

**THE GAMBIA AGRICULTURAL RESEARCH
AND DIVERSIFICATION PROJECT**

(GARD)

FOURTH ANNUAL WORKPLAN

1989 - 1990

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THE GARD PROJECT
FOURTH ANNUAL WORKPLAN

INTRODUCTION

The Fourth Annual Workplan for the GARD Project takes into account the new project environment arising from the following:

- A. The Mid-Project External Evaluation;
- B. Evolution of the National Agricultural Research Board (NARB);
- C. Research Priorities established by the NARB;
- D. Requests by the GOTG's Project Management Committee (PMC) and by AID/Banjul to extend the contract.

These developments are reviewed in section I of the plan. Section II presents a tentative Research Framework that is intended to: (a) place research in the context of development objectives; (b) show the relationships among development objectives, farmer constraints, research priorities, research objectives, and projected accomplishments and benefits; (c) highlight key assumptions and necessary complementary activities outside of research; and (d) guide the measurement of the impact of research. In section II there is also a complete presentation of all DAR and DLS research projects and research objectives. GARD inputs for 1989/1990 are discussed in section III. The complete list of GARD inputs and the departmental budget worksheets are in Annexes A and B, respectively.

I. THE NEW PROJECT ENVIRONMENT

This section discusses how the Project environment has been changed by each of the factors listed above.

A. The Evaluation

The Mid-Project External Evaluation was undertaken in the fall of 1988 and submitted in January, 1989. The findings, conclusions and recommendations are summarized on the following pages (Evaluation, pp. 5-8).

II. OVERALL ASSESSMENT OF PROJECT PROGRESS

A. Findings

Situation at the Beginning of the Project

1. Agricultural research was predominantly crop oriented.
2. The research programs consisted largely of trials from regional and international agricultural research centers which did not necessarily reflect national priorities. In some instances Gambian researchers carried out the trials and submitted the raw data to a regional research network coordinator, but did not receive the results of any statistical analysis.
3. There was a minimal number of well-trained researchers, and they were not well-equipped.
4. There was a general perception that the Agricultural Research Service's activities were not relevant to the country's agricultural development activities.

Achievements to Date

5. Since 1986, the research programs have increasingly reflected Gambian assessments of research priorities. Participation in the trials of regional networks is much more selective than previously. The quality, quantity, and relevance of research results to Gambian conditions has increased significantly.
6. The internal review process for selecting and designing research projects has been strengthened.
7. A substantial number of research personnel have received short-term training, either in The Gambia or abroad, and a number are currently in long-term training abroad.
8. Researchers now have access to computers and have been trained in their use. Thus, the timeliness and quality of analyses, and the reporting of the analyses, has improved significantly; further progress is needed.
9. A program budgeting system (PBS) has been installed in the research service and is helping to bring about improved design of projects and improved financial management.
10. The National Agricultural Research Board (NARB) has been established and has directed the Director of Agricultural Research, as Acting Technical Secretary of the NARB, to draft for the NARB's review and approval an overall research policy statement and guidelines for the design of the agricultural research program.

11. Research on crops has been made the priority concern of a single department, the Department of Agricultural Research, and a research unit is now functioning in the Department of Livestock Services.
12. Pilot promotional activities have been initiated for rice and cowpeas in collaboration with the extension services and NGOs. A grant has been made to Save the Children (USA) for the promotion of improved practices and varieties of rice and millet.

Matters Needing Priority Attention

13. There are still perceptions within the GOTG and among those working with agricultural development that the research service's activities are largely irrelevant to current development needs; in particular, they do not respond adequately to the constraints faced by The Gambia's farmers.
14. In part because of the foregoing, in part because of the conditions of service, there is low researcher morale and a number of qualified personnel have quit the service to work with development activities in The Gambia or with international centers.
15. The implementation of research activities needs considerable improvement.
16. Further improvement in the management and use of financial and other resources is needed.
17. The research service's linkages with the extension service, with NGOs, and with other development projects needs to be strengthened.

B. CONCLUSIONS

1. To help offset Findings 13 and 14 and to ensure that the research program is relevant, the highest priority action needed is the preparation of the research policy/priorities guidelines statement requested by the NARB.
2. The preparation of the policy/priorities statement should involve researchers, personnel from other GOTG departments, and people active with development projects. The statement should integrate overall government agricultural policy, a review of ongoing and planned development activities, potential technology breakthroughs, and a review of farmers' constraints and innovations.
3. The research service needs to increase its attention to farmers' constraints and to give greater publicity to those of its activities which are designed to deal with farmers' problems.

4. To stay current on farmers' problems and to ensure that its findings are transmitted to the farmer, the research service needs to strengthen its linkages with the non-governmental organizations (NGOs) and other development agencies and with the extension service. The research service also needs:
 - a. to ensure the availability of good agricultural and socioeconomic data; and
 - b. to have the capability to analyze the data and disseminate the findings of the analysis.
5. Improved implementation of research projects will require that:
 - a. the MOA: (1) make GOTG funds available as needed to meet research needs, rather than distributing them evenly by quarter throughout the year as is presently the case; (2) decentralize some purchasing authority; and (3) improve the management of the soils laboratory.
 - b. the research service: (1) reduce the number of on-station activities that it tries to implement; (2) utilize NGOs and other development agencies more to help carry out on-farm trials and demonstrations; and (3) manage better the resources available for implementation of activities.
6. Improved management of resources will require:
 - a. greater delegation of authority and responsibility to research station managers and effective use of those delegations by the station managers; and
 - b. improved monitoring of field activities by headquarters staff.
7. If the issues raised in this evaluation are dealt with along the lines of the recommendations which follow, the Project purpose is attainable and the Project can make a significant contribution to the expansion and diversification of Gambian agriculture.

C. RECOMMENDATIONS

1. The Directorate of Agricultural Research (DAR) coordinate the preparation of the research policy/guidelines statement requested by the NARB and submit it to the NARB no later than March 31, 1989
2. Funding requests for research projects for the coming year not be considered until the policy/priorities statement has been submitted to NARB; all projects proposed should be consistent with the policy/priorities statement.

3. The principal farmer constraints be identified as a part of the policy/guidelines exercise; the information collected be utilized to develop the outlines of a program for resolving (or at least alleviating) farmers' problems and for maintaining a surveillance of developments on the farm.
4. The policy/guidelines exercise be carried out in such a way as to:
 - (a) strengthen the linkages of the research service with NGO's and other development programs and with the extension service; and
 - (b) pave the way for more active collaboration in the selection, design, and implementation of research activities.
5. Following the approval by NARB of a research policy and research priority guidelines, a special study of research manpower availability and requirements be undertaken. The study should also focus on career development and job satisfaction issues. Consistent with the findings of the study, a long-term training plan should be developed; it should cover both long- and short-term training priorities.
6. The Ministry of Agriculture (MOA):
 - a. make funds and other resources (e.g., petrol) available on a more timely basis and in accordance with the operational requirements of research;
 - b. delegate additional authorities to research station managers so they can ensure improved implementation of research activities;
 - c. prepare a management improvement plan for Sapu research station; and
 - c. improve the management of the soils laboratory.
7. DAR strengthen its monitoring or the use of its resources so it can assure MOA that delegated authorities will not be abused.
8. MOA fill DAR vacancies so DAR can:
 - a. monitor better the use of resources;
 - b. expand and strengthen its linkages with extension and development agencies, particularly the NGOs; and
 - c. through stronger management, generally improve the effectiveness and efficiency of the research service.
9. MOA should fill the vacant Technical Secretariat positions designed to serve the NARB so that the Secretariat can begin to realize its potential.

10. MOA review the situation in the Department of Planning (DOP), particularly the administration of the National Agricultural Sample Survey (NASS), and consider transferring the National Agricultural Data Centre to the DAR and upgrading the Centre to encompass also socioeconomic data collection and analysis.
11. DAR and DAS should strengthen their technology promotion activities, including through increased collaboration with NGO's and other development projects.

The evaluation elicited considerable discussion and, inevitably, some disagreements. For the most part, however, GOTG, the contractor, and AID consider it a useful document that has focused attention on key issues and has speeded action in a number of areas. Concerning recommendations 1-4 about research priorities, a team from ISNAR was brought in to work with the NARB in their first priority-setting effort. The NARB issued its research priority document in March, 1989. A consultant has been engaged for January, 1990, to deal with personnel and training as suggested in recommendation 5. The GOTG has initiated action on the management and staffing issues raised in recommendations 6-9, and these will receive continuing attention in the future. The GOTG and the contractor disagree with recommendation 10 to move the National Agricultural Data Center (including the National Agricultural Sample Survey--NASS) from the Department of Planning to the Department of Agricultural Research. The DOP is expanding its collection of socioeconomic data and its analytical capacity as suggested in that recommendation.

The last recommendation, to strengthen technology promotion through collaboration with NGOs and via other means, is consistent with a number of activities that were already in the works and it has stimulated even more. This recommendation is also consistent with GOTG's and AID/Banjul's desire for research to have more impact on farmer incomes as soon as possible. However, there are differences of opinion as to the best strategy for achieving this objective. These differences relate to the reliance one should place on (a) GOTG researchers in the ministries, (b) full expatriate assistance in the ministries, and (c) expatriate assistance only nominally associated with the ministries.

The evaluation has had its biggest impact on the project environment by bringing to the fore this mandate to speed the flow of technology and benefits from researcher to farmer. This can be seen in the coming year's plans for the rice technology workshop, Farmer Innovation and Technology Testing (FITT) activities, recruitment of a Research Associate in Horticulture, numerous request from NGOs and other development organizations for collaboration and cooperation, such as joint promotion and distribution of findo seed, preparation of new extension bulletins, and the continuing work of the RELO with extension and NGOs in promoting cowpeas. In responding to this mandate, GOTG researchers have suggested bringing in extension agronomists or Accelerated Crop Production Officers or Field Trials Officers following the example of SAFGRAD. Extension staff have also suggested adding extension agronomists. The addition of such TA/RA personnel is seen as desirable

because the very thin ranks of research personnel have been further depleted by training and continuing attrition.

B. The NARB

The creation of the NARB and its effective functioning are starting to have wide-reaching effects on the government's view of agricultural and natural resources research, on the way the research services plan their programs, on the way researchers orient their work, on coordination among ministries and across disciplines, and on GOTG funding of research. The very fact that Permanent Secretaries, heads of parastatals, private businessmen, and senior researchers all gather periodically to discuss research priorities, training needs, the balance among programs, and funding prospects is bound to improve the strength, efficiency, and relevance of research.

As a result of prodding by the NARB, the Ministry of Water Resources, Forestry, and Fisheries (MWRFF) is developing and presenting research plans for its Departments of Forestry, Fisheries, Water Resources, and Wildlife. Furthermore, they have been asked to present their research plans in a manner similar to the Program Budgeting System (PBS) pioneered by the MOA's Department of Agricultural Research. [In fact, based on the DAR experience, the MOA has asked GARD to help develop PBS for the whole Ministry.]

The NARB has decided that the GOTG should provide one percent of agricultural gross domestic product to support research operations (in addition to salaries). The Chairman of the NARB is discussing this funding level with the appropriate ministers. If approved, this will provide a solid core of funding on which the research units can rely and on which they can base their plans. This should also encourage supplementary funding from donors.

C. Research Priorities

The research priorities established by the NARB with the assistance of ISNAR serve several important functions. They obviously provide a key set of criteria for decisions as to which research programs should and should not be funded. This is especially important in The Gambia with its small research system where significant research efforts can only be expended on the most important commodities and activities. Another important function of the priorities is the guidance they give the researchers. The priorities should guide the external networking links that researchers form, the literature they read, the visitors they devote time to, and the training opportunities they pursue. To the rest of the government and to donors, the priorities send a clear message that research knows where it is headed, that top public officials and private citizens have identified critical areas where research is needed, and that resources allocated to research will be used where they will have the biggest payoff.

D. Contract Extension

The GOTG's Project Management Committee¹ and AID/Banjul have recommended that the GARD contract be extended 18 months to the end of the Project Agreement between AID and GOTG in June, 1992. This will provide more time and funds to pursue the main elements of GARD as they have been evolving over the past 30 months, and it will also allow more attention to be devoted to elements that had to be given somewhat lower priority or that had been deferred.

Thus, GARD will provide more support to natural resources, starting with training, a consultancy on agroforestry/alley cropping, and a resource economist for the Department of Planning (DOP). The contract extension will also allow for more support to the RELO and pilot promotion activities. Support is also being considered for a variety of issues and activities that would complement the research and promotion efforts.

Most such activities lie in the domain of marketing -- both output and input marketing. These include horticulture marketing, sesame marketing, the domestic poultry feed industry, delivery systems for fertilizer and other inputs, and similar issues that continually arise.

II. THE RESEARCH FRAMEWORK

A goal of the NARB is to establish a research system that has a sound National Research Plan as its foundation. The Research Framework takes a step toward this goal by outlining the essential elements of a viable research system. Such a system contributes to national development goals by seeking technologies that will eliminate or at least alleviate the major problems faced by the farmer. As indicated by the scope of the framework, the research service is not alone in this effort. Strong linkages with the extension service and other development organizations are necessary to ensure that farmers receive research results.

The Research Framework consists of the following items:

- Development Objectives;
- Constraints Facing Farmers;
- Research Priorities;
- Research Objectives;
- Research Orientation;
- Projected Accomplishments and Benefits;
- Required Complementary Activities;
- Measures of Research Impact.

¹ The Program Management Committee is composed of the Permanent Secretaries of three ministries: Agriculture; Water Resources, Forestry, and Fisheries; and Economic Planning and Industrial Development.

A. Development Objectives

In the course of setting research priorities, the NARB used the national development goals as a basis for establishing the following development objectives for research:

1. Improve the average level of well-being (income) for all citizens;
2. Obtain a broad-based increase in the rate of rural income growth;
3. Increase the rate of income growth for low-income people more than the average;
4. Reduce year-to-year fluctuations in income.²

B. Farmer Constraints

The Research Task Forces have identified the following nine constraints facing farmers:³

1. Rainfall -- long-run decline;
2. Land -- scarcity in some areas, erosion, lower fertility;
3. Labor -- at planting and weeding, especially for lowland rice;
4. Pests and Disease -- in crops and animals;
5. Plant Stand Establishment -- groundnut, cowpea, maize, sorghum;
6. Animal Nutrition -- all species;
7. Post Harvest -- marketing, storage and processing;
8. Policy and Institutions -- input supply and output marketing;
9. Sociocultural -- adoption rates, gender differentiation, land tenure.

C. Research Priorities

The NARB has assigned priorities to research on crops, livestock, and natural resources based on a weighted combination of the following criteria: current production, expected productivity gains, probability of success, extent of likely adoption, and future demand. These criteria were weighted according to their effect on the four Development Objectives, which were themselves weighted by the NARB.

² Norton, Mills, Gilbert, Sompo-Ceesay, and Rowe. "Analysis of Agricultural Research Priorities in The Gambia." March 1989. p. 1.

³ Ibid. pp. 3-6

The commodity priorities are as follows:⁴

<u>High</u>	<u>Medium</u>	<u>Low</u>
Groundnut	Draft Animals	Sesame
Ruminants	Poultry	Cassava
Early Millet	Late Millet	Cowpeas
Rice, Swamp and Upland	Maize	Irrigated Rice
Vegetables	Sorghum	
Fisheries	Findo	
Forestry	Fruits	
Cotton		

The NARB has also assigned priorities to types of research. These assignments derive from the Farmer Constraints translated into such criteria as the number and severity of research problems, effect on land use, effect on capital use, complementarities with research that can be borrowed from outside, current research emphasis, and research cost.

The priorities for types of research are as follows:⁵

<u>High</u>	<u>Medium</u>
Varietal Screening	Livestock Management
Plant Protection	Socioeconomics
Animal Health	Fisheries Technologies
Soil Fertility and Agroforestry	Natural Resources Studies
Cropping Systems/Cultural Practices	Mechanization
Post Harvest Practices	

These priorities are still considered highly tentative. The definitions need modification, and the scoring system did not sharply distinguish between higher and lower priorities.

D. Research Objectives

The Program Budgeting System and its concomitant objectives statements are most highly developed in the DAR and DLS. The programs approved by the NARB for these two departments are the focus of this section. The DAR is funding research under five programs in 1989/1990. The specific projects within each program were selected according their conformity to the NARB's priorities and with due regard for personnel constraints. Each project and its objective is considered on the following pages.⁶

⁴ National Agricultural Research Board. "Agricultural Research Priorities for The Gambia." March 1989.

⁵ Ibid.

⁶ Sompo-Ceesay, M. S. "Work Program and Budget: Department of Agricultural Research." May 1989.

DEPARTMENT OF AGRICULTURAL RESEARCH

GRAIN LEGUMES AND OILSEEDS PROGRAM

1. **Groundnut Variety Screening On-Station**
Objective: Introduce and screen early maturing varieties from ICRISAT.
2. **Groundnut Variety Screening On-Farm**
Objective: Further testing of most promising short duration varieties under farmer management.
3. **Groundnut Seed Drying and Curing**
Objective: Develop, test and promote improved methods of seed drying and curing to improve seed viability.
4. **Cowpea Promotion**
Objective: Promote and monitor on-farm performance of most promising varieties.
5. **Sesame Promotion**
Objective: Provide seeds and technical advice to NGOs for short duration varieties.

RICE PROGRAM

1. **Promotion of Rice Technologies**
Objective: Promote improved technologies tested and adapted by DAR such as animal traction, row seeding, and weed control to farmers through extension and NGOs.
2. **Animal Traction Follow-up Survey**
Objective: Evaluate adoption of animal traction by participants in the 1988 farmer-managed trials, assess constraints to adoption, and identify farmer adaptations of the technology.
3. **Weed Control**
Objective: Develop an effective and economic weed control program for rainfed and upland rice at five locations.
4. **Fertilizer Recommendations**
Objective: Develop fertilizer recommendations for continuous rice cultivation on Tandako soils.
5. **Rice Ecology**
Objective: Establish a rice ecology classification system as a basis for developing research programs.

HORTICULTURE PROGRAM

1. **Staggered Production of Vegetables**
Objective: Assess technical and socioeconomic constraints to early planting of vegetables aimed at market windows.
2. **Tomato and Cabbage Variety Trials**
Objective: Evaluate performance and yield of varieties in the rainy season.
3. **Water Use Efficiency Trial for Tomatoes**
Objective: Evaluate performance and yield under varying levels of irrigation and mulching regimes.
4. **Citrus Rootstock Trials**
Objective: Identify rootstocks resistant to local diseases.
5. **Mango Cultivar Evaluation**
Objective: Select high-yielding mango cultivars for local and export markets.
6. **Propagation and Promotion of Improved Citrus and Mango Rootstock**
Objective: Provide budded and grafted rootstock for sale to farmers.
7. **Banana Literature Review**
Objective: Review literature on banana management for high yields.
8. **Papaya Management**
Objective: Determine optimal management practices.

UPLAND CEREALS PROGRAM

1. **Early Millet Local Variety Collection**
Objective: Collect local varieties from farmers' fields for on-station screening.
2. **Early Millet Variety Evaluation**
Objective: Evaluate local varieties for yield and for resistance/tolerance to local pests and diseases at Kuntaur, Bakendik, and Sapu.
3. **Biological Control of Striga in Early Millet**
Objective: Screen for natural enemies of striga.

CROPPING SYSTEMS AND RESOURCE MANAGEMENT PROGRAM

1. **Fertilizing the Groundnut/Millet Rotation**
Objective: Determine the most cost-effective and sustainable fertilizer regime.

2. **Santo Faro Fertilization**
Objective: Ascertain the correct fertilizer regime for sustainable crop yields on Tandako soils.
3. **Maize/Cassia Alley Cropping**
Objective: Determine whether Cassia will serve as an alley cropping species by contributing fertility to maize.
4. **Alley Cropping Introduction**
Objective: Determine the feasibility of introducing alley cropping into Gambian farming systems.
5. **Intercropping**
Objective: Study the agronomic, soil and water management, and socio-economics of groundnut-based mixed cropping practices.
6. **Cowpea/Millet Relay Trials**
Objective: Assess the potential yield of a known cowpea cultivar on farmers' millet fields under farmer management and document farmer practices.
7. **Price Responsiveness of Farmers**
Objective: Analyze farmer responses to input and output price policies to develop policy recommendations.
8. **Farmer Innovation and Technology Testing (FITT)**
Objective: Acceleration of productivity increases through expanded participation of farmers and development agencies in technology testing.
9. **Tillage Technology**
Objective: Develop improved moisture conserving cropping systems by studying farmers' tillage techniques on problem soils.
10. **Soil/Water Literature Review**
Objective: Identify technologies in the sub-region that may be adaptable in The Gambia.

DEPARTMENT OF LIVESTOCK SERVICES

The Department of Livestock Services (DLS) proposed research in four program areas for the 1989/1990 season: Small Ruminants, Cattle, Equines, and Poultry. A new director was appointed for DLS in January 1989. This, coupled with the arrival of the new GARD Livestock LTTA, has created the opportunity for the livestock research program to be re-examined. In view of these reorganization efforts, the research priorities and the manpower constraints at DLS, the NARB approved two of the four programs. The Small Ruminant Program was approved with the request that GARD funding be sought, and the Cattle Program was approved with the endorsement of the collaborative research efforts between DLS, ITC, and PARC. The Poultry Program has been postponed until DLS has the necessary personnel to complete the research and the Equine

proposal was rejected as a low priority. A listing of the approved programs and their objectives follows:

SMALL RUMINANT PRODUCTION PROGRAM

PROJECT 1: Development of Small Ruminant Production Systems

Project Objectives: Conduct on-farm research for the development of improved small ruminant production systems for small holders.

1. Use of Range Resources

Objectives: Determine the seasonal changes in vegetation type and plant species selected, nutritive value of range plants, and seasonal changes in weights of small ruminants on rangelands.

2. Use of Crop Residues and Agricultural By-Products

Objectives: Determine amounts and nutritive value of crop residues and agricultural by-products for feeding Tobaski sheep.

3. Tobaski Sheep Fattening

Objectives: Determine the best combination of feeding and health management systems for fattening Tobaski sheep.

4. Small Ruminant Health and Productivity

Objectives: Determine trypanosome level, helminth eggs and changes in flock structure in small ruminants in 10 villages in MID.

PROJECT 2: On-station Development of Feeding and Management Systems

Project Objectives: Develop appropriate feeding systems using crop residues and agricultural by-products, native and introduced browse forages. Develop better flock management systems.

1. Better Use of Groundnut Crop Residues

Objective: Determine best use of stems and leafy hay for feeding with cereal crop residues to sheep.

2. Use of Cereal Brans and Oilseed Cakes for Sheep

Objective: Determine best combination of oilseed cakes and cereal brans for fattening Tobaski sheep.

3. Improved Flock Management Strategies

Objective: Develop better management practices for ewes and does and for rearing replacement lambs and kids.

CATTLE PRODUCTION PROGRAM

PROJECT 1: Bovine Health and Reproduction

Project Objectives: Determine seasonal variation in the quality of semen and the relationship between testicular dimensions and fertility in N'Dama bulls.

1. **Semen Collection**

Objective: Select and train bulls for semen collection using teasers.

2. **Laboratory Evaluation of Semen Quality**

Objective: Determine the semen quality of N'Dama bulls through laboratory techniques.

PROJECT 2: Pan African Rinderpest Campaign (PARC)

Project Objectives: To establish the enzyme-linked immunosorbent assay (Elisa) for rinderpest; identify cattle populations negative for rinderpest; establish a serum bank; train local technicians to use the Elisa kit.

1. **Establishment of Elisa Test**

Objective: Develop ELISA for use in sero monitoring for rinderpest in the Gambian cattle population.

2. **Establishment of Serum Bank**

Objective: Collect and store serum for future testing for other major diseases.

3. **Identification of a Negative Cattle Population**

Objective: Establish a local negative cut-off value for the Elisa test.

4. **Training of Local Technicians to Use the Elisa Kit**

Objective: Train technicians to participate in PARC sero-monitoring campaign.

E. Research Orientation

In its research policy statement, the NARB emphasized the need for researchers to form active linkages with both farmers and the extension service in providing relevant technologies to their clients -- the producers. The GARD Project is actively assisting the Gambian researchers in strengthening these linkages. The constraints statements in the Research Priority Report are evidence of the Gambian researchers' interest in understanding the real needs of the farmers as a basis for making the research programs more relevant.

The NARB/TS Research Planner, the NASS, and the socioeconomist assigned to DAR will assist the research Task Forces in updating the constraints statement annually.

This update will not only measure progress towards the goal of alleviating the constraints, but also provide a basis for reviewing the research priorities in the light of the current mix of constraints.

Researchers will also gain a better understanding of farmer constraints through initiation of the Farmer Innovations Technologies Testing (FITT) program. FITT will bring together researchers, extension workers, NGOs and other development organizations to assist the farmer groups in testing farmer-chosen technologies.

In a small research system such as The Gambia's, it is essential that cost-effectiveness and efficiency be emphasized. Improved cost-effectiveness is possible by using the best available technologies from other national and international research centers. By adapting these technologies to the special needs of Gambian farmers, unnecessary effort and duplication can be eliminated. During the next three years an added emphasis will be placed on networking and collaboration with IARC scientists to maximize Gambian researchers' knowledge of available technologies.

While efforts have begun to improve the efficiency of DAR, it is unrealistic to expect the research service to improve its efficiency without the requisite personnel. The PBS has laid the foundation for more efficient work; DAR must now be staffed with administrative staff capable of managing the service.

F. Projected Accomplishments and Benefits

AID's analysis of agricultural research in Mali suggests consideration of two types of results -- those at the "institutional/scientific level" and those at the "farmer adoption stage." The former refers to the personnel and practices of the research services. The latter refers mainly to new varieties and technologies, but is unclear as to whether these are available for promotion or already adopted.

In the Research Framework for The Gambia, the term "projected accomplishments" will be used to refer to: (a) institutional development in the form of personnel, practices, and organizational structures; and (b) those varieties and technologies that are expected to be ready for promotion. The term "projected benefits" will be used for increases in production, increases in income, improvements in nutrition, decreases in soil erosion, etc., that are expected after farmers have adopted the new varieties and technologies. Between projected accomplishments and projected benefits there are a host of assumptions and complementary activities that lie mainly in the domains of the extension service, NGOs, input and output marketing systems, international markets, weather, locusts, and other actors outside of the research services. The time frame for the projected accomplishments and benefits discussed below is five years.

1. **Projected Accomplishments in Institutional Development** -- Within the next five years, The Gambia's research personnel will have been significantly upgraded with the return of 17 researchers now away for long-term training and others who will start their training programs in the next two years. If salaries continue to increase and if terms of service can also improve, these returnees will all represent net additions rather than, in part, being replacements for those who have left government service. The consultancy by Zuidema this coming January will examine these issues. In addition to benefiting from long-term training, the research service will benefit from large amounts of short-term training for all levels of personnel.

Operating practices in the DAR have already improved considerably in the past 30 months, and continued improvements are expected in selection of projects; better planning, management, analysis and reporting of trials; better liaison with extension and NGOs; better networking with national and international research systems, and better administration and financial management. Management of the Sapu research station must improve considerably. New administrative positions created for the DAR and NARB must be filled promptly, and training must be offered to the new incumbents as appropriate.

The administrative structures for agricultural research have undergone nothing less than revolutionary change in the past 30 months. The entire Ministry of Agriculture has been reorganized, including the creation of a new Department of Agricultural Research. A National Agricultural Research Board has been established to set research priorities and approve research programs. Because it is composed of the very top level of government officials and private and parastatal leaders, this Board is expected to be a powerful force for strengthening and improving research. The National Agricultural Sample Survey will continue to improve as a valuable source of reliable, timely information for the NARB and other policymakers.

2. Projected Accomplishments in Varieties and Technologies -- The DAR is intensifying its search and screening of new varieties of groundnuts, and these efforts are expected to bear fruit in the next five years. The Grain Legumes and Oilseeds Program, however, is extremely understaffed and progress in the short run will depend in part on recruitment of a strong extension agronomist TA to work between this program and Extension. There is an excellent history of screening for improved rice varieties. The recent past has seen the release of three new groundnut varieties, and nine new rice varieties. Varietal screening efforts have begun for sesame and cowpea, but it is harder to predict results.

In horticultural crops, the recent return of the Program Leader from a year's training in fruit research should increase the flow of improved varieties of citrus and mangoes. The main focus of the vegetable effort is not in varietal screening but in management technology. The Horticulture Program is understaffed even more than is Grain Legumes. Therefore, in the short run, one must also look to recruitment of a TA extension agronomist to work among the Program, Extension, and NGOs.

Important technology accomplishments can be projected with reasonable confidence in rice, groundnuts, and horticulture. There is also considerable promise in livestock, where the relatively new research program has recently been joined by a strong TA with a good deal of African experience. In the longer run there may also be new technologies emerging in agroforestry and intercropping, and there is a continuing evolution of fertilizer recommendations.

A set of technological packages for inland valley rice has been under development by DAR in recent years. These will be presented to Extension, SWMU, and NGOs in a series of workshops this June and July. The technologies will be monitored on farmers' fields and will continue to be improved. Relay cropping of vegetables after lowland rice is another technology that holds much promise.

In horticulture, improved technologies are expected for staggered production to take advantage of higher market prices. The market side of this has been studied, and work is underway on the biological and socioeconomic aspects of production. The Horticulture Program also continues work on watering and mulching technologies.

For groundnuts, the major technology accomplishment projected relates to seed viability and plant stand establishment. This involves harvesting practices, post-harvest care, seed dressing, and so forth. Work is already underway on this; a consultancy is anticipated from the Peanut CRSP, and discussions have begun about an extension agronomist TA.

In livestock, the major technological improvements projected are in the field of ruminant nutrition. This is a long-standing, high-priority area. There was some earlier work with MFP, and the new TA is an expert on the subject. The initial focus will be on sheep and goats. Continuing improvements are also expected in animal health management. New poultry technologies may hold considerable potential, and these will be pursued more intensively when three researchers return from training in poultry science (2) and poultry health (1).

3. Projected Benefits -- Predicting the benefits of research is extremely difficult and subject to wide variance. This is because there is a long chain of events between initiating a research activity and finally putting money in farmers' pockets. One has to predict the increased yields from the new technology or variety, the probability of success in the research, the time of success, adoption by farmers, future weather patterns, future prices and availability of inputs, and future prices of the commodity. Each of these, in turn, is subject to another whole set of preconditions, policies, and events. Nonetheless, very rough and highly tentative predictions can sometimes be useful in helping to set directions and keep on track. When reality diverges from prediction, as it almost certainly will, this can serve as a warning and provide clues in the search for problems, constraints, or bottlenecks. Thus, while Projected Benefits from research cannot be used as a standard for measuring the performance of the research system (Projected Accomplishments are more appropriate for that), the benefit predictions and estimates discussed below can provide other "guidance" functions.

The most recent prediction of research benefits was done by George Norton, et al., in conjunction with the NARB priority-setting exercise, and by Brad Mills in a follow-up analysis. A summary table from Norton's report is included in Annex C. It is based on PPMU estimates of the total value of production for each commodity, researchers' estimates of the increases in yield and the probability of success, estimates of maximum adoption levels, and estimates of future demand. Mills translates these predictions into a benefit/cost framework.⁷

An alternative approach would be to develop estimates of yield increases from the experimental data now available in the DAR's Annual Reports.⁸ A sample table showing the kinds of information available is included in the annex. Of course there are differences between experimental results and results obtained by the average farmer adopting the innovation. Boughton's yield-gap analysis shows this clearly for groundnuts, maize, rice, and sorghum (see graphs in Annex C). Another approach would be to take guidance from the historical record. Diallo, O'Neill, and Manneh have reviewed recent research achievements and their economic impacts.

The Annual Workplan exercise obviously does not provide time to sift carefully through the above documents and others; to interview researchers, extensionists, and NGOs; to assess local and international market trends; and do all the other things needed to arrive at Projected Benefits from research. This may well be a continuing task for the Research Planner who will be hired for the NARB Secretariat. Perhaps the Annual Workplan for 1990/1991 will be able to make use of their projections. For the 1989/1990 workplan, the pre-existing estimates and projections cited above and in the annex will have to suffice.

G. Required Complementary Activities

Moving from research accomplishments in institutional development, new varieties and new technologies, to research benefits in the form of higher yields, greater production and more income requires a host of activities and preconditions that complement the research effort. An effective system for delivering research results to the farm is critical. Thus the evolving development of the extension service must continue to go forward and the many NGOs in The Gambia must work closely with both the research and extension services. The policy framework is equally critical. Without adequate price

⁷ Mills, B. "Estimated Benefits from Agricultural Research in The Gambia." April, 1989.

⁸ There was a long hiatus in the publication of these reports. The first Annual Research Report in many years was published in 1988, and covered in-depth the research conducted in 1985 and 1986. In addition, it also provided some coverage of trials from 1981 in an attempt to fill the gap of the missing years. Publication of Annual Reports is now on a regular basis.

incentives, farmers are unlikely to adopt new innovations. Domestic prices, of course, depend heavily on world prices, but it is important that government policy not distort these. A third critical area is the marketing system for outputs and inputs. These must operate in an efficient and timely fashion, they must be flexible enough to adapt to changing market signals, and they must reflect those signals accurately to farmers. If these and other complementary activities and preconditions are in place and operating effectively, then research accomplishments can be translated into benefits for farmers and the nation.

H. Measuring Projected Accomplishments and Benefits

Selection of appropriate measures must be done with one eye on the Projected Accomplishments and Benefits and the other on the types of information already being collected regularly and the feasibility of collecting more. Regarding Research Accomplishments in Institutional Development, many of the following objective measures may be obtainable without too much difficulty: the number of research personnel with a certain level of training; the number of meetings of research task forces; the number of meetings of the NARB; the timeliness of decisions, actions, disbursements, and hirings; accounting for fuel and other inputs at the research stations; the percentage of trials that provided usable data; the percentage of trials on farmers' fields; the number of interactions between researchers and extension and NGOs; the number of visits by researchers to farms; the number of networking trips; the number of contracts to hire assistance from International Research Centers, CRSPs, and other external agencies; etc.

Beyond these objective measures lie subjective, evaluative measures that are more difficult to obtain but are perhaps more important: the relation of the research projects to the NARB priorities and constraints statement; the extent to which new research builds on the results of past research; the scale of the research effort in relation to available resources; appropriate use of networking and borrowing; the quality of research design, management of trials, analysis of data, reporting of results and other assessments.

Research Accomplishments in Varieties and Technology also call for objective and subjective measures. The former would include the number of new varieties released and new technologies passed on to extension and NGOs through workshops, extension bulletins, the FITT process, and other means. Subjective measures would be needed to assess the value of the varieties or technologies, their conformity with priorities and constraints, the extent to which they really are advances over prior releases, and so forth.

Research Benefits call for measurement primarily with objective means. The main source of available objective measures is the Department of Planning's National Agricultural Sample Survey (NASS). The NASS has regularly been reporting area, yield, and production of major crops throughout the country. All three can be important indicators of the extent to which results are having an effect at the farm level. Starting in 1989 the NASS will be expanded to collect information on the use of such purchased inputs as fertilizer, seed, and implements. In some cases this will reflect adoption and spread of new

varieties and technologies. The NASS will also start to record extension coverage and this should help measure the extent to which information about new varieties and new technologies is reaching farmers. Market price data will also be collected, and this will help measure financial benefits.

With information provided by the NASS, the NARB can go a long way toward measuring progress toward their four Development Objectives listed above. National data on production and prices (together with population data) will help measure progress toward i) improving the average level of well-being for all citizens; and ii) obtaining a broad-based increase in the rate of rural income growth. To the extent that low-income groups are concentrated in certain areas, the NASS's data for geographical areas can help measure progress toward iii) increasing the rate of income growth for low-income people more than the average, although special surveys may be needed. Finally, annual comparisons of NASS data will permit measuring progress toward iv) reducing year-to-year fluctuations in income.

Special studies may occasionally be needed to assist in measuring Research Accomplishments and Benefits. However, the limitations of a small system apply to such measuring efforts no less than they apply to the scale of the research itself. A small system must be modest in both lest it over-extend itself and become ineffective in both. Indeed, the full set of objective and subjective measures discussed above is far more than should be attempted in the near future. A small, sustainable start should be made with a few key measures.

III. GARD INPUTS

The preceding section on the Research Framework contains a complete presentation of every research project and research objective in all programs of the Department of Agricultural Research and Department of Livestock Services. As discussed in Section I, it must be emphasized that GARD will continue for the next three years with a program of strengthening the national agricultural research system of The Gambia. At the same time, the Project will have the capacity to expand training and technical assistance into a number of areas not included in the past efforts. This opportunity for expansion poses the challenge of choosing the types of inputs that will be compatible with existing programs and will produce results in the short-term. It was with this challenge in mind that the planning group consulted individuals during the annual workplan exercise. Annex A contains a complete listing of potential GARD inputs for 1989/1990 and beyond.

It is clear that not all the inputs shown in the Annex can be provided in the coming year. For example, the full set of new LTTAs would imply doubling the size of the team, which would be impossible from a managerial point of view. The full set of STTAs would imply one mission arriving every two weeks. The full set of networking and short-term training would barely leave researchers time to do research. Therefore, discussions in the coming weeks will set priorities for implementing the expanded program and deciding which GARD inputs will be most effective, which inputs should be delayed, and which

should be cancelled. The following sections will focus on important issues surrounding certain of those inputs, as well as highlighting new types of inputs.

Training and Assistance for the NARB and Technical Secretariat: Study trips are planned for NARB members and the Technical Secretariat to USDA, US universities, and African nations with structures similar to the NARB. Short-term and possibly long-term technical assistance will be provided in research planning. The NARB has indicated it would like an LTTA if they again fail to recruit a Gambian for the Research Planner position.

The NARB will receive short-term assistance in manpower planning through an STTA visit in January. This will cover issues of incentives, retention, and conditions of service as well as training.

National Agricultural Library: It has been recommended that the GOTG form a task force to plan the creation of a National Agricultural Library, probably at Gambia College. There already are smaller, specialized collections at DOP, Sapu, Abuko, and Yundum. GARD would provide an STTA to assist the task force.

Research Station Management: New station managers have recently been appointed at Sapu and Yundum. GARD will provide STTA input and short-term training in the US to improve station management.

Implementation of PBS in the Ministry of Agriculture: Based on the recommendations of the Peat Marwick report and the success of PBS in DAR, Ministry officials have decided to implement a program-based budgeting system within the MOA for fiscal year 1990-91. This decision represents a major commitment on the part of the Ministry and requires a dedicated planning effort to analyze the personnel, hardware, and training needs, and to ensure the system is compatible with MOFT and MEPID requirements. The GARD Project has been requested to provide the services of its Financial Advisor, Michael McLain, to assist with the planning. McLain will work with MOA and MDI in formulating an implementation plan that defines the necessary inputs and proposes a methodology and time frame for implementing the system.

GARD sees this proposal as a very positive step in strengthening the planning and financial management of the Ministry, but also a step that needs considerable planning and foresight. The Project will be receptive to future requests for consultancies, hardware, or training, within the limits of the GARD budget.

Soils Laboratory: The soils laboratory has not functioned effectively for over 3 years. Initial training of the lab manager came to naught. The recommendations of a subsequent STTA on national laboratory organization was overtaken by the reorganization of MOA. A new effort is called for. GARD will provide assistance and equipment.

Assistance from CRSPs: AID's Bureau for Science and Technology supports Collaborative Research Support Programs (CRSPs) in groundnuts, beans and cowpeas. The DAR's Grain Legumes and Oilseeds Program is seriously understaffed. Groundnut research is the nation's number one priority, and cowpeas

may be important for diversification. Outside assistance is clearly needed, and the CRSPs may be able to provide part of it. A networking visit is planned to the Bean/Cowpea CRSP project in Cameroon. The Peanut CRSP will be contacted about sending an STTA.

Networking and Collaborative Research: Emphasis on using existing technology will involve more Gambian researchers becoming better acquainted with the research of neighboring countries and at the IARCs in the sub-region. When promising areas of collaboration are found, GARD will encourage small contractual arrangements directly between The Gambia and the IARC scientist to facilitate direct involvement of the scientist with the Gambian research program.

Extension Agronomists: The Horticulture Program is as understaffed as the Grain Legumes and Oilseeds Program, and horticulture research has also been accorded a very high priority by the NARB. Both programs will receive help from GARD STTAs this year, but more is needed. The Extension Service has also identified the need for considerable help in these areas. Thus the possibility of two LTTA Extension Agronomists is under consideration, one focused primarily on groundnuts and one on vegetables, especially as a relay crop after lowland rice. These individuals would work between extension and research. Their mandate would be to speed the flow of new technologies to the farmer.

In-Country Training: The DAR will hold a major workshop on rice technologies for extension, SHMU, and NGOs. An STTA who spent two years working on those technologies under GARD will assist with the program. Another workshop under the Farmer Innovation and Technology Testing project will also be held. GARD will provide consultants to assist. The Gambia will join other countries in cosponsoring the first-ever RELO Conference slated for Niamey.

Natural Resources: GARD will significantly increase its support for natural resources in three ways. First, MWRFF personnel will be sent for degree training in forestry and other natural resource topics. Second, an STTA will initiate an examination of the interactions between tenure and such resource issues as ownership of trees and incentives to improve land that is under village control. Third, DOP has requested long-term assistance in resource economics and planning. The exact nature of that assistance has not yet been decided, and it has been suggested that useful advice on different assistance options might be obtained from the AID/S&T project on Environmental Planning and Management.

Biometrics and Computers: The Yundum Station Manager has pointed out that the researchers at Yundum would benefit from a good deal of on-the-job training and assistance in experimental design, analysis, and use of computer hardware and software. GARD will address these needs through in-country training and short-term training programs.

Marketing Economics: A number of issues and opportunities outside the strict definition of research have a major bearing on the impact of research. Many such issues fall in the area of marketing economics. Some examples include

horticulture marketing; sesame marketing; marketing connections between maize producers, maize feed mills and poultry producers; distribution systems for agricultural inputs; interactions between Gambian and Senegalese pricing of inputs and outputs; and opportunities for increased sales to local hotels and export markets. An LTTA in marketing economics could increase the economic impact of research results by addressing the above issues and helping to remove bottlenecks and utilize opportunities.

Equipment, Vehicles, and Renovations: As in past years, GARD will contribute to research supplies and equipment. This year the inputs will include faster, and larger capacity computers for the large data bases at DOP and DAR, and wordprocessors for the main secretarial locations. Also this year, Peugeot and Suzuki vehicles must be replaced and some building renovation must occur.

The provision of these inputs will follow the PBS schedules provided by each research program. The schedule includes both the time the input is needed as well as the entity (GOTG, ADP II, GARD, etc.) responsible for providing the input. (See Annex B for examples of the Department Budget and Program Implementation Schedule.)

A Gambian Agricultural Data Collection: A large amount of information on Gambian agriculture has been collected in a number of earlier studies. These works should be assembled, an annotated bibliography should be compiled and the collection should be set up in The Gambia as well as in the backstopping contractor universities. Such an annotated collection will not only serve Gambian researchers, but also visiting consultants in many fields who now are forced to use valuable time chasing down documents and information on The Gambia. Most of this material is actually more easily obtained and initially assembled in the US. Thus an RA will be hired for one year at Wisconsin to accomplish this chore and also to help the various UW faculty members who are responding to requests from The Gambia for backstopping assistance. A copy of the collection will then be sent to The Gambia when completed.

STTAs: As in past years, GARD will provide STTAs requested by the research Program Leaders. This year there will be STTAs in four new areas not yet mentioned above -- fruits, weed control, publications, and video communication for extension.

ANNEX A

ANNEX A

GARD FOURTH ANNUAL WORKPLAN: 1989/1990

SUMMARY OF INPUTS¹

I. SHORT-TERM TRAINING AND NETWORKING

A. ARMS -- NARB and Technical Secretariat

1. Study trip by NARB Chairman and Head of Technical Secretariat to backstopping Universities and USDA research sites. Sep 89
2. Study trips by NARB members, Head of Technical Secretariat and Research Planner to similar research planning organizations in Africa. Nov 89
3. Head of Technical Secretariat, and COP to ISNAR workshop on planning and management. Sep 89

B. ARMS -- DAR

1. Trip to ISRA in Senegal to establish networking procedures for future collaboration. Jul 89
2. Training in agricultural research management for new Assistant Director. Aug 89
3. Budget Officer, Director and TA to Zimbabwe to view similar Department of Research Finance and Management structure. Dec 89
4. Course in Research Station Management for Sapu station manager. Sep 89
5. Attendance at FSR/E Symposium in Arkansas by six researchers currently studying in the US. Oct 89

C. ARMS -- Research Support

1. NASS statistician and RA to attend International meeting of Survey Statisticians, Paris. Aug 89

¹This workplan includes inputs that are the direct result of GARD participation in Gambian research activities. With the exception of those inputs noted, all of the listed activities will be funded by the GARD Project. For a detailed listing of other inputs to Gambian research, please reference the PBS budget summaries, the Program Implementation Schedules, the manpower roster of Gambian researchers, the ARREV report, and the Research Protocol Handbook.

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D. RESEARCH PROGRAMS -- CROPS

Rice

1. Research Assistant to IRRI for rice production training.
2. Four rice agronomists to IITA and WARDA, Bouake, Cote d'Ivoire. Apr 90
3. Reciprocal visit of rice task force to Djibelor, Senegal. Sep 89
4. Rice agronomist to study weed control at UW-Madison.

CSRM

5. French language training for one researcher. Aug 89
6. Soil physicist to UW to analyze soil-water measurement data; 3 weeks. Feb 90
7. Networking visit to Botswana OFR Project (4 researchers and TA). Mar 90
8. Three Researchers to Senegal to visit ISRA soil fertility work. Jul 89
9. Two researchers to ICRISAT/Niamey to study soil/water research and cropping systems. Aug 89
10. One researcher to ICRISAT/Niamey to study IFDC soil fertility research and on-farm research projects. Feb 90
11. CSRM agronomist and socioeconomist to IITA and Niger to study alley cropping and animal traction potentials. Aug 89

GLOS

12. Groundnut exchange of information; Bambey, Senegal, (3 researchers and TA - 4 days). Jun 89
13. Three researchers to ICRISAT/Niamey to study groundnut production. Aug 89
14. Two Research Assistants to attend groundnut training course at IITA. Oct 89
15. Two Research Assistants to attend crop production course at ICRISAT, Indi May 90

Horticulture

16. Horticulture exchange visit with Djibelor, Senegal, (5 researchers). Jun 89
17. Two Horticulture visits to CDH, Dakar. Jun 89
18. One extension worker to Rutgers Horticulture short course. Jul 89

Upland Cereals

19. Upland cereals to visit research stations in sub-region to collect millet, maize, sorghum, and findo varieties. Several trips during 89/90 season.

E. RESEARCH PROGRAMS -- LIVESTOCK

1. Visit to Kolda and Casamance, Senegal, to network on small ruminant feeding and management studies by D. Richard (2 researchers, 2 days). Jun 89
2. Visit ICRISAT Sahelian Center to see ILCA program on small ruminants and crop/livestock interactions in the Sahel (3 researchers, 3 days). Sep 89
3. ILCA course in Ethiopia on Introduction and Initial Evaluation of Forages. Nov 89
4. Trip to LNERV, ISRA, Dakar-Hann, Senegal for laboratory analysis (1 researcher, 3 weeks). Jan 90
5. Visit to ILCA/Kaduna, Nigeria, to learn about fodder banks (1 researcher, 1 week). Jan 90

F. RESEARCH/EXTENSION LIAISON

1. Attendance and possible co-sponsorship of African RELO conference in Niamey, Niger. Jan 90
2. RELO group to Cameroon to study cowpea storage innovations (3 researchers and TA). Mar 90

II. IN-COUNTRY TRAINING

A. ARMS -- DAR

1. Training in Accounting (1 person, 6 weeks part-time at MDI).
2. Storekeeper training (2 people, 1 week at MDI).

B. ARMS -- Research Support

1. In-service training for NASS supervisors and enumerators. Apr 90
2. Computer training for data entry personnel (5 people, 10 days). Oct 89
3. Computer literacy training for field enumerators (5 enumerators, 5 days). Jan 90

C. RESEARCH PROGRAMS -- CROPS

1. First Groundnut Production Workshop (25 people, 3 days). Jul 90
2. Follow-up Groundnut Production Workshop (25 people, 3 days). Mar 90
3. Rice Production - Water Control Workshop (15 people, 5 days). Jul 89
4. Rice Production Technologies Workshop (30 people, 5 days). Jul 89

D. RESEARCH PROGRAMS -- LIVESTOCK

- | | |
|--|--------|
| 1. First annual workshop, "Livestock Research and Development in The Gambia" (5 days). | Jan 90 |
| 2. Experimental design and statistical analysis workshop (ILCA instructors, 2 weeks). | Feb 90 |

E. RESEARCH/EXTENSION LIAISON

- | | |
|---|--------|
| 1. First FITT Workshop, (25 people, 2 days). | May 89 |
| 2. Second FITT Workshop, (25 people, 2 days). | Jan 90 |
| 3. Farmer Field Day - Sapu area (100 farmers, 1 day). | Oct 89 |
| 4. Farmer Field Day - Yundum area (100 farmers, 1 day). | Oct 89 |

III. SHORT-TERM TRAINING ADVISORS

A. ARMS -- NARB and Technical Secretariat

- | | |
|---|--------|
| 1. To assess human resources and draft long-term training plan (Zuidema). | Jan 90 |
| 2. Assistance with National Research Planning (ISNAR). | Oct 89 |

B. ARMS -- Research Support

- | | |
|---|--------|
| 1. To train ACU staff in video techniques (Hestad). | Jul 89 |
| 2. To assist with summary programs for NASS (Johnson). | Jul 89 |
| 3. To work with National Agricultural Library Task Force (Zweifel). | Nov 89 |
| 4. To assist with research publications (Maurer). | Jan 90 |
| 5. To assist with data analysis of NASS (Johnson). | Feb 90 |

C. RESEARCH PROGRAMS -- CROPS

- | | |
|--|--------|
| 1. To assist with inland valley rice production workshops (Remington). | Jun 89 |
| 2. To assess research station management needs (Schlough). | Jul 89 |
| 3. To assist with Soil Fertility project (Posner). | Feb 90 |
| 4. To assess groundnut production needs (Groundnut CRSP). | Aug 89 |
| 5. To assist with training of GLOS researchers (Ndunguru and Subrahmanyam, ICRISAT). | Aug 89 |
| 6. To assess weed control research project (Doll). | Sep 89 |
| 7. To work with agroforestry and land tenure issues (Lawry). | Oct 89 |
| 8. To assist with refurbishing the soils lab (Peters). | Oct 89 |

9. To assist with horticulture marketing issues (Campbell, date to be determined).
10. To work with station managers (Schlough). Feb 90
11. To review fruit tree research program (Schaeffer). Jan 90

D. RESEARCH PROGRAMS -- LIVESTOCK

1. To assist with design of small ruminant research program (Lane). Nov 89
2. To assist with the establishment of a livestock health research program. Dec 89

E. RESEARCH/EXTENSION LIAISON

1. To assist with first farmer group workshop (Heinrich). May 89
2. To review RELO process (Trent). Aug 89
3. To assist with second farmer group workshop. Jan 90
4. To continue work on strengthening RELO (Clarke). Dec 89

IV. LONG-TERM TRAINING

A. ARMS -- RESEARCH SUPPORT

1. BS in Agricultural Economics at UW (Ebrima Camara). Aug 86-Jun 90
2. BS in Management Information Systems for the NASS at VSU (Lamin Jabang) Aug 88-Jun 92

B. RESEARCH PROGRAMS

1. BS in Agronomy UW (Amadou Mballo). Aug 86-Dec 90
2. BS in Agronomy U of Maryland - Eastern Shore (Kemoring Trawally). Aug 86-Jun 90
3. BS in Poultry Science at Maryland-Eastern Shore (Ellen Secka). Aug 87-Dec 90
4. BS in Horticulture at Tuskegee (Ousman Jarju). Aug 88-Jun 92
5. BS in Soil Science at UW (Babou Jobe). Aug 88-Jun 92
6. BS in Horticulture at UW (Momodou Jabang). Aug 88-Jun 92
7. BS in Agroforestry (Lamin Bojang). Aug 89-Jun 91
8. MS in Agronomy at UW (Mohammed Cole). Jan 86-May 89
9. MS in Agronomy at Cornell (Musa Mbenga). Jan 86-May 89
10. MS in Poultry Science at UW (Patricia Andrews). Aug 87-Dec 89
11. MS in Agricultural Economics at UW (Mohammed Kabay). Aug 88-Dec 90
12. MS in Agroforestry at Idaho (Abdoulie Danso). Jan 89-Dec 91
13. Cropping Systems Agronomist on sabbatical to ICRISAT/Niamey. Feb 90-Jan 91

14. Higher Diploma in Agriculture at ABU, Nigeria, (Essa Drammeh). Apr 89-Jun 91
15. BS in Agric. Engineering at Cal Poly State University-Pomona (Lamin Kassama). Jan 89-Dec 92
16. BS in Agronomy at University of Arkansas (Momodou Sanneh). Jan 89-Dec 92

C. RESEARCH/EXTENSION LIAISON

1. BS in extension/RELO at VSU (Sheriff Sima). Aug 88-Jun 94
2. MS in extension/RELO at VSU (Nyada Baldeh). Aug 88-Jun 94

V. LONG-TERM TECHNICAL ASSISTANCE

A. ARMS

1. Chief of Party (Rowe). Mar 88-Feb 90
2. Financial Administration (McLain). Oct 88-Sep 90
3. RA Statistician/Economist DOP/NASS (DeCosse). Sep 88-Aug 90
4. Extension Marketing Economist. Two Years
5. Senior Research Planner to work with NARB. Two Years
6. RA to work with Natural Resources Planning. Two Years

B. RESEARCH PROGRAMS

1. Cropping Systems Agronomist (Gritton). Nov 88-Oct 90
2. Agricultural Economist (Gilbert). Nov 85-Nov 89
3. Livestock Specialist (Reed). Feb 89-Jan 91
4. RA Socioeconomist; Sapu (Mills). Apr 89-Aug 89
5. Extension Agronomist, Rice and Vegetables. Two Years
6. Extension Agronomist, Groundnuts. Two Years
7. RA Socioeconomist; Sapu. Two Years
8. RA in Horticulture. Two Years
9. RA at UW-Madison to create data library. One Year

C. RESEARCH/EXTENSION LIAISON

1. RELO (Diallo). Sep 86-Dec 89

VI. PEACE CORPS VOLUNTEERS

A. DAR

1. Librarian (Paris). Sep 88-Aug 90
2. Economist (Watt). Sep 88-Aug 90

B. RESEARCH PROGRAMS

- | | |
|--|---------------|
| 1. Research Assistant (Hayes). | Sep 88-Aug 90 |
| 2. Agricultural Economist; Sapu (requested). | Apr 90-Mar 92 |
| 3. Agronomist (requested). | Apr 90-Mar 92 |
| 4. Soils Lab (requested). | Apr 90-Mar 92 |

ANNEX B

MP/LMS/MLI
A. Mott
25-May-89

PROGRAM IMPLEMENTATION SCHEDULE -
DEPARTMENT OF AGRICULTURAL RESEARCH HEADQUARTERS

CODE	BAR													EXPECTED SOURCE OF FUNDS				TOTAL OF FUNDS
	HEADQUARTERS	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	BLF	ADP11	GRD	OTHER	
OPERATIONAL EXPENSES																		
Casual Labor	384	100	100	100	84													
Travel	7,044	587	587	587	587	587	587	587	587	587	587	587	587	384				384
Research Supplies	250	250												7,044				7,044
Computer analysis costs	0													250				250
Protective Clothing	0													0				0
Stationery & Office Supplies	25,167													0				0
Routine needs		1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097	1,097					25,167
Annual Publications			6,000					6,000						13,167				
Vehicle - Fuel & Maintenance	25,593	2,400	2,400	2,400	2,400	2,400	2,400	1,800	1,800	1,900	1,900	1,900	1,093			12,000		25,593
Generator - Fuel & Maintenance	0													25,593				25,593
Library	51,690													0				0
Books and Journals		20,000						20,000										51,690
Supplies		1,000	1,000	1,000	1,000	1,000		1,000	1,000	1,000	1,000	1,000				40,000		
Building Maintenance	30,000	8,000			8,000			8,000			6,000		630	11,690				51,690
														10,000	20,000			30,000
Subtotal - Operational expenses	140,128	33,434	11,184	5,184	13,168	3,084	3,084	24,484	4,484	4,584	10,584	4,584	4,257	64,128	20,000	52,000	0	140,128
TRAINING EXPENSES																		
In-Service Training	240			240														
Overseas Training	?	1/												240				240
Networking	?	1/																0
Subtotal - Training expenses	240	0	0	240	0	0	0	0	0	0	0	0	0	240	0	0	0	240
CAPITAL EQUIP. & FIXED ASSETS																		
Vehicles/Motorcycles/Tractors	240,000																	
2 Peugeot Replacements		240,000																240,000
Agric. Implements	0															240,000		0
Lab. equip & supplies	0																	0
Furniture/Office Equip.	136,080																	0
HD Furniture		6,080			5,000			5,000			5,000			21,080				136,080
HD Equipment		100,000			5,000			5,000			5,000							
Library office equip.	16,100															115,000		16,100
Furniture		5,000						1,100						6,100				
Equipment		5,000						3,000										
Other	0															10,000		0
Construct. of Infrastructure	100,000	30,000						30,000						0		100,000		100,000
Subtotal - Capital equip.	432,180	406,080	0	0	10,000	0	0	64,100	0	0	10,000	0	0	27,180	0	465,000	0	432,180
TOTALS	632,548	439,514	11,184	5,424	23,168	3,084	3,084	104,584	4,484	4,584	20,584	4,584	4,257	93,548	20,000	517,000	0	632,548

1/ See Training Plan for detailed training schedule.

PROGRAM IMPLEMENTATION SCHEDULE
(Illustrative Purposes Only)

DEPARTMENT BUDGET SUMMARY

WPLANI.MKI
RHM
04-Jan-90

BUDGET SUMMARY - DRR PROGRAMS 1989-90

EXPECTED SOURCE OF FUNDS

CODE	DRR HEADQUARTERS	ADMN. SGPU	ADMN. YUNGLIN	ESM	BLDS	HORTICULTURE	RICE	UPLAND CEREALS	SEED TECH. UNIT	TRAINING (all progrs)	DUTS SALARIES	TOTAL OF ALL DRR PROGRAMS	PERCENTAGE OF TOTAL	EXPECTED SOURCE OF FUNDS														
														BLF	DEFICIT AFTER BLF FUNDS	ADP11	GRAB	OTHER	TOTAL OF FUNDS									
SALARIES & ALLOWANCES														11	1,813,000	(110,000)	0	110,000	0	1,923,000								
OPERATIONAL EXPENSES														11														
Casual Labor	549	2,500	11,629	20,710	20,865	22,249	17,494	20,407	17,647	0	0	144,050	3%	48,900	(95,150)	95,150	0	0	144,050									
Travel	9,932	3,304	2,595	11,346	7,410	0	4,682	3,930	4,420	0	0	53,679	1%	50,000	(3,679)	0	0	50,000										
Research Supplies	250	20,823	22,436	28,080	15,699	21,293	31,622	15,419	41,135	0	0	196,757	3%	120,000	(76,757)	25,000	51,757	196,757										
Computer analysis costs	11,900	11,713	2,800	0	0	0	441	322	0	0	0	27,176	0%	0	(27,176)	0	27,176	27,176										
Protective Clothing	0	1,780	2,880	1,435	1,275	0	400	0	0	0	0	7,790	0%	8,000	210	0	0	8,000										
Stationary & Office Supplies	25,167	6,060	5,000	6,585	1,183	2,181	6,933	2,453	3,665	0	0	59,690	1%	20,000	(39,690)	15,000	24,690	59,690										
Vehicle - Fuel & Maintenance	32,838	151,476	139,626	23,634	11,792	10,088	23,883	11,321	20,902	0	0	425,359	7%	80,000	(345,359)	40,000	305,359	425,359										
Generator - Fuel & Maintenance	0	346,812	0	0	0	0	0	0	0	0	0	346,812	6%	250,000	(96,812)	95,000	50,000	395,000										
Library	51,690	0	0	0	0	0	0	0	0	0	0	51,690	1%	0	(51,690)	0	51,690	51,690										
Building Maintenance	30,000	30,000	22,320	0	0	0	0	0	0	0	0	82,320	1%	75,000	(7,320)	7,320	0	82,320										
Subtotal - Operational expenses	162,326	576,468	299,286	91,811	58,224	65,811	85,515	54,314	91,769	0	0	1,395,523	24%	651,900	(743,623)	277,470	510,872	0	1,440,242									
TRAINING EXPENSES														11														
In-Service Training	0	0	0	0	0	0	0	0	0	51,080	0	51,080	1%	0	(51,080)	0	51,080	0	51,080									
Overseas Training	0	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0										
Networking	0	0	0	0	0	0	0	0	0	1,089,900	0	1,089,900	19%	0	(1,089,900)	0	1,089,900	0	1,089,900									
Subtotal - Training expenses	0	0	0	0	0	0	0	0	0	1,140,980	0	1,140,980	20%	0	(1,140,980)	0	1,140,980	0	1,140,980									
CAPITAL EQMT. & FIXED ASSETS														11														
Vehicles/Motorcycles/Tractors	236,000	0	0	84,000	84,000	84,000	0	84,000	0	0	0	574,000	10%	0	(574,000)	135,000	439,000	0	574,000									
Agric. Implements	0	0	0	0	0	0	0	45,000	19,323	0	0	64,323	1%	20,000	(44,323)	19,232	25,091	0	64,323									
Lab. equip & supplies	0	0	0	0	0	40,193	2,590	0	0	0	0	42,783	1%	60,000	17,217	0	0	60,000										
Furniture/Office Equip.	172,950	61,730.00	35,350.00	0	0	0	1,500	0	0	0	0	271,530	5%	0	(271,530)	0	271,530	271,530										
Library office equip.	35,609	0	0	0	0	0	0	0	0	0	0	35,600	1%	0	(35,600)	0	35,600	35,600										
Other	114,750	0	0	0	0	0	0	0	0	0	0	114,750	2%	40,500	(74,250)	0	74,250	114,750										
Construct. of Infrastructure	80,500	25,000	25,000	0	0	19,090	0	0	0	0	0	149,590	3%	0	(149,590)	0	149,590	149,590										
Subtotal - Capital equip.	641,800	86,730	60,350	84,000	84,000	143,283	4,090	129,000	19,323	0	0	1,252,576	22%	120,500	(1,132,076)	154,232	995,061	0	1,252,733									
TOTALS	804,126	663,198	269,636	175,811	142,224	209,094	89,605	183,314	111,092	1,140,980	1,923,000	5,712,079	100%	2,565,400	(2,125,678)	431,708	2,736,913	0	5,774,015									
PERCENTAGE OF TOTAL	14.1%	11.6%	4.7%	3.1%	2.5%	3.7%	1.6%	3.2%	1.9%	20.0%	33.7%	100%	100%	45%	(37%)	7%	48%	0%	100%									

ANNEX C

TABLE 17. USE OF THE WEIGHTED CRITERIA MODEL TO DETERMINE AGRICULTURAL RESEARCH PRIORITIES BY COMMODITY

Commodity	Value Prod. (a)	Yield Incr.	Prob. Succ.	Adopt. Level	Future Demand	Effic. Index (b)	Effic. Rank	Percent Farmers	Farmer Rank	Home Consump.	Consump. Rank	Annual Variance	Weighted Total (c)
Groundnut	153,978	0.15	0.30	0.40	0.95	2633	1	92	3	25	15	11	2.939
Cattle	25,000	0.20	0.40	0.50	1.06	1060	2	47	11	50	12	4	4.048
Early Millet	44,929	0.15	0.30	0.50	1.04	1051	3	55	9	85	4	9	4.335
Swamp Rice	12,276	0.25	0.60	0.40	1.06	781	4	48	10	100	1	17	5.588
Fruit	12,000	0.25	0.50	0.40	1.06	636	5	80	6	50	12	7	5.743
Small Ruminants	7,000	0.25	0.50	0.50	1.06	464	7	85	4	25	15	3	6.811
Vegetables	12,000	0.20	0.50	0.40	1.06	509	6	80	6	25	15	14	7.180
Sorghum	8,519	0.20	0.50	0.50	1.04	443	8	39	13	95	3	18	9.092
Poultry (Village)	7,000	0.25	0.50	0.40	1.06	371	11	95	2	40	14	6	9.575
Late Millet	13,334	0.20	0.30	0.50	1.04	416	9	43	12	85	4	16	9.593
Equines	5,000	0.15	0.50	0.50	1.03	193	12	60	8	85	4	5	10.390
Fisheries	21,800	0.15	0.40	0.30	1.05	412	10	10	18	5	20	2	11.162
Irrigated Rice	7,156	0.10	0.50	0.50	1.06	190	13	15	16	80	7	8	12.635
Upland Rice	2,966	0.25	0.40	0.40	1.06	126	14	25	14	100	1	15	13.202
Sesame	1,400	0.20	0.30	0.50	1.05	44	15	5	19	80	7	12	14.787
Forestry	7,500	0.05	0.25	0.20	1.04	20	19	100	1	20	19	1	15.165
Cassava	300	0.40	0.70	0.50	1.03	43	16	25	14	25	15	10	15.198
Maize	2,833	0.10	0.50	0.15	1.04	22	18	85	4	80	7	20	15.472
Cowpeas	500	0.25	0.70	0.25	1.05	23	17	5	19	80	7	19	16.747
Findo	600	0.10	0.50	0.50	1.03	15	21	5	19	80	7	13	19.187
Cotton	1,755	0.15	0.25	0.25	1.00	16	20	15	16	0	21	21	19.568

(a) Value of production is in thousands of Dalasis

(b) Effic. Index = (Value Prod.)*(Value Incr.)*(Prob. Succ.)*(Adopt. Level)*(Future Demand)

(c) Weighted Total = .721(Effic. Index) + .138(Farmer Rank) + .066(Consump. Rank) + .074(Annual Variance)

Source: Norton et al., "Analysis of Agricultural Research Priorities in The Gambia", March 1989.

Table 5: Economic Analysis of Country Average NPK Tandako Rice Trials*

Treatment N, P ₂ O ₅ & K ₂ O kg/ha	Yield kg/ha	Yield increase kg/ha	Gross return Dal/ha	Cost of Fert. Dal/ha	Net return Dal/ha	Value cost ratio
<u>1985</u>						
1. 0-0-0	1415	-	-	-	-	-
2. 0-30-30	1546	131	131	168	37	0.78
3. 60-0-30	1495	80	80	179	99	0.45
4. 60-30-0	1814	399	399	291	108	1.37
5. 60-30-30	1764	349	349	319	30	1.09
6. 120-30-30	2013	598	598	470	128	1.27
7. 60-60-30	2309	894	894	459	435	1.95
8. 60-30-60	2107	692	692	348	344	1.99
<u>1986</u>						
1. 0-0-0	1058	-	-	-	-	-
2. 0-30-30	1100	42	42	168	126	0.25
3. 60-0-30	1276	218	218	179	39	1.22
4. 60-30-0	1794	736	736	291	445	2.53
5. 60-30-30	1658	600	600	319	281	1.88
6. 120-30-30	1933	875	875	470	405	1.86
7. 60-60-30	1711	653	653	459	194	1.42
8. 60-30-60	1787	729	729	348	381	2.09

Table 6: Economic Analysis of Country Average NPK Bantafaro Rice Trials*

Treatment N, P ₂ O ₅ & K ₂ O kg/ha	Yield kg/ha	Yield increase kg/ha	Gross return Dal/ha	Cost of Fert. Dal/ha	Net return Dal/ha	Value cost ratio
<u>1985</u>						
1. 0-0-0	1596	-	-	-	-	-
2. 0-30-30	1917	321	321	168	153	1.91
3. 60-0-30	2276	680	680	179	501	3.80
4. 60-30-0	2185	589	589	291	298	2.02
5. 60-30-30	2152	556	556	319	237	1.74
6. 120-30-30	2543	947	947	470	477	2.01
7. 60-60-30	2307	711	711	459	252	1.55
8. 60-30-60	2313	717	717	348	369	1.94
<u>1986</u>						
1. 0-0-0	1143	-	-	-	-	-
2. 0-30-30	1367	224	224	168	56	1.33
3. 60-0-30	1888	745	745	179	566	4.16
4. 60-30-0	1813	670	670	291	379	2.30
5. 60-30-30	2055	912	912	319	593	2.86
6. 120-30-30	2243	1100	1100	470	630	2.34
7. 60-60-30	1646	503	503	459	44	1.10
8. 60-30-60	1756	613	613	348	265	1.76

* Prices used in economic calculation:

N	Dal/kg
P ₂ O ₅	2.52
K ₂ O	4.66
Rfce	0.95
	1.00

Source: Department of Agricultural Research "Annual Report, 1985 & 1986".

Table 7mz: Economic Analysis of the Country Average
Fertilizer Management Maize Demonstration Trials - 1983-85

<u>Treatment</u> Urea incorp. and weed mgt.	<u>Fertilizer</u> N, P, & K kg/ha	<u>Yield</u> kg/ha	<u>Yield</u> increase kg/ha	<u>Gross</u> return Dal/ha	<u>Cost of</u> Fert. Dal/ha	<u>Net</u> return Dal/ha	<u>VCR</u>
<u>1983</u>							
No Earthing-up kg/ha	0-0-0	920					
	56-28-0	1586	666	772	120	652	6.43
	104-54-0	1905	985	1142	240	902	4.76
Earthing-up	0-0-0	1135					
	56-28-0	1892	757	878	120	758	7.32
	104-54-0	2381	1246	1445	240	1205	6.02
<u>1984</u>							
No Earthing-up	0-0-0	1048					
	54-23-0	1654	606	703	139	815	5.06
	108-46-0	2229	1181	1370	278	1092	4.93
Earthing-up	0-0-0	1150					
	54-23-0	2009	859	997	139	858	7.17
	108-46-0	2526	1376	1597	278	1319	5.74
<u>1985</u>							
No Earthing-up	0-0-0	1014					
	38-15-15	1790	776	901	180	721	5.01
	76-30-30	2553	1359	1786	360	1426	4.96
Earthing-up	0-0-0	1211					
	38-15-15	1835	624	724	180	544	4.02
	76-30-30	2627	1416	1643	360	1283	4.56

Table 8mz: Economic Analysis of the Country Average
Variety x Fertilizer Maize Demonstration Trial - 1986

<u>Treatment</u> N, P, & K kg/ha	<u>Yield</u> kg/ha	<u>Yield</u> increase kg/ha	<u>Gross</u> return Dal/ha	<u>Cost of</u> Fert. Dal/ha	<u>Net return</u> Dal/ha	<u>VCR</u>
<u>YELLOW MAIZE</u>						
<u>1986</u>						
0-0-0	1332					
38-15-15	1902	570	661	178	483	3.71
76-30-30	2553	1021	1184	342	842	3.46
<u>WHITE MAIZE</u>						
<u>1986</u>						
0-0-0	459					
38-15-15	929	470	545	178	367	3.06
76-30-30	1322	863	1001	342	659	2.93

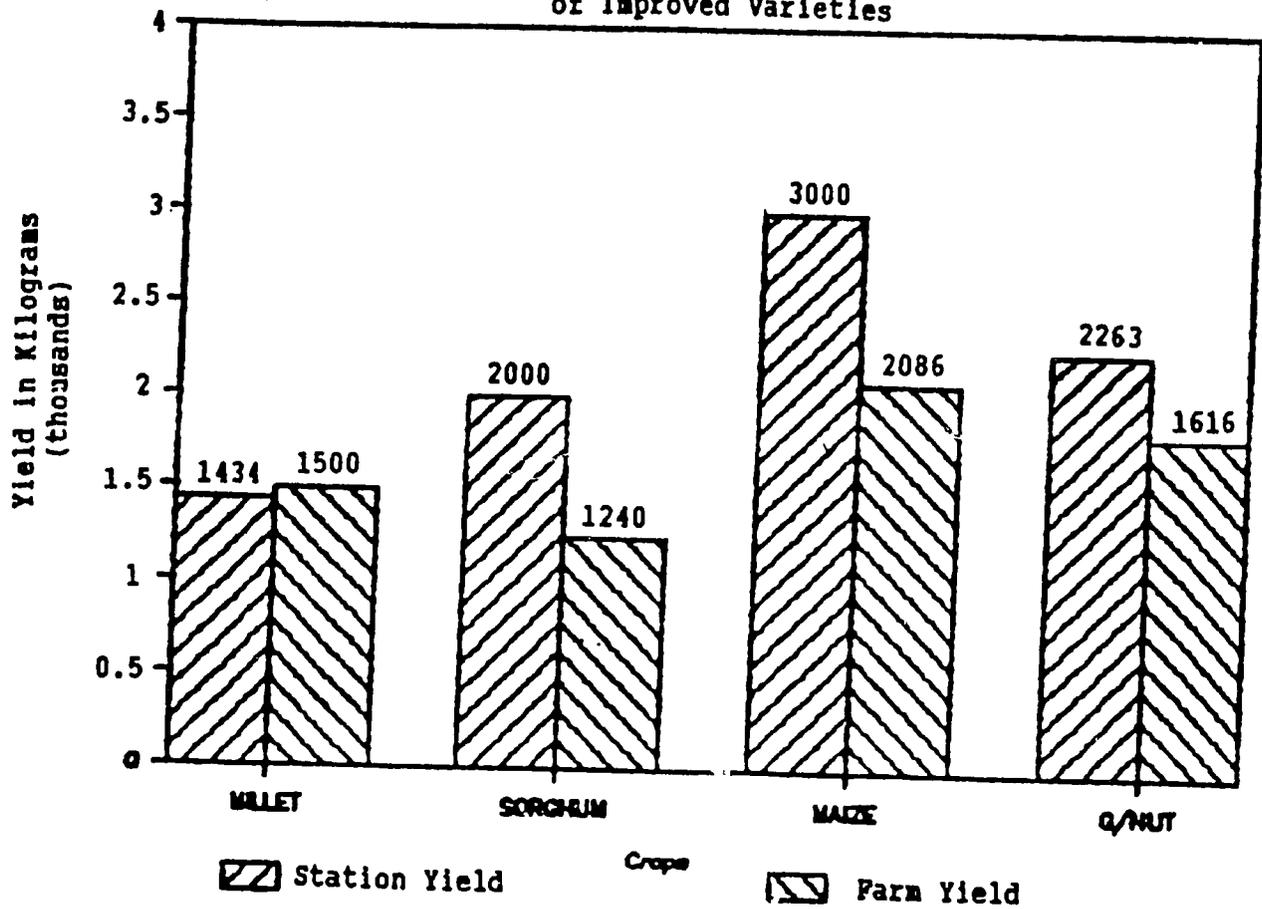
Source: Department of Agricultural Research, "Annual Report, 1985 & 1986".

**Table 1: Pod Yield and Agronomic Characters of Several Groundnut Varieties
Evaluated in the National Groundnut Variety Trial - Sapu and Yundum, 1985-86**

Variety	S A P U						Y U N D U M				
	1985			1986			1986				
	Yield (kg/ha)	Pods/ plant	100 pod wt. (g)	Yield (kg/ha)	Pods/ plant	100 pod wt. (g)	Days to 50% Flowering	Days to Maturity	Yield (kg/ha)	Pods/ plant	100 pod wt. (g)
1. 73/33	1421.9	24.3	127.5	3104.2	37.0	149.6	40	95	2756.2	23.0	85.3
2. 55/437	1604.2	26.5	103.8	2479.2	25.2	101.2	40	116	2309.4	17.4	127.0
3. RC-013	1109.4	23.0	106.2	3166.2	34.2	112.8	41	122	2575.0	19.6	138.1
4. RC-017	1150.0	18.8	100.0	2500.0	25.0	129.7	40	99	1946.9	20.7	109.0
5. GVCT	983.8	19.3	178.8	-	-	-	42	128	1353.1	23.6	149.6
6. M327-69	-	-	-	2177.1	36.2	112.8	-	-	-	-	-
7. SE 28-206	1031.2	24.3	103.8	2468.8	46.2	116.4	42	125	3384.0	23.3	119.4
Mean	1216.7	22.7	120.0	2649.3	34.0	120.4	41	114	2387.5	21.3	121.4
LSD(P=0.55)	376.6	NS	24.0	NS	13.7	21.8	1.0	2.4	693.4	NS	9.8
CV (%)	20.5	22.3	13.3	23.8	26.8	12.0	1.6	1.4	19.3	24.3	5.4
Rainfall from planting (mm)	432.5			814.8			754.3				

Source: Department of Agriculture, Agricultural Research Service; "Annual Report, 1985 & 1986".

Station & Farm Level Yields Comparisons of Improved Varieties



Sources:

1. FAO Fertilizer Programs (1981 - 1985)
2. Department of Agriculture Sapu Research Trials by Programs (1982-1986).

Source: Diallo, O'Neil, and Manneh. "Agricultural Research Achievements in The Gambia and Impacts of Research on Selected Farm Economies", March 1989.

**Table 6: Varietal Improvements - Yield and Profit Increases
Over Local Varieties**

Year	Crop Variety	Yield Increase (kg/ha)	Value Product D/ha	Seed Amount (kg/ha)	Input Cost D/ha	Net Return Yr.1 D/ha	VCR Yr.1	Net Return Yr.5 D/ha	VCR Yr.5
Early Millet									
1983	X-Daru	-15.0	-15.00	6.0	4.35				
1984	X-Daru	198.0	198.00	6.0	4.35				
1985	X-Daru	65.0	65.00	6.0	4.35				
Average	X-Daru	82.7	82.67	6.0	4.35	78.32	19.0	81.80	95.0
Kashum Nyang									
1983	Kashum Nyang	-111.0	-111.00	6.0	4.35				
1984	Kashum Nyang	148.0	148.00	6.0	4.35				
1985	Kashum Nyang	86.0	86.00	6.0	4.35				
Average	Kashum Nyang	41.0	41.00	6.0	4.35	36.47	9.1	40.13	47.1
Sorghum									
1983	E-35-1	19.0	19.00	8.0	5.80				
1984	E-35-1	448.0	448.00	8.0	5.80				
1985	E-35-1	20.0	20.00	8.0	5.80				
Average	E-35-1	162.3	162.30	8.0	5.80	156.50	28.0	161.14	139.9
Samba jabo									
1983	Samba jabo	148.0	148.00	8.0	5.80				
1984	Samba jabo	250.0	250.00	8.0	5.80				
1985	Samba jabo	-44.0	-44.00	8.0	5.80				
Average	Samba jabo	118.0	118.00	8.0	5.80	112.20	20.3	116.84	101.7
Rice									
1985	Peking	245.0	245.00	70.0	50.75	194.25	4.8	234.85	24.1
1985	DJ-11-509	274.0	274.00	70.0	50.75	223.25	5.4	263.85	27.0

Source: Fertilizer Use, Promotion, Distribution, and Credit, FAO Field Document 2, 1987.

Source: Diallo, O'Neil, and Manneh. "Agricultural Research Achievements in The Gambia and Impacts of Research on Selected Farm Economies", March 1989.