WARDA

ANNUAL REPORT 1990

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Foreword

On behalf of the Board of Trustees and the management and staff of the West Africa Rice Development Association (WARDA), I have great pleasure in presenting our Center's *Annual Report 1990*.

The implementation of WARDA's medium-term plan was initiated in 1990, following approval of the plan by the Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR). The major part of our global recruitment drive for international staff to lead WARDA's research, training and communications activities was completed during 1990. We are pleased that WARDA has been able to attract an excellent team of the best rice scientists and other professionals available, who all share our fundamental commitment to a high standard of scientific excellence and to a close working relationship with scientists in the national agricultural research systems (NARS) of WARDA member states.

The major staff changes and program reorientation in 1990 significantly affected operations such that most program activities were placed on a maintenance basis, while only a few new initiatives were introduced. In this report we present results from these and other ongoing tasks within the Continuum, Sahel and Mangrove Swamp Rice Research Programs, as well as progress in training and communications. In the Continuum Program we report progress in the regional characterization research and in breeding and on-farm testing of elite upland varieties. We also report progress in the evaluation of rice varieties for resistance to insect pests, in studies on soil nutrient deficiency and in the evaluation of tillage practices. Progress in the Sahel Program in 1990 related mainly to varietal improvement of rice for wet season cropping and the initial evaluation of germplasm from Latin America.

WARDA has successfully converted its mangrove swamp rice research activities into a network-based structure, in line with our plans for the devolution of responsibilities to NARS rice scientists. Satisfactory progress has been made in defining the Network Program and in initiating joint WARDA/NARS task force research and other collaborative activities. A limited set of activities relating to the development and testing of varieties well adapted to the mangrove swamps was carried out in 1990.

Part of the research block of WARDA's Main Research Center and Headquarters under construction at M'bé, Côte d'Ivoire

During the year, significant progress was made in the consolidation of our ideas for the development of the Research Farm Complex at WARDA's permanent site at M'bé, Côte d'Ivoire. The temporary facilities which had been established at the site in 1989 were put to maximum use in 1990.

WARDA's Board of Trustees and management worked with consultant architects and engineers to finalize the design and to undertake the prequalification of contractors and the tendering process for the construction of the Main Research Center and Headquarters. Contracts for the first phase of this capital development program were let in late 1990. Construction work began immediately and progressed so rapidly that, at the time this *Annual Report* was going to press, the building had reached a reasonably advanced stage.

The Liberian civil war occurred during the year, compelling WARDA to terminate all residual operations there in May 1990. In spite of the total loss of the WARDA Training Center at Fendall in Liberia, training courses planned for 1990 were conducted on an itinerant basis, using carefully selected WARDA member states' rice programs to host the training courses, with national rice scientists serving as resource persons. This approach was much appreciated by our NARS partners and served to strengthen our collaboration with them.

Although this *Annual Report* presents significant progress in WARDA's programs, funding deficits in 1990 necessitated some drastic modifications in the staffing pattern and in the activities which had been proposed and approved in the medium-term plan. Despite severe budgetary constraints, WARDA's management and staff, with the strong support of the Board of Trustees and the Center's major donors, accepted the challenges implicit in the plan's objectives and vigorously pursued its proposed activities.

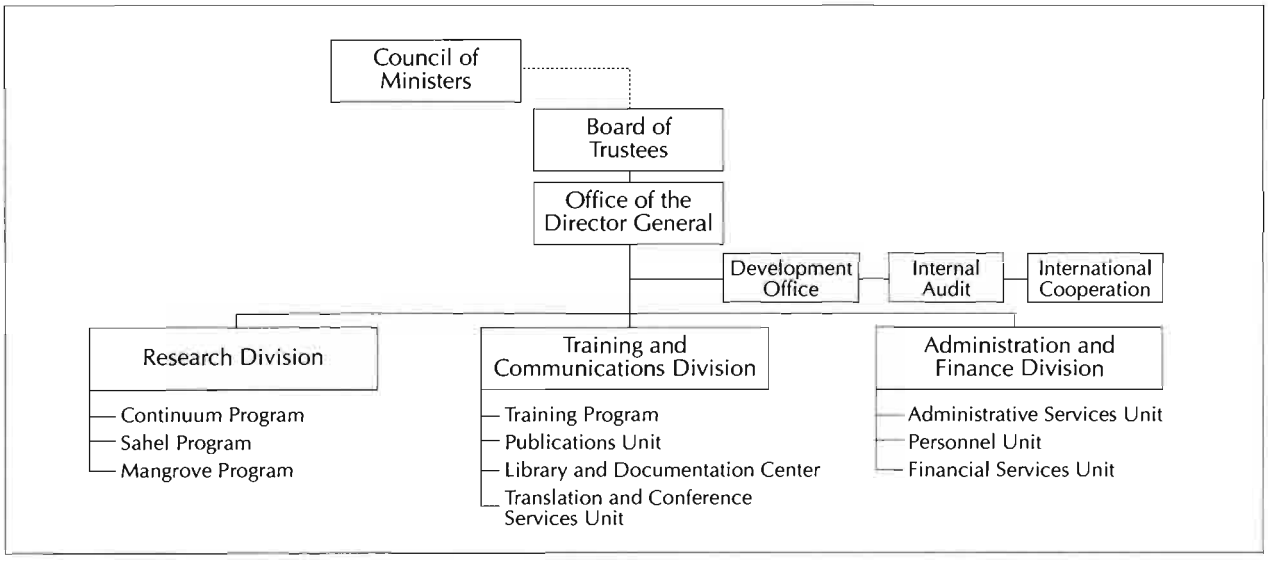
WARDA's Board and management are pleased that the Center's strong governance and managerial structure is now complemented by a strong professional team to implement its long-term research, training and communications activities, to best serve the rice scientists, farmers and consumers in the sub-region.

Eugene R. Terry, PhD (Illinois)
Director General

About WARDA

The West Africa Rice Development Association (WARDA) was formed in 1970 with the assistance of the United Nations Development Program (UNDP), the Food and Agriculture Organization of the United Nations (FAO) and the Economic Commission for Africa (ECA). It is a bilingual, inter-governmental organization presently consisting of 16 countries: Benin, Burkina Faso, Chad, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone and Togo. WARDA's mandate is to assist its member countries to become self-sufficient in rice, a staple food of West Africa.

WARDA became a fully fledged member of the Consultative Group on International Agricultural Research (CGIAR) in 1986 and, accordingly, was reorganized in 1987. An important aspect of this task was to design an appropriate organizational structure which would facilitate the operation of the Center's activities. The organizational chart presented here has been approved by the WARDA Board of Trustees and is consistent with the structures described in the Medium-Term Implementation Plan, 1990-94. WARDA differs slightly from other CGIAR centers in that it has a Council of Ministers, composed of the Ministers responsible for agriculture in the member countries. This arrangement is based on the historical circumstances of the creation of the Center.



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Calendar of Events in 1990

January	18-19	Executive Staff Retreat, Yamoussoukro, Côte d'Ivoire
	24-25	*Azolla* Seminar, St Louis, Senegal
February	14	Tenders Committee No. 11
	26-23 March	Training of Agricultural Trainers course, Fendall, Liberia
March	12-14	CGIAR Center Directors' Meeting, Rome, Italy
	12-17	TAC 51 (WARDA 1991 Budget), Rome, Italy
	20	Tenders Committee No. 12
	26-28	In-House Review and meeting of the Board of Trustees' Program Committee, Rokupr, Sierra Leone
	31	Meeting of the Board of Trustees' Nominating Committee, Bouaké, Côte d'Ivoire
	31	Meeting of the Board of Trustees' Executive Committee, Bouaké, Côte d'Ivoire
April	2-3	Meeting of the Board of Trustees, Bouaké, Côte d'Ivoire
	4	20th Anniversary Celebrations and ground-breaking ceremony for the new Main Research Center and Headquarters
May	7-11	Annual Rice Review, Bouaké, Côte d'Ivoire 7-8 Crop and Resource Management Research Working Group 7-8 Training Working Group 9 Plenary session 10-11 Varietal Improvement Research Working Group
	8	Tenders Committee No. 13
	13-16	Agriculture and the Environment Seminar, USA, attended by the Director General
	24	Executive Staff Retreat, Bouaké, Côte d'Ivoire
	29-30	Meeting of the Program Management Committee, Bouaké, Côte d'Ivoire
June	1	Tenders Committee No. 14
	18-21	Visit of TAC Chairman (Dr A. McCalla) and Executive Secretary, CGIAR Secretariat (Dr A. van der Osten)
July	9-5 October	Rice Production and Research training course, Banjul, The Gambia
	10	Quarterly internal audit review
	28	EEC on-farm adaptive research project monitoring tour
	29-13 August	Joint WARDA/IITA mission on inland valley swamp rice production in Ghana
September	4	Meeting of the Program Management Committee, Bouaké, Côte d'Ivoire
	25	Tenders Committee No. 15
	28	Open day at Bouaké, Côte d'Ivoire, for staff of the AfDB Agricultural Department
October	22-27	TAC 53, Washington DC, USA
	22-1 December	Rice Research Assistants training course, Lomé, Togo
	27	Meeting of the Executive Committee and Board of Trustees, Washington DC, USA
	29-2 November	International Centers' Week (ICW), Washington DC, USA
November	27	Tenders Committee No. 16
December	11	Tenders Committee No. 17 and contract between WARDA and contractors signed
	12	M'bé site meeting (consultants and contractors)
	17	Meeting of the Program Management Committee, Bouaké, Côte d'Ivoire

RESEARCH

In 1990 WARDA's Research Division entered the first year of work as set out in the Center's Medium-Term Implementation Plan, 1990-94. A global recruitment exercise that had begun in 1989 was completed by the end of 1990. Fifteen new scientists and senior research support personnel were recruited to staff WARDA's three priority research programs. With the arrival of these new staff, research directions laid out in the medium-term plan started to become operational. Detailed work plans for 1991 were developed. At the same time, major farm development work at WARDA's new Main Research Center and Headquarters in Côte d'Ivoire accelerated to support a rapidly expanding program of field work.

In the Upland/Inland Swamp Continuum Rice Research Program based in Côte d'Ivoire, as well as in the Sahel Irrigated Rice Research Program based in Senegal, WARDA's departing scientists established trials in 1990, with two goals. The first was to maintain the momentum of past scientific progress; the second was to rapidly familiarize the incoming scientists with their new environments. In addition, a major new research project was initiated during 1990 in the Continuum Program. The aim of this project is to locate and characterize the principal rice cropping systems in Côte d'Ivoire. Characterization work in 1990 represented the first stage of a large regional characterization research effort which WARDA is carrying out in collaboration with national and international partners.

In WARDA's Mangrove Swamp Rice Research Program, the emphasis shifted from technology generation to a new thrust in technology transfer. Feedback from on-farm trials and national programs in recent years indicated that WARDA has succeeded in selecting and developing a number of higher yielding and more stable rice varieties which are well adapted to mangrove swamp conditions. It was equally clear, however, that these improved varieties were not getting to the region's farmers; some local adoption had been achieved through on-farm research efforts, but more widespread adoption was needed. Through a special project funded by the United States Agency for International Development (USAID), WARDA began addressing the constraints hampering the transfer of these new technologies. Within the framework of a newly launched regional network, WARDA scientists began assisting national partners to conduct an intensified program of adaptive on-farm trials and to multiply and maintain pure seed of the improved cultivars.

1.1 A NEW TEAM AND NEW CHALLENGES

Peter Matlon

Recruitment of WARDA's New Research Team

In 1988, the Board of Trustees and senior management decided that WARDA could achieve the level of excellence expected of a center within the Consultative Group on International Agricultural Research (CGIAR) system only if its permanent scientific staff won their positions through rigorous international competition. A major step in WARDA's reorganization was thus completed in 1990 when a new team of senior scientists was recruited after a competitive international search.

In early 1989 the positions were advertised in major international journals and in all other CGIAR centers, as well as in over 100 universities and research institutions in West Africa, Asia, Europe and North America. The scientists then employed by WARDA were also invited to apply, in order to ensure that the experience and skills of former team members could be properly evaluated and the best staff retained.

The response was immediate and unexpectedly large. By early 1990 more than 1100 candidates had applied for the 17 available positions. A substantial number of these candidates applied from other CGIAR centers. Some 65 short-listed candidates were interviewed in Bouaké, Paris, Delhi and Washington DC, and offers of employment were made by May 1990.

As a result of this recruitment exercise, WARDA has attracted some of the best rice scientists available worldwide (*see pages 8-9*). However, the recruitment of excellent scientists was not the sole aim of the exercise; the Center made considerable efforts to ensure that the candidates shared WARDA's basic institutional values and research perspectives. Each scientist recruited demonstrated a professional commitment to working in close partnership with scientists in national agricultural research systems (NARS). The new staff also have considerable experience in interdisciplinary teamwork, understand the integral role of on-farm research, and appreciate the value of farmers' participation in the development of new technologies.

Research Challenges

Once the new scientific team had assembled, it began to address the major challenges facing the restructured WARDA. A new rigor, coherence and standard of excellence had to be instilled into WARDA's research activities.

The first major task was to make operational the directions set out in WARDA's Strategic Plan and Medium-Term Implementation Plan. This involved defining priority research activities and developing detailed work plans which fully exploit the talents and experience present in the new team.

The second task was to initiate dynamic and relevant approaches that responded more effectively to the needs of NARS in West Africa; this required early and extensive consultation with national program researchers to develop a new vision and new mechanisms for WARDA/NARS collaboration. WARDA recognized that past collaboration with national researchers had not always been satisfactory and that national programs had not benefited as they had expected.

Resource-poor West African farmers grow rice under low-input production systems

The third task, to be undertaken while the new WARDA scientists were formulating their research activities, was to play a key role in planning and developing WARDA's new research farms and laboratories in Côte d'Ivoire and Senegal.

Setting an Interdisciplinary Research Agenda

Research plans for 1991 were developed through a 'team planning exercise'. The objective of this exercise was to formulate an integrated plan of work that fully exploits the disciplinary mix in each program's team. It was also designed to encourage scientists to view their individual work as part of a team effort aimed at achieving clearly defined goals.

There were three major stages in the planning exercise:

1. Each program team identified and prioritized team projects which would serve as the focal points for planning, implementing and reporting WARDA's research activities. The projects comprise interdependent interdisciplinary research efforts aimed at addressing closely related constraints. Through team workshops, the projects provisionally defined in the medium-term plan to provide a general research orientation were critically re-examined and modified where necessary in order to make them more coherent and to facilitate their implementation. A list of priority projects was produced, accompanied by a justification for each project, a description of its general scope and an identification of scientists responsible for implementing the project.

2. The program teams established how each team member would contribute to meeting project goals. Individual scientists within each project team were given responsibility for one or more tasks, on which they would report progress during project reviews. During this stage the scientists also specified how their activities would involve collaboration with scientists in national programs.

3. The teams drew up detailed protocols or work plans for each project activity. An important aspect of this exercise was to determine how experiments could be combined or modified to serve the needs of several scientists, thereby achieving resource efficiencies and greater interdisciplinarity in implementation and reporting.

The team planning exercise was completed in 1990. There will be changes in the initial plans, some of them fundamental, but these can be made only after experience is gained during the next few years. Nevertheless, the initial exercise has provided a solid point of departure and has created an invaluable sense of team awareness to guide future research activities.

Initiating New Approaches to Working with NARS

West Africa's rice growing environments are highly diverse, and WARDA's resources are too small to meet all their needs. The Center recognizes that it cannot succeed in the development of improved rice technologies without working with and through strong national programs. For this reason, its Strategic Plan identifies the NARS in member states as its principal client group, and the strengthening of their research capacity as one of its primary objectives.

Following extensive consultations with national programs, beginning in 1988, WARDA has developed a new vision to guide its collaboration with NARS. The vision has been set out in a plan of action which outlines the mechanisms for collaboration and the principal collaborative initiatives.

Rice is fast replacing the traditional coarse grains and tuber crops as a major food staple in West Africa

The regional rice research system. The new plan of action is geared towards achieving the most efficient means of generating and transferring improved rice technologies within the region as a whole. WARDA views the regional rice science infrastructure as a single system comprising interdependent components. Because agroecological environments cut across political boundaries, technologies produced by one NARS or in any particular WARDA program location will generally have considerable applicability elsewhere in the region. Under the plan of action, efficient structures and processes will be in place to maximize such research spillover.

As a starting point in planning collaborative research, WARDA is helping national programs to assess their strengths and weaknesses, to determine their most appropriate roles within the regional rice research system and to develop activities that fit these roles. The potential for spillover means that only certain NARS should invest in building the capacity to carry out the full range of activities required for technology generation. Smaller NARS may make better use of their limited resources by becoming efficient spillover recipients through the identification, selection and adaptation of technologies developed by other programs.

The consultative process with NARS. At the Annual Rice Review held in Bouaké, Côte d'Ivoire in April 1989, two permanent Research Working Groups were established, one on Varietal Improvement Research and the other on Crop and Resource Management Research. Each group is composed of national program scientists and WARDA program leaders, and serves as a 'think tank' in assessing and planning regional rice research. The Working Groups are the principal fora in which new approaches to collaboration will be developed.

The basic unit for executing collaborative research efforts within the regional system will be the Task Force. This can be regarded as a mini-network that brings together regional scientists currently working on identical research problems in similar rice growing environments. A Task Force has three objectives: to coordinate research activities, thus eliminating unnecessary duplication and identifying the most complementary forms of cooperation between rice research programs; to ensure that research results flow rapidly and efficiently to other user NARS; and to target technical, material and financial assistance to national programs.

At a meeting of the Varietal Improvement Research Working Group held in Bouaké in May 1990, four Task Forces were constituted on the basis of the principal rice growing ecosystems:

Irrigated rice improvement for the Sahel
Mangrove swamp rice improvement
Upland rice improvement
Rainfed lowland rice improvement

The Crop and Resource Management Research Working Group, which met at the same time, recommended that five Task Forces be established during 1990-91, to focus on the following issues:

Cropping systems in the continuum
Problem soils in the continuum
Integrated pest management
Continuum characterization
Sahel characterization

Damage by birds is a major constraint to rice production in the upland areas of West Africa

The members of each Task Force represent only those countries in which the target ecosystem is directly relevant to rice production and at least one national scientist is actively working on the Task Force theme. Although each Task Force is supervised by a WARDA scientist, its activities are planned and managed through consultation and consensus decision making. The Mangrove Swamp Rice Network was the first Task Force to be established in 1990. Details on its structure and activities are given on pages 14-16.

Mobilization of funds for NARS. Many NARS lack the resources to carry out even rudimentary collaborative activities with international centers. WARDA has a role to play in mobilizing (but not directly providing) additional resources to enable national programs to carry out their core programs. Accordingly, it is now serving as a 'broker' to help NARS attract external funding through the Task Force structure to support collaborative research activities of regional significance. One of the crucial roles of the Task Forces is to identify NARS activities for which external support can be requested, to critically examine national proposals and, where appropriate, to recommend approval. WARDA scientists work with their national colleagues in the Task Forces to develop proposals and funding requests that are not only technically sound but also consistent with an efficient allocation of resources within the regional rice research system.

This initiative should succeed in attracting new funds into the West African rice sector, funds which are essential if more and better research is to be conducted by the national programs. Strong support for the initiative has already been received from several donors, including USAID, the African Development Bank (AfDB) and the European Economic Community (EEC).

Developing WARDA's Research Infrastructure

The third task facing the new scientists in WARDA's Continuum and Sahel Programs is to assist in the planning and development of WARDA's research facilities. Although this has added to their workload considerably, it has also provided them with a unique opportunity to shape their future working environment.

M'bé Research Farm, Côte d'Ivoire. In 1989 WARDA began its first upland rice experiments on an undeveloped tract of land that was to become the site of the new Main Research Center and Headquarters. The site is in the M'bé Valley, about 35 km north of Bouaké in central Côte d'Ivoire. Initially, experimentation was limited to 14 ha. In 1990, however, WARDA received authorization to begin developing the full 700 ha of land generously provided by the Government of Côte d'Ivoire. Under the supervision of the new Farm Manager, the development of the research farm progressed rapidly in 1990. Upland experimental fields were expanded and the first plots for irrigated lowland trials were prepared for cultivation. Access roads, workshops and temporary field laboratories were constructed.

The development of the research farm is based on the innovative concept of creating a research environment reflecting the realities of the West African farmer. This will ensure that technologies developed on the research station will be well adapted to farmers' conditions. Large tracts of experimental areas have been set aside for ongoing management under low-, medium- and high-input levels to suit the needs of specific experiments. Thus it will always be possible to test and select technologies under conditions normally found only 'outside the fence' of most research stations. Other areas are being left under natural vegetation to serve as long-term controls. These areas will permit scientists to gauge the sustainability of new WARDA technologies and to monitor the effect of WARDA's farm development on the natural environment.

Scientists in the Continuum Program have contributed significantly to the development of the research farm. They have also worked closely with WARDA's architectural consultants on final design of the research office and laboratory complex. The requirements of each discipline are now appropriately reflected in the building plans. A detailed account of the construction of this complex is presented on pages 59-61.

Facilities at N'diaye and Fanaye, Senegal. WARDA's new Sahel Program leader and key staff in the program have changed their research locations and initiated a major development and upgrading of research facilities. As late as 1988, the program's activities were inefficiently dispersed at several locations along the Senegal River. Scientists' offices were located in St Louis, the laboratories were located 110 km away at Richard Toll, and the main experimental fields were at Fanaye, 180 km from St Louis.

Following a survey in 1989 of irrigated conditions throughout the Senegal River Valley, WARDA selected an experimental site at N'diaye, 25 km from St Louis, as the location for its major research activities. N'diaye was particularly attractive as it is a primary location for the Société Nationale d'Aménagement et d'Exploitation des Terres du Delta du Fleuve Sénégal et des Vallées du Fleuve Sénégal et de la Falémé (SAED), the national agricultural training and extension parastatal responsible for irrigation development in the Senegal River Valley. An agreement was signed with SAED which established a framework for research and training collaboration and for cohabitation at N'diaye. On the basis of this agreement, WARDA will work closely with SAED in diagnosing farmers' constraints to irrigated rice production, testing technologies on-farm and training rice production specialists. Two buildings provided by SAED have been converted into laboratories and offices for scientists and support staff, and an adjacent block of developed irrigated land has been allocated to WARDA for experimental use.

WARDA facilities at the national station in Fanaye have also been substantially upgraded. The activities here focus on the distinct agroclimatic and soil conditions of the upper valley of the Senegal River, an area that is representative of many inland irrigated areas throughout the Sahel. WARDA scientists are concentrating their crossing and seed multiplication work at N'diaye; physiology research is being conducted at both N'diaye and Fanaye; and the selection of genetic materials for inland irrigated conditions is continuing at Fanaye. The rehabilitated facilities at both locations are now providing WARDA with a more efficient infrastructure, which should lead to rapid progress in its new research initiatives.

Profiles of Personnel who joined WARDA's New Research Team in 1990

Dr Elvis A. Heinrichs is the new Program Leader and Entomologist in WARDA's Continuum Program. An American citizen, he was awarded a PhD degree in entomology in 1967 from Kansas State University, USA. His career has included both academic and international agricultural research. He comes to WARDA from Louisiana State University where he was Professor and Head of the Department of Entomology between 1985 and 1990. Prior to that, he was Head of the Department of Entomology at the International Rice Research Institute (IRRI) in the Philippines for 10 years. Dr Heinrichs' major research area has been applied entomology, with emphasis on host plant resistance and integrated pest management. He has had over 300 research articles published and has edited seven books.

Dr Abdoul Aziz Sy takes up the position of Pathologist in WARDA's Continuum Program. He earned a Doctorat d'Ingénieur from the Université Paul Sabatier in Toulouse, France in 1976, and a Doctorat d'Etat ès Science from the Institut National Polytechnique (INP), Toulouse in 1987. A national of Senegal, Dr Sy returns to West Africa after teaching and conducting research at INP from 1979 to 1990. During this period, he established and directed a team of INP researchers working on biological control of plant diseases, with emphasis on the control of rice blast, an area in which he has published extensively.

Dr Akinwunmi Adesina, a Nigerian citizen, joins WARDA as a Production Economist in the Continuum Program. He earned a PhD degree in 1988 from Purdue University, USA for his analysis of farmer behavior in the adoption of new technologies in Niger. Following his PhD work, he was awarded a prestigious Rockefeller Foundation Social Science Research Fellowship. Prior to joining WARDA, Dr Adesina was based in Mali as Assistant Principal Economist for the West Africa Sorghum Improvement Program of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

Dr Edgar W. Richardson is WARDA's new Biometrician at the Main Research Center in Bouaké. An American citizen, he comes to WARDA from the International Livestock Centre for Africa (ILCA) in Ethiopia, where he held a similar position. Dr Richardson earned a PhD degree from Texas A&M University, USA in 1986 for research on methods of analyzing data derived from drought stress trials. Having worked previously in crops research in Mali, his specialties are in the areas of experimental design, research planning and computer applications. With his extensive experience in data processing and in training researchers in the use of statistics and computers, he will also serve as coordinator of WARDA's computer services.

Mr Thomas Remington joins WARDA as a Cropping Systems Agronomist, to initiate research on rice cropping systems in the Continuum Program. An American citizen, he brings considerable West African experience to WARDA, having worked previously as a Field Trials Officer in Mali, and as a Field Agronomist responsible for establishing animal traction training centers in Togo. Mr Remington's research interests are in ecological characterization, mechanization and research/extension links.

Dr Monty Jones has been appointed as Upland Rice Breeder in the Continuum Program. A Sierra Leone national, he earned a PhD degree in plant biology in 1983 from the University of Birmingham, UK. He comes to WARDA from the International Institute of Tropical Agriculture (IITA), where he served as Rice Breeder and Coordinator for a rice program in Cameroon conducted jointly by IITA, the Institut de Recherches Agronomiques (IRA) and the National Cereals Research and Extension (NCRE) project. Dr Jones had previously worked with WARDA as Head of the Varietal Improvement Program and Senior Research Officer at the Rokupr Rice Research Station, Sierra Leone. During this period he was instrumental in selecting and developing a number of improved rice varieties which have been widely adopted in the mangrove swamp environments of Sierra Leone, Guinea and Guinea-Bissau.

Dr Lawrence Becker joins WARDA as a Geographer, responsible for initiating research on the characterization of the diverse continuum ecosystems in West Africa. An American citizen, he earned a PhD degree from the University of London, UK in 1989 for research on land use patterns and farming systems in a savanna zone of Mali. He has also conducted research on Mali's national rice research system, focusing on the adoption and impact of modern rice varieties. Winner of a Rockefeller Foundation Social Science Research Fellowship, Dr Becker's work at WARDA is being co-sponsored by the Rockefeller Foundation.

Mr Chitti Babu Buyyala has been appointed Farm Manager and Farm Development Officer, responsible for planning and supervising the development and operation of WARDA's new experimental farm at M'bé, Côte d'Ivoire. An Indian national, he brings to WARDA considerable experience in research farm development and management. From 1974 to 1980 he served as an Assistant Engineer at ICRISAT and was involved in the development of its main research center near Hyderabad, India. Mr Buyyala later worked with IITA as Farm Development Engineer at Ibadan, Nigeria. Between 1984 and 1990 he was based in Zaïre, where he was Farm Manager and Development Engineer for a project conducted by IITA and USAID.

Mr Michio Takeda, a Japanese national, is a Post-Harvest Technology Specialist from the Japanese International Cooperation Agency (JICA). After completing his training at Tokyo University in 1953, he occupied a number of positions in Japan's Ministry of Agriculture and Forestry and Ministry of Foreign Affairs. His work with the Food Agency of Japan included conducting food surveys, research on storage and milling systems, and analyses of grain quality. In 1988 Mr Takeda joined WARDA's post-harvest technology unit in Liberia as a JICA expert. Now based at M'bé, Côte d'Ivoire, his task will be to analyze consumer preferences for rice and to establish a grain quality analysis laboratory at WARDA's Main Research Center.

Dr Kouamé Miézan, an Ivorian national, has been appointed as the new Program Leader and Rice Breeder in the Sahel Program. After earning a PhD degree in genetics and plant breeding from Kansas State University, USA in 1978, he worked with the genetics laboratory of the Institut Français de Recherche Scientifique pour le Développement en Coopération (ORSTOM) in Côte d'Ivoire. During this period he was involved in several rice collection missions throughout Africa. In 1983 he joined WARDA as Leader of its Upland Rice Project near Bouaké, Côte d'Ivoire, a position which he held until he took up his new responsibilities in the Sahel Program. Dr Miézan's research specialty is in quantitative genetics, with particular emphasis on the characterization and utilization of *Oryza glaberrima* to improve the stability of improved rice cultivars.

Dr Michael Dingkuhn, a German national, has become the first Physiologist in WARDA's Sahel Program. He conducted research for both his masters and doctoral degrees in IRRI's Agronomy Department, and was awarded a PhD degree from the University of Hamburg, Germany in 1985 for research on the effects of varietal water stress on water use efficiency and photosynthesis. He remained at IRRI as a Collaborative Research Scientist until 1990. Dr Dingkuhn will carry out research on the mechanisms governing tolerance of the rice plant to the harsh climatic and edaphic stresses characteristic of Sahelian environment, and will participate in efforts to develop more stable improved cultivars. He will also utilize plant growth modeling techniques to assist in the characterization of the diverse rice growing ecosystems of the Sahel.

Dr Martin Agyen-Sampong has been appointed Network Coordinator of WARDA's Mangrove Program. A Ghanaian national, he earned a PhD degree in agricultural entomology from the University of Edinburgh, UK in 1971. He has served WARDA since 1976, first as Entomologist and then as Leader of the Mangrove Program based at Rokupr, Sierra Leone. Under his leadership, considerable progress was made in the development of high yielding rice varieties adapted to the mangrove swamp environment. His task as Network Coordinator is to establish and 'animate' the Task Force with responsibility for mangrove swamp rice improvement.

1.2 TRANSFERRING IMPROVED RICE VARIETIES TO NATIONAL PROGRAMS AND FARMERS IN THE MANGROVE SWAMP ENVIRONMENT

Martin Agyen-Sampong

WARDA has made considerable progress in developing higher yielding and more stable rice varieties which are adapted to the unique stresses of the mangrove swamp environment. However, the transfer of these varieties to national programs, their subsequent multiplication and their ultimate adoption have remained limited. WARDA's new program thrust in this environment will seek to minimize the constraints to rapid technology transfer.

With funding from USAID, WARDA set up a Mangrove Swamp Rice Network to work with national program scientists. The network has two primary objectives: to provide national rice research programs with more direct access to existing new varieties; and to strengthen the capacity of national institutions to build on progress already made by WARDA in mangrove swamp rice research.

The Mangrove Swamp Environment

The mangrove swamps of West Africa represent a challenging environment for rice cultivation. Most varieties developed for upland, inland swamp or irrigated conditions are poorly suited to the mangrove swamp areas. To meet the needs of rice farmers in these areas, varieties and cultivation practices must be developed under mangrove swamp conditions.

Boats are the main means of transport to and from rice fields for many small farmers in the mangrove swamp environment

Mangrove swamp rice fields are located near the coast and are saline for much of the year. During the rainy season, however, they experience a salt-free period when freshwater floods wash the land and displace tidal flows. Because of the silt deposited during the annual flooding, soils are generally more fertile than in other environments but they are also characterized by high salinity and sulphate acidity. Lower rainfall during the past two decades in much of West Africa has substantially reduced seasonal flushing, further accentuating both problems. As the soils dry out, pH levels may fall as low as 2.5 during very dry seasons.

Rice plots in mangrove swamps are often some distance from villages, and farmers tend to cultivate additional plots in adjacent inland swamps and upland areas. As a result, labor input in the mangrove swamp plots is generally limited and the areas cultivated are smaller than in the other major rice growing environments of West Africa. Furthermore, rice cultivation in mangrove swamps is highly labor intensive, particularly at the beginning of the season when salt-tolerant silt grass must be cleared from the fields and incorporated into the soil.

Rice is currently cultivated on 214 000 ha of the approximately 1.2 million ha of mangrove swamps in West Africa. The major producing countries are The Gambia, Guinea, Guinea-Bissau, Nigeria, Senegal and Sierra Leone (*see Table 1*). Current yields are about 1.8 t ha^{-1}. A well-focused applied and adaptive research program, combined with efficient technology transfer, could increase sustainable yield to 2.2 t ha^{-1} in the 1990s. If the area under cultivation remains stable, this would represent an additional annual output averaging about 77 000 t, with a value of US$ 14 million at current world prices.

TABLE 1
Distribution of mangrove swamp rice area and production in West Africa

Country	Mangrove area under cultivation (ha)	% of national rice area	% of national rice production
Guinea-Bissau	90 000	80	80
Guinea	64 000	12	18
Sierra Leone	35 000	6	12
The Gambia	10 000	52	54
Senegal	10 000	20	16
Nigeria	5 000	0.7	0.9

Research Achievements

Since 1977, USAID has funded WARDA's research activities at the Rokupr Rice Research Station in Sierra Leone. Significant progress has been made in the development and transfer of improved cultivars which have been tested on-farm with small farmers in Guinea, Guinea-Bissau and Sierra Leone. Over 5000 introduced varieties have been screened for adaptation to the mangrove swamp environment and nearly 800 local varieties have been collected, purified and characterized. The breeding work has concentrated on developing varieties with varying times-to-maturity which are adapted to the full range of salt-free periods. Emphasis has also been placed on developing plants with medium height (90-130 cm), to minimize silting problems and the damage caused by flooding, and with relatively stiff straw, to reduce lodging under high fertility conditions.

WARDA breeders have identified sources of tolerance/resistance to many of the biotic and abiotic stresses in this environment, such as salinity, iron toxicity, sulphate acidity, blast, brown spot, stem-borers and crabs. These lines have been widely used in the breeding program. Three of WARDA's most promising varieties, WAR 1, ROHYB 4-1-3-B-2 and WAR-81-2-1-2, are believed to have acceptable tolerance to the full range of stresses. The breeders have also identified local and improved varieties with good ratooning ability. This trait enables farmers in areas with relatively long salt-free periods to grow a second rice crop without the additional costs of preparing the land, raising seedlings and transplanting.

Iron toxicity can severely reduce lowland and irrigated rice yields, and thus WARDA is placing major emphasis on developing varieties with tolerance to high levels of toxicity

Initial feedback from national programs on several varieties developed or identified by WARDA suggests that there has been some local adoption. These varieties include WAR 1, for planting in areas with salt-free periods of 125-150 days, and ROHYB 6 and Kuatik Kundur, which are well adapted to growing periods of 150-180 days. There has been less progress in developing varieties for growing periods of 180-200 days.

Over 150 crosses have been made to incorporate additional traits into improved varieties. Several multiple crosses have increased the genetic variability in breeding populations. Backcrosses have also been made to improve particular characteristics, such as blast resistance in some recommended varieties and promising lines. A modified rapid generation advance technique has been used to speed up generation advancement. Progeny of the most recent crosses made by WARDA are now in the F_5 generation and require two additional seasons before new improved fixed varieties can be developed and released.

Collaboration with National Programs

Brief descriptions of the collaborative activities undertaken with national programs in The Gambia, Guinea, Guinea-Bissau, Nigeria, Senegal and Sierra Leone are given here.

The Gambia

Since 1981, WARDA has collaborated with Gambian scientists in conducting varietal trials in about 15 locations each year. There has also been collaboration in training field technicians and conducting socioeconomic surveys and rice pest and disease surveys.

Guinea

In 1981-82, WARDA assisted the Ministry of Agriculture in initiating a program designed to strengthen rice research and increase production in the mangrove swamps. Problems were identified, joint activities planned and resources shared. In 1986, WARDA and the Ministry conducted 30 joint trials of promising varieties, with fertilizer use, in 12 locations to test local adaptation. As a result of this work, WAR 1, Kuatik Kundur, ROHYB 6, Kuda Hirang and Raden Mas have been widely adopted in the Sonfonia and Coyah regions of the country. Guinea's national rice program has tested a WARDA-developed nitrogen injection system and has conducted surveys of pests, weeds and diseases. In the 1989-90 season, WARDA provided new technologies and training to four internationally supported rural development programs in the country.

Guinea-Bissau

Collaboration between WARDA and Guinea-Bissau began in 1980 with a joint project to breed salt-tolerant and early maturing varieties. Over 400 WARDA varieties and advanced lines have been tested in collaborative national trials, leading to the release of varieties such as WAR 1, ROHYB 6, WAR-6-2-B-2 and ROK 5. For these and other released varieties, WARDA has regularly supplied foundation seed for in-country multiplication. In 1988 and 1989, promising varieties verified in previous collaborative trials were tested at the Caboxanque Research Station. Testing of a synthetic pheromone developed by WARDA entomologists for monitoring *Maliarpha separatella* moth populations has continued for several years in Guinea-Bissau as part of a regional program. There has also been collaboration in conducting pest and disease surveys and in training in integrated pest management.

Nigeria

WARDA has worked closely with Nigeria's National Cereals Research Institute (NCRI), providing varieties for tests and participating in joint pest and disease surveys.

Senegal

Since 1983 Senegalese scientists at the Djibelor Research Station in southern Senegal have been working with WARDA to screen early generation materials sent from Rokupr. Further testing of WARDA varieties has continued through advanced variety trials and trials for salt tolerance.

Sierra Leone

The WARDA-Rokupr station has cooperated with a number of research and training institutions, especially the national Rice Research Station (RRS) at Rokupr, as well as with development agencies and projects carrying out on-farm demonstrations of WARDA technology packages. Collaboration is implemented through joint planning and review of research activities. WARDA and the RRS also cooperate in exchanging and testing promising rice varieties. When WARDA's program in Rokupr started in 1977, a number of F_2 materials and fixed lines such as ROK 5 and ADNY 301 were received from the RRS. Advanced lines from WARDA, such as ROHYB 6, WAR 1 and WAR 77-3-2-2, are now being used in the RRS breeding program. WARDA and the RRS have also worked closely on a collaborative breeding program to develop improved varieties which are tolerant to rice yellow mottle virus.

Adoption of Improved Rice Varieties

Since the mid-1980s, WARDA has multiplied and purified seeds of recommended varieties, promising varieties and breeder materials for distribution on request to national research stations and extension agencies. In on-farm trials conducted at several locations in The Gambia, Guinea, Guinea-Bissau and Sierra Leone, the new short- and medium-duration varieties have outyielded farmers' best traditional varieties fairly consistently by a margin of 25-30%.

However, very little information is available on adoption patterns, and what is available tends to be highly localized. Surveys show that WARDA's on-farm research activities have contributed to the localized adoption of ROK 5, especially in salt-limiting swamps in The Gambia, north-west Guinea and Guinea-Bissau. In one area of Guinea-Bissau, for example, it is estimated that over 80% of farmers grow ROK 5 on at least part of their cultivated land. This variety is also widely grown in associated swamps of southern Senegal. The WARDA-bred variety WAR 1, recently released in Sierra Leone, is a promising replacement for ROK 5 in short-season environments. Other released varieties showing considerable adoption potential are CP 4, ROK 10, Kuatik Kundur and ROHYB 6-WAR-6-2-B-2.

The major constraints to wider adoption of such materials appear to be weak or non-existent seed multiplication services, poor seed handling capacity in research and development agencies, and inadequate agricultural extension services.

The Mangrove Swamp Rice Network

A primary objective of the WARDA Mangrove Swamp Rice Network is to develop new approaches to overcome the constraints to adoption. Such approaches must take account of the variation between NARS in terms of human, infrastructural and financial resources and of the fact that no single NARS is currently strong enough to assume the research leadership currently provided by WARDA. However, by working together within the framework of a coordinated network and sharing responsibilities according to their different comparative advantages, the NARS can exploit past gains and maintain the momentum created by WARDA's research achievements. An assessment of national comparative advantages must include:

- an evaluation of the agroecological zones in which mangrove swamp rice research is being conducted, as defined by rainfall, soils and salt-free periods;
- an appraisal of the quantity and quality of resources currently committed to mangrove swamp rice research and the resources likely to be committed in the future;
- identification of the relative disciplinary strengths of each NARS.

The network began its work by conducting a series of 1-week in-country assessments, led by WARDA's Network Coordinator. The objective of the assessments was to learn from national scientists and research and development policy makers their medium- and long-term plans, to assess national capacities and to reach agreement on the role each NARS would play in the network during 1990-92 and beyond. At a workshop of network members scheduled to be held in early 1991, the various national plans will be integrated into a common plan of action and a Steering Committee composed of national program scientists and the WARDA Network Coordinator will be constituted.

On the basis of the plan of action, national programs which are strong enough to take the lead in certain areas of applied research will be identified. It is proposed, for example, that the lead role in hybridization, be assigned to the RRS in Sierra Leone, and lead roles in soils analysis be assigned to the Institut Sénégalais de Recherches Agricoles (ISRA), the NCRI in Nigeria and the RRS. Other national programs will collaborate mainly in adaptive research in their representative ecosystems. Programs with inadequate resources will be involved mainly in testing and transfer activities.

Research Thrusts of the Network

The Mangrove Swamp Rice Network is coordinating work in a number of closely related priority areas.

- *Ecosystem characterization.* A characterization of rice growing conditions in the mangrove swamp ecosystems of West Africa has been initiated. This study will describe the nature, location and extent of distinct mangrove ecosystems which can serve as separate recommendation domains to guide future varietal improvements and extension efforts.
- *Adoption study.* A study initiated in 1990 aims to measure the adoption of improved mangrove swamp rice varieties in Sierra Leone and Guinea and to identify the factors determining adoption or rejection by smallholder farmers. It will also evaluate yield effects of new varieties in order to assess the impact of past varietal improvement research.
- *Development of fixed lines.* The remaining segregating progeny of past crosses made by WARDA are being advanced to develop fixed lines selected for high yield and good adaptation to the stresses in the mangrove environment. Sets of F_4 and F_5 materials are being distributed to the stronger national programs for *in situ* selection.
- *Multilocational trials.* Regional multilocational trials of the most promising fixed lines and varieties are being conducted to identify those best adapted to the various mangrove ecosystems.
- *Seed multiplication.* The best-adapted of these materials will be purified and multiplied. Initially, this work will be conducted at WARDA and later at national program locations.
- *On-farm trials.* Network members are conducting coordinated on-farm trials to verify farm-level performance and to provide the necessary impetus to extension efforts.

Support to Network Members

Technical and financial support. Exchange of breeding materials, multilocational trials and on-farm tests are designed and managed by the network members, with WARDA providing technical backstopping and mobilizing the necessary financial support through the Task Force mechanism described earlier. Monitoring tours and planning and evaluation workshops are being held to ensure that individual country needs are met and that results are fully discussed and widely disseminated.

At WARDA's request, USAID has generously provided funds to support research activities undertaken by national programs to meet network objectives. The funds are being used to cover the incremental costs of trials that are additional to the program activities normally funded through national budget allocations, as well as to permit modest upgrading of infrastructures and to purchase the equipment required to participate

effectively in network tasks. Proposals for funding put forward by national programs will be reviewed and approved by the Steering Committee.

Information dissemination. National programs in the network also benefit from the selective dissemination of information (SDI) program launched by WARDA in 1990. Through this program, profiles of national scientists have been developed indicating their disciplinary specialties, as well as current and prospective research foci. On the basis of these data, WARDA carries out periodic computer literature searches to identify and disseminate relevant information. This service also helps fill major gaps in the document collections of national programs.

Training initiatives. To promote effective collaboration in rice research activities in the region, the skills of national program staff must be upgraded. Training needs have been assessed on a country-by-country basis and training activities tailored to suit particular national requirements. Immediate priority is being given to developing skills in techniques of seed multiplication and production of pure lines and in the design and operation of on-station and on-farm trials.

The network is coordinating an expanded training program for the individual training of researchers and for the group training of field and laboratory assistants and technicians. Three types of advanced individual training are being offered:

- *Research Scholars.* WARDA is providing research fellowships for outstanding African students pursuing PhD degrees in agriculture. Two scholars are currently being supported: a Liberian student from the University of Wisconsin, USA, who conducted field research in 1990 on the adoption of improved rice varieties in Sierra Leone and Guinea; and a Senegalese student at the Agricultural University of Wageningen, The Netherlands, who is characterizing the soils and soil-related stresses in representative mangrove swamp areas of the region.

- *Post-Doctoral Scientists.* A young Ivorian scientist who recently completed his doctoral program at Kansas State University, USA has joined the WARDA team in Rokupr for a 2-year training period. He is responsible for managing seed handling, multiplication and distribution.

- *Visiting Scientists.* WARDA has launched a visiting scientist program for national researchers as a means of reinforcing skills, focusing attention on specific problems and forging links to facilitate future cooperation. National scientists will spend varying periods at Rokupr to gain experience in areas which are weak in their national programs. Eight such positions per year are envisaged, beginning in 1991.

Group training workshops and courses are being held at Rokupr and at national program locations. One workshop/course will be offered each year on: mangrove rice production; seed multiplication; research methods; and on-farm trials.

Benefits of the Network

As indicated earlier, the ultimate objective of the Mangrove Swamp Rice Network is to transfer improved technologies to national programs and farmers and to strengthen the capacity of national programs to undertake mangrove swamp rice research. WARDA is confident that the new thrusts initiated in 1990 will lead to significant growth in rice production and substantially enhance the abilitity of national institutions to build on the progress already made in mangrove swamp rice research.

1.3 CHARACTERIZATION OF RICE GROWING AGROECOSYSTEMS IN COTE D'IVOIRE

Lawrence Becker

Research to characterize rice growing agroecosystems in Côte d'Ivoire was initiated in 1990 as part of a larger, regional project. The study involves collecting data on rice production systems and on factors affecting production in order to map the major agroecosystems in which rice is grown. It will also include an analysis of the objectives of rice farmers, the distribution of rice intercrops, important vertebrate pests, weed species, fertilizer use and pesticide use.

Using a rapid rural appraisal approach, a WARDA agronomist and geographer interviewed about 200 extension agents and farmers in each of Côte d'Ivoire's 50 departments. In over 150 locations where field observations were made they also met rice processors, wholesalers and retailers. Based on these data, WARDA has produced an updated preliminary map depicting the land area covered by cultivated upland and lowland rice, the relative importance of local and improved rice varieties in different areas, and the most common varieties currently grown.

The results of the study will be used to select sites for more in-depth characterization and technology testing. The study may also serve as a model for NARS in other WARDA member countries interested in conducting a similar exercise.

Characterization: Definition and Objectives

Agroecological *characterization* is the identification of the key biophysical and socioeconomic factors which influence crop growth and production. The focus of characterization is thus on defining the crop environment. In order to address specific constraints and problems, patterns or types of crop environments can then be categorized. This step is termed agroecological *classification*.

Crop environments can be characterized on different scales. They can encompass large geographical zones on a continental scale with many factors affecting the crop, or they can be analyzed in detail with the focus on a few variables within a small study area. Scientists at IRRI, where considerable work on rice agroecological characterization has been done, distinguish between the objectives of characterization studies according to these different scales. Large-area studies can contribute to identifying research priorities and selecting sites for more detailed studies. Smaller-area studies can be used to provide inventories of natural resources, interpret data from multilocational trials, recommend areas for crop introduction, and predict the impact of new technology.

WARDA recognizes four broad rice environments in West Africa: the irrigated Sahel, the coastal mangrove swamp, the deepwater floodplains of inland rivers and lakes, and the upland/inland swamp continuum. Water availability and soils vary throughout these environments; this variability, as well as numerous other factors such as unequal access to land and labor, results in different types of rice cropping systems. Each system, distinguished by its particular ecological, social, political and economic context, can be called a rice-based agroecosystem.

The upland/inland swamp continuum was selected as the focus of WARDA's characterization research because of its importance in terms of area, production and number of farmers. Characterization research started in 1988 with a detailed study of the M'bé Valley in Côte d'Ivoire, the location of WARDA's Main Research Center. The present study is much broader, extending to other rice growing areas of the country.

Methodology

Useful studies of agroecological factors and rice geography in Côte d'Ivoire have already been carried out by the Institut des Savanes (IDESSA), as well as by the Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières (IRAT) and the Institut Français de Recherche Scientifique pour le Développement en Coopération (ORSTOM). These studies covered the distribution of rice varieties, and included case studies on soils and climate.

The WARDA study began with a literature review, which revealed knowledge gaps in some key areas and determined the objectives of the study. These objectives are:

- to update the information on rice production and varietal distribution;
- to obtain a preliminary indication of the major constraints to rice growing and production;
- to identify the cropping systems in which rice is a vital component.

In planning the study, WARDA scientists benefited from the experience of the Agroecological Studies Unit of the Centro Internacional de Agricultura Tropical (CIAT) in characterizing and classifying agroecological regions. The CIAT team had sought to compile a comprehensive database for rice researchers on rice farming methods and the location of rice production in Latin America, correlated with soil types and climatic regimes. Rather than using theoretical crop growth parameters to determine 'possible' rice environments, they first identified the existing distribution of rice production and then tried to develop a system to explain this distribution.

The WARDA study followed a similar procedure. To establish a database, WARDA scientists first made an approximation of the rice farming area in Côte d'Ivoire, based on information obtained from national agricultural extension services and during interviews with national agricultural officials. Primary data on rice cropping systems were derived from interviews with regional agricultural officials and farmers, and from the observations of researchers during site visits. These data were compiled and then sent back to rice workers in each region for confirmation. With this complementary input, a second approximation will be made.

To characterize rice growing agroecosystems on a national level, a list of key factors affecting rice production was prepared from the literature review. These factors were incorporated into a questionnaire, which was pre-tested with extension agents and other agricultural system workers (*see Table 2*). The agronomist and geographer then conducted 88 interviews with regional site officials, each interview lasting 1-2 hours. To obtain a rough idea of the regional distribution of rice production, they presented the officials with a map of the region and asked them to mark it with color pens indicating major, intermediate and minor rice producing areas and villages.

TABLE 2
Factors investigated during interviews in the agroecosystem characterization study, Côte d'Ivoire

Indigenous and immigrant ethnic groups
Ethnic groups of rice growers*
Main crops by ethnic group
    Food crops; cash crops
Area of rice under an extension program (CIDV,CIDT, SATMACI)*, **
Valleys
    Area developed with water control
Rice varieties*
    Names; relative importance
Primary objective of rice farming*
    Food or cash
Rice calendar*
    Sowing and harvesting dates; number of annual rice crops
Planting methods*
    Broadcast; dibbling; mechanical sower; transplanting
Harvesting methods*
    Small knife; sickle; mechanical harvester
Crops planted with rice in the same field at the same time*
Crop rotations involving rice
Number of successive years that rice can be grown in the same plot
Land rent for non-indigenous peoples
Labor
    Tasks by gender; presence of wage or labor exchange groups; wage rates for rice workers
Presence of ox-drawn plowing in rice fields*
Range of paddy prices
Fertilizer use*
Important weed species*
    Weeding practices
Important bird pests*
Important insect pests*
    Insecticide use*
Important mammal pests*
    Measures taken to combat pests

* Distinction was made between upland and valley rice
** Compagnie Ivoirienne pour le Développement des Productions Vivrières; Compagnie Ivoirienne pour le Développement des Textiles; Société d'Assistance Technique pour la Modernisation Agricole en Côte d'Ivoire

WARDA's geographer interviewing a rice farmer at Bangolo, Côte d'Ivoire, during the agroecosystem characterization study

These interviews were complemented by visits to 189 villages, valleys, irrigation works, agricultural projects and fields. At each location, the survey team identified rice varieties, weeds, bird pests and the plants occupying the ecological niches suitable for rice. Farmers described their rice growing practices, farming objectives, crop rotations, labor allocation and major problems. The interviews with farmers were conducted in French or Dioula. In towns with rice processing facilities, the team visited hulling and parboiling industries to examine the varieties of rice being processed and determine the source of supply.

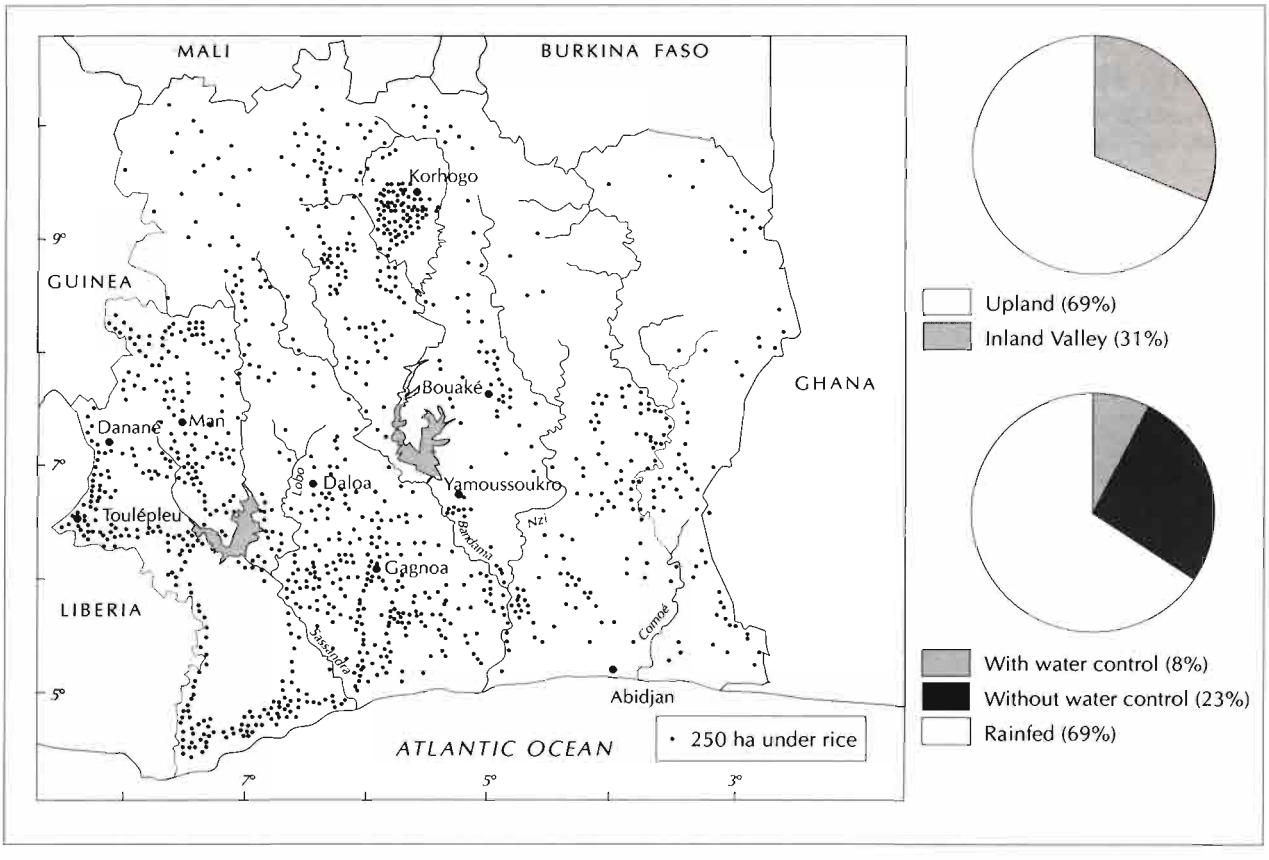
The data collected during the field trips have been put on a database linked to a geographic information system (GIS), which enables WARDA to produce maps with overlays of the various factors affecting rice growing agroecosystems. The data will then be manipulated in order to identify the key factors in a particular region or ecosystem. This will allow researchers to determine where, for example, the presence of certain weed or bird species may be major yield loss factors. The key factors are also being used to classify rice growing agroecosystems. The initial characterization and classification will be completed in 1991.

Preliminary Results

As the data collection for the first approximation will not be completed until March 1991, only preliminary findings are reported here. These include the total rice area cultivated in 1990, the proportion of cultivated area by landscape position (upland or lowland) and proportion of that area by the source of water (irrigated, swamp or rainfed). Information on the regional proportion of traditional and modern rice varieties in different production systems is also presented.

The total area of rice cultivated in Côte d'Ivoire during 1990 is estimated at 321 530 ha. That this figure is lower than the 1980-84 average of 368 000 ha is attributable mainly to the poor rainfall conditions in 1990. As shown in Map 1, rice is grown throughout the country, although production is more concentrated in some areas (such as the region west of the Bandama River in the south, and the densely populated area around Korhogo in the north) than in others. It also appears to be developing in the east, especially near the Comoé River. About 69% of the area under rice is upland and 31% inland valley or lowland (23% without water control and 8% with water control).

MAP 1
Distribution of rice areas cultivated under upland and inland valley swamp conditions (with and without water control) in Côte d'Ivoire, 1990



Upland rice is concentrated mainly in the higher rainfall, traditional rice growing areas in the south-west and west. The Korhogo Department in the north also accounts for a significant proportion of the upland rice area (8.2%), although it represents only 3.8% of the country's total land area; the widespread cultivation of upland rice in this area can be attributed mainly to the extension activities for rice production undertaken by the Compagnie Ivoirienne pour le Développement des Textiles (CIDT), the national cotton company.

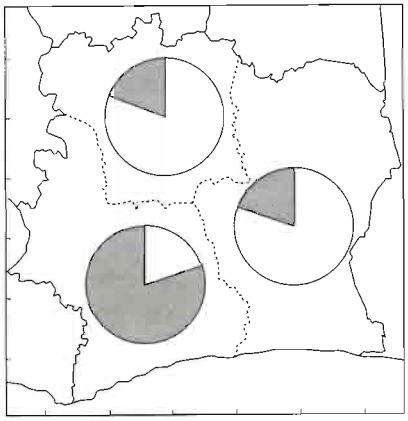
Inland valley rice with no water control is more evenly distributed throughout the country. In the forest zone in the east and west, it is grown mainly by immigrant farmers, while in the north it is grown by Malinké and Sénoufo women. Inland valleys with water control are defined by the presence of some form of bunding or control system that retains valley water. In the valleys in and around each of the urban centers of Bouaké, Daloa, Gagnoa, Korhogo and Yamoussoukro, farmers grow over 1000 ha of irrigated rice. In the west, between Danané and Toulépleu, the construction of many small waterworks in the 1970s by the former state rice development organization, Société de Développement du Riz (SODERIZ), coupled with farmers' own bunding, increased the irrigated rice area to 3000 ha in 1990.

A characteristic feature of rice production in Côte d'Ivoire is its tremendous diversity. Both upland and lowland rice, as well as irrigated, flooded swamp, strictly rainfed and groundwater-assisted conditions, are all important. The rice varieties grown include a rich mixture of traditional and modern varieties, a few widespread but most localized. Rice farmers come from a wide variety of backgrounds, and this tends to influence farming practices. Many of them are immigrants from Burkina Faso, Guinea and Mali; others are Ivorians who have migrated in search of employment. Indigenous people in the south-west and west are especially important rice producers, growing rice on their ancestral lands.

The survey revealed that the adoption of modern varieties varies both by region and, particularly, by ecosystem (*see Map 2a*). Table 3 lists some of the modern and traditional rice varieties grown in the different regions of the country. In all regions, Iguapé Cateto and Morobérékan are the most common

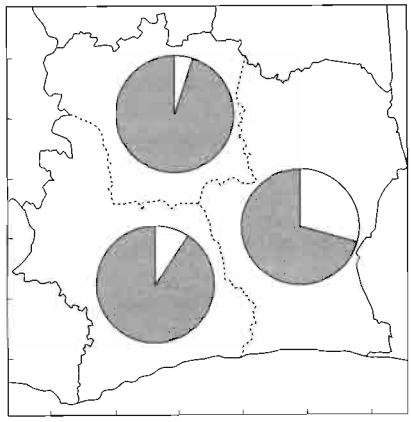
TABLE 3
Some modern and traditional rice varieties in Côte d'Ivoire, 1990

Upland varieties	Regional distribution	Lowland varieties	Regional distribution
Modern varieties:		*Modern varieties:*	
Iguapé Cateto	widespread and common	Bouaké 189	widespread, very common
Morobérékan	widespread, common in north-west	IR 5	widespread
IAC (164, 165)	widespread but not common	Jaya	sparse
IRAT (136, 144)	widespread but not common		
Dourado	sparse	*Traditional varieties:*	
Traditional varieties:		Fossa	widespread, locally common in east
Azi	south-west	Guissi	west
Aziko	south-west	Zoh	west
Non non non	south-west	Djoukemin	north-west
Zonwlin-Kroumy	south-west	Mereké	north-west
Clémencié	west	Bintoubala	north, central
Kouiklonlé	west	Gambiaka	north, central
Mandeba	west	Laviara	north
Pantigbé	west	IM 16	north-east



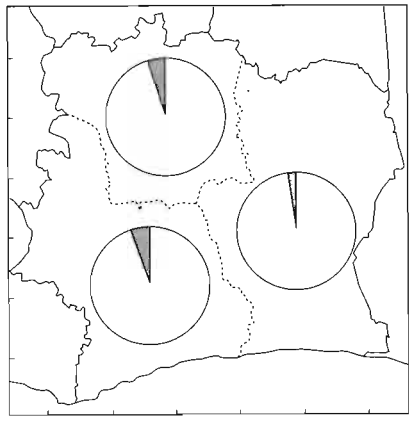
Traditional varieties
Modern varieties

MAP 2a
The proportion of upland areas sown to traditional and modern rice varieties in the south-west, north-west and east of Côte d'Ivoire, 1990



Traditional varieties
Modern varieties

MAP 2b
The proportion of inland valley areas (with no water control) sown to traditional and modern rice varieties in the south-west, north-west and east of Côte d'Ivoire, 1990



Traditional varieties
Modern varieties

MAP 2c
The proportion of inland valley areas (with water control) sown to traditional and modern rice varieties in the south-west, north-west and east of Côte d'Ivoire, 1990

and widespread modern upland rice varieties. Other modern upland varieties distributed by the extension services but cultivated by relatively few farmers include IRAT 136, IRAT 144, IAC 164, IAC 165, IDSA 6 and IDSA 10.

As indicated in Map 2b, traditional varieties dominate inland valleys where there is no water control. Their hardiness and greater stability accounts for their continued popularity in valleys where hydrological conditions vary widely in both space and time. The most common modern varieties in these valleys are either those recommended for irrigated conditions, especially Bouaké 189, or rainfed varieties, notably Iguapé Cateto and Morobérékan. The use of varieties originally recommended for other ecosystems suggests that appropriate varieties for inland valleys without water control are not yet available to farmers.

In contrast, modern varieties are now grown in over 90% of the inland valleys with water control (*see Map 2c*). This dominance can be attributed to the development of irrigated rice farming by SODERIZ in Côte d'Ivoire during the 1960s and 1970s. Modern varieties became established where farmers adopted new irrigated rice technologies. The most common irrigated variety is Bouaké 189, followed by IR 5 and Jaya.

Institutional Collaboration

The current work was planned jointly by WARDA, IITA, the Winand Staring Centre (WSC) of The Netherlands, and the Agricultural University of Wageningen, The Netherlands. While WARDA began work on

characterizing the rice-based agroecosystems in Côte d'Ivoire, IITA started compiling data for a large-area study of inland valleys in West and Central Africa, based on climate, soils and economic factors. From the large-area study, sites and methods for more detailed site characterization studies will be selected.

This initial study of Côte d'Ivoire represents a first step in WARDA's characterization studies and will be adapted to other circumstances and modified in the years ahead. The approach adopted in this study is now being considered by researchers from national rice research programs for use in other parts of West Africa. WARDA will help national programs carry out similar characterization projects.

SUMMARIES OF RESEARCH ACTIVITIES

Continuum Program

PROJECT 1

DEVELOPMENT OF IMPROVED AND SUSTAINABLE SOIL FERTILITY MANAGEMENT PRACTICES

Soil Nutrient Deficiency Studies

Many soils in Africa are deficient in nitrogen and phosphorus. In 1989 WARDA initiated a 3-year study to determine the level of mineral reserves in the soils of the ecological zones in Côte d'Ivoire.

These trials were continued in 1990 in the upland and hydromorphic ecosystems in M'bé Valley. The Chaminade method, whereby complete fertilizer (CF) is compared to the same treatment minus the element to be measured, was used to determine soil reserves of nitrogen, phosphorus, potassium, calcium, magnesium and zinc. In 1990 there was an extended drought during rice grain formation, resulting in total crop failure in the upland sites and low yields in the hydromorphic site. As reflected in vegetative growth, only the nitrogen treatments showed symptoms of deficiency in both the upland and hydromorphic sites. There were no apparent phosphorus, potassium, calcium or magnesium deficiencies after 2 years.

The trials will continue in 1991. There is a need for future studies to determine at what point soil phosphorus and potassium reserves begin to decrease.

Effect of Three Sources of Phosphorus on Upland Rice Yields

There are a number of rock phosphate deposits in West Africa with a high phosphorus content. The deposits offer a more affordable alternative for African farmers than imported chemical fertilizers, but the most efficient sources and doses need to be determined.

At Man in the western forest zone of Côte d'Ivoire, three sources of phosphorus — tricalcium phosphate (34% P_2O_5), aluminium phosphate (34% P_2O_5) and simple superphosphate (18% P_2O_5) — were tested at the rates of 0, 15, 30, 60, 75, 90 and 105 kg ha^{-1} on two medium duration varieties, IDS 6 (an improved variety) and Wabzi (a traditional variety). The experimental design was a split plot with four replications and fertilizers in the main plot and varieties in the sub-plot. Residual effect was measured in 1990 after 2 years (1988-89) of phosphorus application.

As in 1988 and 1989, the 1990 results showed no significant difference between the phosphorus application rates. There was no residual effect of phosphorus on rice yield. Use of ^{32}P indicated that the phosphate absorption capacity of the soil is so high that even 2 years of phosphorus application are not sufficient to increase the available phosphorus content. There was no difference between the three sources in their effect on soil phosphorus status. Phosphorus absorption by the soil was measured using KH_2P0_4 as the phosphorus source.

Table 4 indicates that when high levels of KH_2P0_4 (30 and 50 ppm) are added to soil, the greater part is absorbed and very little remains in the soil solution after 24 hours of equilibration.

TABLE 4
Measurement of phosphorus absorption by the soil using KH_2PO_4 and labeled ^{32}P, M'bé Valley, Côte d'Ivoire, 1990

		C mg P l^{-1}	r/R	n	E_1 mg P kg^{-1} of soil
Control without fertilizers		0.005	0.04	0.46	1.21
KH_2PO_4 30 ppm	30 mn	0.1	0.14	0.35	7.5
	24 hrs	0.031	0.08	0.32	3.8
KH_2PO_4 50 ppm	30 mn	0.21	0.21	0.36	13.4
	24 hrs	0.042	0.1	0.36	4.0

C = soil phosphorus concentration
r/R = ratio between remaining radio-activity (r) in soil solution and initial radio-activity (R)
n = soil characteristic constant (varies from 0.5 to 0)
E_1 = available phosphorus in soil solution

Research on phosphorus management in acid upland acid soils will be continued by exploring the use of organic matter, such as animal manure, compost or straw, to increase phosphorus availability.

Effect of Chemical Fertilizers on Upland Rice Yields

In 1989 and 1990 studies were conducted to determine the effect of chemical fertilizers on upland rice yields in M'bé Valley. The results obtained in 1989 showed that nitrogen was the most limiting factor, with significant linear grain yield responses to higher nitrogen doses.

In 1990 three doses each of nitrogen (0, 40 and 80 kg ha^{-1}), phosphorus (0, 45 and 90 kg ha^{-1}) and potassium (0, 40 and 80 kg ha^{-1}) were applied to a short duration upland variety (ITA 257) in a factorial randomized block design with four replications. The results indicated a negative effect of nitrogen, attributable to the severe drought that year. Yields under high nitrogen doses (40 and 80 kg ha^{-1}) were lower than in the control, because evapotranspiration and water requirements were increased by high tillering (*see Figure 1*).

These results demonstrate the risk associated with chemical fertilizer use on upland rice in drought-prone areas. Time series multilocational data from trials of this type are required to estimate economically optimal and risk-efficient fertilizer formulae and application rates. There is also a need to monitor the changes in nutrient availability which may occur after 3-4 years of cultivation following a long fallow period and to assess their implications for recommended fertilizer practices.

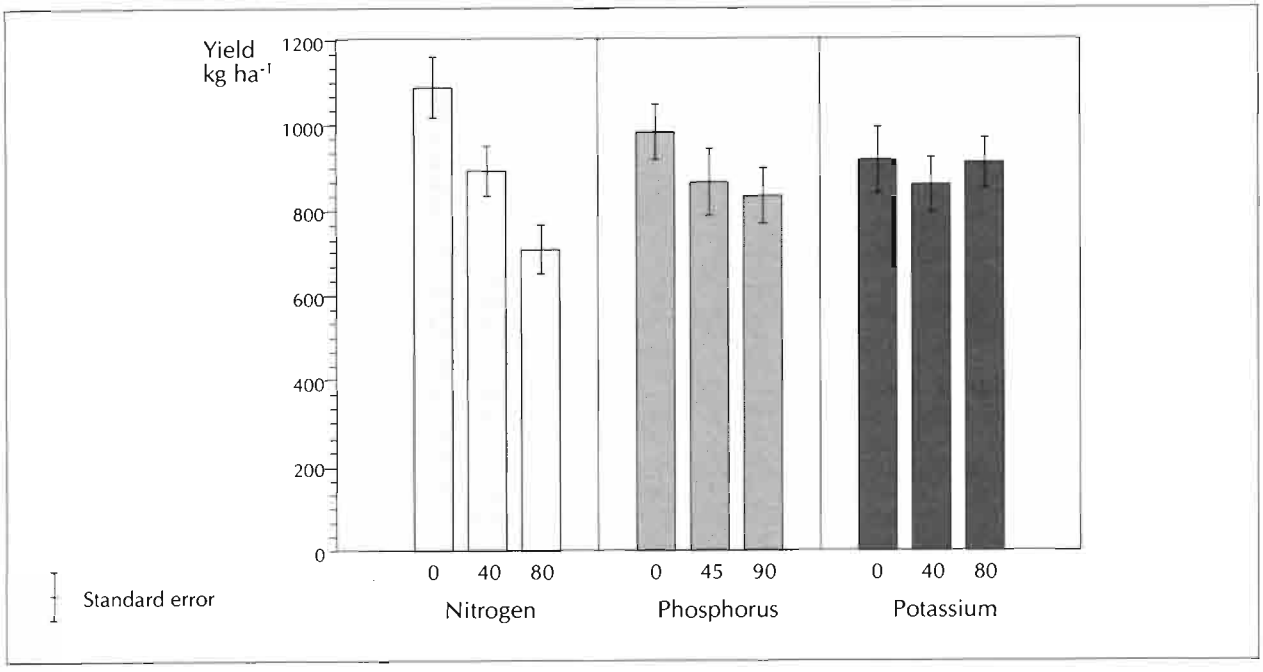
PROJECT 2

DEVELOPMENT OF ECONOMIC AND SUSTAINABLE WEED CONTROL PRACTICES

Evaluation of Tillage Practices

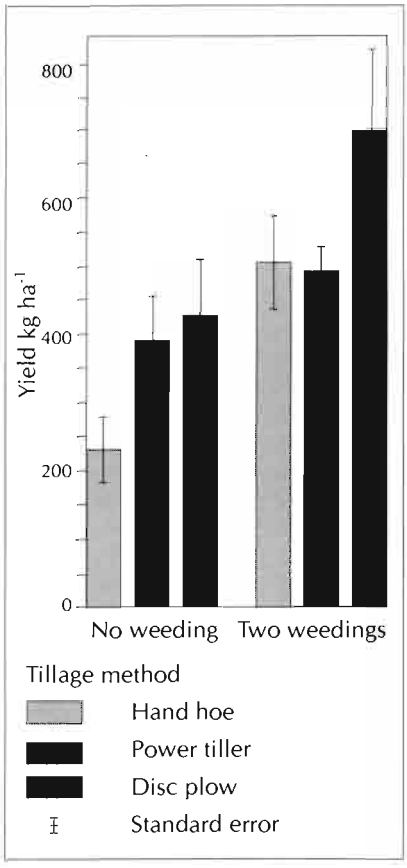
Weeds and declining soil fertility are severe constraints to upland rice production and induce farmers to practice shifting cultivation. Past studies have shown that certain land preparation practices prior to seeding can reduce subsequent weed populations in rice fields. A field trial conducted in 1989 showed that weed biomass at the time of the rice harvest was significantly

FIGURE 1
Effect of nitrogen, phosphorus and potassium applications on yields of an upland rice variety (ITA 257), M'bé Valley, Côte d'Ivoire, 1990



The use of a power tiller in rice production systems significantly reduces weed biomass

FIGURE 2
Effects of tillage method and weed control on the yields of an upland rice variety (ITA 257), M'bé Valley, Côte d'Ivoire, 1990

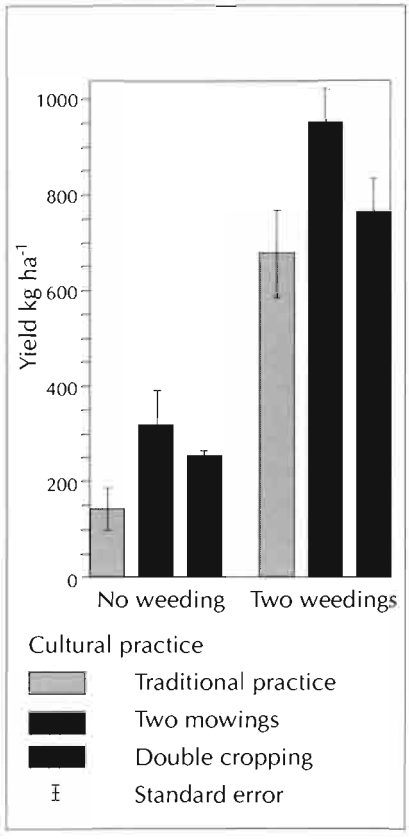


reduced when the seedbed was prepared using a power tiller rather than a hand hoe. Another trial conducted during that year showed that mowing weeds prior to seedbed preparation or cropping cowpea prior to planting rice both reduced weed populations in rice fields.

In 1990, the power tiller vs. hand hoe experiment was modified to include a tractor-pulled disc plow and the interval between the two tillages was increased from 3 weeks to 5 weeks. The mowing vs. double cropping trial was also modified, to compare the effectiveness of traditional land preparation (in which fields are not tilled until the time of seedbed preparation) with two mowings and double cropping of cowpea before seedbed preparation (using power tilling). In addition, the plots were either handweeded twice after planting or received no handweeding.

In the first trial, yields were highest in plots tilled with a tractor-pulled disc plow, followed by two handweedings (*see Figure 2*). In the second trial, yields were highest in plots mowed twice prior to seedbed preparation, followed by two handweedings (*see Figure 3*). Mowing twice prior to seedbed preparation, with no subsequent weed control, gave a higher yield than the traditional practice with no weed control during the season.

FIGURE 3
Effects of pre-season cultural practices and weed control during the season on the yields of an upland rice variety (ITA 257), M'bé Valley, Côte d'Ivoire, 1990



Additional evaluation of weed control practices, incorporating economic analyses, is needed to develop effective and sustainable weed control strategies for upland rice. Future experiments must also separate the effects of tillage methods on weed populations from their effects on water infiltration and root penetration of rice plants.

PROJECT 3

DEVELOPMENT OF IMPROVED RICE VARIETIES FOR THE UPLAND AND HYDROMORPHIC ECOSYSTEMS

Rice Breeding Activities

In 1990 the rice breeding program focused on the development of higher yielding and more stable rice varieties for the upland, hydromorphic and lowland ecosystems. Selections were made from advanced lines, promising varieties and segregating populations, as well as from lines with agronomically improved traits and with resistance or tolerance to major stresses, such as drought, blast, sheath rot, glume discoloration and brown spot.

To solve specific problems, several observational and yield trials were conducted at Man (forest zone), Odienné (savanna zone) and M'bé (transition zone); the sites represented a wide range of upland rice growing conditions. Entries in observational nurseries were planted in single plots of two to four 5 m rows and in yield trials in plots of 2-3 m x 5 m.

The two new WARDA-Bouaké bred sister lines, WAB 56-104 and WAB 56-125, continued to rank among the top five varieties in various on-station replicated yield trials conducted in 1990 (*see Table 5*). At the Man, Odienné and M'bé sites they gave an average yield of 2211 kg ha^{-1} and 1738 kg ha^{-1}, respectively, and showed moderate resistance or tolerance to drought, blast, sheath rot and glume discoloration; at the M'bé and Odienné sites, however, drought stress resulted in lodging. Other promising lines are WAB 99-1-1, WABC 165 and IRAT 144. More than 250 lines and 1000 F_2-F_6 individual plants were selected from various nurseries and segregating populations for further testing in 1991 and for use in the breeding program.

WARDA breeders systematically screen all promising materials for satisfactory levels of resistance to blast

Varieties which performed well in the replicated yield trials in 1989 and 1990 will be advanced to on-farm varietal trials in 1991. Work on hybridization will be increased and the emphasis in breeding will shift from obtaining high yields to obtaining more stable yields. The screening of materials at on-farm, on-station and 'hot spot' locations in order to identify lines with tolerance

TABLE 5
Grain yield of promising varieties in advanced yield trials conducted at M'bé, Odienné and Man, Côte d'Ivoire during the wet season, 1990

Variety	Grain yield (kg ha^{-1})			
	M'bé	Odienné	Man	Mean
WAB 56-104	2541	2700	1393	2211
IRAT 144*	1537	2450	1740	1909
WABC 165	2051	2200	1100	1784
WAB 99-1-1	1989	2284	986	1753
WAB 56-125	1832	1934	1447	1738
WAB 56-15-1	1410	1350	1860	1540
WAB 56-3-1	1335	1100	1426	1287
WAB 96-13-1	1032	450	1066	849
WAB 96-7-1	466	433	1413	771
Mean	1577	1656	1384	1539
CV (%)	39.9	32.0	18.4	
LSD (5%)	902	731	378	

* Check variety

and resistance to the major yield reducing factors will play an increasingly important role in WARDA's breeding program, beginning in 1991.

On-Farm Testing of Elite Upland Rice Varieties

WARDA began on-farm varietal testing in Côte d'Ivoire in 1984. The objective of this work is to evaluate promising rice varieties, with and without fertilizer use, under a wide range of rainfall and soil conditions representative of farmers' conditions.

In 1990 four varieties (IAC 164, IDSA 10, WAB 56-104 and WAB 56-125) were evaluated by four farmers in each of two villages (Kregbé and Gagnoa) with a bimodal rainfall pattern and in each of three villages (Danané, Mandougou and Ponondougou) with a unimodal rainfall pattern. Two levels of nitrogen (0 and 69 kg ha^{-1}) were applied to each variety.

None of the improved varieties significantly outyielded IAC 164, the currently recommended variety. Average yields were generally low, ranging between 1360 and 1460 kg ha^{-1} in the bimodal rainfall zone, and between 980 and 1260 kg ha^{-1} in the unimodal zone. The response to nitrogen was highly significant, with an average yield increase of 2.5 kg per kg/N. There was a significant varietal effect under a unimodal rainfall pattern, with IAC 164 and WAB 56-125 outyielding IDSA 10 and WAB 56-104. However, there was no difference between the varieties under a bimodal pattern. An analysis of varietal stability, with varietal yield regressed on the average yield at the 12 sites which have a unimodal rainfall pattern, revealed that IAC 164 and WAB 56-125 outperformed the other two varieties in both poorer (<1000 kg ha^{-1}) and better (>1000 kg ha^{-1}) environments.

After 6 years of on-farm varietal tests, WARDA's new team is now re-evaluating the methodologies used previously. New approaches involving a higher degree of farmer participation and more rigorous evaluation of post-harvest traits will be employed in on-farm tests in 1991.

Evaluation of Pest Resistance in Rice Varieties

Over 40 insect species have been reported as pests of upland rice in Côte d'Ivoire. There is an ugrent need to develop pest management systems that are safer, more cost effective and less harmful to the environment than methods which involve the use of chemicals.

An essential first step is to understand the ecology of insect pests and their natural enemies. Control tactics that take advantage of weak points in their behavior and life cycle must then be developed.

The emphasis in entomology research at WARDA during 1990 was on studies of the population dynamics of upland rice insects on the M'bé plateau and on evaluating rice varieties for insect resistance. In order to determine the insect population dynamics at M'bé, two rice varieties, IAC 164 and IDSA 6, were planted on 23 May and 12 June. Insects were sampled with sweepnets and tillers were examined for stem-borer infestation. A stalk-eyed fly, *Diopsis* spp., and a leaf-feeding beetle, *Chnootriba similis*, were the most abundant species present. The lepidopterous stem-borer population was low in 1990 but, of the species present, *Maliarpha separatella* was most abundant. The populations of *Diopsis* peaked at 75 days after sowing of the first crop, when they were most abundant on IDSA 6 (*see Figure 4 overleaf*). This may have been because IDSA 6 is a longer duration and higher tillering variety than IAC 64.

In the varietal evaluation study, 175 *Oryza glaberrima* varieties collected

Root-feeding termites are among the wide range of insects which attack upland rice in West Africa

from throughout Africa were screened for resistance to *D. longicornis* in two tests in the screenhouse at IITA, Ibadan, Nigeria. At M'bé, 40 *O. glaberrima* varieties, 16 F_4 rice x sorghum hybrids, and several of WARDA's most promising elite upland varieties were field evaluated for resistance to stem-borers. In the screening for resistance to *Diopsis* spp. at IITA, CG 112-2, MG 7-2, YG 333 and UG 46 consistently showed the least damage in both tests. In the screening at M'bé, the lowest infestations were observed for WAB 442, WAB 448 (both from rice x sorghum parentage) and WAB 56-104.

Future entomology research will focus on the development of pest management systems for smallholder farmers. Control tactics emphasizing varietal resistance and biological and cultural control will be developed based on an understanding of the ecological factors regulating key insect pest populations.

PROJECT 4

CHARACTERIZATION OF THE UPLAND/INLAND SWAMP CONTINUUM AT M'BE VALLEY, COTE D'IVOIRE

In 1989, a multidisciplinary experiment to characterize the continuum was initiated at WARDA's Main Research Center in M'bé Valley. The experiment consists of three blocks, 120 m x 40 m, each oriented vertically along the continuum with an average slope of 1-3 %. Two upland rice varieties (short duration IAC 146 and medium duration IDSA 6) and two lowland varieties (IR 5931-110-1 and Bouaké 189, both medium duration) were grown along the continuum, with and without fertilizers. The design was a split plot with variety in the main plot and fertilizers in the sub-plot, with 12 sections running parallel to the valley bottom at distances of 10, 20, 30, ... 120 m from it. The trial was repeated in 1990.

Study of Groundwater Dynamics

The low rainfall in 1990 significantly changed the soil hydrology profiles of each block. In two of the blocks (A and B), the hydromorphic zones were considerably narrower and lower on the slope than they had been in 1989. In block C, the hydromorphic zone occurred both on the bottom land and (because of a topographical depression) on the mid-slope (10 m to 50 m from the valley bottom), whereas in 1989 the bottom land had been completely flooded (*see Figure 5*).

Varietal Response to Position on the Continuum

Lowland varieties gave superior yields only in the hydromorphic zone. Among

FIGURE 4
Population dynamics of *Diopsis* spp. on two upland rice varieties sown at different dates at M'bé Valley, Côte d'Ivoire, 1990

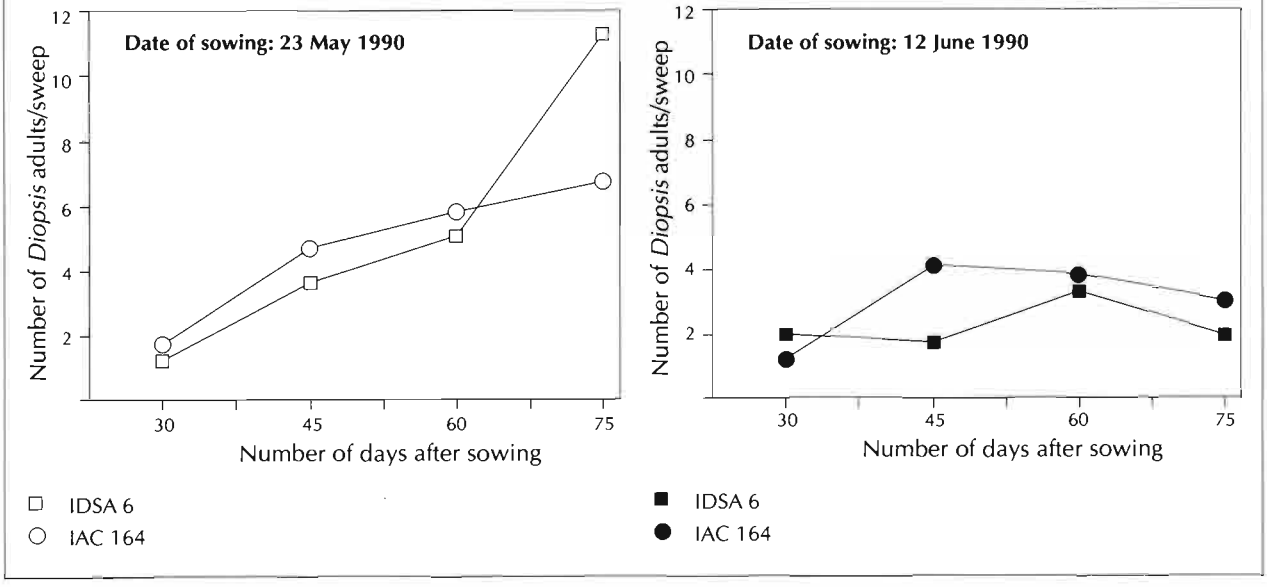
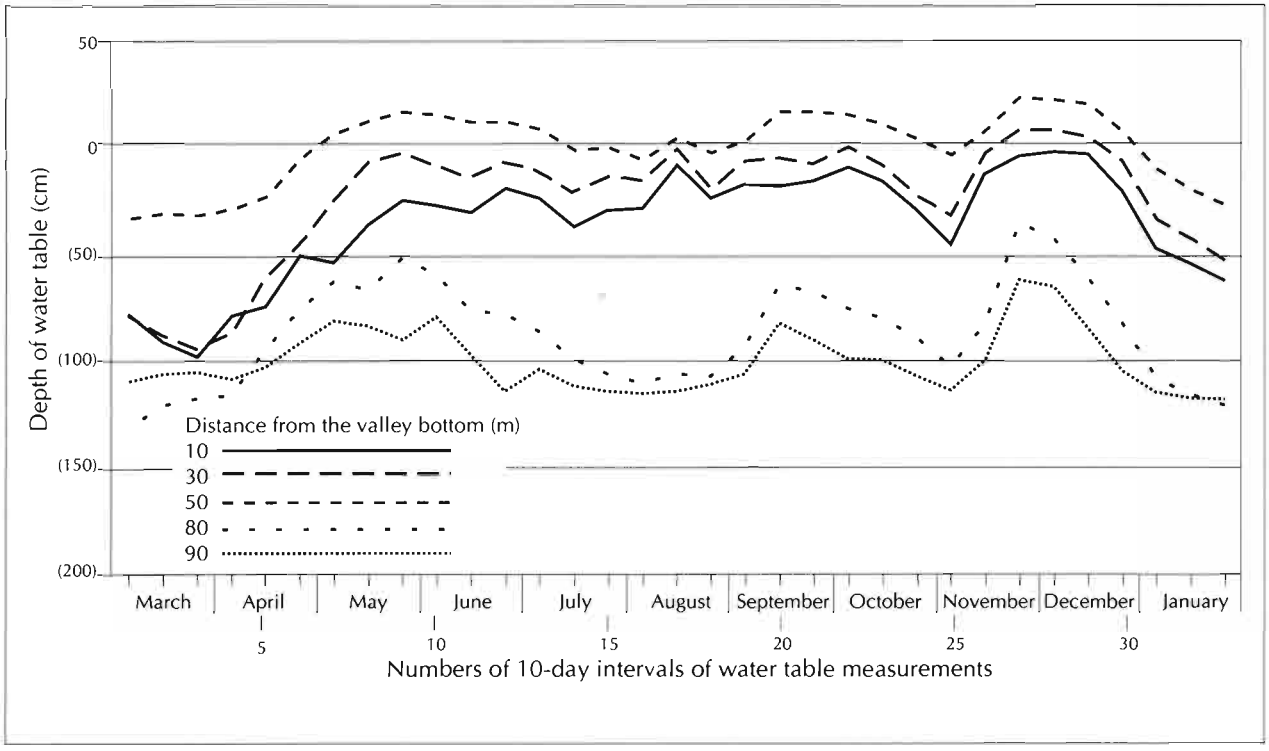


FIGURE 5
Water table dynamics along the upland/inland swamp continuum, M'bé Valley (block C), Côte d'Ivoire, from March 1990 to January 1991



the upland varieties, IDSA 6 seems to be well adapted to hydromorphic conditions, whereas IAC 164 reacted poorly to excess water. In the upper part of the hydromorphic zone (depth of water table below 50 cm), water was the main limiting factor at all the sites, because of the drought conditions. Rice yields remained low even with fertilizer application.

To assess varietal performance according to position on the slope, the yield of each variety was regressed on the average yield of the four varieties at 39 landscape positions. IAC 164 performed best when the overall average yield was less than 1 t ha^{-1} (y intercept of 1.06 t ha^{-1}) and IR 5931-110-1 responded best to improved hydromorphic conditions; IDSA 6 seems to be the most plastic rice variety among those tested, with the most stable yields in all parts of the continuum (*see Figure 6 overleaf*).

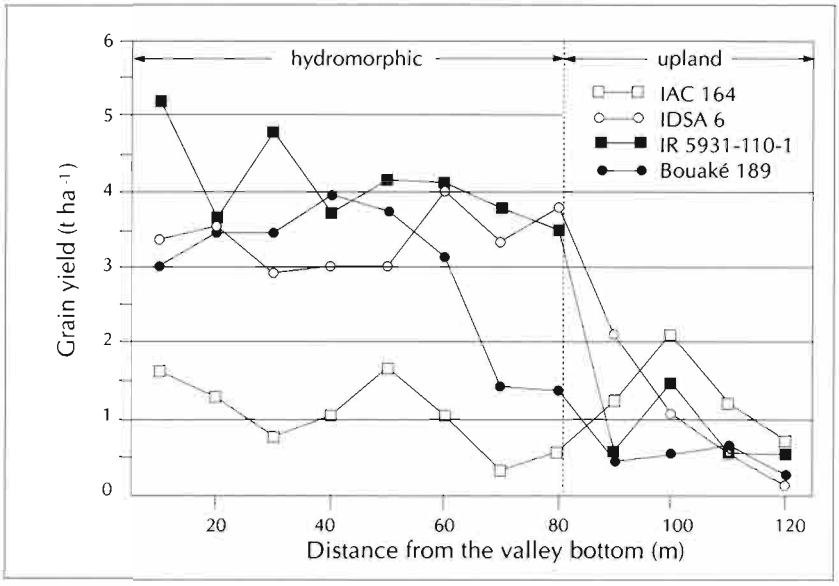
To complete data collection under varying rainfall conditions, the study will continue for a third and final year in 1991. In collaboration with the plant pathologist, diseases will be scored at the three sites.

Insect Pest Populations along the Continuum

Insects were collected with sweepnets along the valley slopes at 2-week intervals, beginning 30 days after sowing. Tillers were dissected to determine the stem-borer species present and their abundance.

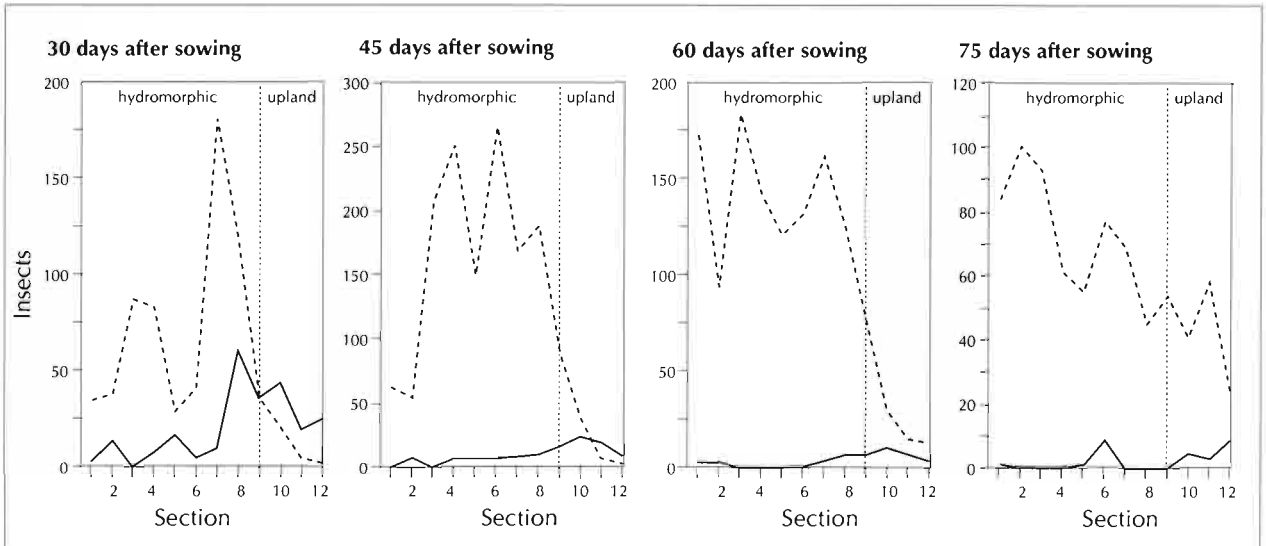
The most abundant insect pest species along the continuum were: the stalk-eyed fly, *Diopsis* spp.; the leaf-feeding beetle, *Chnootriba similis;* the stem-borer, *Maliarpha separatella;* and the gall midge, *Orseolia oryzivora*. Pest populations were generally highest in those sections lying between 10 m and 50 m from the valley bottom where the depth of the water table averaged about 25 cm. Populations of *C. similis* increased towards the upland part of the contiuum, whereas *Diopsis* spp. and stem-borers were most abundant in the hydromorphic zone (*see Figure 7 overleaf*).

FIGURE 6
Grain yield of four rice varieties, with fertilizers, along the upland/inland swamp continuum, M'bé Valley, Côte d'Ivoire, 1990



Because of the variable abundance of insect species at different levels of the toposequence, insect pest management strategies targeted specifically at the upland, hydromorphic and lowland ecosystems must be developed. Additional studies will be carried out at diverse locations to determine the effects of temporal and spatial factors on insect pest populations at various levels of the toposequence.

FIGURE 7
Populations of *Diopsis* spp. and *Chnootriba similis* (per 50 sweeps) at different levels of the continuum at 30, 45, 60 and 75 days after sowing, M'bé Valley, Côte d'Ivoire, 1990



Note: These are the observed number of insects per 50 sweeps at one of the three sites on the continuum, thus there is no measure of variability (such as a standard error) associated with these values

Sahel Program

PROJECT 1

DEVELOPMENT OF HIGHER YIELDING AND MORE STABLE RICE VARIETIES FOR WET SEASON CROPPING

Preliminary Yield Trials

Introduced high yielding varieties tested by the Sahel Program in the past have shown great instability in yield performance over seasons and locations. Because of their relative yield stability, Jaya, a medium duration variety, and I Kong Pao, a short duration variety introduced over 15 years ago, are still the most widely grown varieties in the Senegal River Valley. In 1990, 48 elite short and medium duration cultivars were tested at Fanaye to assess yield stability in the Sahel environment.

Two trials of 24 cultivars each were planted: a short duration trial, in which the cultivars were compared with I Kong Pao; and a medium duration trial, in which the cultivars were compared with Jaya. A randomized complete block design, with three replications, was used. Entries were planted in 14-row plots, with a plot size of 4.2 m x 2.8 m. The area harvested for yield evaluation was 8.36 m^2.

Among the short duration entries, RAU 2007-6-69-12-13 (6290 kg ha^{-1}), TNAU 7693 (5950 kg ha^{-1}) and ITA 230 (5630 kg ha^{-1}) all outyielded I Kong Pao (5300 kg ha^{-1}). In the previous year, TNAU 7693 (6110 kg ha^{-1}) and ITA 230 (6000 kg ha^{-1}) had outyielded I Kong Pao (5010 kg ha^{-1}). Among the medium duration entries, IET 6279 (6870 kg ha^{-1}), S499B-28 (6400 kg ha^{-1}), IR4422-98-3-6-1 (6310 kg ha^{-1}), BG 400-1 (6230 kg ha^{-1}) and ITA 306 (6040 kg ha^{-1}) all outyielded Jaya (5440 kg ha^{-1}). In 1989, IET 6279 (6420 kg ha^{-1}) had outyielded Jaya (5090 kg ha^{-1}).

These results suggest that it may be possible to identify improved varieties for the Sahel irrigated environment that perform consistently better than the most commonly grown materials. Entries which have shown some stability over the past 3 years will be used in coordinated advanced yield trials in 1991.

Initial Evaluation of Germplasm from Latin America

Since its establishment, WARDA's Sahel Program has been receiving and evaluating Asian germplasm. The most widely grown irrigated rice varieties in the Sahelian countries are of Asian origin. However, in other rice growing environments in West Africa, particularly in upland areas, many of the most successful varieties grown by farmers are of Latin American origin. In view of the similarities between the rice ecosystems in West Africa and Latin America, promising Latin American cultivars were tested to determine their adaptability to the Sahel environment, with a view to broadening the genetic base of improved varieties in the region.

Manual land leveling and inadequate land preparation contribute to low and unstable rice yields in the Sahel

In collaboration with CIAT, 110 irrigated rice cultivars from Cuba, the Dominican Republic, Mexico and Peru were planted in an unreplicated trial in the wet season at Fanaye, Senegal in 5-row plots, with a plot size of 5 m x 1 m. Jaya (medium duration) was used as a local check. Nineteen promising lines showing good adaptation were identified for further evaluation in advanced nurseries in 1991. Of these, eight are medium duration (120-135 days) and the rest short duration. ECIA 156-S4-1 and ECIA 157-S7 were the highest yielders among the medium duration lines, while ECIA 125-F4-9 and ECIA 33-1-J2-2-1-1 were the highest yielders among the short duration lines. Most entries had slender grains, which should appeal to the majority of Sahelian rice consumers, but height may be a handicap as many entries were taller than Jaya (102 cm).

Although only 19 lines were identified for advanced nurseries in 1991, most entries will be evaluated in the 1991 dry and wet seasons to further assess their performance stability and their reactions to the major seasonal stresses of the Sahel environment.

PROJECT 2

DEVELOPMENT OF HIGHER YIELDING AND MORE STABLE RICE VARIETIES FOR DRY SEASON CROPPING

Preliminary Yield Trials

As an increasing number of Sahelian rice farmers are interested in double cropping, there is a need to identify cultivars suited to the hot dry season in terms of duration and tolerance to the major climatic constraints, including extremes of cold and heat. Past results suggest that short duration varieties with cold tolerance at the vegetative stage and heat tolerance at the reproductive stage can take advantage of solar radiation in the hot dry season to produce high yields. However, considerable yield instability has been observed among most introduced high yielding varieties.

A trial was conducted in 1990 to evaluate 24 promising short duration cultivars for yield performance and agronomic characteristics under hot dry season conditions, with I Kong Pao as a check. A randomized complete block design, with three replications, was used. The entries were planted in 11-row plots, with a 5 m x 2 m plot size. The area harvested for yield evaluation was 7.36 m^2. IR 28128-45-2 (5530 kg ha^{-1}), IR 31787-85-3-3-3-2 (5470 kg ha^{-1}), IR 50 (5330 kg ha^{-1}) and IR 39357-133-3-2-2 (5280 kg ha^{-1}) outyielded I Kong Pao (4930 kg ha^{-1}). In 1989, the entries IR 31787-85-3-3-3-2 (5730 kg ha^{-1}) and IR 39357-133-3-2-2 (5520 kg ha^{-1}) had outyielded I Kong Pao (5410 kg ha^{-1}).

These results suggest that progress can be made in selecting high yielding varieties with stable performance in the hot dry season. The trial needs to be repeated in 1991 to assess performance stability before coordinated advanced yield trials are initiated with NARS in the Sahel region.

Mangrove Program

PROJECT 1

DEVELOPMENT OF HIGHER YIELDING AND MORE STABLE RICE VARIETIES WELL ADAPTED TO MANGROVE SWAMP CONDITIONS

Over the past 3 years, WARDA's Mangrove Program has continued its work on selecting improved varieties suited to the adverse conditions of the mangrove swamp environment. The aim of the varietal improvement activities in 1990 was to identify higher yielding varieties with better stress tolerance and adaptation to the different salt-free growing periods in the mangrove swamps. To this end, F_5-F_6 segregating materials were selected/bulked, and observational yield and replicated yield trials were conducted.

In the 1990 observational yield trials, WAR 100-2-12-5 and WAR 115-1-2-11-4 (110-135 days-to-maturity) were among the 10 leading varieties, yielding over 5500 kg ha^{-1}. These results are consistent with those obtained in 1988 and 1989. The 10 leading varieties comprised six WARDA selections (the two varieties mentioned above, as well as WAR 115-1-2-11-2, WAR 100-2-11-1, WAR 100-3-10-1 and WAR 100-3-2-1). In the replicated yield trials, WAR 115-1-2-10-5, WAR 100-2-15-1 and BG 400-1 outyielded the check IR 10781-143-2-3. Over 3 consecutive years (1988-90) these three varieties have consistently outyielded the check.

The superior yield performance of these leading WARDA-Rokupr varieties will be further assessed in regional multilocational trials to be conducted in 1991 within the framework of the Mangrove Swamp Rice Network (*see pages 14-16*). The trials will also give an indication of their adaptability to different mangrove ecosystems. Future demand for stress-tolerant varieties suited to these ecosystems will be met through hybridization, selection and screening by WARDA and leading national programs in the region.

TRAINING AND COMMUNICATIONS

After over two decades of organizing group training activities, it seems an appropriate time to review the progress in WARDA's training activities over the past decade and to outline future plans. In 1990, the main emphasis was on developing the concept of itinerant training, whereby courses were organized in close collaboration with and hosted by the NARS of some WARDA member states. This proved very successful, and will encourage WARDA not only to continue with this effort but also to expand it.

Communications activities involved re-organizing and strengthening WARDA's publishing capability so that the Center can respond more effectively to the needs of the growing research effort. The Library and Documentation Center expanded its agricultural database, acquired more journals and other documents, installed modern equipment and improved its facilities to enable it to meet the rapidly increasing demand from WARDA and NARS scientists for literature searches and document delivery. The Translation and Conference Services Unit continued to provide an efficient service to WARDA's expanding research and publications programs.

Much of the expansion undertaken in 1990 benefited from the support given by the United Nations Development Program (UNDP), which funded the group training activities, and by the Technical Centre for Agricultural and Rural Cooperation (CTA) in The Netherlands and the International Development Research Centre (IDRC), which provided funds for improving the facilities of WARDA's Library and Documentation Center.

2.1 A DECADE OF GROUP TECHNICAL TRAINING AT WARDA

Anthony Youdeowei

Since its creation in 1970, WARDA has recognized human resources development as a priority activity necessary to strengthen the rice science capabilities of the NARS of WARDA member states. Training activities, consisting of individual programs and group technical courses, have therefore been developed as a vital and integral component of WARDA's overall operational program. This report presents an overview of progress, with particular focus on the 1980-90 period.

Goals of WARDA's Group Training Program

Most of the WARDA member states lack the critical mass of manpower needed for effective rice research and production. Surveys in 1989 revealed that only seven out of the 16 member states had more than five full-time rice scientists and seven had fewer than five; in two member states there were no full-time rice scientists. In addition, the knowledge and skills of the few rice scientists and technologists in the region need to be constantly upgraded to keep abreast of developments in rice science research.

WARDA's group training program has been designed to enhance manpower development in rice research in West Africa by increasing the quantity and quality of scientists and technicians in the region. The program has five clearly defined goals:

- to help build up the critical mass of well-trained rice scientists and technicians in West Africa;
- to strengthen the capacity of NARS to enable them to meet national goals for rice research, training and production;
- to enhance the effectiveness of rice science and technology training in national institutions;
- to develop regional and international cooperation in training in rice science;
- to increase the flow of relevant information to rice researchers in West Africa.

Program Implementation

Based on the training needs of NARS in the member states, WARDA's group technical training courses were categorized into three major groups:

Research-related courses:

Computer Applications and Statistical Analysis in Agricultural Research
Rice Research Assistants Course
Rice Agronomy
Scientific Writing for Agricultural Research Scientists

WARDA trainers take the opportunity during group training courses to interact with and train smallholder rice farmers in improved rice growing techniques

Production-related courses:

Rice Production and Research
Crop Protection
Upland Rice Production
Sahel Rice Production
Mangrove Rice Production
Water and Irrigation Management for Rice Production
Post-Harvest Technology

Technology transfer-related courses:

Training of Agricultural Trainers
Development of Training Materials
Writing and Production of Agricultural Extension Materials

During the 1980s, the program focused on:

- providing training in the research techniques needed for effective WARDA/NARS collaborative research, enhancing familiarity with new and existing rice production technologies, and improving the skills of trainers and others responsible for disseminating information on rice production technologies;
- establishing a formal trainee follow-up and support system through in-country training courses and the use of WARDA alumni as Associate Trainers.

A graphic illustration of number of people trained by WARDA in the 1980-90 period is provided in Figure 8. The specialist courses offered by WARDA from 1980 to 1990, and the number of participants from member states who attended these courses, are given in Table 6 (*see page 40*). Prior to March 1990, group training courses were held at WARDA's Regional Training Center in Fendall, Liberia. With the intensification of the civil war in Liberia, however, arrangements were made to organize courses in Banjul, The Gambia and in Lomé, Togo. The courses offered in 1990 came under a special project funded by the UNDP and aimed at strengthening WARDA's training and communication capacity. Three courses were organized during the year:

Training of Agricultural Trainers (TOT):

Held from 26 February to 23 March 1990, this course was conducted in English for 22 participants from five anglophone West African countries (The Gambia, Ghana, Liberia, Nigeria and Sierra Leone). The main resource persons were two experts from the Office of International Cooperation of the United States Department of Agriculture (USDA). The primary objective of this course was to develop expertise and skills in adult learning techniques in order to strengthen farmer training capabilities in the NARS. At the end of the course, plans were made for follow-up in-country TOT training courses.

Rice Production and Research Training Course:

With the assistance of the Government of The Gambia, this course was held at The Gambia College in Brikama from 9 July to 3 October 1990. It was conducted in English and French with simultaneous translation throughout the classroom and field practical sessions. The 23 participants were drawn from Chad, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo. Resource persons included two WARDA Trainers, two Associate Trainers (former WARDA trainees from the NARS of Nigeria and Benin), two interpreters, one technical co-ordinator, eight WARDA rice scientists, four NARS scientists, three experts from field projects being undertaken by the Food and Agriculture Organization of the United Nations (FAO) and the International Fund for Agricultural Development (IFAD), and four experts from universities in West Africa. The objective of the course was to improve rice production skills in the various rice growing ecologies in the region.

The Rice Production and Research training course in The Gambia: (left) trainees establishing experimental field plots; (right) an FAO expert instructing trainees in post-harvest techniques

Rice Research Assistants Training Course:

This course was held in Lomé, Togo from 22 October to 1 December 1990. The Government of Togo gave full support to the course, including local transportation and the release of three rice scientists from the national program to assist in organizing the course. The International Fertilizer Development Center (IFDC-Africa) assisted with financial administration and provided two resource persons to give lectures and conduct field practicals on techniques for laying out fertilizer trials. Other resource persons included one trainer and three scientists from WARDA and eight scientists from the Mali and Togo NARS. The 23 trainees came from eight francophone countries (Burkina Faso, Chad, Côte d'Ivoire, Guinea, Guinea-Bissau, Mali, Niger and Togo). The course strengthened the research support capabilities of technicians working with rice scientists in national programs. Special attention was given to developing skills in experimental design, conducting field trials, and collecting, analyzing and interpreting experimental data.

FIGURE 8
Number of people from national programs of WARDA member states trained by WARDA, 1980-90

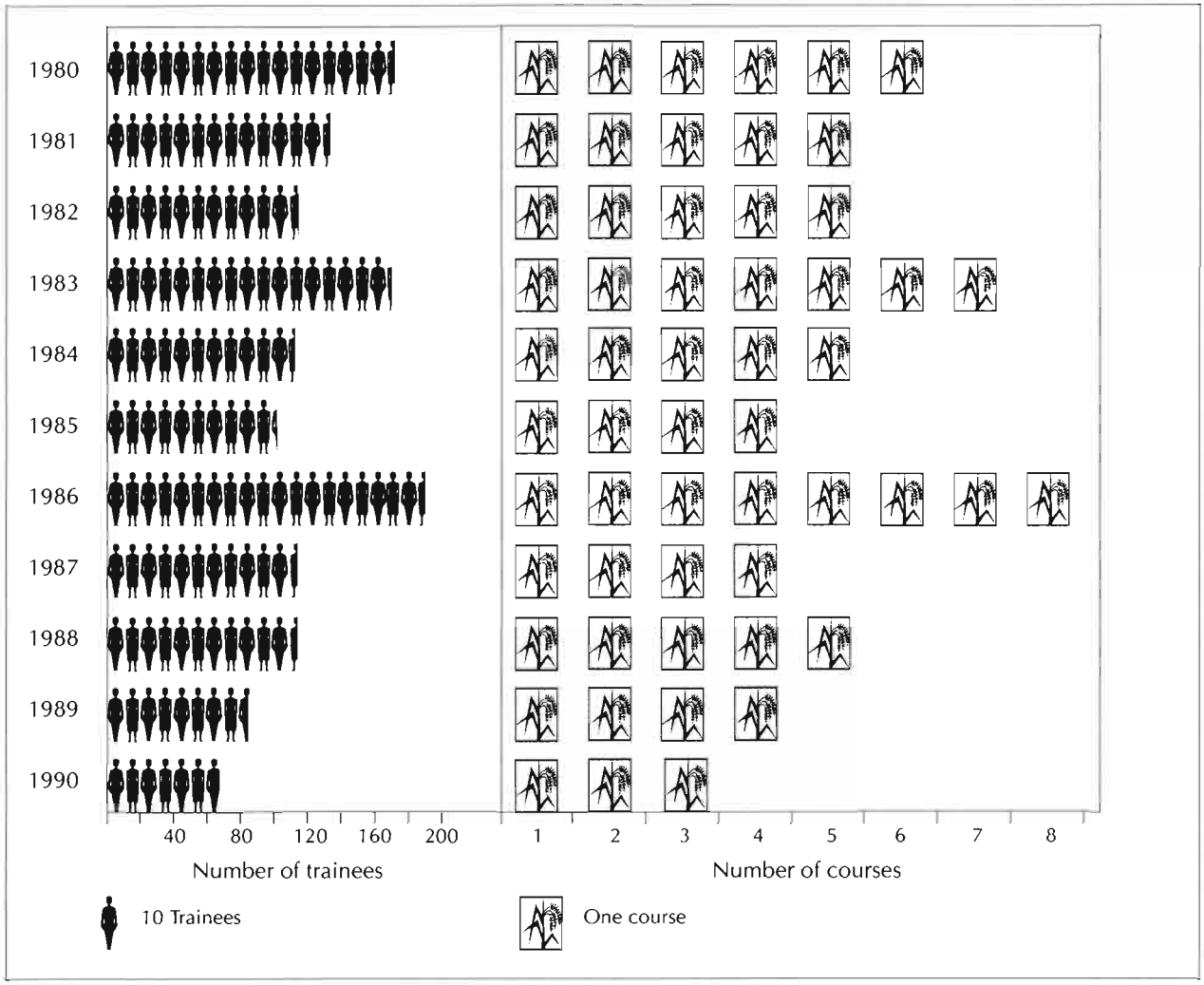


TABLE 6
Number of participants in WARDA group training courses, 1980-90

Course	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Intensive Rice Production and Extension (Liberians only)	38	32		26	20		26		25	20		187
Field Assistants	28			28								56
Rice Production and Research	28	32	29	32	33	34	26	24	20	22	23	303
Post-Harvest Technology	28	26	26	26	28	15	23	22	23	23		240
Project Management	29	23		20								72
Seed Multiplication	23		21				12					56
Rice Research Assistants		23	23		19						23	88
Integrated Pest Management			28									28
Azolla Seminar				14								14
Grain-Eating Birds Seminar				26			15					41
Audio-Visuals and Extension					24		21		18			63
Farm Machinery Use and Maintenance						24	18	25	20			87
Farm Mechanization and Appropriate Technology						29						29
Mangrove Rice Production and Research							52					52
Rice Drying and Storage in the Tropics								35		22		57
Training of Agricultural Trainers											22	22
Number of courses per year	6	5	5	7	5	4	8	4	5	4	3	56
Number of trainees per year	174	136	127	172	124	102	193	106	106	87	68	1395

Research technicians undergoing practical training in laying out experimental plots during the Rice Research Assistants training course in Togo

During the three specialist courses held in 1990, training manuals were developed for use in future courses and to assist trainers in WARDA member states. A newsletter, *Trainerlink*, has been established and is published after each course to encourage an exchange of views and experiences on WARDA's group training activities. This newsletter also helps WARDA to maintain contact with trainees and provide follow-up support.

Regional Impact of WARDA's Group Training Program

WARDA's training has strengthened collaboration with NARS scientists and made a significant contribution towards building a nucleus of middle-level technicians for rice production, research and related activities in the Center's member states. In 1982, a study of 100 former WARDA trainees in eight member states showed that 97% of them were still directly or indirectly working in rice production. A study in 1987-88 of 399 former WARDA trainees in 14 member states showed that 81% had remained involved in work on rice for at least 50% of their time. In a follow-up study in 1988, based on a questionnaire and individual interviews, 80% of former trainees attributed career advancement to the training they had received from WARDA.

As part of the ongoing follow-up process to evaluate the impact of WARDA training, interviews are conducted regularly with former WARDA trainees. Overall, the feedback from former trainees has been very positive, as illustrated by the extracts overleaf from letters received in 1990.

Before I came on the Rice Production and Research course, I did not know much about rice cultivation — this can be seen from my benchmark evaluation sheet. But by the end of the program, I had learnt many improved techniques in rice cultivation such as land preparation, raising seedlings, transplanting, water management, fertilizer management, pest management, rice post-harvest activities, etc. I understood most of the major constraints to rice cultivation in West Africa and how to deal with them. I am now very well equipped to serve as production specialist and also rice scientist.

Prior to the Rice Production and Research course in March 1990, I was privileged to attend a Training of Agricultural Trainers (TOT) course organized for the first time by WARDA in Liberia. The aim of the course was to train participants in the most recently developed training methodologies in order to train other agricultural trainers and farmers. Thanks to this TOT course, I am now well prepared to transfer to others my knowledge acquired from the Rice Production and Research course.

(Mr Kwame Bam, Kwadaso Agricultutal Research Station, Kumasi, Ghana)

Mrs Hadiatou Dantsey, a Rice Breeder in the Togolese national program who was trained by WARDA, utilizing the knowledge and skills gained from WARDA courses for her work

I participated in the two courses organized by WARDA on Rice Drying and Storage in the Tropics and also on Rice Seed Production. I gained a lot from these courses, especially the one on Drying and Storage, which has helped me solve problems caused by mould and insect pests which I have been facing for years. Upon my return back home, I shared my knowledge with colleagues at work through seminars and open discussion sessions. My contact with WARDA scientists during the seed production seminar gave me an opportunity to improve my breeding work.

Recently, I was invited by WARDA to assist as Guest Trainer during its Research Assistants course organised in Lomé, Togo, from 22 October to 30 November 1990. This assignment was good experience for me. It helped me improve my capacity to transfer knowledge to others and I also learnt how to organize courses and deal with people of different backgrounds and nationalities. This is a good example of collaboration between WARDA and NARS. I will welcome other occasions like this.

(Mrs Hadiatou Dantsey, Recherche Agronomique, Lomé, Togo)

I was fortunate to attend the Research Assistants course in Lomé from 22 October to 30 November 1990. This was an opportunity for me to improve my knowledge in rice research. The course contents were well selected and their presentation by various lecturers was excellent. What I liked most was the field trip, the practical work in the field, the case studies and the group discussions. They helped me to understand better what had been taught in theory. I returned home very satisfied with the course.

(Mr Diallo Dioukamady, Recherche Agronomique, Kogoni, Mali)

2.2 A STRATEGY FOR COLLABORATING WITH NARS IN TRAINING ACTIVITIES

Anthony Youdeowei

In line with the objective to strengthen the involvement of NARS in WARDA's training activities, as elaborated in the Medium-Term Implementation Plan, 1990-94, WARDA launched three training initiatives in 1990: itinerant training courses; the establishment of a trainer intern program for West African women; and the establishment of a WARDA/NARS training group.

Itinerant Training Courses

This initiative involves conducting WARDA group training courses in member countries, in close collaboration with the national programs of these countries. This provides WARDA with the opportunity to:

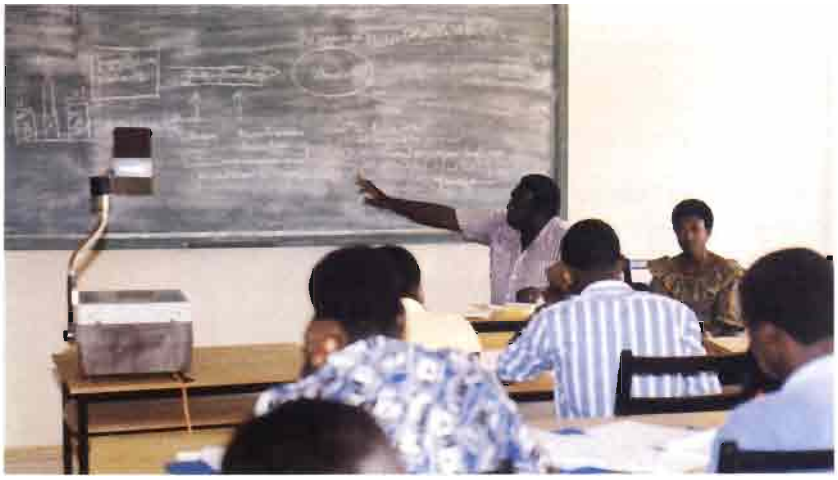
- interact more effectively with the national programs and governments of WARDA member states;
- facilitate the exchange of ideas and experiences between WARDA scientists and NARS training participants;
- promote interaction between training participants from WARDA member states;
- strengthen the training capabilities of national programs.

Funding for WARDA's group training activities has been provided by the UNDP; Dr V. Angelo, the UNDP resident representative in The Gambia, presented the certificates to trainees graduating from the Rice Production and Research training course in 1990

NARS scientists participate extensively in the itinerant training courses, both in the planning stages and in the implementation and evaluation of the courses:

- they serve as members of expert consultative teams which plan the curricula and decide on training methods, and they help identify appropriate NARS rice scientists and technologists to use as resource persons for the courses;
- during the course, they give lectures, tutorials and field practical exercises in their areas of expertise;
- they may act as Group Training Co-ordinators, to help WARDA's resident trainers organize various components of the courses, and may take responsibility for conducting and analyzing course evaluations.

NARS personnel who are former WARDA trainees participate in the courses as Associate Trainers; they live in the same hostel as the new trainees, which promotes close interaction between the two groups.



Two former WARDA trainees from the Togolese national program, Mr Y. Dogbé and Mrs H. Dantsey, were invited to assist with the Rice Research Assistants training course as Associate Trainers

The number of NARS personnel involved in the two itinerant courses held in 1990 in The Gambia and Togo (*see pages 38-39*) is shown in Table 7. The degree of participation in these courses has promoted the desired multiplier effect from WARDA's training program, and the positive results achieved in 1990 have encouraged WARDA to intensify its itinerant group training activities in the years ahead.

TABLE 7
Participation of NARS scientists in WARDA's group training courses, 1990

Training course/activity	Resource Persons/Trainers	Associate Trainers	Training Co-ordinators
Rice Production and Research	8	2	2
Rice Research Assistants	8	2	1
Course Planning	2	—	—

Trainer Intern Program for West African Women

In recognition of the role of women in rice production systems in West Africa and the need for women trainers in the region, WARDA established a special program in 1990 for training women trainers. The program represents WARDA's contribution to the UNDP activities on Women in Development.

An increase in the number of women trainers in West African NARS will facilitate the transfer of rice technology to WARDA's main target group — smallholder farm families. It is estimated that over 80% of the smallholder rice farmers in the region are women. WARDA's itinerant training courses will provide ample opportunity to identify potential candidates for the trainer intern program. The first candidate identified in 1990 was Mrs Zainabou Cole, a Gambian rice scientist.

Training Working Group

In early 1989 WARDA organized a WARDA/NARS training conference to discuss the training needs and priorities of the NARS programs in West Africa. One outcome of this conference was the establishment of a WARDA/NARS Training Working Group.

The group advises on WARDA's training activities and provides a channel through which NARS personnel can influence decisions on the content, frequency and location of WARDA training courses. The first meeting of the Working Group took place during the Annual Rice Review, held at WARDA in May 1990.

2.3 INFORMATION MANAGEMENT SUPPORT TO RICE SCIENTISTS IN WEST AFRICA: THE WARIS PROJECT

Alassane Diallo

In most NARS in the WARDA member states, the resources needed to provide information services to rice scientists are grossly inadequate. Libraries are poorly funded and understaffed, and severe foreign exchange shortages restrict the purchase of books, subscriptions to journals, access to international databases and the acquisition of computer hardware and software. With financial support from the IDRC, WARDA has established the West African Rice Information System (WARIS) project to collect, process, analyze, repackage and disseminate information relevant to rice research and production in West Africa.

The WARIS project proposal grant of CAD$ 293 415.00 was approved in June 1990 by the IDRC and a first disbursement of US$ 78 555.00 was made in August 1990 upon WARDA's acceptance of the grant conditions. The first phase of the project involved purchasing an AST Bravo/386SX (100 MB hard disc) computer, a WYSE color monitor, an EPSON 1050 printer and a BUSIMATIC 1625 heavy duty photocopier. With this new equipment, the Library and Documentation Center has been able to significantly improve its services to users. This was reflected by an increase in number of users once the new equipment was operational.

Objectives and Components of WARIS

The objective of the WARIS project is to strengthen and upgrade WARDA's present library services and establish the infrastructure necessary for the development of an effective information service capable of responding to the needs of WARDA's scientists and clients. As a regional rice information system, WARIS will become the major channel for the exchange of information and knowledge among the scientists and policy makers in the region. It also aims to become the main source of all information generated by the world's rice research community which is relevant to West Africa.

To create awareness about the services offered by WARIS, plans are in hand to produce a brochure and two posters outlining the project's structure and services. A quarterly WARIS newsletter, containing information on new developments in rice science, will be published and distributed through NARS information systems.

WARIS Activities

Specific WARIS activities include library development, database development, information retrieval and dissemination and support for national rice information systems.

Library Development

The library collections will include all information relevant to rice production in the Sahel, mangrove swamp and upland/inland swamp continuum ecosystems of West Africa, with the emphasis on agronomy, soil science, weed science, economics, plant physiology, post-harvest technology, entomology, pathology, breeding, engineering, biotechnology and farm management. Special attention will be given to distributing material on African rice varieties in general and on *Oryza glaberrima* in particular.

The library holdings are being developed through subscribing to core journals (about 200 titles), updating the present journal collection by purchasing back issues, and acquiring basic texts and reference materials for the libraries at the Main Research Center and at WARDA's two stations in Senegal and Sierra Leone. Materials published in English, French and Portuguese, including non-conventional documents produced by member countries, will be obtained through collection missions. By the end of 1990 the library monograph collection totalled 12 600 and the number of serial titles held was 1050. The collection also included maps and more than 3000 microfilms.

The libraries of WARDA's research stations at Rokupr in Sierra Leone and St Louis in Senegal will be upgraded and staff from each station will be trained in library management. This program will give WARDA scientists at these stations better access to information needed for their research activities.

Database Development

An important component of WARIS is the West African Rice Bibliographic Database (WARBI), an in-house database. WARBI will contain conventional and non-conventional literature relevant to the subject scope of WARIS, and will incorporate data from regional sources and international agricultural databases such as AGRICOLA, AGRIS, CAB International and TROPAG. References from relevant external databases will be

acquired on tapes or CD-ROM. Information from the database will be distributed on diskette to NARS libraries.

Institutional and statistical databases are also being developed. The former will contain information on NARS products and services, infrastructure, manpower and research programs. The latter will contain information on rice production indicators and will be used to assist in monitoring the development of rice in WARDA member countries. A *West African Rice Statistics Yearbook* will be produced.

Information Retrieval and Dissemination

WARIS also provides a wide range of information products and services, including those outlined here.

- Retrospective literature searches are undertaken for WARDA and NARS rice scientists by consulting CD-ROM agricultural titles, such as AGRICOLA (NAL), AGRIS (FAO), CAB Abstracts, SESAME and TROPAG.
- Lists of tables of contents in rice research and production journals received by the WARDA library are compiled and distributed monthly to all West African rice scientists. The lists are accompanied by a request form allowing scientists to order up to 50 photocopied pages free of charge. To ensure the efficiency of this service, the library's journal collection is being expanded to include key periodicals.
- Two regional directories, one on *Rice Research Institutes and Scientists*, and the other on *Rice Research Projects and Programs*, will be published. The information will be derived from the institutional database.
- Specific publications, such as a *Quarterly Accessions Lists*, *Quick Bibliographies*, an *Annual List of Serial Holdings* and a *Catalog of WARDA Publications*, will be produced from the bibliographic database.

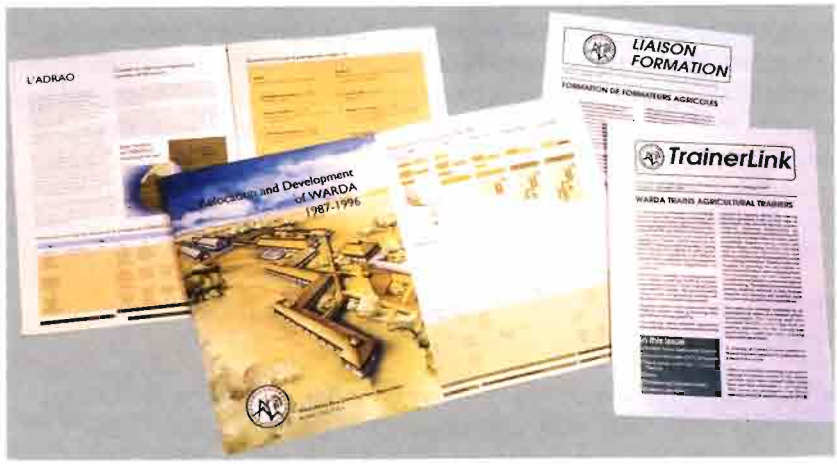
Among the information sources used by WARIS to conduct literature searches are CD-ROM titles, including AGRICOLA

Support for National Rice Information Systems

The rice research information systems of WARDA member states are being strengthened in a number of ways through the WARIS project. For example, a survey of national capacities is being conducted to assess national problems and needs. A back-up service is being provided through the supply of reference materials, photocopies and original documents, and on-the-job training is being offered to upgrade the skills of national library staff.

SUMMARIES OF COMMUNICATIONS ACTIVITIES

Publications Unit



The *1989 Annual Report*, published in English and French, was produced in-house up to camera-ready stage, and then printed out of house and distributed. The Publications Unit also produced all the documents required for WARDA meetings in 1990. Other publications in 1990 included:

- a brochure on the relocation and development of WARDA;
- the *Director General's Newsletter* (Nos. 2 and 3), reporting on the progress in WARDA's activities during the transition period; as this phase was completed in 1990, it was decided to terminate the publication of this newsletter;
- *Trainerlink*, a Training Center newsletter launched in 1990 and published in English and French; this newsletter reports on WARDA's training activities and provides a medium for the exchange of views on rice science training in West Africa;
- WARDA Briefing Document.

Library and Documentation Center

The capacity of WARDA's Library and Documentation Center was significantly upgraded by the acquisition of library holdings and the establishment of links with international agricultural information sources, such as those at the International Rice Research Institute (IRRI), the Agricultural University of Wageningen in the Netherlands and the Centre for Agricultural Publishing and Documentation (PUDOC).

Library Collection

In order to fill gaps in the library collection, during 1990 WARDA purchased: 762 books; 6824 pages of reprints/photocopies; 362 annual reports; 238 catalogs, brochures and pamphlets; 2268 issues of periodicals; and 159 miscellaneous publications. About 100 theses and non-conventional documents were collected or borrowed from various institutions in Bouaké and Abidjan, photocopied, bound and deposited in the library. The library now subscribes to 86 journals, an increase of 18 titles since 1989.

Database Management

The bibliographic database holds the 12 600 monograph titles available in the library and the newly developed serials database holds the 1050 journal titles to which the library subscribes. The computerized mailing list contains about 2500 addresses of institutions and individuals. This list was used to distribute about 3000 copies each of the *1988 Annual Report* and the *1988-89 Highlights*, as well as two issues of the *Director General's Newsletter*, to officials in WARDA member states and the donor community.

WARDA has acquired micro-CDS/ISIS software (version 2.3) from the United Nations Educational, Scientific and Cultural Organization (UNESCO), through the International Council for Research in Agroforestry (ICRAF), under a special arrangement within the CGIAR system. This has expanded the capacity of the bibliographic database and the mailing list considerably. The new version can handle an unlimited number of databases, with a maximium of 16 million records in each database.

With financial and technical support from CTA, WARDA now has the four major CD-ROM agricultural titles (CAB International, TROPAG, AGRIS and the CIMMYT Maize Germplasm Inquiry System). These CD-ROM databases have consideraby increased the Docu-

mentation Center's capacity to directly access international agricultural literature and have allowed extensive retrospective literature searches to be carried out.

Information Users' Services

With the establishment of the WARIS project, a questionnaire was designed and distributed to potential users of the selective dissemination of information (SDI) service in West Africa. All questionnaires are expected to be returned by the end of March 1991 and the SDI service will start operating in April/May 1991.

To increase awareness of the materials held by WARDA's library, two documents are compiled and distributed to WARDA stations and NARS. These are: *Current Contents at WARDA*, which contains the tables of contents of all journals to which the library subscribes (the library's journals subscription list has been revised and expanded by WARDA scientists): and *Quarterly Accessions Lists*, a document which lists the titles of materials received by the library.

The computerized literature search service for WARDA and NARS scientists began in 1990, and over 40 searches were carried out. The search topics included:

Rice diseases in West Africa

Wetlands in Africa

Yield stability analysis in rice, wheat, sorghum and maize

Selection indices in rice, wheat, sorghum and maize

Screening (selection) for salinity, iron toxicity and acidity

Resistance/tolerance to salinity, iron toxicity and acidity

Socioeconomic aspects of rice in West Africa

Sequential sampling

Sedentarization of farmers in Côte d'Ivoire

Rice production costs in West Africa

On-farm research

Relationships between physiological disorders in irrigated and upland rice in West Africa's forest area

Origin and ethno-geographical evolution of upland rice in Côte d'Ivoire

French literature relevant to maize cropping and farming systems in West Africa

Effects of seeding density and fertilizer on yield and weed infestation in maize

Rainfall probability

Animal traction and rice in West Africa

Phosphorus cycling

Planthoppers (Delphacidae): resistance to insecticides, insecticide-induced resistance, and effects of plant growth regulators

On request from users of WARDA's library and documentation services, books were loaned and photocopies of articles, documents and originals of documents were delivered free of charge.

WARDA's Documentalist attended the 4th meeting of the Regional Consultative Commission of the Sahelian Documentation Network, organized by the Reseau Sahélièn de Documentation et Technique (RESADOC) and held at Praia, Cape Verde from 28 to 31 May 1990.

Translation and Conference Services Unit

During 1990 more than 230 documents were translated from English into French. These included publications such as the *Annual Report 1989* and *Trainerlink*. The unit also provided logistical support for meetings and conferences, and assisted in WARDA's communications with francophone scientists and collaborators, to reinforce the bilingual character of all WARDA events and major publications.

INTERNATIONAL COOPERATION

In 1990 WARDA continued to consolidate collaborative links with national and international institutions and set up several WARDA/NARS thematic Task Forces to provide fora for discussions on research collaboration. Stronger links were also established with international research institutes outside the CGIAR system.

3.1 COLLABORATION WITH NATIONAL INSTITUTIONS

Djawadou Sanni

Contact with the rice research programs of WARDA member states was maintained through the organization of a series of regional meetings and training and communications activities. Contacts were also established with individual NARS in order to plan and implement more country-specific research activities. Through meetings organized by regional agricultural institutions and the NARS of WARDA member states, scientists were able to discuss common problems and exchange ideas.

WARDA In-House Review

The In-House Review, which took place in Rokupr, Sierra Leone, focused on WARDA's Mangrove Program. It was attended by 25 scientists from national research institutes in Guinea, Guinea-Bissau, Nigeria, Senegal and Sierra Leone. The participants reviewed WARDA's research activities in the mangrove swamp ecosystem and contributed to the design of a future research program that will be of direct interest to a greater number of national programs working in the mangrove swamp environment.

Annual Rice Review Meeting

During the 1990 Annual Rice Review Meeting (ARRM), the first operational meetings of the three Working Groups established during the previous ARRM were held. Each Working Group reviewed the WARDA

report on the survey of rice research resources in the region and the WARDA discussion paper, *Framework and Directions for WARDA/NARS Collaboration.*

The ARRM was attended by 19 scientists representing the NARS in WARDA's 16 member states. The participants decided that special Task Forces should be created (*see pages 5-6*) and that, as from 1992, the ARRM should be replaced by a bi-annual West African Rice Symposium.

Azolla Seminar

Early in 1990 an end-of-project seminar was organized to close the *Azolla* Project. The seminar was attended by 16 participants from Côte d'Ivoire, Ghana, Mali, Nigeria, Senegal, Sierra Leone, the FAO, IRRI and the Université Catholique de Louvain. The achievements of the project were reviewed and discussions were held on the utilization of project findings and the prospects for further research on *Azolla* in West Africa.

National Program In-House Reviews

In 1990, WARDA participated in the rice program reviews conducted by the NCRI (Nigeria), ISRA (Senegal) and the RRS (Sierra Leone). These meetings gave WARDA scientists an opportunity to interact with their partners in national programs.

Contacts with Individual NARS

Côte d'Ivoire

Scientists from WARDA's Continuum Program met with scientists from the Ivorian national program, Institut des Savanes (IDESSA), to plan complementary research activities in order to avoid duplication.

Ghana

A joint WARDA/IITA mission was undertaken at the request of the Ghanaian Ministry of Agriculture, under the auspices of the EEC delegation in Accra. The mission identified ways in which rice production in the western region of Ghana (once a prosperous rice producing area) could be enhanced through the development of inland valley swamp rice production. After a tour of the south-western region, the mission recommended collaboration and assistance in the following areas:

- supply of rice varieties (mainly short duration varieties) for trials to be conducted by Ghana's Crops Research Institute;
- training in rice research and production techniques; involving the participation of former trainees in WARDA's Training of Agricultural Trainers course and Rice Production and Research training course;
- characterization of inland valley swamps in the western region of Ghana;
- study of rice policy in Ghana.

Nigeria

WARDA's Director of Training and Communications initiated a joint publishing project with the NCRI in Nigeria to produce a West African edition of *Farmers' Primer on Rice Production*, originally published by IRRI.

Senegal

The WARDA Director of Research held meetings with ISRA (Sahel) Management to explore mechanisms for improving collaboration between WARDA and ISRA. A rice pathologist from the Senegalese national program acted as a resource person in the preparation of the curriculum and materials for a training course on integrated pest management to be organized by WARDA in July 1992.

3.2 COLLABORATION WITH INTERNATIONAL AND REGIONAL INSTITUTIONS

Djawadou Sanni

International Rice Research Institute (IRRI) and the Centro Internacional de Agricultura Tropical (CIAT)

A team of WARDA scientists, headed by the Director of Research, visited IRRI Headquarters in the Philippines to develop a research plan involving collaboration between WARDA and IRRI, with some input from CIAT. The head of CIAT's rice program participated in the discussions. A number of areas, outlined below, were identified as suitable for collaboration. In addition, a draft tripartite agreement between WARDA, IRRI and IITA was prepared.

Upland Rice Improvement

Collaboration in research activities aimed at improving upland rice will involve:

- characterization of blast populations and population dynamics in key 'hot spots', using RFLP or DNA fingerprinting techniques;
- identification of phosphorus-efficient and aluminium-tolerant germplasm and traits for aluminium tolerance and phosphorus uptake;
- examination of root penetration and root structures in upland rice;
- increased cooperation in upland rice breeding through expanded germplasm exchange (including segregating materials) and the exchange of a common set of indicator lines to characterize key testing sites;
- greater exchange of literature, especially in various areas of entomology.

Sahel Research

Three main areas of collaboration in Sahel research were identified.

- *Germplasm exchange.* IRRI will help WARDA reconstitute its germplasm collection, much of which has been lost as a result of inadequate storage conditions in Senegal, and will provide the Sahel Program with F_2 materials from lines being developed for direct seeding for *in situ* selection. WARDA will also request breeding lines and special donor materials.

- *Screening WARDA materials for stress resistance.* Until WARDA develops its own facilities for cold and salt screening at N'diaye in Senegal, IRRI will screen materials sent from WARDA. Most cold-tolerance screening will be done in South Korea, through an agreement between IRRI and the South Korean national program, but some might also be done in IRRI's laboratories where greater control of diurnal temperature fluctuations is possible. Salt-screening will be done in IRRI's laboratories and screenhouses. WARDA will begin sending appropriate materials to IRRI in early 1991. IRRI will also assist WARDA with rapid generation advance of WARDA segregating materials which show good tolerance traits.

- *Training.* IRRI will provide training for WARDA research assistants and techicians in the use of equipment for screening for cold and salt tolerance.

Genetic Evaluation

The joint WARDA/IRRI proposal concerning the activities of the International Network for Genetic Evaluation of Rice (INGER), which had been prepared for submission to the UNDP for funding (beginning in 1992), was discussed, modified and approved by both parties. The main features of the proposal are that:

- separate budgets for INGER activities in West Africa and in East, Central and Southern Africa (ECSA) be established;

- INGER-West Africa is integrated into the decision-making structure and activities of the Task Forces;

- funds be provided to support a senior scientist, recruited jointly by WARDA and IRRI, to manage INGER-West Africa.

Other WARDA/INGER activities during 1990 are reported on page 57.

International Institute of Tropical Agriculture (IITA)

Collaboration between WARDA and IITA during 1990 focused mainly on the characterization of continuum environments and support for WARDA's lowland rice breeding program, based at IITA.

Continuum Characterization

Representatives from WARDA, IITA and the WSC (The Netherlands) met in Bouaké, Côte d'Ivoire in November 1990 to review progress in joint characterization activities, to formulate a procedure for accelerating consideration by the Dutch Government of a pre-project proposal on joint characterization activities,

and to agree on the procedure for preparing and submitting a project proposal in mid-1991 to the Dutch Government, requesting funding for joint characterization activities during the main project phase.

In the pre-project phase, the activities of WARDA and IITA researchers will correspond largely with the work plans developed in the previous meeting. Small-scale surveys will be conducted, with the responsibilities shared between the collaborating institutions. Up to four additional countries are to be selected for characterization studies during a meeting with representatives of NARS in Bouaké in June 1991.

Lowland Rice Breeding Program

IITA agreed to provide experimental sites, office and laboratory space, and administrative assistance for WARDA's lowland rice breeder posted to IITA. WARDA retained 22 former employees in IITA's rice program and purchased essential field and laboratory equipment which had been used in IITA's rice program.

Japanese Research Institutions

WARDA established contacts with several Japanese research institutions, with the following objectives:

- to gain an overview of Japanese rice science institutions;
- to introduce and explain WARDA's new mandate, structure and activities to Japanese scientists and research managers;
- to identify mechanisms for establishing direct collaboration with Japanese scientists and research institutions.

Discussions were held with the Tropical Agricultural Research Institute (TARC), the National Agricultural Research Center (NARC), the National Food Research Institute (NFRI) and the National Institute of Agrobiological Resources (NIAR). From these discussions, it was clear that the key institution with which WARDA could establish effective collaboration was TARC. There is also potential for collaboration with NARC (physiology and biotechnology), NIAR (germplasm storage and maintenance) and NFRI (grain quality analyses).

Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD)

The potential for direct collaboration with CIRAD was explored in 1990. WARDA indicated that research on soils in the Sahelian environment and on soils or soil/water management in the continuum environment would be the most complementary activities to its existing core programs.

British Research Institutions

WARDA contacted several British institutions with the aim of developing collaborative projects in a number of areas. These institutions included CAB International, the International Institute of Entomology (IIE), the

British Museum of Natural History, the Natural Resources Institute (NRI), the International Institute of Parasitology (IIP) and the International Institute of Biological Control (IIBC). Collaboration in weed research was also explored during a visit to the Long Ashton Research Station. The following initiatives have resulted from these contacts:

- CAB International has prepared a concept paper on rice pest management in West Africa, setting out areas of collaboration with WARDA. The two main areas of collaboration are nematology studies and insect pest management, with the emphasis on biological control.
- IIP is preparing a project proposal for collaborative nematology studies under the CAB International umbrella. The project will consist of an initial survey in Côte d'Ivoire, lasting about 3 weeks. Based on the results of this survey, a proposal to conduct yield loss and diagnostic surveys in various West African countries will be developed.
- the Overseas Development Administration (ODA), through the NRI, agreed to fund a 3-year collaborative project with WARDA. An NRI scientist will be posted to WARDA for 6 months of each year of the project, beginning September 1991.

Panel of Experts on Environmental Management for Vector Control (PEEM)

The Executive Secretary of PEEM visited WARDA to determine the scope for collaboration in human health issues and to help WARDA develop a frame of reference for health-related studies. Contact was also made with the Centre Pierre Richet (a Bouaké-based French institution conducting research on vector-borne human diseases) and the Centre Universitaire de Formation en Entomologie Médicale et Vétérinaire (part of the University of Abidjan) to identify national institutions with which collaboration in health research might be initiated.

3.3 OTHER CONTACTS

Djawadou Sanni

During 1990 WARDA participated in several regional meetings organized by national and regional institutions.

Economic Community of West African States (ECOWAS) Workshop on Coordination and Integration of Agricultural Research in West Africa

The objective of this workshop, held in Lagos, Nigeria, was to formulate a program for promoting the coordination and integration of agricultural research in the region, in order to minimize duplication and repetition. In the long term, the program should lead to better use of the limited human and financial resources in West Africa. The workshop reviewed the problems facing NARS and recommended that countries in the region should allocate 1% of their GDP to agricultural research and development, as proposed in the Lagos Plan of Action.

Institut Sénégalais de Recherches Agricoles (ISRA) Workshop on Agricultural Research in Africa

Entitled 'Days of Reflection on Agricultural Research in Africa', this workshop was held in Senegal to mark ISRA's 15th anniversary. The objectives of the workshop were to give African research leaders the opportunity to discuss common problems and exchange views, to initiate a dialogue with donors on research funding constraints, and to open ISRA's doors to its clients. Participants from throughout Africa and from institutions such as the World Bank, CGIAR, CTA, USAID and the Special Program for African Agricultural Research (SPAAR) attended the meeting.

International Network for Genetic Evaluation of Rice (INGER)

Established by WARDA, IRRI, CIAT and IITA, this network provides rice scientists throughout the world with a mechanism through which rice breeding lines can be tested under a wide range of agroclimatic conditions and gives them access to a wide range of varieties. The network also helps national programs identify genetic materials better suited to their growing conditions and encourages them to share their materials with each other. WARDA is responsible for the participation of West African NARS in INGER activities.

In 1990 all WARDA member states, apart from Chad and Mauritania, participated in the evaluation of INGER-Africa upland and irrigated nurseries. Several NARS scientists also participated in INGER monitoring tours of Burkina Faso, Guinea, Guinea-Bissau and Senegal.

Conférence des Responsables de la Recherche Agronomique Africains et Français (CORAF) Rice Network

CORAF was established to reinforce national institutions involved in agricultural research with a view to developing a strong African scientific community. Its activities are carried out through commodity research networks. The priorities of the CORAF Rice Network are:

- the development of new varieties adapted to harsh environments, particularly with regard to irregular rainfall, uncertain flooding or low temperatures;
- disease control, through monitoring cryptogamic, viral and bacterial diseases and their evolution, and developing selection methods for varietal resistance, especially to blast;
- weed control, through drawing up a weed inventory and developing control methods;
- promotion of modern methods for characterizing rice growing environments (estimates of potentials and constraints) and developing crop techniques and systems suitable for establishing permanent rainfed rice paddies.

WARDA participated in the CORAF General Assembly, which was held in Lomé, Togo to review the activities of the network in varietal improvement, crop protection and rice economics. Among the recommendations made were the updating of the directory of CORAF scientists, a survey of national rice research capabilities, a study of the rice sector and a study of the improvement of rice production with low-cost land development.

CAPITAL DEVELOPMENT

4.1 WARDA'S MAIN RESEARCH CENTER AND HEADQUARTERS AT M'BE, COTE D'IVOIRE

Peter Mather

Following the decision in 1988 to relocate WARDA's Main Research Center and Headquarters from Liberia to Côte d'Ivoire, a development plan was drawn up. This plan involved using temporary accommodation at Bouaké, Côte d'Ivoire and the phased development of permanent accommodation at M'bé, 35 km north of Bouaké. Advertisements were placed internationally and tenders were obtained from prequalified contractors. After negotiations on the costs, a contract was signed for construction work to begin on Phase 1A in December 1990. This phase is scheduled for completion in February 1992.

The buildings to be constructed during Phase 1A are:

Main research facilities
: The accommodation includes: laboratories for Soil Science, Agronomy, Weed Science, Pathology, Entomology and Plant Breeding; offices for scientists, support staff and some administration staff; and service rooms. As a result of funding problems, the following facilities (representing about 37% of the accommodation) will not be completely finished or serviced during this phase: Physiology and Inter-Center Activities laboratories; Germplasm Research Unit; and some offices.

Insectory

Greenhouses and screenhouses (base only)

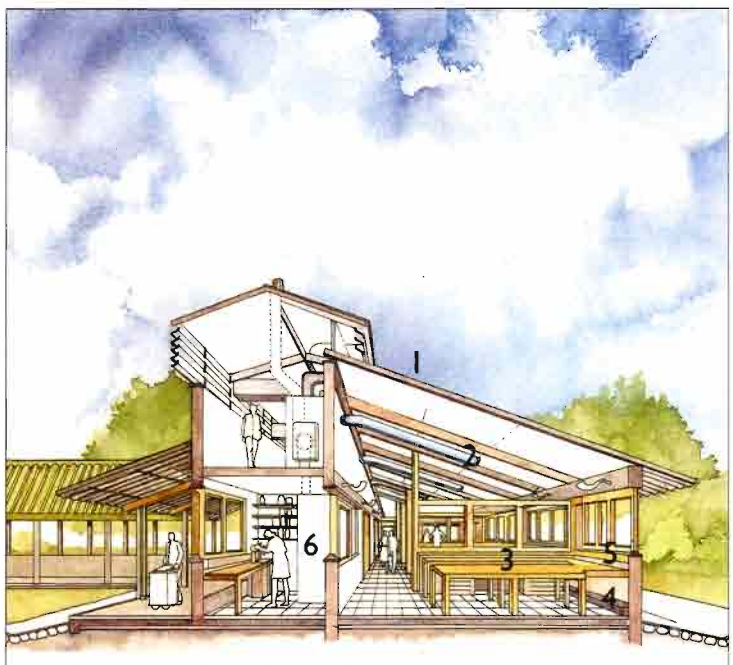
Farm complex, workshops and machinery spare parts store

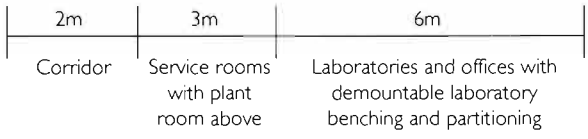
Generator/transformer house

Volatile chemical store

Fuel station and control posts

Associated infrastructure





1 Corrugated roofing, insulation and lining, steel roof structure on concrete beams
2 Air conditioning ducting
3 Demountable laboratory benching
4 Piped services and waste
5 Electrical trunking
6 Position of fume cupboards with extract system above

Section of WARDA's Main Research Center, being constructed at M'bé, Côte d'Ivoire

Contracts have been let and are in progress for water supply, main power to the site, microwave telephone equipment and a microwave telephone pylon.

The Design Intent

The key characteristics of the design of the Main Research Center and Headquarters buildings and infrastructure are replicability, flexibility and modularity:

- the building development will serve as a model for related organizations in the region operating under similar financial and environmental conditions (such as national agricultural research centers);
- the use of modular offices and laboratories provides an in-built flexibility and capacity for growth, catering for possible changes in the sizes of departments over time as program changes occur and financial and other resources become available;
- the materials being used in the construction are economic and easy to maintain, and local materials will be used where appropriate;
- the buildings are designed to be compatible with their tropical setting and to reflect the culture of the region, so as to create a highly conducive research and work environment.

The research facility is a single-storey building, characterized by courtyards and open corridors. It includes four zones:

- laboratories, interspersed with offices; the partitioning and demountable benching in this zone gives it considerable flexibility (for example, partitions between interconnecting laboratories can be removed to cater for joint working practices);
- a more fixed area which includes the service rooms (such as balance rooms, preparation rooms and rooms incorporating fume cupboards);
- a gallery over the fixed rooms, serving these rooms as well as the laboaratories and offices;
- an external open access corridor.

Temporary Accommodation

After the completion of the temporary offices and laboratories, their long-term use was reconsidered. It was decided that they would be used, on a permanent basis, as the Upland Research and Maintenance Center, in view of their proximity to the upland research farm. Additional workshops and equipment stores were erected to accommodate machinery associated with the upland research program.

Financial statement

Warda personnel

List of acronyms

West Africa Rice Development Association

Statement of Financial Position as at 31 December 1990

(expressed in US dollars)

	1990	1989
CURRENT ASSETS		
Inventory	82 505	66 872
Accounts Receivable - Donors	1 452 382	272 569
Accounts Receivable - Other	432 367	303 458
Fixed Deposits	—	1 143 719
Cash and Bank Balances	2 779 159	449 853
Total Current Assets	4 746 413	2 236 471
CURRENT LIABILITIES		
Accounts Payable	250 043	147 300
Provisions and Accruals	1 591 241	820 764
Contributions in Advance	864 915	514 973
Project Fund Balances	68 457	81 438
Total Current Liabilities	2 774 656	1 564 475
Net Current Assets	1 971 757	671 996
Property, Plant and Equipment	3 469 961	3 450 194
NET ASSETS	5 441 718	4 122 190
Represented by:		
Restricted Funds		
Capital Fund	3 469 961	3 450 194
Capital Development Fund	1 579 733	10 468
Unrestricted Funds		
Working Capital	500 000	500 000
Operating Fund	(107 976)	161 528
FUND BALANCES	5 441 718	4 122 190

The financial statements were approved by the Board of Trustees on 9 April 1991 and were signed on their behalf by:

Director General

Director of Administration and Finance

West Africa Rice Development Association

Grants and Contributions for the year ended 31 December 1990

(expressed in US dollars)

	UNRESTRICTED CORE	RESTRICTED CORE	SPECIAL PROJECTS	CAPITAL DEVELOPMENT	TOTAL 1990	TOTAL 1989
DONORS						
World Bank	1 600 000	—	—	—	1 600 000	1 630 000
Sweden	615 631	—	—	—	615 631	400 508
Canada	609 438	—	—	174 125	783 563	566 466
IDRC	—	21 686	—	—	21 686	—
AfDB	200 000	—	—	150 000	350 000	350 000
The Netherlands	97 104	—	—	536 688	633 792	227 392
Germany	296 448	155 558	—	689 263	1 141 269	836 493
France	237 525	29 383	—	871 384	1 138 292	316 489
Japan	801 609	—	141 666	505 614	1 448 889	929 191
Belgium	60 298	—	35 000	170 760	266 058	157 109
EEC	—	431 787	—	—	431 787	—
UNDP		69 000	418 213	—	487 213	189 459
USA	—	333 103	—	—	333 103	386 257
Italy	128 375	—	—	—	128 375	218 064
UK	175 035	—	—	—	175 035	105 998
Rockefeller Foundation	—	3 770	—	—	3 770	—
Subtotal	4 821 463	1 044 287	594 879	3 097 834	9 558 463	6 313 426
MEMBER STATES						
Burkina Faso	18 604	—	—	—	18 604	—
Mali	18 604	—	—	—	18 604	—
Sierra Leone	18 604	—	—	—	18 604	—
Subtotal	55 812				55 812	
SUNDRY INCOME	91 074	—	—	41 355	132 429	99 988
Grand total	4 968 349	1 044 287	594 879	3 139 189	9 746 704	6 413 414

West Africa Rice Development Association

Statement of Activity by Funding Source for the year ended 31 December 1990

(expressed in US dollars)

	UNRESTRICTED CORE	RESTRICTED CORE	SPECIAL PROJECTS	TOTAL OPERATING	CAPITAL DEVELOPMENT	TOTAL 1990	TOTAL 1989
INCOME							
Grants and Contributions							
Donors	4 821 463	1 044 287	594 879	6 460 629	3 097 834	9 558 463	6 313 426
Member States	55 812	—	—	55 812	—	55 812	—
Other Income	91 074	—	—	91 074	41 355	132 429	99 988
	4 968 349	1 044 287	594 879	6 607 515	3 139 189	9 746 704	6 413 414
EXPENDITURE							
Research Programs	1 748 968	876 951	175 796	2 801 715	—	2 801 715	2 489 810
Training and Communications	1 110 255	71 270	418 483	1 600 008	—	1 600 008	1 306 166
General and Administration	1 925 415	—	—	1 925 415	—	1 925 415	1 861 732
Capital Development	—	—	—	—	243 088	243 088	495 971
Total Non-Capital Expenditure	4 784 638	948 221	594 279	6 327 138	243 088	6 570 226	6 153 679
Capital Expenditure	325 486	96 066	600	422 152	1 326 836	1 748 988	233 816
	5 110 124	1 044 287	594 879	6 749 290	1 569 924	8 319 214	6 387 495
EXCESS OF (EXPENDITURE OVER INCOME) INCOME OVER EXPENDITURE	(141 775)	—	—	(141 775)	1 569 265	1 427 490	25 919
Extraordinary Items	(92 047)	—	—	(92 047)	—	(92 047)	—
Inter Fund Transfer prior year adjustments	(25 761)	—	—	(25 761)	—	(25 761)	25 510
FUND BALANCES AT BEGINNING OF YEAR	161 528	—	—	161 528	10 468	171 996	120 567
Further provision for doubtful debts	(9 921)	—	—	(9 921)	—	(9 921)	—
FUND BALANCES AT END OF YEAR	(107 976)			(107 976)	1 579 733	1 471 757	171 996

WARDA Personnel

Office of the Director General

Eugene R. Terry, PhD [3]	Director General
Robert I. Ayling, ThD [1,3]	Special Assistant to the Director General
Salif Camara, MS [5]	Internal Auditor
Djawadou Sanni, Eng. GR [3]	Special Assistant to the Director General for International Cooperation

Administration and Finance Division

Gordon MacNeil, MBA [3]	Director of Administration and Finance
Kwame Akuffo-Akoto, BSc, FCCA [3]	Financial Controller
Bola Andrews, MA [5]	Administrative Officer
Ursule Konan, ML, CFB [5]	Personnel Officer

Research Division

Research Coordination

Peter Matlon, PhD [3]	Director of Research
George Paku, PhD [1,3]	Agro-Statistician
Edgar W. Richardson, PhD [2,3]	Biometrician
Chitti Babu Buyyala, BSc [2,3]	Farm Manager
Michel Briat, IA [6]	Assistant Farm Manager

Upland/Inland Swamp Continuum Program

Bouaké, Côte d'Ivoire

Kouamé Miézan, PhD [1,3]	Program Leader and Breeder (to July 1990)
Elvis A. Heinrichs, PhD [2,3]	Program Leader and Entomologist (from October 1990)
Abdoul Aziz Sy, PhD [2,3]	Pathologist
Akinwunmi Adesina, PhD [2,3]	Production Economist
Monty Jones, PhD [2,3]	Breeder
Lawrence Becker, PhD [2,3]	Geographer/Post-Doctoral Fellow
Thomas Remington, MSc [2,3]	Cropping Systems Agronomist
Gallus Cassian Nyoka, PhD [1,3]	Weed Scientist
Emmanuel Akinsola, PhD [1,3]	Entomologist
Mortuza Choudhury, PhD [1,3]	Breeder
Victor Nyanteng, PhD [1,3]	Economist
Sitapha Diatta, DEA [3]	Research Associate
Roger Diallo, Ing. Agr. [5]	Research Associate

Suakoko, Liberia

Ayo O. Abifarin, PhD [1,3]	Breeder

Sahel Irrigated Rice Program

St Louis, Senegal

Kouamé Miézan, PhD [2,3]	Program Leader and Breeder (from July 1990)
Michael Dingkuhn, PhD [2,3]	Physiologist
Johnson Olufowote, MSc [1,3]	Breeder
Alioune Coly, Doctorat [1,3]	Physiologist

Mangrove Swamp Rice Program

Rokupr, Sierra Leone

Martin Agyen-Sampong, PhD [3]	Network Coordinator and Entomologist
Sylvanus Fannah, MSc [1,5]	Entomologist
Harris Bernard, MSc [1,5]	Weed Scientist
Sahr Fomba, PhD [1,5]	Pathologist
Charles Dixon, MSc [5]	Soil Scientist

Post-Harvest Technology

Fendall, Liberia

Michio Takeda, BSc [7]	Post-Harvest Specialist
Ayodele Adewusi, MS [1,4]	Processing Engineer

Training and Communications Division

Anthony Youdeowei, PhD, FAAS [2,3]	Director of Training and Communications

Training Center, Fendall, Liberia

Kaimasa Conteh, MSc [1,3]	Chief, Training Center
Inoussa Akintayo, PhD [1,3]	Trainer

Communications

Christiane Soufflet, MA [3]	Translator/Reviser
Alassane Diallo, MSc [3]	Documentalist
David Hill, MSc [1,3]	Publications Specialist
Tah Asongwed, DEA [1,3]	Translator/Interpreter
Solange Bembatoum, DESS [5]	Translator

Capital Development

Gregory Servant, BBA [2,4]	Capital Projects Officer

1 Left on or before 31 December 1990
2 Joined in 1990
3 International senior staff (core programs)
4 International senior staff (complementary programs)
5 Professional general service staff
6 French co-operant
7 Japanese contract staff

List of Acronyms

AfDB	African Development Bank
AGRICOLA	Agricultural On-Line Access (National Agricultural Library, USA)
AGRIS	Agricultural Information System (FAO)
ARRM	Annual Rice Review Meeting
BNDA	Banque Nationale de Développement Agricole (Mali)
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CIDA	Canadian International Development Agency
CIDT	Compagnie Ivoirienne pour le Développement des Textiles (Côte d'Ivoire)
CIDV	Compagnie Ivoirienne pour le Développement des Productions Vivrières (Côte d'Ivoire)
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement (France)
CNRST	Centre Nationale de Recherche en Scientifique et de Technologie (Burkina Faso)
CORAF	Conférence des Responsables de la Recherche Agronomique Africains et Français
CTA	Technical Centre for Agricultural and Rural Cooperation (The Netherlands)
ECA	Economic Commission for Africa
ECOWAS	Economic Community of West African States
ECSA	East, Central and Southern Africa
EEC	European Economic Community
FAO	Food and Agriculture Organization of the United Nations
GIS	geographic information system
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
IARI	Indian Agricultural Research Institute
ICRAF	International Council for Research in Agroforestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDESSA	Institut des Savanes (Côte d'Ivoire)
IDRC	International Development Research Centre
IFAD	International Fund for Agricultural Development
IFDC	International Fertilizer Development Center
IIBC	International Institute of Biological Control (UK)
IIE	International Institute of Entomology (UK)
IIP	International Institute of Parasitology (UK)
IITA	International Institute of Tropical Agriculture
ILCA	International Livestock Centre for Africa
INGER	International Network for Genetic Evaluation
INP	Institut National Polytechnique (France)
IRA	Institut de Recherches Agronomiques (Cameroon)
IRAT	Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières (Côte d'Ivoire)
IRRI	International Rice Research Institute
ISRA	Institut Sénégalais de Recherches Agricoles
JICA	Japanese International Cooperation Agency
NARC	National Agricultural Research Center (Japan)
NARS	national agricultural research systems
NBPGR	National Bureau of Plant Genetic Resources (India)
NCRE	National Cereals Research and Extension project (Cameroon)
NCRI	National Cereals Research Institute (Nigeria)
NFRI	National Food Research Institute (Japan)
NIAR	National Institute of Agrobiological Resources (Japan)

NRI	Natural Resources Institute (UK)
ODA	Overseas Development Administration (UK)
ORSTOM	Institut Français de Recherche Scientifique pour le Développement en Coopération (formerly Office de la Recherche Scientifique et Technique Outre Mer)
PEEM	Panel of Experts on Environmental Management
PNDC	Provisional National Defence Council (Ghana)
PUDOC	Centre for Agricultural Publishing and Documentation (The Netherlands)
RESADOC	Reseau Sahélièn de Documentation Scientifique et Technique
RFLP	restriction fragment length polymorphism
RRS	Rice Research Station (Sierra Leone)
SAED	Société Nationale d'Aménagement et d'Exploitation des Terres du Delta du Fleuve Sénégal et des Vallées du Fleuve Sénégal et de la Falémé
SATMACI	Société d'Assistance Technique pour la Modernisation Agricole en Côte d'Ivoire
SDI	selective dissemination of information
SODERIZ	Société de Développement du Riz (Côte d'Ivoire)
SPAAR	Special Program for African Agricultural Research
TAC	Technical Advisory Committee (CGIAR)
TARC	Tropical Agricultural Research Center (Japan)
TOT	Training of Agricultural Trainers
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WARBI	West African Rice Bibliographic Database
WARIS	West African Rice Information System
WSC	Winand Staring Centre (The Netherlands)

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