	1071	1625
Variety	ROK 5	-129	-7	249	523	1029	99	312	567	851	1347
	CP 4	-201	-30	175	402	801	110	281	486	714	1112
Fertilizer Injection	ROK 5	-68	267	669	1115	1896	253	588	710	1436	2217
	CP 4	115	501	963	1477	2376	408	794	1256	1770	2669
Mechanical Ploughing	ROK 5	-186	72	381	724	1325	42	299	608	952	1552
	CP 4	-116	138	443	782	1276	109	363	669	1009	1613
Complete Package	ROK 5	-41	376	878	1435	2410	237	655	1152	1713	2688
	CP 4	-47	314	747	1224	2073	228	589	1022	1504	2348

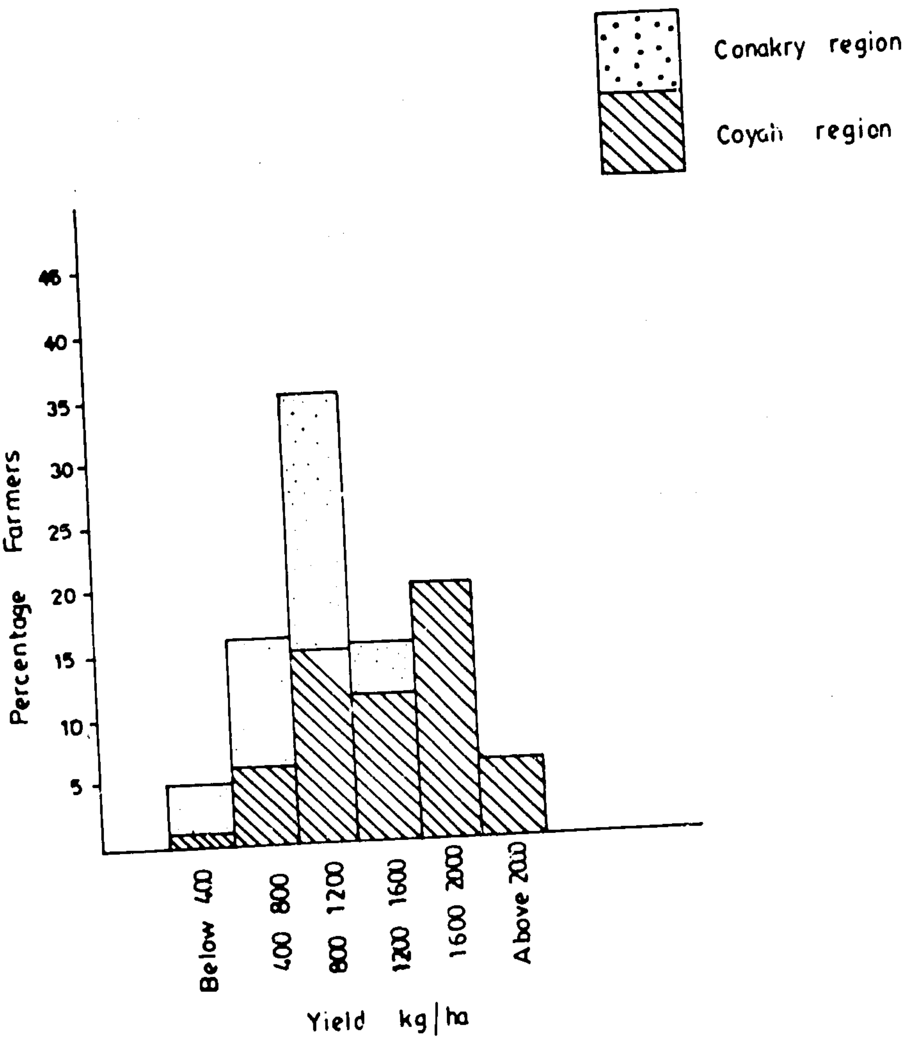

Fig 11. Frequency distribution of yield levels in the Coyah and Conakry regions of Guinea.

WARDA'S COLLABORATOON WITH OTHER INSTITUTES

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

Catholic University (UCL)
Louvain, Belgium

The agreement between UCL and WARDA is to study the use of Azolla and blue green algae as sources of nitrogen for rice production. Trials have been conducted at Suakoko in Liberia and Rokupr in Sierra Leone. The main project site is at Fanaye in Senegal. The Belgium Government provides funds for the Azolla project.

International Centre of Insect Physiology and Ecology (ICIPE)

WARDA and ICIPE, located in Nairobi, Kenya, agreed to undertake collaborative research 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.

International Crop Protection (ICP)
University of California, Berkeley

WARDA Collaborates with ICP in its programme on Integrated Pest Management. The programme includes a variety of research, training, extension and farmer-demonstration activities. WARDA/ICP/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.

International Fertilizer Development Centre (IFDC)

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

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 Senior Rice Breeder was seconded to WARDA. The agreement has been renewed several times and is still current.

The collaborative activities include exchange of genetic materials, training programmes, collaborative trials, joint monitoring tours and attending each other's conferences. The collaborative activities will be extended to joint research on iron toxicity. IITA will fund part of the cost of the research. WARDA cooperates in the screening of early generation (F3, F4 and F5) lines of late duration varieties from IITA under Suakoko upland rice conditions.

International Rice Research Institute (IRRI)

Since 1973, IRRI has been supplying WARDA with lines and varieties for IETs and coordinated trials. In 1976, WARDA and IRRI reached a formal agreement by which WARDA agreed to play an active role in the International Rice Testing programme. In 1979, to further strengthen the linkage between IRRI and WARDA, IRRI posted a liaison scientist to Africa, based in IITA, but with major commitments to the West African region. Other areas of collaborative efforts are in training, 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 Niger was formulated for the control of rice grain-eating birds. The project document was finalized at a meeting in Dakar in December, 1980. The region was divided into four zones reflecting differences in ecologies and species of bird pests. The UNDP has provided funds for this project and the first phase, which involves training, will be implemented in 1983.

VISITORS TO THE RESEARCH DEPARTMENT IN 1982

Dr. Bakary V. Ouayogode	BP 604, Bouake, Ivory Coast - 18/1/82
Dr. E.J. Azagoa	University of Port Harcourt, Nigeria - 15/3/82
Professor F.A. Onofeghara	University of Port Harcourt, Nigeria - 15/3/82
Mr. Josiah N. Brown	ECOWAS Fund, BP 2704, Lome, Togo - 23/3/82
Dr. A. N. Mphuru	Faculty of Agriculture, Box 643, Morogoro, Tanzania - 25/3/82
Dr. J.C. Moomau	Executive Director, Near-East Foundation, New York 10006, N.Y. U.S.A. - 7/4/82
Ms. Delmer J. Dovley	Near-East Foundation, New York, N.Y., 10006 - 7/4/82
Dr. J. Adamu	W.H.O. Consultant, Liberia 25/5/82.
Mr. Viho Expedit	DAFA/MDRAC Project, Porto Novo, Benin - 1/6/82
Mr. & Mrs. Oscar E. Anderson	University of Georgia Experiment Station, U.S.A. - 6/6/82
Dr. R.C. Picket	Wm Cary Int'l University, Pasadema, CA, U.S.A. - 16/7/82.
Dr. Probodh C. Batia	INDUSS SERVICES LTD., Clive Row, Calcutta-1, India - 28/7/82
His Excellency Ed. Martins	Ambassador of Nigeria to Liberia - 3/8/82
Mr. David Hughes	Guinea Bissau Mangrove Swamp Rice Mission, FAO, Rome - 6/8/82
M. Bonette Federier	FAO Consultant for WARDA/2213 Project - 13/9/82
Dr. Charles S. Ofori	FAO, Rome - 18/11/82
Professor R.O. Adegboye	University of Ibadan, Nigeria - 21/12/82.

A C K N O W L E D G E M E N T

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