

WARDA ACTIVITIES HIGHLIGHTS



1983



W A R D A
RESEARCH AND DEVELOPMENT
H I G H L I G H T S
1983

WARDA

The West Africa Rice Development Association (WARDA) which was formed in September 1970 under the auspices of UNDP, FAO and ECA is an intergovernmental organization consisting of 16 member countries namely: Benin, Burkina Faso (Upper Volta), Chad, Ivory Coast, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone and Togo.

The Headquarters of WARDA are located in Monrovia (Liberia) while its four Regional Research Stations are located in Bouaké, Ivory Coast (upland rice); Rokupr, Sierra Leone (mangrove and swamp rice); Richard-Toll, Senegal (irrigated rice); and Mopti, Mali (deep water/floating rice). In addition, WARDA has a regional Training Center at Fendall (Liberia) and five Sub-Regional Coordination Offices responsible for the five zones into which the 16 member countries have been grouped.

WARDA is one of the 13 International Agricultural Research Centers (IARCs) of the Consultative Group on International Agricultural Research's (CGIAR) network. The Association has been mandated to assist its member countries to achieve self-sufficiency in rice, a staple food of West Africans.

The Association receives funds and assistance, in kind, from the following:

- member countries;
- CGIAR and the following countries and institutions: Belgium, Canada, Federal Republic of Germany, France, Japan, Nigeria, The Netherlands, and Sweden; African Development Bank, World Bank, International Fund for Agricultural Development and the Organization of Petroleum Exporting Countries;
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- International aid agencies of governments of the following countries: Belgium, Federal Republic of Germany, France, Great Britain, Italy, Japan, The Netherlands and Switzerland.

WARDA RESEARCH AND DEVELOPEMENT
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TABLE OF CONTENTS

	Page
1. RESEARCH DEPARTMENT	
Zone I	1
Zone II	2
Zone III	4
Zone IV	6
Zone V	8
Technical Support Services	10
Special Research Project: Bouake, Ivory Coast	22
Special Research Project: Rokupr, Sierra Leone	25
Special Research Project: Richard-Toll, Senegal	29
Special Research Project: Mopti, Mali	31
2. DEVELOPMENT DEPARTMENT	
Development Activities	33

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

1. Coordinated Variety Trials (CVT)

Coordinated variety trials were conducted at various locations in the zone with the objective of introducing directly superior varieties to suit the various growing conditions in a reliable and quicker way.

In the dry season trial under irrigated conditions in 1982, the short duration variety BR 541-BKN 19-3-4 gave the highest yield of 6465 kg/ha at Sapu in The Gambia. In Fanaye, Senegal, IR 2823-399-5 gave the highest yield of 6705 kg/ha. For the medium duration trials, IR 9782-144-3 gave the highest yield of 5.3 t/ha in Sapu while ITA 230 gave the highest yield of 7.2 t/ha in Fanaye, Senegal.

In the wet season upland short duration trial conducted in 1983, the highest yields of 2005 and 1421 kg/ha were obtained from varieties IRAT 144 and DJ 12-539-2 respectively in Sefa, Senegal and Caboxanque, Guinea-Bissau. IRAT 170 and ITA 118 produced top yields of 6.0 and 5.6 t/ha respectively in the medium duration trial at Caboxanque.

For the irrigated short duration trials, the highest yields obtained were 6.1 t/ha for variety BG 90-2 at Sapu in The Gambia, 3.9 t/ha for variety 32-XUAN-5-D at Contuboel in Guinea-Bissau, 3.9 t/ha of TOS 103 at Djibelor in Senegal, 5.8 t/ha and 5.3 t/ha for variety BR 161-2B 53 at Kaedi in Mauritania and Fanaye in Senegal respectively.

With regard to the medium duration varieties, ITA 212 produced the highest yield of 6.0 t/ha at Sapu for the moist zone. In Contuboel, however, ITA 249 with a yield of 4.9 t/ha was the highest yielder. In Djibelor, Kaedi and Fanaye, varieties IR 2928-7-3-1-1, IR 2071-586-6-3 and IR54 gave the highest yields of 3.5, 9.5 and 9.8 t/ha respectively.

In a mangrove swamp variety trial at Caboxanque in Guinea Bissau, variety SL 22-617 gave the highest yield of 5.8 t/ha. For deep flooded varieties the BKN series have consistently been among the top five in both The Gambia and Senegal. Varieties Sentral Merah and BKN 6986-38-1 gave the highest yields of 3.4 and 5.0 t/ha respectively at Kudana in The Gambia and Djibelor in Senegal.

2. On-farm Trials

A number of on-farm trials were carried out in the zone. In The Gambia, improved varieties tried under strictly upland

conditions were Peking, IRAT 112 and IRAT 133, whereas for freshwater lowland, the varieties were DJ 11-509, IRAT 109 and IR 442 -2-58. In Contuboel, Guinea Bissau, varieties used were BG 90-2, BW 78 and I Kong Pao. Due to inadequate and erratic rainfall distribution, yields were low. In Mauritania where the trials were well managed under irrigated conditions, yields of up to 7.0 t/ha were obtained.

3. Adaptive farmers trials

Most of the trials carried out failed due to inadequate rainfall to desalinate the soil. However, at Jareup where ROK 5 was cultivated, a yield of 827 kg/ha was obtained.

ZONE II (Guinea, Liberia, Sierra Leone)

In 1983, 17 Initial Evaluation and Coordinated Variety Trials (IET and CVT) were conducted in zone II. On the whole eight sites were selected for these upland, irrigated, swamp and deep-flooded trials.

Only one irrigated on-farm trial was conducted in Liberia but six on-farm trials were conducted in Guinea.

The main trial results were as follows:

1. Upland Variety Trials

At Gueckedou, IRAT varieties which produced between 1.5 and 2.6 t/ha were the most productive followed by ITA 162 (2.2 t/ha) and C22 and FAROX 299 (2.1 t/ha). At Kenema, IRAT and ITA varieties produced yields of a similar level.

2. Short and medium duration varieties were tested under the irrigated variety trials.

Of the short duration varieties ITA 245, KN 144, IR 13538-48-2-3-2, IR 27931-47-3-3, KAU 1661, and CNM 31 produced very high yields. At Kenema ROK 12 (Control) and ITA 245 produced very high yields and at Kindia the highest yields were obtained from 70s 103, BG-90-2 (check) IR 13427-40-3-3-2-3-5 and 32 ZUAN 5-D.

As far as medium duration varieties are concerned, it was observed that IR 2071-5-6-3, improved Mahsuri (check) IR2928-7-3-1-1, BW 248-1-2071-556-5-6-3, IR 4422-98-3-6-1, IET 6050, IR 3259-P5-160-1 ITA 212 and CR 1022 produced high yields at Suakoko. At Kenema, the yields of IET 6056, IR 2071-586-5-6-3, IR 2928-7-31 ITA 123, IR 3259-P5-160-1, ITA 231, and ITA 249 were above 4.5 tonnes. At Kindia only ITA 242 produced 5 t/ha however the yields of P5-160-1, ITA 249, IR2928-7-3-1-1, ITA 231 and ITRA 123 were above 4.0 t/ha.

ITA 123 and BR 161-B2-58 were severely attacked by neck blast. It was observed that BR 508-BR-9 had complete lodging at three sites namely: Suakoko, Kindia and Kenema.

3. Deep-Flooded Variety Trials

The best results of these trials were obtained at Gbomsamba (Sierra Leone). SL 22-6-17, Warkayo-1, ANDY 301 and BKN 6986-38-1 were the most productive varieties. The results obtained at Konkani (Guinea) were unsatisfactory and this was due to the floods which subsided at a time when the rice started flowering.

4. Swamp Variety Trials.

The best results of these trials were obtained in Rokupr. The most productive varieties were Moyamban-1, Warkayo-1, Baydahn SL 22-6-17, Rohyb6, and War 6-2-B-2.

At Sonfonia, with the exception of IR 5617-113-1-1, Kaolack (control), Rohyb 1-1, IR 4712-113-3-1-2, Rohyb 6, War 6-2-13-2 and IR-4707-140-1-3, the other varieties were susceptible to soil salinity and iron toxicity.

5. Initial Evaluation Trials

Two Initial Evaluation Trials under irrigated conditions were conducted at Kindia and Suakoko and two of such trials were conducted under upland conditions at Rokupr and Suakoko.

Kindia: The varieties tested at Kindia were:

IET 56, BR 51-74-61-51, Vijaya ITA 222, IET 6496, ITA 241, TOX 1725-1-8-20-1, IR 25-861-35-3-3, ITA 249, PNA 277-F4-247-1, TOX 1835-8-1 and X-3-DT.

Suakoko: The varieties tested at Suakoko were:

ITA 249, TOX 1835-8-1, X-3-D-T, BR 4-8-2, BR 316-16-4-4, FAROX 239-3-2-1, IR 13538-48-2-3-2, IR 21931-47-3-3, PNA 237-F4-130-1, TOX 1835-11-1, TAICHUNG SEN YU 10, TOX 1838-9-1, BR 4-34-13-5, FAROX 233-6-2, etc.

3.4 On-farm Trials

On the whole, six trials were conducted in Guinea, four in Liberia (3 under upland and one under irrigated condition).

Only irrigated on-farm trials produced fairly satisfactory results.

The best results of irrigated trials were obtained at Kindia but in Balama (Liberia) late transplanting affected the performance of varieties tested.

Under swamp conditions it was observed that Djabon which produced 3.3 t/ha at Sonfonia and 2.6 t/ha at Kobayah was the most productive variety.

As far as upland rice is concerned, late sowing, as well as damage caused by leaf-eating insects and termites have contributed significantly to the low yields. Only one trial in which IRAT 136 and IRAT 109 were used produced satisfactory results.

ZONE III (Mali, Burkina Faso (Upper Volta), Ivory Coast)

On the whole, 28 Initial Evaluation and Coordinated Variety Trials as well as 151 on-farm trials were conducted in Zone III.

The results were as follows:

1. Initial Evaluation Trial

With respect to upland rice the following were observed:

- No serious blast attacks for this reason; blast resistant varieties were not used. However certain varieties such as EPXBR 543, R313, IR3656-13-3; IR 19819-31-2-3, etc were susceptible to blast.

With respect to irrigated rice three trials were conducted at Gagnoa, Kou Valley and Kogoni. Very few diseases were observed in the Kou Valley and at Kogoni however, blast attacked certain varieties. On the contrary at Gagnoa, extensive damage was caused to almost all varieties by the Rice Yellow Mottle virus. Varieties which were more seriously affected were: ITA 212; BR 40-82-1/C 3; PK 123-41-1-1-1 and BW 267-3.

Sheath rot was also observed on FAROX 231-1-1-1; FAROX 228-2-1; PK 81-104-1 IR 9698-16-3-3-2; DG 362-7; FAROX 236-1-1-3.

2) The coordinated trials of strictly upland rice of a short duration did not generally yield satisfactory results. They were either destroyed by drought (the case of 'DJ' varieties in all stations) or they germinated as was the case of the following varieties IRAT 146; IRAT 147 and ITA 135 ; 150 at Odienne, Man and Lenforola. Varieties which performed well were: IRAT 146 (3453 kg/ha), IRAT 144 (3760 kg/ha), ITA 117 (3453 kg/ha) and IRAT 113 (3287kg/ha).

Varieties which produced the highest yields during the trials of medium duration upland rice were: ISA 6(3294 kg/ha) and IRAT 169(3119 kg/ha).

The two varieties which produced the highest yields during the coordinated short-duration irrigated rice trials were: 75-48-30 and BG 90-2 (BG 90-2 produced 7980 kg/ha and 75-48-30 produced 8910 kg/ha).

The results of irrigated rice in the wet forest zones, have shown that short-duration varieties produced average yields. Of the medium-duration varieties, the promising varieties, were: IR 4422-98-3-6-1, ITA 231, IR 2070-586-5-6-3 and ITA 212.

Of the short duration varieties in irrigated rice in the Sahelian zone, BG 90-2 produced high yields (7490 kg/ha) at Korhogo; BR 24-2-1 and TOS 4688 produced average yields of 4350 kg/ha and 2560 kg/ha respectively in the Kou Valley. BR 13-473 and BR 24-2-1 are susceptible to blast. Medium-duration varieties which were tested at Korhogo produced yields above 6000 kg/ha. Only BW 170 produced yields below 5000 kg/ha. In the Kou Valley, ITA 222 produced the highest yield (7130 kg/ha).

The deep-flooded rice trial was conducted in an area where the flood level was 30 cm. The yields per hectare of BKN 6987-161-1-3 and ROK 16 were very high (5020 kg/ha and 4920 kg/ha respectively).

3) On-Farm Trials.

Results of on-farm trials in Ivory Coast have shown that IRAT 144 produced the highest yield (1119 kg/ha on the average). In Burkina Faso IRAT 147 produced the highest yield (939 kg/ha) followed by Dourado Precoce. In Mali IRAT 10 produced the highest yield.

Varieties tested in the forest zone produced low yields due to drought which occurred in most trial sites, and to the damage caused by birds, cutting-grass and some diseases (leaf blast).

Under irrigated rice trials, BR 51-319-9 produced average yields of 3641 kg/ha and IET 2885 produced the highest yields in developed swamps. Results of the on-farm trials in Mali have shown that there is no significant difference between the average yields of BG 90-2 (3012 KG/HA) and Gambiaka (3029 kg/ha)

In Ivory Coast there was no significant difference in the average yields of the two varieties recommended for extension namely: 75-48-30 which produced an average yield of 6192 kg/ha and BG 90-2 which produced an average yield of 6209 kg/ha. However an in-depth study of results has shown that the yield of BG 90-2 appeared to be higher than that of 75-48-30.

ZONE IV (Ghana, Nigeria).

1. Coordinated Variety Trials (CVT).

A total of twenty two coordinated trials were conducted in the zone i.e seven in Ghana and 15 in Nigeria.

Promising varieties in the irrigated trials identified at various sites were:

1. Tono (Ghana) TOS 103 in the short duration trial
2. IITA (Nigeria) IR 21931-47-3-3 and ITA 245 in the short duration trial.
3. IITA (Nigeria) IR 2928-7-3-1-1 in the medium duration trial.
4. Badeggi (Nigeria) C 1322-28 and KN 144 in the short duration trial.
5. Badeggi (Nigeria) IR 2928-7-3-1-1 in the medium duration trial.

Major obstacles which affected yields in the trials were drought particularly at Tono and Kpong in Ghana, Rhynchosporium infection and stemborer damage particularly in Nigeria.

For the upland trials entries that showed some promise included IRAT 133 at Ikenne and IRAT 144 at Ibadan all in Nigeria, while BKN 6986-38-1, SENTRAL MERAH, IR 2071-586-5-6-3 and BKN 7022-10-1-4 were the promising entries in the deep flooded trials.

Major limiting factors in the upland trials were drought particularly at Nyankpala (Ghana) and Ibadan in Nigeria. Blast disease was more serious at Ikenne for IRAT 146 and ITA 117. Helminthosporium disease was heavy as in the past on some entries at Ikenne-DJ11-541-1, IRAT 133, IRAT 146 and ITA 117 while Rhynchosporium was found to be more serious on two entries at Ikenne namely DJ4-135 and ITA 132. Stemborer infestation was found on several entries at Moor Plantation in Ibadan, while Dead heart was severe on DJ12-539-2 and white heads on DJ11-541-1, DJ12-539-2 and ITA 117.

Deep flooded varieties experienced stemborer infestation with white heads appearing on varieties ADNY 301, KUATICK, KUNDUR and MANGRA.

ON-FARM TRIALS

2. In Ghana all the on-farm trials in the Northern and Upper Regions failed due to drought. Trials conducted at Asutsuare in the south gave useful results. The top yielder was BR 51-118-2 with 5.6 t/ha. However, farmers ranked IR 3273-P339-2 as the best variety with a yield of 3.6 t/ha because of its grain quality.

In Nigeria on-farm trials zonal trials were conducted at Badeggi and Edozhighi for irrigated short and medium duration varieties and at Ibadan, Ikenne, Akure and Amakama for upland short and medium duration varieties.

In the irrigated short duration trials at Badeggi, an entry from WARDA CVT, TOX 516-19-SLR gave the highest yield of 6.7 t/ha while at Edozhighi, another entry from WARDA CVT, KN144 also gave the highest yield of 3.4 t/ha. However, the mean yields show ITA 245 (4.8 t/ha) as the highest yielder, followed closely by KN 144 (4.7 t/ha) and TOX 516-19 SLR (4.4 t/ha).

In the irrigated medium duration zonal trials, the top three yielders at Badeggi were BR 51-118-2, ITA 123 and BR 168-28-23 with yields of 7t, 6.7t and 6.7t respectively. AT Edozhighi yields were very low with ITA 212 as the top yielder with 1.8 t/ha.

In the short duration upland trials the top yielders at the various sites were IRAT 133 with a yield of 2.8 t/ha at Ibadan, ITA 162 at Ikenne with a yield of 1.07 t/ha, IRAT 110 at Akure with a yield of 1.65 t/ha and ITA 162 at Amakama with a yield of 1.05 t/ha.

In the upland medium duration trials, the top yielders were ITA 256 with a yield of 6.93 t/ha at Ibadan, IRAT 104 with a yield of 1.59 t/ha at Ikenne, ITA 141 with a yield of 2.62 t/ha at Akure and ITA 141, ITA 4420 and IRAT 104 with yield of 1.2 t/ha at Amakama.

ZONE V (Niger, Benin and Togo)

In 1983 about thirty Initial Evaluation trials (IET), Coordinated Variety Trials (CVT) and on-farm trials were conducted at fifteen sites in Zone V. These trials involve upland, irrigated and deep-flooded rice varieties.

As a result of poor rainfall throughout the year, an extremely limited number of coordinated variety trials was carried out. Results of this cropping season were therefore very inconclusive and most of the trials were scorched under the drought conditions.

In the irrigated variety trials (wet zone) short duration varieties KN 144, TNAU 7893, KAU 1661 and Medium-duration I and IR varieties performed well both in Benin and Togo. In the Sahelian Region on the other hand, the varieties which seemingly exhibited the best yield performance on the Libor and Touala sites in Niger were short-duration ones: BR161-28-53, TNAU 7893 and IR 135-38-48-2-3-2 as well as medium-duration varieties ITA 222, B 2360-8-9-5.

The performance of the on-farm trials also fell below expectations.

In Niger, varieties BG 90-2 and IR 1529-680-3, for which farmers had already shown a preference, gave the highest yield. Variety BR 51-46-5 also claimed the attention of farmers especially following the incidence of *Xanthomonas* on IR 1529-690-5. On the whole, yields were lower than those generally obtained in the area, averaging about 4 t/ha.

The deep-flooded trial at Kolo which is the only trial that survived till maturity produced results similar to those obtained in research stations under the same rice cultivation system. The average yields of 6t/ha are quite unusual since they are usually around 4 tons/ha.

In the upland trial in Togo, variety IRAT 13 which has been identified in recent years as the variety showing the best resistance to drought did not confirm this characteristic in this trial. It should be noted that all the upland trials in Benin were completely destroyed by drought.

At the end of this rather marginal cropping season, it was observed that the new WARDA entries have, once again, exhibited a good yield performance and have thus increased the local collections in each country. The varieties which are to be used for on-farm trials and extension purposes will be obtained from this collection. Furthermore, it is gratifying to note that many of the new entries continue to perform better than the local checks which are themselves considered as old improved and widely recommended varieties.

Given the limited facilities of the irrigated rice cultivation, it would have been much more advantageous to conduct On-Farm trials on a larger scale under the upland conditions in Benin and Togo since such trials are likely to benefit a larger number of rice-growers.

TECHNICAL SUPPORT SERVICES

A. IRON TOXICITY SCREENING

In 1983, four main types of experiments were conducted under a project in which IITA, CARI and WARDA were cooperating.

1) Cultivars from CIAT:

The first set of trials was the screening of sixty-seven cultivars introduced from CIAT, Colombia. A resistant check was planted after every 10 plants. Iron toxicity scores were made based on foliar symptoms at 4, 8, and 12 weeks after transplanting. The most tolerant entries are 21548; 16492; 21790; 21809; 16404; 21701; Suakoko 8; 18452; 22119; 16497; 22421; 22434 and 18454. Many of the tolerant entries were of better plant types than the check. They also outyielded the check though they were not more resistant.

2) Iron Toxicity Screening Set of the International

Rice Testing Program (IRTP);

The screening set consisted of 60 entries. They were planted under iron toxic conditions with two replications. The soil pH of the trial site ranged from 4.2-4.5. The most resistant entry was IR 5741-73-2-3. This and other entries will be further tested under more controlled conditions.

3) Pot Screening at Suakoko:

Dried and thoroughly mixed soil, collected from iron toxic sites, was put in 8-litre plastic buckets. After two weeks of sub-mergence, four 3-week old seedlings of each test entry grown in non-toxic soil were transplanted into each bucket. Each bucket also had one seedling each of a susceptible and a resistant check. Entries were rated according to foliar symptoms of iron toxicity at 4, 8 and 12 weeks after transplanting. Seventy-two cultivars were tested. The entries with high tolerance, good panicle exertion and clean grains were Tox 960-72-1; Tom 2-30 Tom 2-65; Tom 2-20; and Tom 2-17.

4) Field Screening Trials:

Ninety cultivars were screened. Seedlings were raised on a non-toxic nursery for three weeks before transplanting. The plants were spaced 20 x 20 cm in 3 meters long rows, with four replications. The resistant checks were Suakoko 8 and Gissai 27. The susceptible checks were IR 26 and IR 5. There were many entries (for example Tox 960-42-1 and Tox 711-18-7) that were found resistant, with good grain length, desirable days to maturity, good panicle exertion and plant height.

B. INTERNATIONAL RICE TESTING PROGRAM (IRTP)

1. International Upland Rice Observational Nursery

(IURON 1983).

Several entries yielded higher than the check and ITA 130 was the highest yielder. Other good entries were BR 51-282-8; IR 24761-35-3; Tox 475-NIBI-NKI-L53-B; IR 5931-110-1; R9-1-6-1-3-1-1; CISANDANE, Chianung S1-P1; IRAT 125 and 16871.

2. International Rice Observational Nursery (IRON 1983)

Several entries were better than the control e.g. BPI 3402, IR19670-263-3-2-1, IR25560-132-2-3, IR25916015-3-2 and BG380-2.

C. SCREENING OF DIFFERENT UPLAND BREEDING POPULATIONS

A total of 105 populations received from IITA and IPRI were screened under high rainfall upland conditions at Suakoko, Liberia. As a result, fifty-nine lines were selected from 28 populations for further assessment.

D. GERMPLASM

IN 1983, 528 collections were rejuvenated and multiplied. Some characterization was also done.

E. DISEASE SURVEY:

1) Incidence of bacterial blight:

A joint survey by WARDA and IITA was carried out in the Sahelian countries of the WARDA region (Mali, Niger, Upper Volta and Senegal) to confirm the occurrence of bacterial leaf blight, *Xanthomonas oryzae*. The result of this survey substantiates the occurrence of this disease in all the Sahelian countries. It was noted that in some cases the incidence was associated with high nitrogen level. The disease was mostly found in irrigated and deep flooded paddy.

To reduce its incidence in future, it is recommended that

- a) paddy from infected plants should not be used as seed,
- b) only tolerant varieties be grown, and
- c) nitrogen application be restricted to about 80-100 kgs/ha.

2) Incidence of Rice Yellow Mottle Virus:

During the same survey by IITA/WARDA, the incidence of Rice Yellow Mottle Virus (RYMV) was determined with the antiserum for Rice Yellow Mottle Virus prepared by IITA. Most of the samples tested from Niger, Upper Volta, Mali showed positive reactions. The disease was very severe and extensive in areas around Tillabery in Niger. Samples from Fanaye and Dagana (Senegal) showed negative reaction.

F. AGRONOMIC STUDIES

UPLAND RICE:

1. Package Evaluation Study

The objective of this study was to find out the factor(s) that limit rice yield in the upland soils (plinthic aerisols) when put under continuous rice crop after bush fallow in high rainfall area. In the fourth continuous rice crop, the study has shown that:

- the grain yield with traditional method (702 kg/ha) could almost be tripled by fertilizer applications, weeding, mulching by straw, line sowing and insect control;

- fertilizer application without weeding greatly increased the total number of weeds and reduced the grain yield. Both fertilizer application and weeding are necessary for higher grain yield.
- similarly, straw mulch greatly increased the rice yield by reducing the total number of weeds and also conserving moisture in the upland soils;
- line sowing is important for proper weeding and to reduce weed population competing with rice for soil moisture, sunlight and nutrients;
- monocotyledonous weeds dominated followed by broadleaf weeds;
- insect control by systemic Furadan 3G application improved grain yield.

2. Disease incidence and yield response of rice (cultivar LAC 23) to nitrogen under bush fallow continuous rice cultivation

The result has shown that rice yield increased significantly with increase in N levels. However, yield increase per kg with applied N was highest at 60 kg N/ha (9.3 kg rice /kg N) and decreased at higher N levels.

The incidence of leaf scald increased with increasing N levels and the highest scoring (4.50) was recorded between 180 and 210 kg N/ha. Similarly, grain discolouration was at higher levels of N.

The present study again shows that N application alone will not maintain grain yields in upland rice as soil organic matter content decreases; exchangeable cations, CEC and soil pH may cause low yields in succeeding rice crops.

LOWLAND SWAMP

1. Package Evaluation Study

The objective of the study is to identify the optimum combination of agronomic practices and also the factor(s) that limit rice production in lowland swamp ecology with iron toxicity problems.

The factors include: methods of land preparation, transplanting, fertilizer application (60 kg/ha each

of N, P205 and K2O: three equal split doses of N and K, and basal P). Weeding (twice), insect control (three equal split doses of Furadan 3G at 1.2 kg a.i./ha) and soil amendment by straw burnt (at the rate of 4 t/ha). The treatments were so designed as to develop a complete package (CP = line transplanting, fertilizer, weed and insect control, straw burnt, first ploughing after harvest and second ploughing and puddling before transplanting), and an intermediate package (IP = CP - first ploughing after harvest). The traditional method consisted of random transplanting, no fertilizer or insect control, one hand weeding, no straw-burnt application, and one ploughing and puddling before transplanting.

The trial results have shown that effect of treatment on rice yields was significant ($P = 0.01$). Traditional method produced the lowest rice yield of 3.3 t/ha followed by IP-weed control (3.5 t rice yield/ha) while IP-fertilizer, IP-insect control and IP-straw burn produced 18, 14 and 13 percent less rice yields respectively than IP.

At the trial site aquatic broadleaf weeds dominated, while grasses and sedges (dominant weeds in dry season fallow) were insignificant during the wet season. IP-weeding has the highest number of weeds followed in descending order by traditional method and IP-line sowing.

The inferences from the above study are as follows:

- the rice yields with traditional method (3.3 t/ha) could be increased by 40 percent by adopting a package consisting of fertilizer application, weeding, line planting (for proper weeding), insect control and soil amendment by straw-burnt application;
- one ploughing after harvest of the wet season rice crop, when soil is still moist may be useful to discourage weed establishment and infestation during the dry season fallow. Thus time taken to plough and puddle the hard soil before transplanting of the wet season rice could be greatly reduced. This need further investigation;
- rice field ploughed after harvest of the wet season rice will absorb water easily during the beginning of the following rainy season, and as a result land preparation could be done much earlier without waiting for thorough soaking of lowland swamp soil by rain water. Thus the long turnaround period in establishing the wet season rice crop could be shortened.

2. Evaluation of various sources of nitrogen fertilizers

In 1983, among the N sources, Sulfur Coated Urea (SCU) with 22.0 percent dissolution rate, Urea Super Granules of 1g

and commercial urea were compared at three N levels (28.2, 56.4 and 84.6 kg N/ha). There were ten treatments including one control treatment (no nitrogen).

The effect of treatment on rice yield was highly significant ($P = 0.01$). Regardless of N sources, the yield difference between control and 28.2 kg/ha level was not significant. However, rice yields in all N sources at 56.4 and 84.6 kg N/ha level were significantly greater than those at 28.2 kg N/ha and the control treatment.

Within the various N sources the interaction between sources and levels of N was significant. The results have also shown that USG at 56.4 kg/ha, as far as rice yield is concerned, is as good as 84.6 kg N/ha of commercial urea and SCU. The 1983 season trial results have shown that USG placed in the reduced soil layer at transplanting is a better N source, as far as rice yield is concerned, than either SCU broadcast on soil surface at transplanting or commercial urea applied in three split doses.

3. Evaluation of Various sources of phosphorus fertilizers

The objective of this study was to evaluate phosphate rocks such as Tunisia (3% P₂O₅), Jordan (3% P₂O₅), Morocco (33.4% P₂O₅) and Togo (36.5% P₂O₅), and also triple super phosphate for agronomic and economic effectiveness in lowland swamp (Gleyic Acrisol). It was started in 1981 and continued in 1982 and 1983. There were 16 treatments (i.e. five P sources each at 20, 40 and 60 kg P₂O₅/ha) including a control treatment (no P).

The two wet seasons (direct effect) and two dry season (residual effect) trial results could be summarised as follows:

a) Direct effect

- in both years yield response to applied P was significant. However, regardless of P sources, rice yields in 20 kg P₂O₅/ha were not significantly greater than those in control;
- rice yield increased significantly with P₂O₅ level from 40 and 60 kg/ha in both years;
- in the first year, Tunisia phosphate rock (mean of all P levels) gave the highest rice yields and this was superior to other sources of phosphorus while, in the second year, there were no significant rice yields differences among Tunisia and Jordan phosphate rocks

and triple super phosphate; however all the three P sources produced significantly greater rice yields than Morocco and Togo phosphate rocks;

- as far as rice yields are concerned Togo phosphate rock is least effective as P source followed by Morocco phosphate rock.

b) Residual effect

- in both years yield response to residual phosphorus was significant;
- in the first year, in all P sources rice yield in 20 kg P₂O₅/ha treatments was significantly greater than that in the control. This was not recorded in the second year residual P trial;
- in both years, the rice yields in residual 40 and 60 kg P₂O₅/ha treatment were significantly greater than those in 20 kg P₂O₅ /ha treatments. However, the yield differences between residual 40 kg and 60 kg P₂O₅/ha treatments were not significant;
- in the first year, the rice yield response to residual phosphorus was highest in Jordan phosphate rock, while it was not in Tunisia phosphate rock in the second year.

c) Combined effect (direct and residual)

- Tunisia and Jordan phosphate rocks produced higher rice yields than other P sources in the first year;
- in the second year Tunisia and Jordan phosphate rocks were as effective as triple superphosphate. While Morocco and Togo phosphate rocks were less effective as P sources.

4. Yield response of rice varieties to nitrogen in lowland swamp

A collaborative experiment (between IITA and WARDA) was conducted in the 1982 dry season. There were 16 rice cultivars tested at 60 and 120 N kg/ha. Out of 16 rice cultivars tested there were 13 ITA series and three checks including one local check Suakoko 8 which is tolerant to iron toxicity. The 1982 dry season trial results have shown that

only varietal differences in rice yields were significant. Rice yields of 5.0 t/ha were recorded in ITA 239, ITA 242, FARO 15, ITA 254, ITA 252 and ITA 245. These rice yields were compared with the local check Suakoko 8 (3.8 t/ha), which gave significantly smaller rice yield than 11 rice varieties. Incidence of leaf blast was higher in 120 kg/ha treatment than that in 60 N/ha in most of the rice cultivars.

On the basis of performance of rice varieties during the 1982 dry season five ITA varieties (ITA 239, ITA 242, ITA 245, ITA 252 and ITA 254) were selected and the local check Suakoko 8 was included in the 1983 wet season trial. These six rice varieties were tested at N levels of 0, 40 and 80 kg/N/ha.

The trial results are summarized as follows:

- Rice yields decreased with increasing N level from 0 to 80 kg/ha in ITA 252, ITA 242 and ITA 245.
- While in ITA 254, ITA 239 and Suakoko 8 rice yields increased at 40 kg/ha and decreased at 80 kg/ha.
- ITA 254 at 0 kg N/ha gave 4.3 t rice yield/ha which was significantly greater than rice yields in other varieties at all N levels.
- Iron toxicity scoring varied with rice cultivars and N levels. ITA 239 and ITA 254 showed lower iron toxicity scoring (1.25 to 2.50) than other varieties (3.25 to 5.25).
- ITA 254 exhibited promising performance. This variety gave higher rice yields in both dry (5.0 t/ha) and wet (4.3 to 4.8 t/ha) seasons as well as lower iron toxicity scoring (2.0) in the wet season than the local check Suakoko 8 (3.8 t and 2.8 t 3.4 t rice yield t/ha in dry and wet seasons respectively).

SUPPORT GIVEN TO SPECIAL RESEARCH PROJECT
-----Deep Water/Floating Rice Project, Mopti, Mali
-----Effect of fertilizer application on the plant growth and development, and nutrient uptake of rice under semi-arid deep water conditions

The objective of the present study was to investigate the effect of fertilizer (NPK) application on the plant growth and development, and nutrient uptake of improved deepwater rice cultivar (BKN 6986-167) at various growth stages and to see if there is any suitable management practices that can improve rice yield in the deepwater soils.

A similar trial, using the recommended deepwater rice cultivar Khao Gaew, was conducted at Mopti in the 1981 wet season.

The 1983 study shows that as far as dry weights of vegetative parts such as leaf and stem are concerned, there is a positive response to applied fertilizer. Similar application of fertilizer caused significant increase in total tillers and harvest in improved deepwater variety BKN 6986-167 (226 to 234/m²) in 1983 was higher than that in traditional deepwater rice cultivar Khao Gaew (57 to 62 tillers/m²) in 1981, under the prevailing conditions at Mopti. Similarly applied fertilizer significantly increased the LAI (leaf area index) during the pre-flood as well as post flood periods in BKN6986-167. The maximum LAI of 5.28 inches without fertilizer (FO) and 8.08 inches with fertilizer (F1) treatment was recorded at the booting stage.

At harvest the fertilizer treatments produced higher total grain yield, grain yield from both basal and aquatic tillers, total number of panicles, number of panicles from basal tillers and number of filled grains in 100-grain than treatments without fertilizer. However, the differences between the two treatments were not significant. These observations again show that under deepwater conditions at Mopti, the improved deepwater rice cultivar BKN 6986-167 does not exhibit significant yield response to fertilizer.

ORNITHOLOGY

Extensive field surveys were carried out for the first time along 3000 miles in four major rice producing counties (Montserrado, Bong, Nimba and Lofa) to assess the bird damage and to obtain an overview on how an effective, economic and locally oriented bird control strategy could be formulated under wet tropical conditions. The survey methods include:

- i) transect road surveys,
- ii) mist netting,
- iii) count/transect road survey,
- iv) questionnaire and interview, and
- v) direct observations.

Major Bird Pests of Rice :

The village weaver (*Ploceus cuculatus*) and the chestnut weaver (*Ploceus nigerrimus*) are the abundant bird pests of rice in Liberia. Both of these birds are resident, mainly in villages where individuals can breed throughout the year. During the breeding season they mainly feed on rice and insects.

Extent and severity of damage to rice varies from one cultivated area to the other depending on the proximity of nesting and roosting sites to target fields. Upland rice grown close to villages where large numbers of birds exist, is usually more severely damaged than rice grown in the interior parts close to the rain-forest fringes. The farther the cultivation of rice is shifted from villages, the less the damage.

Generally, it has been observed that weavers damage is closely associated with both the relative distribution and abundance of oil-palm and coconut plantations, used for nesting, and the relative proximity of rice fields to human settlements, suggesting that damage is largely localized. The larger the cultivated area, and evenly distributed the damage, the less the impact.

Other bird pests of economic importance like the black and white mannikin, the orange-cheeked waxbill and the yellow-mantled whydah are particularly destructive during the milk stage of the plant.

RECOMMENDATIONS

- 1) This assessment of bird pest problems to rice in Liberia based on extensive field surveys should be used to design a suitable bird control strategy applicable under the humid tropical ecology.

- 2) Under the existing humid tropical rice cultivation conditions where upland and swamp rice crops are cultivated within thick rain-forest ecology and the fact that major pests usually breed and roost in trees located within close vicinity of human settlements, a bird control strategy based on "direct crop protection" approach offers the only possible solution to this complex locally-oriented problem. "Direct crop protection" is defined to mean methods used for protecting crops in the fields from bird damage rather than killing the birds at their roosts/colonies to prevent their subsequent attack. The latter is usually referred to as "indirect crop protection". The application of pesticides using aerial or ground techniques against bird concentrations in nesting and roosting sites, as currently practised in the Sahelian or semi-arid savanna zones in Africa is obviously ruled out in the case of Liberia. It is ecologically hazardous, logistically difficult and economically unjustifiable. Catching birds by mist-nets in their roost is also a difficult and less effective task adversely affected by the tallness of trees in which birds roost. Therefore, the direct crop protection approach in the fields lends itself as the only strategy which can effectively prevent or reduce crop losses. This might involve using integrated methods where by: extensive bird netting bases on a good knowledge of the behaviour of birds in relation to positioning of nets, biologically oriented bird-scaring devices based on a good knowledge of the behaviour of birds towards a combination of improved visual and oratory stimuli, and finally the limited use of chemical bird-repellents, particularly in large schemes, could all be combined and implemented.

3. Bird pest control is fundamentally a team work operation which requires follow-up and cooperation among farmers to avoid repelling birds from one field moving to inflict damage on other fields. Traditional bird scaring, can be significantly improved through biological and experimental field tests to increase its efficiency and reduce its labour input, e.g. modifications of scare-crows, orange and blue flags.

4. Nest destruction campaigns, carried out collectively by farmers on systematic basis at the village level, particularly from July to October, might be effective in reducing part of the bird populations through the removal of eggs and nestlings. It was evident from our observation in 1983 rice season that most of the damage caused by birds during the late ripening stage was due mainly to village weaver juveniles, probably born in July of the same year.

SPECIAL RESEARCH PROJECT ON UPLAND RICE BOUAKE - IVORY COAST

The activities undertaken at the Bouake station in 1983 included multilocational trials as well as studies on varietal adaptation to mechanized cultivation, adaptation to intensive cultivation with sprinkler irrigation and regional adaptation under varying rainfall conditions. With the exception of the study on regional adaptation, most of the activities were carried out within the framework of the IDESSA rice programme.

Multilocational Trials

The purpose of these trials was to identify new high yielding varieties with more desirable agronomic and grain qualities. These varieties should also exhibit a potential for wide adaptability and great attention paid to genotype x environment interaction. A wide geographical network including those of IDESSA, WARDA and CIDT as well as two sets of high and low fertility trials were adopted.

As far as yields are concerned, varieties ISA 1, ISA 7, ISA 9, ISA 11, ISA 13 and ITA 235 were the highest yielders among the early-maturing varieties. The Asian and traditionally African varieties did not produce any new significant results. Among the medium-duration varieties ITA 141, ITA 162, ISA 5 and other ISA varieties proved to be more productive as compared to IRAT 104, IRAT 13, and IRAT 170. IRAT 161 and IRAT 156 remained susceptible to lodging. BG 187 showed a high incidence of lodging even with a low fertility rate. As mentioned earlier, the traditionally African varieties did not produce any unusual results.

With respect to yield stability, comparative trials were conducted between IRAT 104 and Iguape Cateto as well as IRAT 109 and Dourado Precoce to assess their yield stability. These two trials were significantly different at 1%.

Insofar as grain quality is concerned, the criteria studied were milling output of head rice and translucence. With respect to the first criterion, IRAT 144 was the top yielder. IRAT 112 and Dourado Precoce gave poor yields. As far as the second criterion is concerned, the most translucent of the 19 varieties scoring from 0-9, were ISA 13, ISA 15, ISA 4 and ISA 17 (below 0.60). The most opaque were Iguape Cateto and ISA 7 (3.05 and 3.08 respectively).

Suitability for Mechanized Harvesting

This trial was jointly conducted by CIMA, IDESSA and WARDA. The aim was to assess field losses due to shattering and to test the equipment used for measuring shattering rate that was designed at the Bouake station. In order to

accurately measure the shattering rate, it is important to use varieties with the same level of maturity which have all been subject to the same climatic conditions. Spaced-out sowing was therefore carried out starting with the late-maturing varieties. Harvesting was carried out with a BEDONI harvester and a hard-straw thresher.

Ground losses were measured with the use of a quadrat and losses due to cutter-bars and handling of sheaves was assessed visually.

The ground losses observed varied between 0.6 and 7.9% respectively and the number of grains lost were between 10 and 88 per square meter respectively. Thus, the losses observed were relatively low. However, the correlation between moisture content and shattering rate has led to the assumption that the shattering effect would have been greater in paddy fields with a higher degree of maturity.

Attempts were made to determine whether the equipment used to assess shattering could also be used to determine the causes of shattering in the field and whether the measurements obtained corresponded to the field losses after the use of a harvester. Trials conducted by three different methods, (0-9 scoring after visual assessment, counting and grain losses after sampling, roller type equipment used in the trial), revealed that there is a fairly high correlation ($r=0.87$) between shattering caused by the equipment and the ground losses assessed. This has made it possible to confirm that the equipment used at the research station can indeed cause shattering in the field.

Intensive Upland Rice Cultivation with Supplementary Irrigation

Since this type of rice cultivation has been given low priority in the varietal creation programme, no variety that is actually suited to this type of rice cultivation system has been identified. Nevertheless, variety 949M which is highly resistant to lodging and has the same qualities and defects as IRAT 13 was tested for its suitability to upland conditions.

This variety was sown at a rate of 75kg/ha with a basal fertilizer application of 380kg/ha. RONSTAR was applied at the rate of 4.5 l/ha to control weeds and urea was applied as top dressing in split applications of 104 and 63 kg respectively. The rainfall recorded was 191 mm and the volume of water supplied through irrigation was 880mm. The yield obtained was 3.48 t/ha. Yield increases might likely be obtained through good soil preparation and by sowing a previous crop other than rice. It is also important to

acquire a variety that is equally resistant to lodging but one which matures early and possesses good grain quality.

It is absolutely necessary to intensify climatic observations in order to assess the scope of upland rice cultivation and determine its yield potential. In this respect attempts have been made to design a method to determine the optimum dates for cultivating upland rice. A system was adopted whereby a crop with a given duration is grown in such a way that its optimum water needs are met when water supply is most abundant. Thus the sowing to heading period of varieties that are currently widely recommended in the Ivory Coast were established beforehand as well as the stages of the growth cycle which would occur during the wet and semi-wet seasons. The sowing to panicle initiation stage can conveniently occur during the semi-wet season. The change of the panicle initiation to the grain-filling stage 15 days after heading should occur during the wet season. Maturity lasts for 15 days and occurs during the semi-wet season or even during the dry season. The water needs which follow the vegetative phases are shown below:

Short duration	S	PI	H	M
	0	41	76	106 days
Medium duration	0	57	97	127 days
		xxxxxxxxxx		
Long duration	0	75	130	150 days
		xxxxxxxxxx		

S = Sowing

PI = Panicle Initiation

H = Heading

M = Maturity

--- Stage of the growth cycle which can occur during the semi-wet season.

xxx: Stage of growth cycle which should occur in the wet season.

The values mentioned above were found to fluctuate. Practically-speaking, it is recommended that sowing should be carried out after rainfall. At the beginning of the season, sowing should be carried out several days before the optimum date if there are adequate moisture conditions. This theoretical optimum sowing dates should, in practice be considered as the deadline. These results have made it possible to draw-up maps for the Ivory Coast which can be used as sowing date guidelines.

SPECIAL RESEARCH PROJECT ON MANGROVE SWAMP RICE,
-----ROKUPR - SIERRA LEONE

Varietal Improvement: Thirteen new short duration varieties significantly outyielded the current recommended lines in replicated yield trials as well as in trials conducted on farmers' fields during 1983.

An advanced breeding line Rohyb 15-WAR-3-3-B-2 performed better than the leading medium duration mangrove swamp rice variety, ROK5, by margins of 24% in station trial and 10% in farmers' field trials. The variety, Rohyb 15-WAR-3-3-B-2, maturing 5 to 10 days earlier than ROK5 has potential for use in short rainy season areas of Northern Guinea, Guinea Bissau, Southern Senegal and The Gambia. Six of the new promising varieties were nominated for inclusion in the 1984 coordinated variety trial for mangrove swamps.

Twenty-seven lines outyielded their adjacent checks in observational yield trials under tidal mangrove and associated swamp conditions in 1983. A new advanced line WAR 44-21-3-2 outyielded the adjacent CP4 check by a margin of 43% to 129%.

Thirty-six new crosses involving one locally selected or bred material and introduced parents were successful. F2 seeds were successfully raised in the dry season. Also in 1983, thirty three promising lines were selected from various IRRRI nurseries for further evaluation and use in breeding.

Soil-fertility: Fertilizer tests on farmers' rice within the region indicate that phosphorus and phosphorus plus potassium were essential for rice production in The Gambia and the Republic of Guinea, respectively. This contrasts situation in Sierra Leone where nitrogen is the major limiting nutrient for rice in the vast majority of mangrove swamps.

Results from the Scarries mangrove swamps in 1983 confirm that method of application was the main factor influencing the response of rice to nitrogen in mangrove swamps. Deep placement by the injection technique, a single application procedure developed by the project, was more beneficial and desirable for farmers, producing a 51.3% increase in grain yield over control as against half as much by single or split broadcasts of the fertilizer.

Over the years, mechanical cultivation of mangrove swamps has consistently outyielded the farmers' manual method of

land cultivation. Results obtained in 1983 show that after five consecutive seasons of ploughing of the plots with or without nitrogen, mechanical ploughing alone was as effective as 40 or 80kg N per ha under farmers' method of land cultivation in increasing the grain yield of rice.

Azolla has a high potential as a means of stabilizing and improving soil nutrient status and reducing dependence upon chemical nitrogenous fertilizer for lowland rice production. Results obtained in 1983 confirm that the incorporation of two crops of Azolla was as effective as urea at 40kg N per ha, in increasing rice grain yield in the associated swamp. The incorporation of one crop of Azolla plus 20kg N per ha was equivalent to 40 or 80kg N per ha in raising the grain yield of rice in the associated swamp.

Pest management: Land preparation with the single axle 8HP power tiller was effective in controlling *Paspalum vaginatum*, the major weed of tidal mangrove swamps as well as the sedge, *Cyperus articulatus*. Pre-plant non-selective herbicides, glyphosate and paraquat were also effective in weed control but with these, grain yield was not significantly different from the untreated control. Application of weed control treatments in March was less effective than application made between April and June.

Glyphosate and paraquat were shown to have effective control over *Oryza longistaminata*, a rhizomatous weed common in the associated mangrove swamps.

On farmers' rice in the Scarries region of Sierra Leone, Stam F34T produced significant grain yield increase over the no weeding control.

Insect pest population studies on farmers' rice fields in the Scarries area continued during 1983 as the basis for effective decision making in integrated pest control and overall crop management. A lower stemborer infestation was recorded in 1983 due possibly to delayed and high initial rainfall during the season. *Phanergetoma major* an important parasite of *Maliarpha separata*, *Rhaconotus* sp. and *Venturia crassicauda* had been consistently effective in suppressing stemborers. Larval parasitism reached a peak of 71.4 percent.

Studies on seasonal abundance of insect pests in the Republic of Guinea indicated predominance of *M. separata* and *Chilo* stemborers in the Sonfonia and Koba districts respectively.

In crop loss assessment of farmers' rice, the variety Barka Madina, sustained 22 percent yield loss in Coyah, Guinea. In Sierra Leone, the Rokupr bred variety Rohyb

15-WAR-3-3-B-2 had a smaller crop loss, 14% and heavier grain yield (4350kg per ha) than other promising selected varieties.

Studies undertaken in 1983 show that crop loss resulting from crab damage could be minimized if the seedling rate was reduced to the range of 9-15 per hill in a plant population of 32 hills per sq. meter, although farmers in the Scarcies area transplant 15-40 seedlings per hill with about 16 hills per m².

Eight percent of the varieties screened for resistance to crab damage were rated below 20% crab damage. The degree of heritability to resist crab damage as estimated was moderately high (h=61%) indicating that there is genetic variability for tolerance to crab damage in rice varieties screened.

Crop loss due to brown spot disease in the long season areas of the Scarcies range from 7.3 to 31.1 percent and 5.8 to 17.6 percent in the tidal mangrove and associated swamps respectively. In short season areas recorded crop losses were in the order of 4.4 to 23.2 percent of Moribaia (tidal mangrove) and 4.6 to 31.9 percent at Kibanka (associated swamp). Dirty panicle phase of the disease was thought to cause more damage since the grain were directly attacked. Grain yield losses due to neck blast recorded on ROK5 and Pa Nylon, a local variety, at Mapotolon, an area with salt-free period of less than four months, were in the range of 28.0 to 44.3 percent and 19.6 to 32.2 percent respectively.

The estimated grain yield loss due to pale yellow mottle virus ranged between 29.6 and 93.8 percent in ROK5 and from 19.6 to 75.1 percent in Angkata, local variety with some tolerance to the disease, with higher yield losses incurred when seedlings were inoculated as compared to adult plants in a screenhouse test.

Technology assessment: Results of adaptive trials conducted in the Scarcies region of Sierra Leone during 1983 indicate that farmers' yield in the short season areas could be increased by 0.6 ton per ha on average if ROK5 is used which gives a net revenue increase of Le186.00 per ha. Its comparatively shorter duration vis-a-vis the traditional varieties makes it ideal for the salinity regimes but necessitates additional labour for bird scaring which farmers are not accustomed to.

The application of 40 kg nitrogen per ha, by the injection technique, on traditional varieties increased farmers' rice grain yield by over 1.0 ton per ha in the short season areas and 0.45 t per ha in long season zones, giving net revenue increases of Le351.00 and Le150.00 per ha respectively. Nitrogen applications on the improved

varieties ROK5, in short season areas, and ROK10, in long season areas, effected grain yield increases of 1.5 t per ha and 0.44 t per ha, respectively, over the traditional practice. This increased net revenue by Le174.00 per ha in the short season area and L375.00 per ha in the long season area. The tediousness of the fertilizer application operation i.e. deep placement by injection, presents a bottleneck for adoption of the technique. Efforts to improve on the ease of the operation will enhance the potential for adoption of the technique. The package involving improved variety, nitrogen application and mechanical ploughing gave the highest yield increase and the indications are that a change from traditional practice to the complete improved practice will increase net revenue by an average of Le245.00 per ha over all zones and ecologies.

The change from traditional to improved farming practices is considered to involve only moderate increases in the labour requirement while the increases in net revenue are high. Thus the packages are economical and feasible and as such they stand good chances of adoption.

Results of similar trial conducted in the Republic of Guinea indicate that the improved varieties ROK5 and ROK10 were better on an average than the traditional varieties but their durations were not quite appropriate for the areas in which they were tested. Also, soil conditions in the Republic of Guinea necessitate using varieties that are tolerant to iron toxicity.

Mechanical ploughing tended to exacerbate nutritional problems, presumably iron toxicity, in the rice crop in Guinea.

Under drought conditions in The Gambia ROK5 showed a high potential for increasing rice grain yield presumably because it was shorter in duration than the traditional varieties. The present drought conditions in the region warrants shorter duration salt tolerant varieties as ROK5 could not withstand a more severe drought.

SPECIAL RESEARCH PROJECT ON IRRIGATED RICE

RICHARD-TOLL, SENEGAL

1. Variety Improvement

Four variety improvement trials were conducted in 1982-1983 involving 67 short and medium duration varieties. Their yield performance was good.

The best results per trial were the following:

Trial I

- IR 9782-144-3-3-3
- IR 2823-399-5-6

Trial II

- BR 51-91-6
- IR 3272-P339-2

Trial III

- RP 1899-1481-78-1
- IR 19791-12-1-2-2-2

Trial IV

- RP 1125-1548-1-4-3
- RP 1125-1526-2-2-3

2. Soil Science

a) A comparative trial of the effect of granulated urea and urea on rice yield using three sowing methods showed the best combinations for obtaining the best results:

- Combination 1: Direct sowing with granulated urea
- Combination 2: Direct broadcast sowing with granulated urea
- Combination 3: Transplanting with super granules.

b) The ploughing in of *Sesbania Rostrata* either alone or with increasing doses of nitrogen increased grain and straw yield by 2 and 3 tonnes respectively as compared with the non-treated check variety.

c) The effect of Azolla as compared with the results obtained using chemical fertilizer and Azolla as a single crop or in association with rice, by combining these two techniques was studied. Azolla has a greater effect on grain and straw yield. All the treatments gave significantly higher yields as compared with the check.

3. Weed Science

The presence of *Oryzae barthii*, *O. longistaminata*, sedges and some dicotyledons (*Ludwigia* spp, *Sphenoclea zeylanica*) is a constraint in rice production. The use of herbicides (9 herbicides), the effect of hand and chemical weeding, and the use of *Azolla* in rice cultivation was tested and an increase in yield was observed.

4. Entomology:

The main rice pests currently identified in the valley are *Chilo zacconius*, *Hieroglyphus daganensis*, *Mythimna loreyi*, *Aleurocybotus indicus*. Three miticides (Azodrin, Hostathin and Marocide) were used to control mites.

The major pests found in farmers' fields were *Chilo zacconius*, *Hieroglyphus daganensis* and *Diacriasia scorlilla*.

Pests were caught in light traps at Richard Toll: *Mythimna loreyi*, *Diacriasia scorlilla*, *Cretonotus leucanoides*, *Eldana saccharina*, *Sesamia calamistis*, *Chilo zacconius*, *Scirpophaga sumbribrosa*.

5. Technology Assessment and Transfer Programme (TAT)

The TAT irrigated rice programme began with the study and identification of constraints in irrigation, root infestation, insect and mite attacks, bird damage, etc. Adaptive trials began in the 1984 off season and focused on the modified Dupog nursery and spaced-out sowing, line transplanting, split application of nitrogen, introduction of KH-998, BGF 90-2 and IR 2823 varieties, chemical weeding using Ronstar 120, Basagran PL and Tamariz as well as hand weeding at 20 and 40 days.

6. On-farm trials

Three on-farm trials were conducted:

1. Simple NP trial

The effect of NP application on rice yields on Fonde and Hollalde soils was tested. The effect is more pronounced on Hollalde soil. Trials on hydromorphic soils gave fairly conclusive results.

NPK trials

Two trials gave interpretable results. The results of these two trials do not show any response to a double dose of nitrogen, which is the same as the results obtained in the NP trials. However, the first results do not show any phosphorus effect.

3. Organic matter application trial

The use of animal dung powder to partially replace chemical fertilizers was tested and higher yields were obtained as compared with the check.

7. Water management

The study of the village irrigated plots (PIV) was carried out from July 1982 to July 1984. Some insight has been gained about the actual situation. The research focused on the following:

- the historical development of the PIV: they were developed by the farmers with the help of the development corporations;
- development: constraints at the beginning for the power-tiller;
- needs and consumption: needs and consumption were noted;
- water distribution and method of irrigation;
- organization of irrigation;
- socio-economic aspects: The importance of PIV in cereals production was determined.

SPECIAL RESEARCH PROJECT ON DEEP WATER/ FLOATING RICE, MOPTI-MALI

In Mali, the 1983 cropping season for rice has been described as catastrophic. Rainfall and water levels in rivers Niger and Bani were so low that floods could not enter the majority of the polders including the WARDA experimental polder. Pumping water from river Niger directly into the experiments helped a little but could not adequately simulate natural conditions. Out of 46 experimental sites at the station, only 42 could be seeded and only 38 succeeded. Similarly out of 109 out-station experimental sites, only 11 succeeded.

Varietal Improvement: The breeding programme which started in 1983 with IRRI collaboration has received F2 seeds. A drought tolerance breeding programme with BKN varieties and Nam Sangui and Leb Mue Nahag 111 as donors is also underway. Crosses involving the rice varieties *O. sativa* and *O. glaberrima* are also being attempted.

Screening tests included 4 sets of material obtained from the International Rice Deep Water Observations Nursery (IRDWON), the Floating Tolerance Rice Screening sets (55 entries), the Medium Deepwater Rice Screening Set (42 entries), the Deep Water Floating Rice Screening Set (58 entries), the Initial Evaluation Test, and the Rapid

Generation Advance (368 lines), with the objectives to identify a broad spectrum of resistance to environmental stresses. Selection was based mainly on elongation ability early maturity, resistance to stemborers and phenotypic appearance at harvest.

In the observation trials, 23 line selected from the 1981 IET and IRDWON trials that failed in 1982 due to drought were tested. One WARDA Coordinated Variety Trial in the medium zone (65cm water depth) was also undertaken. However, the plant life cycle of all varieties was shorter than the local check, Khao Gaew.

Agronomy: Most of the agronomy trials conducted outside the station were destroyed by drought. Trials on the influence of spacing on yield did not show significant difference between 20 cm, 30cm and 40cm spacing; thus confirming results of previous years. Trials on fertilizer efficiency indicated that various sources of nitrogen do not appear to demonstrate superiority over the control.

Weed Control: Preliminary results demonstrated that line drilling, and especially line dibbling at 30cm and 40cm could save seed, weeding time and improve the efficiency of hand weeding. Investigations on the critical time of hand weeding *O. barthii* and mowing the perennial wild rice *O. longistaminata* under water were 5 weeks after rice emergence and 2 weeks after flood arrival respectively.

Entomology: The relative susceptibility of selected varieties to stemborers is shown in the table below. The insecticide Furadan 3G at 1 to 1.5 kg/ha of a.i. and Birlane 10G also at 1 to 1.5 kg/ha of a.i. applied a few days before flood arrival continued to show superiority over other treatments.

Susceptibility of Some Varieties to Stemborers
Attack at Mcpti, 1983

Varieties	Number of Chilo per 100 tillers	Number of Maliarpha per 100 tillers	% infested tillers
BKN 6323	2.21	23.86	33.05
Khao Gaew	4.00	25.56	38.92
DM 17	4.36	34.29	42.38
Mali Sawn	4.25	36.67	52.38

Seed Production: Due to the installation of a sprinkler and a permanent pumping system, it was possible to produce 25.556 t of seed which is sufficient for next year's experiments.

DEVELOPMENT DEPARTMENT

Activities

The activities of the Department consist of mainly three programmes; namely Technology Assessment and Transfer (TAT); Technical Assistance Programme (TAP); and Rice policy analysis, mechanization and water management studies.

Technology Assessment and Transfer Programme (TAT)

The concept of technology assessment and transfer has the twin objectives of evaluating the improved technology for its suitability to farmers' socio-economic and production needs, and of devising and testing an extension strategy for use by national extension organizations in transferring the improved technology to farmers. Under the TAT programme, socio-economic studies were completed in mangrove swamp areas of Sierra Leone, The Gambia, Guinea, in the deep water and floating areas of Mali, and in the upland rice areas of Ivory Coast. Through these studies agro-climatic and socio-economic production constraints for rice are being identified.

Four improved technology packages were identified for the mangrove swamp areas of Sierra Leone, and tested through 40 adaptive trials. On the basis of the yield performance, economic analysis and socio-personal factors, it can be concluded that:

- a) ROK5 could be grown alone or with fertilizer (40kg of N/ha injected at 20cm below the surface at early tillering) in the short duration areas, and would increase net revenue by over 40 percent.
- b) CP4 should not be grown without fertilizer. With fertilizer, net revenue could be expected to increase by over 50 percent.
- c) Mechanical cultivation (land preparation and/or puddling with a single axle power tiller) alone may not be economical, but its main effect is in reducing the drudgery of hand digging.
- d) The complete package consisting of an improved variety, fertilizer application and mechanical cultivation could be expected to increase net revenues by 25-40 percent, as well as reduce the drudgery of hard labour.

In order to test an extension education strategy for the transfer of power tillers and fertilizer injectors to the

farmers in the mangrove swamp areas of Sierra Leone, three pilot farmers cooperatives have been organized. One power tiller has been provided to each cooperative on credit, and the members have paid an initial deposit that has paid a part of the credit. Further, intimate contacts have been established with the extension staff of the North West Integrated Agricultural Development Project, (NWIADP) Kambia to integrate these technologies into their extension work.

Further, improved packages are being tested through 164 adaptive trials in four countries namely: Sierra Leone, The Gambia, Guinea and Mali in 1983/84 crop season.

A zero-tillage study conducted in the upland rice conditions in Liberia indicated that no-till system using the rolling jab-planter and herbicides is not likely to be a success, judging from the conditions under which the traditional farmer cultivates his upland rice crop and coupled with the economic factors of these conditions.

TECHNICAL ASSISTANCE PROGRAMME (TAP)

Under the TAP, WARDA assists its Member States with rice project preparation and implementation. In 1983, activities under this programme covered The Gambia, Guinea, Guinea Bissau, Liberia, Mali, Mauritania, Senegal and Upper Volta

A rice seed multiplication review was conducted in The Gambia. It was estimated that The Gambia will need 250 t of certified rice seed annually. It has been recommended that the Sapu Experimental Farm should directly produce foundation II seed and registered seed, while certified seed should be produced through registered out-growers. In addition, WARDA also donated two small rice mills and three sets of quality control equipment to The Gambia, and also helped for their proper installation. Training was also provided in the proper use and maintenance of the equipment.

After a survey of the rice post-harvest techniques and problems in Guinea, it was recommended that steps should be taken to protect the old rice mills at Forecariah from further damage so that it could be rehabilitated after a further study by WARDA.

A rice seed multiplication review of Guinea Bissau was conducted in which three alternative systems for producing certified seed to meet the needs of the country by 1992 were examined. In the first system, all stages of seed multiplication are undertaken at mechanized state farms. In the second system multiplication of G0 to R1 is done at the mechanized state farms while certified seed is multiplied by

contract growers. In the third system, production of G0 to R1 in the State Farms is by animal traction, while R1 is multiplied by contract seed growers. The internal economic rate of return was estimated to be negative, at 14 and 18 percent for the three systems respectively.

In order to assist the Government of Liberia, in preparing designs for rehabilitation of the irrigation projects, topographical surveys were completed for Zieh Town (45 ha), Foya-5 (30 ha) and Bandedja (2 ha) projects. Engineering and economic analyses are also in progress for these and other projects like Foya 1, Foya 2, Foya 4, Gbedin, etc. After a rice seed multiplication review of Liberia, WARDA also recommended that the multiplication of rice seed should be done only through the SmallHolder Rice Seed Multiplication Project (SRSP) and that incentives to contract seed-growers need to be increased if the target of 750 tonnes of certified production by 1986 is to be achieved.

On the basis of a rice seed review in Mali, it was recommended that Operation de Production de Semences (OPS) should conduct a survey of users of seed, in order to estimate seed demand in terms of quality and quantity. The OPS should purchase, treat and distribute the seed. Foundation seed should be produced by the OPS at its Molodo and Mopti centres while the other centres of Babougou and Dalabani should be used for R2 seed production by contract farms.

A seed review of Senegal estimated the demand for certified seed at about 1420 tonnes by 1990. It was recommended that either the WARDA Regional Seed Centre at Richard Toll may continue to produce seed for the next 10 years up to stage R1, or the rice seed production be transferred to Fanaye after two years. Financial implications for both the alternatives were also worked out.

On the request of the Government of Upper Volta, a WARDA staff member has been posted to Bobo-Dioulasso as Rice Industry Advisor for 2 to 3 years. During this period, he will conduct and supervise studies of rice production, marketing and distribution including milling and storage.

During the year, concerted effort was made to collect information on the follow-up of Member States' projects designed in the past by the Department. From the results, it is clear that quite a large number of the projects are being implemented in part or in whole. Most of the projects that have not yet been implemented, particularly those identified in the last two years, are still under study and are likely to be implemented.

Other Programmes

1) Rice Statistics Programme: The 5th Edition (Abstracts) of the Rice Statistics Yearbook was published.

2) Policy and Financial Analysis and Advice: A study was also completed on the Recent Policies and Programmes related to Rice production, consumption and trade in West Africa. Some of the major findings of the study are as follows:

- a) Since 1960, the rate of growth in food production in the sub-region, has lagged behind the rate of growth of population. Consequently rice has been second to only wheat as the most important food item imported.
- b) The consumption of rice has increased much faster than that of other foodcrops as it is readily available, and is cheaper due to import and consumer price subsidies.
- c) The production of paddy in the sub-region having reached nearly 3 million in 1975, declined to about 2 to 7 million tonnes in 1979. The trend occurred in all the countries in the sub-region except Ivory Coast, Liberia and Mauritania. The decline in output is both in area cultivated and yield obtained.
- d) Considerable efforts are being made in the sub-region to increase rice production especially through developing river basins and dams. However, in a few countries, the targets set for rice production are difficult to achieve, and in some countries, the measures taken have a negative effect.

3) Mechanization and Water Management Studies: A review of rice mechanization in The Gambia and Nigeria was undertaken. For Nigeria, recommendations were made for the choice of equipment for cooperatives and seed multiplication firms. In The Gambia, the review focussed on introducing animal traction for irrigated rice cultivation.

A project with the objectives of testing a range of small scale mechanical equipment suitable for mangrove and valley bottom rice cultivation was prepared which has been approved by FAO.

Water Management Studies have also started in Senegal. Villages for the study of water use in small irrigation projects were selected and monitoring of water use started.

4) Post-Harvest Technology: A design was prepared and a prototype of an improved traditional village parboiling unit has been constructed from local materials. Laboratory tests of the unit produced good quality parboiled rice.