PD-AAX-313
ISN 54702

NIGER APPLIED AGRICULTURE RESEARCH

ANNEXES

(683-0256)

1049b +
DISK 2/17b

ANNEX A

INSTITUTIONAL ANALYSIS

CONTENTS

I. Introduction

II. Lead Institution: National Agronomic Research Institute of Niger

- 2.1. Responsibilities and Organization of INRAN
- 2.2. Staff Levels and Distribution
- 2.3. Distribution of Financial Resources
- 2.4. Assignment of Personnel
- 2.5. Researchers as Civil Servants
- 2.6. Linkages with Agricultural Services/Information Flow
- 2.7. Infrastructure
- 2.8. Delivery System for Research Results
- 2.9 Institutional Issues

III. Participating Institutions

- 3.1. Rural Engineering (Genie Rural)
- 3.2. The Agriculture Service
- 3.3. OMAHA
- 3.4. The Union Nigerienne de Cooperatives (UNC)

IV. Summary of Institutional Constraints

- 4.1. Rural Institutions (Cooperatives)
- 4.2. Bureaucratic Structures
- 4.2.1. Personnel Relations
- 4.2.2. Materials Management
- 4.2.3. Planning
- 4.2.4. Decisionmaking
- 4.2.5. Control
- 4.2.6. Professionalism

I. INTRODUCTION

The following discussion highlights key issues raised in the course of project paper preparation. Considerable related information may be found in the Niger Irrigation Sub-Sector Assessment (1984), updates of this document, the updated Project Evaluation Summary of the mid-term evaluation of the Niger Cereals Project (PES), the Irrigation Annex to the USAID/Niger CDSS, recent Institutional Analyses of INRAN (Painter, CILSS) and evaluations of Niger's irrigated perimeters (SOGREAH, ONAHA, Ministry of Plan:Arnould). No attempt is made to duplicate the information concerning institutional relationships contained in these documents.

The following institutions interact in the design, execution and management of irrigation activities and dryland farming in Niger: the National Agronomic Research Institute (INRAN); the line services of the Ministry of Agriculture; the irrigated perimeter management parastatal (ONAHA); the Nigerien Cooperative Union(UNC); nearly all the international donors; and the farmers themselves. The first four are discussed in this annex; donor activities are discussed separately, and farmers are discussed in the Annex B, Social Impact Analysis.

II. LEAD INSTITUTION: THE NATIONAL AGRONOMIC INSTITUTE OF NIGER

2.1 Responsibilities and Organization of INRAN

Created on 7 January 1975 by ordinance number 75-1 to succeed IRAT (French Tropical Agronomy Research Institute), as a Public Establishement of a non commercial character, INRAN is currently under the authority of the Ministry of Agriculture, although as a research organization it maintains links with the Ministry of Higher Education and Research.

INRAN carries overall responsibility for developing new crop varieties, providing Mo generation seeds to the seed multiplication service, conducting soils and water analyses, and (in response to expressed needs) making agronomic recommendations to the extension services. Current orientations include commodity-oriented breeding programs for major crops, production systems research, on-farm research, improved dissemination of research results, and establishment of a dialogue with farmers through on-farm trials.

Table A-1 shows the various divisions of the Insitute. Those divisions which are not currently operational are indicated with dotted lines. Some divisions are not fully operational such as the training division (DEF), the research-extension liaison unit (CRV), and the documentation center (DOC). In part this is due to the lack of administrative staff, but also to the absence of an overall organizational plan which would integrate the activities of these units into ongoing management patterns.

The organigram does not accurately reflect the relationships between departments. It does not show, for example, that the Program and Studies Division (DEP) is charged with coordination of research programs. The absence of this vertical link between the DEP and these divisions reflects the need for more effective institute-wide coordination of research. Recently, a

series of cross-department working committees have been created through the Niger Cereals Research project (NCR) to facilitate strategic planning. On-farm research programs permit a more inter-disciplinary approach to the execution of research programs. INRAN's research programs endeavour increasingly to deal with a range of interrelated factors as part of an ensemble or production complex, rather than as isolated themes (which until recently was the approach to research and extension employed in Niger).

2.2. Staff Levels and Distribution

INRAN currently employes 31 Nigerien researchers (A1 and A2 cadre), 28 expatriate researchers (a considerable number of whom have only undergraduate training), 44 technicians at the B through D levels (with education levels ranging from junior high school to three or four years of technical training in agriculture) and 424 support staff composed of secretarial and clerical staff, and skilled and semi-skilled laborers. Skill levels of lower level personnel (B through D) and support staff are modest. Staff levels are not yet sufficient to carry out research in all areas of the Institute's responsibility.

The heavy emphasis given by INRAN to programs in rainfed agriculture is apparent in the distribution of researchers and technicians. The Division of Agronomic Research (DRA) accounts for half of all the Institute's A and B level personnel. The rest are distributed across all other divisions.

Personnel are concentrated in Niamey and at the Kolo and Tarna research stations. Staff levels are most adequate in the area of drylands cereals selection, production systems, and crop protection. These activities are localized at the Tarna and Kolo stations. The Rural Economy Division (DECOR), situated primarily in Niamey, is quite effective in running its program of on-farm research.

The Division of Ecological Research (DRE) is the division most concerned with irrigated agriculture. INRAN currently has one newly trained hydrologist as head of the water economy section and one rice breeder. Within the DRE there is an irrigation studies group charged with the development and monitoring of irrigation research activities. Initiation of proposed project irrigation research activities will require more personnel than are currently available to the concerned divisions. Some forty INRAN personnel are now in university programs. Of those returning to the Institute in 1988, perhaps two soil scientists and one agronomist will be assigned to irrigation research. An agricultural/irrigation engineer is essential; this position could be filled through secondment of a Rural Engineering Service personnel to INRAN while an INRAN participant is in training. DECOR economists should be able to devote part time to perimeter diagnostic activities. If irrigation activities begin slowly as planned, these staff levels will be sufficient to begin activities. By the fourth year of the project, NAAR participants should have returned to strengthen the program.

The Research Extension Unit is responsible for the coordination of research activities and the creation of a tripartite dialogue between itself, researchers and extension services. With only one non-specialist person

currently assigned to the unit, it is inadequately funded and staffed. Development of this unit is a key project objective and essential to improving INRAN's impact upon Nigerien farming.

2.3 Distribution of Financial Resources

Allocation of financial resources reflects the traditional commodities and research station orientations to agricultural research. The plant breeding division receives 44% of research funds, while the plant protection research receives 36%. Dependent on outside funding sources, INRAN's on-station research potential is subject to the vagaries of donors' funding priorities and research management capabilities.

2.4. Assignment of Personnel

Recruitment to INRAN may be: (1) permanent via a mechanism of permanant detachment from another service; (2) temporary via secondment ("mise a la disposition de...") from another service or (3) provisional under terms of the convention governing civil service postings. One advantage to this system is that it allows INRAN to make use of agents whose salaries are payed by their oversight ministry (ministère de tutelle).

2.5 Researchers as Civil Servants.

INRAN personnel are civil servants. Once in service, seniority and acceptable ratings are more important to career advancement than performance per se. The real rewards within the civil service often go to persons who simply put in their time without substantive input. Advancement is gradual but steady. It is not surprising therefore that there is a certain lack of motivation on the part of some researchers. The lack of a work context which valorises research work, discourages younger cadre from seeking detachment to INRAN.

There are a few possible advantages for researchers. The first consists of the monthly bonus given to persons engaged in research. A-level personnel receive an additional 13,000 CFA francs each month; B-level personnel receive a bonus of 10,000 CFA francs, and C and D-level cadre receive a 7,000 CFA franc monthly bonus. A second type of bonus is given to persons in positions of responsibility. This amounts to 10,000 CFA francs per month given to division, department and sub-division heads. There are 32 such positions at INRAN.

Access of researchers to advanced training programs bears no necessary relationship to institutional needs for upgrading staff in response to research requirements. Instead, researchers are subject to civil service rules which impose a five year interval between long-term training stints on all personnel.

There are signs that long planned changes in the status of INRAN, and of its staff, will finally be implemented. These changes include the drafting of a well defined legal convention governing status, career path, performance

evaluations and incentives for superior performance. The INRAN Director General and the Rector of the University have been prime movers in this effort. If a new charter is approved by the council of ministers, many obstacles in the way of improved institutional performance and project success will be removed.

2.6. Linkages with Agricultural Services/Information Flow

INRAN participates in annual meetings of the agricultural technical services to canvass their research priorities and make them aware of research findings. There is no other effective formal channel of exchange between INRAN, other Agricultural Services and ONAHA. Aside from these formal annual meetings and a few contractual links with ONAHA, ICRISAT, FAO, etc.; there are few occasions held for exchange of information or views, and it appears that few unofficial initiatives are undertaken to provide or secure information.

Information does not flow freely within the organization. Between Niamey and the stations and sub-stations, and even between departments, there is a need for greater communication. Younger researchers and technicians need more supervision from senior staff. Good supervision is a crucial component of the professional development of researchers, and the overall development of effective research teams within the institution.

Generally, horizontal linkages between rural development services in Niger are weak. The problem is by no means limited to INRAN. While part of the problem is doubtless due to the workload of the field-level services, it is also possible that unsatisfactory response to INRAN research endeavours is the result of an intangible, yet real "image" problem or credibility gap, which has long bothered the institution. There is little to differentiate INRAN scientists with advanced degrees from other civil servants in terms of career path or rewards.

2.7. Infrastructure

Laboratory facilities at Tarna are generally adequate and even underutilised, i.e., the quarantine laboratory and the crop protection garage. The problem here is an anarchic pattern of infrastructure development, maintenance and deployment. At Kolo, infrastructure, including laboratories, office space, lodging and warehouse space are inadequate to sustain the activities of drylands scientists already in place . INRAN has already developed plans for some new facilities, and others should be considered as part of USAID counterpart funding activities.

In both locales, field and laboratory equipment is often overly complex or out-of-service. The system of equipment management needs much improvement. New facilities being built at Konni by FAO will enable INRAN to reinforce and expand its activities at this sub-station, including irrigation research.

Neither the Kolo and Tarna stations nor the sub-stations are functioning effectively for irrigation research because of the deterioration of infrastructure, some of which was installed in the early 50s and is in dire need of rehabilitation. As mentioned in the irrigation agronomy annex, it is questionable whether the CEHA center at Tarna is worth rehabilitating. However, use of the old experimental farm on the Djiritawa perimeter nearby would make a useful substitute.

Because of INRAN'S failure to use it effectively, part of the Tillaberi sub station may be absorbed by the Tillakaina garden perimeter. The Indoudou station 25 kms north of Agadez, built by the GTZ, has been abandonned since 1982 and has suffered from serious pilfering. This is unfortunate since excellent work was carried out here comparing dallou and modern irrigation methods.

The sub-station Bengou would be an excellent research site for trials on crops grown on micro-systems in the nearby Dallol systems, and indeed once had an irrigation system. ICRISAT seems to be repairing part of it. Part of the Lossa CERDAT station may be turned over to INRAN. This will enable INRAN to intensify research on soils water and plant relationships on the troublesome river terrace soils. Under NAAR, USAID must provide some infrastructural support to the substations, and to the Kolo and Tarna stations through counterpart funds to realize the potential represented by these statons..

Time constraints made a precise determination of infrastructure and equipment needs impossible for the design team, but some indication of these needs has been given in the agronomic and irrigation engineeering annexes. The procurement plan and indicative commodities list reflect the teams's best assessment of these needs. An equipment inventory and the development of a management plan will be priority activities during the pre-implementation phase of the NAAR project.

2.5. Delivery System for Research Results

INRAN'S capability to register, up-date, and market technical results of research are still limited. Its institutional memory capacity and pedagogical skills remain weak. Some extendable research data has been retained from IRAT research and some fruitful results have come out of associations with ICRISAT and other international organizations, as well as the larger productivity projects. However, in some cases results are simply recopied from technical documents produced by seed or appropriate technology clearing houses. Data is often not up-to-date internationally, nor in terms of the results of local applications of technical recommendations. In addition, far less data has made its way into technical sheets for mass distribution than is actually available.

Limited efforts have been made to translate research results into extension materials in French and in national languages. But extension agents and perimeter directors who have little real understanding of the purpose or potential of research, complain that the technical "fiches" developed by INRAN diverge from peasant reality and that station conditions cannot be reproduced in the field. These agents do not know how to adapt research results to local situations. While certain progress has been made in the area of information diffusion, INRAN lacks the resources to "get the information to the masses".

Visits to ONAHA perimeters and garden sites, indicate that technical information collected or prepared by INRAN is not often made available to perimeter personnel or arrondissement. The dissemination of technical information about rain-fed agriculture is woefully inadequate. However, it must be said in INRAN's defense, that this deficiency is overshadowed by the inability of the Agricultural Services to deliver to the farmer, adequate supplies of any improved input in a timely and effective fashion.

The considerations outlined in the preceding three paragraphs led the design team to call for the creation of a Research Extension Liaison Unit which builds upon progress made in developing the research extension linkage, and emphasizes activities which will institutionalize this linkage..

2.9. Institutional Issues

INRAN has a modest record of successes, of which as a young and underfunded organization, it can be proud. It has conducted inventories, and developed a number of improved varieties of dryland crops. It has produced purified strains of local varieties of some of these crops. It has produced purified rice seed for multiplication. It has developed a series of technical recommendations both for cereals and garden crops and carries out station, in field and interactive on-farm trials in many of these areas. INRAN has carried out its own soils research under contract to funding agencies and ONAHA. A beginning has been made in reconstituting inventories of local irrigated and dryland crop varieties.

Among INRAN'S most pressing institutional problems which should be addressed under the NAAR Project are :

1. The unsatisfactory status for researchers within the civil service

2. INRAN has no long range plan for its research activities nor for its institutional future. There is a confusion about research goals because of the lack of coordination between INRAN and the production and extension units of the Ministry of Agriculture.

3. The lack of clearly defined tasks and responsibilities among units, for example between divisions and stations; and the lack of communication between different units and sections, particularly those which take a production orientation and those which take a system orientation approach to research.

4. There is no formal human resources development and management policy at INRAN. This is in part due to INRAN'S dependence upon other divisions of the Ministry of Agriculture for source of cadre.

5. Although the means and equipment at its disposal are limited, INRAN nevertheless has neither the staff nor the systems which would allow it to manage these resources efficiently. Anarchic procurment of a hodgepodge of makes and models of equipment and supplies is partly to blame. No system for preventive maintenance and periodic renewal of plant and equipment exists either.

6. INRAN'S formal links with its institutional partners are weak.

7. Due to insufficient funds and managment, its stations at Tarna, and Kolo and its sub-stations at Bengou and Tillabery are underused and deteriorating.

8. INRAN's budgetary autonomy is slight. Budgetary allocations have stagnated seriously over the past five years. Transactions in excess of one million frances require Ministerial approval. Since over 70 % of its operating budget is absorbed by salaries, virtually all of INRAN'S ongoing research activities are dependant upon donor financial support.

9. There is a lack of specialized trained personnel in all phases of irrigated agricultural research, especially at the critical station and substation levels, and in extension.

10. The manner in which on-farm trials are carried out is not entirely satisfactory, either from a pedagogical standpoint or scientific point of view. Low level employees who have been inadequately trained in conducting research trials are still responsible for placing and monitoring them, while the researchers may neglect to explain either to them or to the farmers what is going on at the different stages of the trials. Frequently yield samples are not returned to farmers, and rarely do they recieve any results which they can understand let alone share with their neighbors.

11. Due to resources constraints, available technical information ha not been reproduced in sufficient quantity and in appropriate form for distribution to extension agencies and farmers.

Analysis conducted by the CILSS, USAID and others have detailed the structural and organisational weaknesses of INRAN in great detail. Bereft of an official policy framework for scientific research, deprived an overall national research strategy, inheritor of an outdated approach to agronomic research, faced with a monumental research agenda conceived in an atmosphere of crisis, exposed to extreme fiscal vulnerability, drastically understaffed, saddled with inevitable shortcomings in its management system, INRAN'S resultant efforts could only be dispersed, poorly coordinated, and unprioritized. Resources have not always been efficiently devoted to projects of national priority. However, the current directorate seems positively disposed to undertake serious and sweeping organizational reforms. The climate seems to be changing in INRAN's favor, and considerable progress has been achieved through the support of the Niger Cereals Project The moment is opportune for USAID to intervene to strengthen this organization..

III. PARTICIPATING INSTITUTIONS

The classic services of the Ministry of Agriculture have overall responsibility for extension activities. The services most directly concerned are Rural Engineering, Production, Extension, Fruit and Gardening, and Crop Protection. Production has been responsible for obtaining seed inputs from INRAN. Extension handles technical training of farmers and gardeners via its district agents and by placing agents directly on certain projects. INRAN's technical handouts somtimes reach cadre at the arrondissement level. Fruit and gardening does not now seem a very active service, although it has been conducting some work on date palms, and the viruses and fungi affecting mangoes and citrus trees. INRAN itself does very little horticultural work, all of it dependent upon outside technical assistance. Crop Protection intervenes in agriculture via the Service de Protection de Vegetaux, financed by German, Canadian, and USAID money, to provide limited pest control services. Some research activities have been funded at INRAN, but the impact of the entmological work has been limited.

3.1. Rural Engineering (Genie Rural)

Rural Engineering (Genie Rurale) is charged with the conception and execution of small and large irrigation projects, but with ONAHA'S input in the latter case. The service has executed any number of school and village garden projects, and has worked effectively with INRAN-Agadez in testing new irrigation techniques. Many agents have diplomas from a regional engineering school in Burkina. Relations between Genie Rural and ONAHA are good, thanks to the rapport between the two director generals. Relations between Genie Rural and the other agricultural services have been dramatically improved by the internal reorganization of the Ministry of Agriculture. Formerly collaboration was limited, but now the assistant directors of Agriculture in four out of seven departments are also departemental directors of Genie Rural.

Genie Rurale's role in irrigation is presently limited by a lack of resources and limited numbers of qualified personnel. There are only 6 engineers in the division and only one regional office is headed by an engineer. However, the rural engineering training program at IPDR provides its graduates with the technical elements necessary to conceive and execute small scale irrigation infrastructure. Graduates from this program should soon begin to be placed at the arrondissement level,and could be a key point of articulation with the Research-Extension Unit of INRAN.

Within Genie Rural, a limited effort has been made either to extend or to experiment with available technical innovations in irrigation, although many cadre seem to have the technical qualification to design and execute irrigation systems. Expatriates who have worked with Genie RUral often say there is a kind of modernist bias in their approach, e.g. they would rather use small pumps that adapt traditional water extraction techniques to new contexts. Other agencies of the Ministry of Agriculture often seem disinterested in tradiitional techniques. There is ample scope for the intervention of skilled expatriate technical assistance to work with Genie Rural and INRAN to develop and test innovative technologies of extraction and distribution, incorporating both traditional and modern approaches.

Genie Rural could also be a source of cadre for INRAN. Students with engineering training could well be detached to INRAN, and be sent for further training in the U.S. to the masters level. Those already holding an Ms. could be sent for further supplementary training and/or serve as counterparts to the engineers serving in the irrigation research units to be created within INRAN.

3.2. The Agriculture Service

Arrondissement and district level Agriculture agents provide inputs and advice to the farmers on the dry season garden projects. Agents at the arrondissement level are normally responsible for administering INRAN'S program of multilocale on-farm experiments. Unfortunately, because of their heavy workoad, delays in transfer of payments for labor from INRAN to the Ag Service and finally to them, disinterest in research, and inadequate training and supervision, INRAN has never received results from more than 20-30% of these trials.

Agriculture agents recieve from two to four years of training at IPDR in Kolo. Training for those completing the full four years now includes a gardening component. Agents at the district level have generally only two years of training at Kolo, and thus have not received much specialized training. Few have any specialized training or aptitude in research methods, developing local organizations, dispute mediation, and most critically, extension methods themselves.

District agents rely on the arrondissments agents for technical advice. Arrondissement level cadre are spread too thinly to provide the dense extension services needed, and local agents lack the necessary training and resources to respond to local needs. Perhaps the greatest problem is the inability to monitor on going projects in order to correct misconceptions and technical errors before they lead to failure or farmer disallusionment.

Some cadre have been innovative in dealing with their situation. At Gaya, for example, the FAC sponsored Gaya Fruit Project made funds and vehicles availables so that the arrondissments agriculture agents could hold a series of short training sessions with the seven district agents and local farmers over the course of a month. Theoretical discussions were held in the evenings and practical demonstrations during the days. The arrondissement agents want to pursue these short courses which they juged very useful for farmers with no experience in gardening. The research/Extension liaison unit could encourage such activities.

In general, local agents are unaware of the resources which research could make available to them. The NCR project has also found agents of the Agriculture Extension Service among the least responsive to efforts to involve them in the on-farm research program. This type of program contradicts the top down extension style which has always characterized the approach to extension in Niger. This attitude constitutes an institutional constraint on the success of the Applied Agriculture Research Project. Success in this area is conditional on progress made by the newly arrived APS extension team.

3.3. ONAHA

ONAHA, created in 1979, manages and maintains irrigation infrastructure and provides training and extension services to farmers. ONAHA manages perimeters in which the state, in cooperation with the donors, is the major investor.

ONAHA is divided into the following divisions:

- The Division of Administrative Accounting and Financial Affairs;

- The Division of Infrastructure which, in liaison with Genie Rural, carries out studies and executes new perimeters;

- The Division of Production and Perimeter Management (Mise en Valeur) which has overall responsibility for supervision and extension demonstration, experimentation and the like, on the perimeters;

- The Division of Materials and Equipment;

- The Division of Regional Directorates (Niamey, Tillaberi and Tahoua) under the authority of which are the perimeter directors.

According to a list of agents prepared in September of 1985, the Direction General of ONAHA contains 32 cadre of which six are A level. Several candidates for long term training in engineering and/or irrigation management could be found among them. The Regional Directorate at Niamey contains 14 cadre of which two are A level. Eleven of these are perimeter directors. The Regional Directorate of Tillabery contains 14 cadres of which two are A level. Four are perimeter directors. The Regional Directorate at Tahoua contains 29 cadre of which six are A level. Five are perimeter directors. Of the total of 95 agents, only eight were directly charged with extension/training functions.

Recruitment to ONAHA is generally by assignment within the Ministry of Agriculture. The problem of precipitous movement of personnel in-and-out of the Office has apparently lessened since the appointment of the new Secretary General.

Perimeter personnel provide liaison to regional ONAHA authorities who handle major maintenance activities. National authorities tend to see ONAHA'S role as primarily technical. Perimeter personnel, especially on smaller perimeters since the dismantling of UNCC, find themselves called upon to play a wide range of coordination, training and management roles which they are often poorley preprared to carry out.

Under current policy, some directors on particularly large (Namari Goungou) or successfull (Toula, Guidan Magagi) perimeters may soon become the employees of the local cooperatives. This initiative, which aims to make perimeter directors more responsive to local organizations, entails risks as well. Checks and balances have yet to be designed to prevent abusive excercise of local authority. However, it seeks to encourage directors to perfect and/or excercise their professional competence in the interests of overall perimater performance. This policy therefore consitutes an opportunity for INRAN to more agressively pursue its applied research program in irrigation. Given the interest displayed in the NAARP project by the current direction of ONAHA, the project should seek to exploit this opportunity.

The role of the Division of Infrastructure overlaps with the functions generally attributed to the Service of Genie Rural and the Ministry of Agriculture. As part of its on-going policy dialogue with the Ministry of Agriculture and ONAHA, USAID should encourage the trend in direction of giving Genie Rural responsability for the execution of projets entailing indirect state investment, i.e., the small scale well and irrigation projects, leaving ONAHA with the overall responsibility for projects entailing direct GON investment, i.e., the perimeters with full control.

The Divisions of "Mise en Valeur" and of "Infrastructures" are the key contact points for INRAN within the national directorate of ONAHA. The latter contains a monitoring and evaluation unit which has also been the division which has coordinated donor-funded applied research and extension activities within ONAHA. Alleged weakness on INRAN'S part have led the DMV to exercise a certain reticence in concluding collaborative applied research agreements dealing with INRAN and compelled them to undertake their own Mo rice seed production activities with Belgian assistance at Saadia. However as the division charged with developing and monitoring perimeter production systems, it is a key focus for the production systems research component of the NAAR. Perimeter specific research protocols should be designed cooperatively by INRAN'S research Liaison Unit and ONAHA'S Applied Research Unit.

Site visits have shown that despite some improvments in developing production systems perimeters, particularly the inland ones are still functionning far below their agronomic capacity. Present water managment and control systems leave a great deal to be desired. While some problems are due to errors of conception, a great many more are due to the sheer lack of knowledge about how water is used and behaves. Improvement of these systems via a vigorous program of on-perimeter diagnosis and trials provides a critical challenge for NAARP and INRAN to demonstrate the utility of this approach.

The ONAHA directorate in Niamey is well aware of the need for research to overcome production system problems. But agents at the perimeter level do not in general, understand research, nor its potential. They are indifferent, if not hostile to the notion of on-perimeters research with its emphasis on dialogue and experimentation. In a few rare cases however, perimeter personnel have initiated their own little experments in hopes of improving production efficiency. The project should not aim to transform the conception of research among perimeter staff in the short run. Rather is should seek to develop a decentralized program of on-perimeter experiments, the results of which will in themselves promote a change in attitude.

The Director General of ONAHA indicates that he would welcome the opportunity to involve some of its agents in long term training in conjunction with that recieved by INRAN cadre. The project should explore the opportunity to develop improved collaboration between the two institutions by means of complementary and overlapping training in U.S. and this country institutions. The WMSII training program in Morocco might provide one mechanism for instigating joint short-term training for technicians from both INRAN and ONAHA.

Another opportunity for improving collaborative activity between the two will be provided by the training activities initiated by the Research Extension Liaison unit for perimeter directors and extension agents as the following arguments suggest.

It is unfortunately the case that performance of ONAHA personnel on the perimeters seems to be evaluated primarily on whether the maintenance and utilities fees are paid, and the perimeters are being cultivated according to the central plan. This forces a kind of police role on perimeter personnel. Other performance indicators, such as transfer of management functions to the cooperatives and amortization or maximisation of productivity, appear to be secondary and are viewed as "long run" objectives. In many cases, once the perimeter enters into regular service, often agents seem to be left to "se debrouiller".

Surpisingly, certain progress has been made in the area of collaboration between ONAHA personnel and farmers who have worked out modus vivendi in a number of cases. In the Maggia, many directors have a great deal of experience on the perimeters, and a number appeared to enjoy the confidence of the cooperative leadership, if not always that of the individual farmers. However, this accomodation has been bought at the expense of rigorous management of scarce perimeter resources. The NAAR project could actively contribute to the realization of the "secondary" goals mentioned above, through active on-perimeter research and training of perimeter agents.

To summarize, ONAHA'S problems which are germane to the goals of NAARP include:

1. Lack of sufficient quality seed (except cotton) of locally adapted varieties to extend to the cooperatives on the perimeters.

2. Weakness of its applied research capacities. There is an absence of personnel with whom the INRAN Research Extension service can interact. Those cadre who have developed innovative solutions to local problems, such as application of animal fertilizer to prevent rice plants from yellowing, have no organized forum in which to exchange ideas with INRAN or other ONAHA cadres

3. Absence of credible, alphabetized peasant intermediaries with whom ONAHA can carry out a dialogue about the performance of new crop varieties, irrigation techniques, management methods, etc.

4. Absence of pedological technique among perimeter staff.

5. A limited repertoire of technical responses to existing problems, e.g.,:

a) should floating rice be planted in flooded areas of the perimeter in the absence of sufficient improved seed?

b) what techniques of seed treatment should be recommended to the cooperative?

c) what varieties should be substituted for the standard varieties in the dry season given limited availability of water?

c) how should fertilizer doses be modified to deal with localized variations in soils chemistry?

e) are permanent or seasonal solutions to water shortage problems more economical, as in the case of Daikaina where its dry season water is blocked by the Toula dike.

6. ONAHA personnel and budgetary resources have been cut back drastically in recent years, leaving it with few extension personnel and a limited number of technical cadre. The policy of transfering control over the perimeters to the cooperatives has left it without the means to enforce truly important technical themes. As a result, its ability to implement animal traction programs, to train farmers in management and technique, to follow activities at the seed farm, and even to promote the new rice varieties are severely limited. ONAHA seems to be in a holding pattern, awaiting the start of the massive World Bank rehabilitation program through which ONAHA hopes to see its financial resources, personnel, rolling stock and status improve.

3.4. The Union Nigerienne de Cooperatives (UNC)

Since the Zinder seminar, the following functions are supposedly being transfered to the local cooperatives under a national umbrella organization, the UNC:

- Management of agricultural inputs;
- Management of a line of credit or rolling fund to finance various cultivation costs;
- Management of water tower;
- Primary maintenance of perimeter infrastructure;
- Calculation of recovery of perimeter tax (redevances)
- Marketing of harvest;
- Creation of a cooperative contingency fund.

In addition, the Comite de Gestion is supposed to assume full responsability for the following:

- Monitor the quality of canal clearance and plowing;
- Determine other necessary tasks related to plowing and clearing;
- Determine a calendar for water distribution and monitor it;
- Determine needed repairs to the perimeter;
- Manage the distribution of agricultural inputs;
- Establish and accounting system and stewardship for the cooperative rolling fund and other components of the redevance;
- Marketing of cotton and rice and other commercial crops.

Cooperative officers, whether in the Maggia, along the river, or on the garden sites provide credit and marketing management services to the farmers and act as an intermediary to them and the technical services. They also provide liaison to UNC from which the perimeter management committee purchases agricultural inputs on credit at the beginning of each season. Repayment is then made at the end of the harvest. UNC also continues to monitor repayment of loans taken from CNCA under the old UNCC structure such as those for animal traction equipment. While marketing of cash crops is a traditional cooperative activity in Niger, ouside of the river and Maggia Valley perimeters, the role of the cooperatives in marketing has been reduced since the decline in legume production provoked by the persistance Sahelian drought.

The presence of dynamic, literate cooperative officers can make major difference in the overall economic well-being of the perimeters, just as the presence of venal, self-interested, or incompetent ones can create disorder. Well functionning sites like Guidan Magagi in the Maggia, the women's garden coopetative at Koboul in the Dallol Boboye, or Toula on the river seem to have effective officers, whereas Galmi and Konni in the Maggia, Tara and Kaigatarou along the river (neither of which functions particularly well) do not.

Overall, the relatively weak role of the cooperatives seems linked to unresolved questions concerning land tenure and economic return as is discussed in the technical annex concerned with the social context of NAARP. However, farmers are able to identify a number of areas in which their cooperatives could play a positive role in perimeter evolution (presuming an adequate level of training):

a) respect for the water calendar;
b) respect for the agricultural calendar;
c) management of processing equipment (reaper-harvesters, thrashers);
d) maintenence activities.

Carrying out these activities successfuly requires a greater level of understanding of irrigation and crop cycles than GMP heads currently possess.

In the Maggia Valley, the situation is quite diverse, but there are perimeter "comites de gestion" who handle all of the functions supposedly attributed to them, and cooperatives which have taken fairly effective control of their commercial activities. Guidan Magagi works the best of the four perimeters examined during a brief survey undertaken for WMSII-Cornell University. Tounfagi and Moullela were also assuming a certain measure of control.

Galmi, and Konni I, the latter studied by the Ministry of Plan, as well as WMSII are not functionning as they are supposed to. In the former case, the fundamental problem identified was the undemocratic method by which irrigation unit (GMP), "comite de gestion", and cooperative officers were chosen. This has resulted in a very directive management style in which there is virtually no upward flow of information. There is also no way for ordinary farmers to communicate complaints to the URC or to the administrative authorities since the latter in general refuse to recieve communications which have not gone through the lower levels of the Societe de Developpement.

At Konni, the "indiscipline" of the farmers is a constant complaint of the ONAHA personnel. However, the real problems at Konni are the inability of ONAHA to help them organise, land tenure issues, problems with the attribution of parcels, and agronomic problems which provoke a very uncertain economic rate of return to labor. Nearly a quarter of the 150 farmers questionned by the Ministry of Plan remained interested in possible activities the cooperative might undertake to improve the technical and economic performance of the perimeter.

In the Niger River Valley, the situation of the cooperatives is equally diverse, but in general, the above mentioned management activities are not effectively carried out by the cooperatives. The cooperatives most notable success has been in marketing. According to the farmers questionnad, forty percent of the on-perimeter production of some 150 farms monitored by the Ministry of Plan in 1984, was sold to the cooperative. Consultants working for the Plan indicated that of the three river valley cooperatives studied, the cooperatives worked relatively well at Toula and Namari Goungou. The former site is characterized by a certain overlap betweem local organizational structures (kin and ethnic units), and cooperative units. The latter site has been the focus of some CCCE activity in the area of coop development.

IV. SUMMARY OF INSTITUTIONAL CONSTRAINTS

4.1. Rural Institutions (Cooperatives)

In general, it is worth underlining the point that the notion of the cooperative is new to Nigerien peasant society. These societies are highly stratified and deeply divided by caste, class, ethnic divisions, several hundred years of local warfare and slaving, and 60 years of colonial rule. Therefore, their ability to conceive, initiate, and manage semi-autonomous local level organizations (even if the GON administration and ONAHA were in fact willing to let them do so) is very limited.

Cooperative institutions are stronger in the central part of the country than in the west, but cooporate institutions are everywhere undeveloped. The recent study of rural institutions in the Niamey department conducted by DAI, and the Ohio State University, both conducted for USAID/Niamey, provide considerable detail relevant to this point.

4.2. Bureaucratic Structures

Nigerian bureaucratic structures are still relatively ineffective in managing research, including those agencies whose primary mission is research. Whether at the Ministries of Agriculture or Plan, INRAN, or, ONAHA, most researchers have found it very difficult to mobilize logistical support and personnel within optimal research time frames. Administrative distrust of research, inertia, and unnecessary complicated accounting procedures sometimes compromise even the best protocols.

None of the participating institutions discussed above presently have the capability to sustain a program of applied irrigation research, and the mechanisms by which such program might be organized are only nascent. INRAN however, has demonstrated a capability to conduct drylands research, and is the most promising candidate for developing an additional program of applied irrigation research. Negative experience with previous attempts to develop collaborative research programs, have led most of the institutions implicated in the project to be wary of committing themselves wholeheartedly to a new research program. For example, ONAHA complains that:

1) Research tends to be overly theoretical, and/or
2) The results are often unsuited for practical application, and/or
3) The results are not delivered.

Nevertheless, there is a recognition of the need for improved techniques in the face of the ongoing economic and ecological crisis in Niger among the various instituuional actors in agriculture. It may well be that the NAARP can make a positive contribution by placing such improved techniques in the hands of Nigerien farmers.

To summarize, the following general points about Nigerien bureaucratic institutions can be made:

4.2.1. Personnel Relations

Norms about hiring and firing are rarely enforced. Recruitment occurs through personal influence and security of employment is a generally accepted norm. Disagreements are tolerated, but not if publicaly expressed. A monolithic conception of authority prevails. The occupational hierarchy reinforces status distinctions observed in the larger society. In place of open channels for advancement, great stress is placed on formal qualifications.

Formally, recruitment to the various services is first the result of educational tracking, and the individuals' abilities to pass examinations and obtain scholarships. Second, it depends on perceived need within the administration as determined by the Ministry of Fonction Publique, and in the case of INRAN, ONAHA, Genie Rural, etc, the Ministry of Agriculture.

Evaluation and promotion with individual services is governed by the rules laid down at Fonction Publique which apply to all agents accross the board. There is no distinction made between researchers and administrators, or line or staff positions in this regard.

Agents are graded by degree of educational attainment and years of service. "A" level cadre have the greatest educational attainment. Within each grade, there are levels and scales. Advancements between levels is a matter of years of service and the results of yearly performance evaluations. Reclassification, or changes of grade are also influenced by these criteria, but above all by educational attainment. It is worth pointing out that clients of the government services have no say in the evaluation of agents.

Cadre must now wait five years between stints of long term training. However, access to scholarships is not automatic. Departure for training entails passing exams and obtaining consent of ones superiors.

4.2.2. Materials Management

Resources destined for specific purposes are frequently diverted to meet urgent needs in other sectors. It is impossible to count upon the availability of special equipment, let alone vehicles. The distinction between public and private goods is not much respected. Maintenance of existing materials is poor because the prime effort is directed towards acquiring new capital.

4.2.3. Planning

There is a flexible attitude towards planning and scheduling. Reluctance to execute policy as scheduled is reinforced in those cases where uncertainly about jurisdiction is recognized.

4.2.4. Decisionmaking

Institutions lack expertise in organizational behavior and modern theories for organizational management. Institutionnal memory is virtually nil due to the high velocity of turn-over in personnel. Reassignment every two to three years is common. Decision-making techniques are highly personalized. Consequently, management is weakly institutionlized. Managing sustained performance proves very difficult as personalities within an institution change.

4.2.5. Control

Large organizations tend to be divided into small units controlled by individual top managers. Distrust of ones associates and subordinates is common, and many managers routinely employ protective strategies towards subordinate staff. Downward communication is facilitated and expected. Lateral and upward communications are discouraged. Formal channels of communication are completely clogged with routine reports, many of which bear little relation to performance or organzational goals.

The predominance of vertical hierarchical linkages and communication channels within individual rural development services, over horizontal, integrative linkages between services, often results in patterns of routine program implementation in which minimial and occasionally no detailed information is shared by service representatives in the field. Systematic exchanga of information is limited to formal institutionalized encounters between services.

4.2.6. Professionalism

Managers show marked ambivalence about technical matters, often avoiding them to the extent of nonaction or sabotage. Alternatively they view them as constraints which prevent action. The few available specialists are thrust into general managerial roles leaving junior and/or inexperienced staff to handle critical technical matters, and often with little oversight of their execution. Professional norms thus have little influence over activities.

The project will develop management and implementation strategies to overcome the constraints to effective implementation here identified. While these are spelled out in the section on implementation arrangements, the following general principles should be followed:

1. Agreements should be formalized in writing;
2. Performance incentives must accompany innovations in program implementation;
3. Efforts to strengthen horizontal linkages must build in clear benefits to the contracting parties;
4. Self-conscious efforts must be devoted to ensuring information transfer and exchange;
5. All relevant agencies must be involved in planning and evaluating research programs if results are to be accepted;
6. Programs must be developped which accomodate inevitable slippages between planning and execution.

7. Technical assistance must seek to build up personal relationships with counterparts and other active participants in project activities, never relying on professional ethics or reputation to ensure program success.

8. Institutionalization of management systems will require constant monitoring and reinforcement.

ANNEX B

SOCIAL SOUNDNESS ANALYSIS

CONTENTS

I. Introduction

II. Critical Socio-Economic Issues

2.1. Ethnicity

2.2. Land Tenure

2.3. Economic Strategies

2.4. Labor Scheduling

2.5. Political Issues

SOCIAL SOUNDNESS ANALYSIS
POTENTIAL IMPACT OF PROJECT ON AGRICULTURAL PRODUCTIVITY

Achievement of project aims requires working with farmers of different regions and with differing degrees of experience in, and specialized knowledge of drylands and irrigated agrculture. The existing small and medium sized perimeters, for example, represent quite diverse situations in terms of ethnicity, land tenure arrangement, crops, agricultural skills, access to markets, access to technical services, methods of labor deployment, relationships to the administration, etc. Devising an effective program of applied agricultural research entails a thorough grasp of the socio-economic context on the part of researchers, including the logic of peasant production, and perceived constraints to improved productivity. Knowledge of peasant agriculture on the part of implementing agents has often proved to be limited and in some cases erroneous.

For over fifteen years a homogeneous package of technical recommendations was diffused throughout Niger. At times, the themes have proved inappropriate to local conditions. Because of this, proposed extension themes have sometimes been rejected by local farmers. Evaluations conducted by Ithaca International and the Ministry of Plan in 1984 revealed that the impact of the extension of technical themes on local agricultural practices in Zinder and Niamey departments is extremely limited. Some of the themes, which have been better received in southern Maradi department, were ill-adapted to specific local conditions, too risky under the current rainfall regime, or were too expensive.

Even now, some themes with a commodity improvement focus are being extended, but are of dubious value when placed within the larger context of farmers' overall managment strategies. For example, a single farmer may typically use a mix of cereal sub-varieties adapted to differing soils and water conditions. This is a risk minimization strategy. INRAN's extension packages emphasize use of unique varieties in only three recognized rainfall zones. Clearly, a farmer who accepts a unique variety over his diversity of varieties, may percieve that he is puting his production at risk.

In light of the questionable value of traditional extension themes, INRAN, Agricultural Extension and ONAHA cadre now give lip service to socio-economic issues. Nevertheless, they generally percieve socio-economic issues as constraints to progressive adoption of the technical themes produced by research, rather than a source of knowledge to improve agronomic research..

What is needed in the framework of the Niger Applied Agriculture Research Project, is to inject more diversity into INRAN's dryland farming systems research program and into the extension recommendations which result from it. This can best be accomplised by the installation of an information loop between farmers and researchers through a reinforced program of on-farm research. However, the notion that analysis of the logic of peasant production systems could be a positive input to research is a novel one, and one that will have to be reinforced by the social scientists and their natural science colleagues working within the framework of the NAARP.

Niger's current and planned irrigated perimeters and contre-saison sites touch virtually all of the main ethnic groups in the country, and include a variety of imported and indigenous water management systems and cropping techniques. Many are untested in local conditions. Developing any unified program of applied irrigation research thus seems not only wrong-headed, but doomed from the start. A more successful approach will be to adopt a decentralized program specific to the needs of different "type" sites. Thus extension of a modified program of on-farm research such as that developed by DECOR, and devoted to identifying "type" sites, recommendation domains and researchable solutions to local problems seems warranted.

Among the critical socio-economic issues identified by previous research which have impinged upon the adoption of agronomic themes and the success of irrigated perimeters are; land tenure, ethnic complexity, local political relationships, labor scheduling (including the division of labor by gender), household economic strategies, access to markets, and access to inputs (including credit). These are the major socio-economic variables which need to be addressed in the design and development of new farm research programs for the study of both dryland and irrigated agriculture systems, and in designing extension recommendations.

Site visits have confirmed the importance of each of these factors, although the importance of each of them to agricultural productivity varies from place to place. The issues are reviewed below. This review should provide a point of departure for the social science technical assistance to be provided to the on-farm research program in DECOR within the framework of the NAARP.

Ethnicity

Ethnic variables enter into the agronomic picture at three levels:

1. Experiental/
2. Internal social characteristics/
3. Ethnic boundary maintenance.

Ethnic groups in Niger vary in the degree of commitment to and interest in agriculture. At one extreme are nomadic pastoralists. The pastoral vocation of the Fulani means that their committment to gardening (e.g. the Tabalak site) or to rice cultivation on irrigated perimeters (e.g. Say) is problematic at best. Yet some groups have been confronted with the choice of at least temporary conversion to gardening or starvation. Such groups are not key targets for building sustained improvements in productivity in spite of the national enthusiasm for the "reconversion" of the nomads. Even the desirability of ensuring a continued committment to agriculture in the nomadic zone is questionable.

At the other end of the continuum, certain ethnic groups have extensive experience with both dryland and irrigated agricultural production, and also have well-defined preferences in terms of crops grown and crops consumed. Thus the Wogo river people are past masters in the art of floating rice

production. Zarma, in the Dallol system, have time-tested techniques of rice production on seasonally flooded bottom lands, and for sweet potato and sugar cane production even on natron-laden soils. Aderawa Hausa, in the Maggi Valley region, have selected very high performing varieties of onions and tomatoes for production and marketing in both fresh and dried forms. Servile caste Tuareg in the Air region, have developed the dallou irrigation system for wheat and vegetables, a system which has yet to be improved upon. Gobirawa Hausa in the Goulbi N'Maradi (a fossil river course) and long-resident Haussa populations of southern Zinder, have a long tradition of garden crop production, especially sugar cane cultivation. The Manga of Diffa, clustered along the bed of the Komadougou Yobe, have perfected techniques of sweet red peppers production and drying. They have become major suppliers of "tattasai" to markets in Niger and Nigeria.

The very richness of their experience sometimes makes it difficult to introduce new crops or techniques to these groups, especially given the weak comparative performance of many modern methods and the low level of technical expertise of extension agents. However, such people should be used as a resource in developing the research agenda for irrigated agriculture and for extending time-tested methods into areas with untapped irrigation resources.

The structure of ethnic groups also plays a role in agricultural research and extension. The Zarma have a legitimate reputation as highly independant farmers and, when it comes to land tenure, for litigiousness. These characteristics complicate development of irrigation land, since this usually entails both modification of land tenure arrangements and acceptance of more collective work habits. Such behavior poses special problems for extension since resources and information are rarely pooled above the household level.

Persistant social obligations of ethnically distinctive groups toward former noble or warrior patron groups (such as those of smith-caste Tuareg, Buzu and Bella groups toward Tuareg, Kourtey, or Songhai nobles) sometimes interferes with their ability to respect the cropping calendar and financial obligations imposed upon them by the state at irrigated sites. Respect for obligations imposed by the former patrons carries more certainty of long term payoff than does respect for obligations imposed by the bureaucrats who work for the state.

Conflict between pastoralists and agricultarists over scarce pasture/garden land near watering points is another unresolved problem. Competition for resources will inhibit investment in unproven horticultural practices and well development. In this context, it would be well worth determining whether pasturing, fodder production, vegetable gardening, or some combination of these strategies makes the "better" economic and socially sound use of these lands.

Groups with a certain tradition of ethnic homogeneity, without a warrior tradition, who are secure in their land tenure arrangements, and or who benefit from long-established residence in a given area, are often easier to work with in developing new agricultural practices than groups which lack these characteristics.

Inter-ethnic land tenure relationships are an important factor in determining the success of extending new irrigation techniques. This aspect is discussed below.

Land Tenure

Land Tenure and land use patterns are one of the fundamental factors which enter into production decisions on family farms in Niger. Programs which aim to intensify agricultural production must take into account:

1. the different objectives for agricultural production (e.g., satisfaction of household food requirements, satisfaction of individual cash requirements) held by different members of the family (male household heads, female household heads, wives, dependant males etc.). and which are in turn;

2. related to the different types of control (collective v. individual) exercised over land, and

3. the socio-demographic location (village in-fields vs. village out-fields vs. bush fields) of collective and individual fields.

Attribution of parcels on irrigated perimeters and on garden sites is supposed to follow certain general principles. Occupants of the land have first access to improved sites. In theory, parcels are allocated in function of family size and previous yields. In practice, power, personnal connections, social status and other extrinsic factors play a determinant role in allocation. These procedures often have a negative impact on farmer motivation on the perimeter, which in turn discourages cooperation in scheduling of production, and ultimately leads cadre to complain of farmers' "lack of discipline".

Land tenure is ultimately vested in the state, but farmers enjoy use rights of virtually indefinite duration on dryland parcels. Supposing that they obey the rules set down by ONAHA and/or the local cooperatives for their exploitation, tenure on irrigated parcels is also of indefinite duration. Cooperatives have the right to allocate empty parcels, but in practice, they try to respect the wishes of deceased parcel holders, and of neighboring parcel holders as far as new allocations are concerned. ONAHA perimeter directors keep out of allocation as much as possible, in order to avoid charges of favoritism.

When the state appropriates land for perimeter construction, installation of research plots, or training centers, etc., the real fragility of peasant tenure is made apparant to all. It is these incidents that stick in the memory. This situation discourages farmers from making capital improvements on land on which the state exerts outright control, or displays an interest.

Land tenure problems have appeared on a number of the perimeters along the river, including newly created systems, as well as at Konni I and Galmi. The problems are of two orders. First, there are cases where pre-existant land tenure disputes have been transfered onto the perimeter after its creation. This is notably the case along the river, and apparently in the Komadougou Yobe area. Here, competing local authorities who have long sought to translocate disparate types of pre-colonial authority over dependent populations, and/or territory into outright possession of land in the European sense, have tried to extend this control onto the perimeters.

Second, there have been cases where groups had prior access to land under temporary arrangements, but found their rights circumscribed after the perimeter's creation. This has often been the case for women along the river. Woman at Namartigoungou for example, have been given a rather unsatisfactory plot for vegetable production, but have recieved virtually no technical advice. Those at Karma have been more lucky in that a large irrigable parcel has been set aide for their use. However, they too need technical advice and assistance in organizing their purchases of inputs and for marketing.

By contrast, women have been able to gain access to contre saison parcels fairly readily, as at Falmey or at Koboul, within the framework of an Africaire gardening project. In these cases, the traditional women's right to a garden plot within their husbands' fields have been adapted to a new context.

A fourth issue was identified at sites where gardening has long been practiced, e.g., the Bengou sweet potato gardens, or the floating gardens of sugar cane at Nyakoye Tounga, the manioc plantations at Mombeina, or at certain sites along the Dallols Boboye, Mawri or Fogha. Here the space is almost fully occupied and farmers may hesitate to experiment with innovations which pose risks to their production. Farmers were uninterested in perimeter development for example, having been discouraged by the negative example of the Tara perimeter.

A final critical land tenure issue, perhaps the most general case, is the authorities' non-respect of the letter or spirit of the rules of parcel attribution. This occurs both intentionally and unintentionally. Intentional violations seem more common on the larger perimeters involving diverse populations. Cases have been reported at Namari Goungou, N'dounga, Galmi, Lossa, and Konni I, where political considerations have affected distribution. Unintentional violations were uncovered in many places, such as Namari Goungou, Tara, and Galmi.

At Namari Goungou, the creation of the perimeter disrupted the system of land rents controlled by the local Kado aristocracy and freed the Wogo farming population from their obligation to pay ground rent. Whereas the Wogo areas of the perimeter aristocracy, and those areas controlled by the Bella (neither of whom have a strong farming tradition) do not. Their seems to be problems with attempted sabotage of perimeter functioning on the part of the disgruntled Kado.

On the "contre saison" sites, land tenure issues have also arisen due to the frequently heavy handed bureaucratic tactics employed to appropriate garden lands. In some cases, prior ownership has been ignored, while in others, authorities have ridden rough shod over the use rights of pastoralists, exacerbating conflict over scarce dry season resources.

In the Zarma-speaking areas (the Dallol Boboye for example) and along the river where overlapping land claims exist, land disputes are most likely to arise should government services intervene to improve infrastructure. In these areas, even careful sociological surveys may not preclude future disputes. Land tenure disputes are less likely in the Hausa speaking areas.

It will be more difficult to introduce productive innnovation in areas where land tenure is a problem, than in areas and on perimeters where land tenure relations have been worked out. It may well be that agronomic research cannot mitigate tenure-related constraints on production, but to avoid falsely compromising their research, scientists need to build recognition of these factors into their on-farm research protocols and extension recommendations.

Economic Strategies

A definitive answer to the question of the economic viability of the irrigated perimeters is not at hand. Disagreement over yield data and the value of extra-perimeter production constrain the validity of available analyses. The results of the Ministry of Plan evaluation suggests that individual households may produce average gros earnings of 77,000 to 173,000 FCFA. These compare favorably with earnings from off perimeter farming. Isolated cases of very high earnings from irrigated rice, in the 600,000 FCFA range, exist. Gros income from off perimeter production ranged from 67,000 FCFA to 207,000 FCFA.

In considering the economic benefits of irrigated rice production, everything depends upon the other resources available to the household. Where floating rice or millet production is possible, or when commerce is an important activity as at Konni, earnings from irrigated agriculture sometimes provide a lower return to labor than these activities. Where these, or other possibilities are less interesting, returns to irrigated agriculture are more significant to the household, although not necessarily greater.

In tabulating research results for extension, production function calculations will need to be developed which take into consideration not only the value of recommendations for increased productivity of irrigated agriculture, but also the opportunity costs related to other economic activities. Cost benefit analyses must relate these opportunity costs to the increased labor or input requirements imposed on farmers by the recommended practices.

ONAHA's monitoring-and-evaluation unit is sanguine about the economic viability of irrigated rice production. Its data show that in some cases, average monthly earning compare favorably with those of paid laborers governed by the SMIG, or minimum wage laws. Net returns on irrigated rice production of over 200,000 FCFA were reported.

However, perimeters have unquestionably run into problems by disrupting household economic strategies, or perhaps more commonly, failing to resolve pre-existing problems. For example, of the four perimeters studied by the Ministry of Plan in 1984, only at Namari Goungou were household food requirements met from combined perimeter and dryland production. Evaluations of the Ibohamane perimeter, on which fertile bottom land previously used for sorghum production was converted to cotton and sorghum production, have claimed that household food self-sufficiency was negatively affected. Many farmers at Galmi made the same claim about the effect of the perimeter on their level of food production. However on the perimeters north of Tillabery, dryland cultivation has become increasingly problematic and as a result, farmers have turned to the perimeters as their major source of agricultural revenues.

Another factor which turned up in the Ministry of Plan's evaluation of river perimeters, was that returns to labor per day and/or per unit of household labor employed were, in some cases, more favorable for dryland than irrigated crops. The underlying problems here include overall poor use of water resources with a consequent increase in charges, and poor performance of the degraded or inappropriate crops or crop varieties used on some perimeters.

Research results presented by the monitoring-evaluation unit of ONAHA rejected these contentions and sought to demonstrate that rice production provides greater nutritional security than would be available to farmers without the perimeters, and that yields per labor input are superior to those on dryland agriculture. North of Tillabery, the decline in rainfall has resolved some of these issues in favor of the perimeters. However, it is clear that the nature of the impact of irrigated perimeter development on household economic well-being remains an unresolved issue.

Dry season gardening is a crucial part of household economic strategies in many areas. However, the radical increase in output due to the new impetus given these crops, has had a negative effect on some producers due to market price declines. For example, monopsonistic market conditions and limited storage technologies depress farm gate prices for dry season onions in the Maggia region. Farmer recognition of the effect on prices of distance to market, competition with Nigerian produce, and problems associated with preservation and transportation may constrain intensified production in areas as diverse as Agadez (potatoes), the Dallols (sugar cane and sweet potatoes), and the Maggia (tomatoes and onions). Lack of markets definitely limits the potential of wheat production, and may be a constraint to the development of innovative oil and cash crops like sesame, sunflower, and soy. Lifting of such constraints will require a conjoint agronomic, sociological and agro-economic research and extension effort.

The Tillakaina perimeter (devoted to intensive gardening) has been forced to face these economic constraints most directly. Tillakina suffers from elevated pumping and maintenance charges (100,000 F/ha) due to the fact it is situated on a river terrace 13 m above the river, and has been hard hit by market price declines accompanying increased output on the small garden sites. Exploitation of European markets for green beans has been hampered by market channel length and protective behavior of European market gatekeepers.

21

A long-tarm solution to Tillakaina's problems might be sought through a regional market study, agronomic research on garden crops with a local market potential, or partial reconversion of the site to a national garden crop seed multiplication center.

Labor Scheduling

Labor scheduling problems at periods of peak agricultural activity are severe everywhere in Niger. The overlap beteen seeding and first weeding on rainfed parcels, which is one of the critical bottlenecks, becomes especially severe when the rains fall homogeneously over a large area. On the rice perimeters, where transplanting may conflict with seeding and weeding of rainfed parcels, the problems are magnified. Labor scheduling problems are less severe on the small scale-gardening sites, which are exploited mainly in the agriculturally slack dry season. Here, the labor scheduling problems are related to timely delivery of water over a given surface from traditional or cement wells with limited recharge. There is no absolute shortage of household labor in most cases, but most recent research has shown that recourse to paid labor to mitigate periodic shortages is very common. Research devoted to identifying major bottlenecks in particular regions, and identifying labor saving cultural practices or irrigation techniques, should pay off in increased productivity.

On the riverine rice perimeters, the problem of labor scheduling appears to be particularly severe:

1. At the time of the dry season rice harvest which may overlap with dryland planting;

2. At the time of the dryland harvest which may overlap with preparation of seed beds for the rice perimeters;

3. During the dry season when young male household members sometimes migrate in search of disposate cash income.

On the Maggia perimeters, the situation is not so problematic. There is some competition between cotton (a labor intensive crop) and dryland sorghum in the rainy season. Since farmers are able to grow remunerative cash crops like onions on the perimeters, and to benefit from stored groundwater around the perimeters to grow this and other garden crops in the dry season, there is less labor conflict here.

The problem which has arisen in the Maggia is a conflict between dry season perimeter production and dry season garden production where the crop grown on the perimeter is perceived (correctly or not) to represent a poorer return to the farmers labor than the off-perimeter crop.

On the new "contre-saison" sites, it seems the expansion of the dry season gardening most often represents a mere intensification of prior practice through improved access to technology. Hence, there is less of a labor scheduling problem. For women however, their interest in gardening is constrained by their duty to perform other daily household chores before they can engage in gardening.

Farmers' seeming inability to furnish adequate perimeter labor at peak agricultural periods, and apparant unwillingness to participate in the collective work of canal and infrastructure maintenance, baffles and irritates ONAHA cadre. The PID and PP teams witnessed evidence of these problems on a number of systems. Hypotheses explaining so-called "labor indiscipline", consistent with the literature include:

1) this is a reaction to the wholesale imposition of perimters by external authorities, and or heavy handed management tactics;
2) this is a response to technical difficulties and questionable economic performance of perimeter systems;
3) this is a symptom of difficulties experienced by household heads in mobilizing unpaid household labor to work on new cash crops for which the household has not yet defined acceptable pooling and redistribution mechanisms;
4) it is a response to the fragile land tenure situation noted above.

Labor mobilization or scheduling problems have been exacerbated by limiting cooperative and technical training to senior men, to the neglect of women and younger men. This method of delivery of information is based on the erroneous assumptions that:

1. These men are key decision makers who wield effective authority over women and younger men within the family farm unit;

2. That they will transmit information to these other groups,

This method has resulted in a limited diffusion of technical information and passive resistance on the part of neglected groups to participate wholeheartedly in perimeter affairs. Uncertainties about the wisdom of proposed technical themes contributes to the resistance to participate in collective agricultural perimeter work.

There are perimeters like Moullela, Guidan Magagi, and Tillakaina where farmers have even undertaken to extend perimeter infrastructure on their own, as well as to maintain the system. However, at the first site it is also apparent that farmers employ agricultural practices that are not only agronomically incorrect but wasteful of their labor.

The locally initiated garden sites at Bengou, Nyokoye Touga and Saboula (Falmaye), or Mombeini, Kaboul (Birni N'Gaoure) are well-maintained within the limits of farmers access to technology. In successful cases, technical innovation seems to be a matter of simple intensification of prior practice. Access to technology, rather than labor shortages, seem to be the major constraint on increases in production. It is less clear what additions should be made given the difficulties in managing somewhat more complex poly-cropping-systems like those at Ruwana, Djiritawa, or Moullela.

Political issues

The stated objective of the SOCIETE DE DEVELOPPEMENT is to elicit the voluntary and active participation of the population in national development activities. It is ostensibly through this organization that many of the dry season gardening sites are to be initiated and executed.

The Societe de developpemant is however, very young. Among the general populace and cadre alike, there is considerable uncertainty about its roles and prerogatives, and there is evident reticence to take much initiative within this new institutional framework. The risk of its becoming yet another directive bureaucratic agency are considerable. The local CVD and CSRD positions tend to be manned by retired functionnaires, "traditional" authorities, wealthy merchants, and the like, who threaten to stiffle the popular voice. The dynamism of the various organs of the Societe de Developpement remain to be determined in particular contexts.

Applied research programs should however attempt to work with these bodies to strenghten their popular content and decision-making ability, while at the same time seeking to determine the impact of local political structures upon the agronomic and agro-economic performance of irrigated sites.

With the drought and pest-induced decline of rainfed legume production (particularly in the groundnut zone were traditional focii for struggle over resources takes place), perimeters and the garden sites have become a new locii for negociating control over resources. Each of the vertically integrated institutions which have been discussed in the Institutional Annex seem to have a vested interest in asserting control over some of these resources. Because of the exquisite partioning of bureaucratic structure and perogatives in Niger, it may be expected that they will act in ways which are not in conformity with the agro-economic goals of producers.

Considerable local innovation and evolution of authority has occurrd on the perimeters. Perimeter management committees play the role of intermediary between the village cooperative and the farmer/cooperators. They vary in the way they function depending upon the extent to which the officers also hold other local positions of authority: cooperative officership, chief, alphabetization agent, teacher, merchant, Islamic teacher, etc. With the shifting of input delivery and marketing functions to the cooperatives from ONAHA and the now defunct UNCC, cooperative funds become important; cooperative officership becomes increasingly attractive; and one frequently finds a doubling up of functions between the Committee, the Cooperative and the CVD.

When doubling up occurs, increased potential for corruption and coercion, and on the other hand, for more effective management results. The absence of political checks and balances in Nigerien bureaucracies accounts for this paradox. A charismatic responsible leader can thus mobilize the perimeter to action; where a corrupt and self-interested one can create unhappiness, and resistance among farmer/cooperators to acceptance of technical interventions in agricultural practice. This is so because practically the sole constraints on the behaviour of the cooperative come from the top down: i.e., that the perimeter maintenance fees are collected, and that the technical agents be able to present credible accounts to their superiors.

ONAHA or Agriculture Extension Agents have some interest in developing working relationships with cooperative officials (on perimeters and the garden sites, respectively) since the latter often know more about the social milieu than the technical agents, and the agents must depend upon them to implement successive phases of the agricultural or marketing campaigns. They have little means of coercion at their disposal, nor any particular means of rewarding the officials. When they are lucky enough to deal with effctive cooperative officers, they may (in return for some degree of labor discipline) sometimes avoid policing cooperative management practices that the outsider might deem questionable. It would be a positive step if a more positive role in agricultural extension could be substituted for this political role of the extension services through the on-farm trial and extension program of NAARP.

Effective social controls which prevent conflicts from occuring are most easily established below the village or coop level (i.e. at the level of the irrigation unit on the perimeter or the garden plot on the gardening sites). Reciprocal labor exchange between extended family members facilitates respect of watering schedules or application of technical themes. If the GMP or garden section head is a senior family member, technical directives passed down by him are more likely to be obeyed than otherwise, field operations performed in synchrony, maintenance charges paid or made up with interpersonal no cost loans, etc. There is some incentive for farmers to follow the lead of sector heads, since the latter can sometimes shield farmers from formal admonishment for breaking perimeter rules. This is especially true if the sector heads can establish a tradition of ensuring discipline as defined by the technical agents.

Resource management above the parcel or irrigation unit level is sometimes problematic for local farmers, especially when authority is contested. Farmers and agents sometimes welcome the intervention of outside experts in regulating certain disputes about technical matters or forestalling them. Rather than face endless disputes about whether so and so took part of a parcel or took more than his share of water, or did not do his share of well or canal maintenance, farmers sometimes prefers to have rigid unambiguous directives imposed from on high. Some cadre fear that without this sort of pressure, farmers would begin to cheat on the rules, especially if the rules conflict with household labor allocation goals, risk avoidance, or individual profit motivations. Allowing the free play of these factors can easily escalate out of control as it has at Konni and Tara for example.

Arrangments for inter-institutional cooperation are few, and cadre have little motivation to build inter-institutional linkages. The only existing structure of inter-institutional adjudication is the administrative authority, whose interference in local matters (being unpredicable), the cadre, the customary authorities, the cooperative officers, and the farmers seek to avoid.

In general, conflict occurs when the goals of interested parties in the perimeters or sites conflict, or when the operation of constraints on one group threatens the realization of goals held by other groups. Conflict can be avoided by careful attention to resource allocation, economic return, and respect for local systems of authority and decision-making. Site specific on-farm research should seek to clarify and find solutions for these problems.

The result of the absence of inter-institutional linkage and litigation resolution mechanisms, is a diversity of context-dependant political responses to particular organizational problems, which can have unpredicable impact on agronomic practice and even the best programs of applied research and extension.

ANNEX C

DRYLAND AGRONOMY TECHNICAL ANALYSIS

CONTENTS

I. Introduction

A. MILLET

1. Present senior staff
2. Proposed staff for millet at Tarna
3. Testing sites
4. Research topics
   a. Breeding
   b. Agronomy
   c. Entomology
   d. Pathology

B. COWPEAS

1. Present senior staff
2. Proposed staff for cowpeas at Kolo
3. Testing sites
4. Research topics
   a. Breeding
   b. Agronomy
   c. Entomology
   d. Pathology

C. SORGHUM

1. Present senior staff
2. Proposed staff for sorghum at Tarna
3. Testing sites
4. Research topics
   a. Breeding
   b. Agronomy
   c. Entomology
   d. Pathology

D. PEANUTS

1. Present senior staff
2. Proposed staff for peanuts at Tarna
3. Testing sites
4. Research topics
   a. Breeding
   b. Agronomy
   c. Entomology
   d. Pathology

E. RICE

1. Present senior staff
2. Proposed staff for rice at Kolo
3. Testing sites
4. Research topics
   a. Breeding
   b. Agronomy
   c. Entomology
   d. Pathology

F. MAIZE

1. Present senior staff
2. Proposed staff

G. WHEAT

1. Present senior staff
2. Proposed staff at Tarna

H. VEGETABLE CROPS (HORTICULTURE)

1. Present senior staff
2. Proposed staff at Tarna

I. Implementation Table for Agronomic Research

J. Summary Comments for Field Research

II. Technical Support Services

A. Plant and Soil Analysis

B. Cereal Quality Analysis and Testing

C. Data Analysis and Statistical Consulting

D. Gene Bank and Long-Term Seed Storge

III. Relationship of INRAN to International Research Centers

TABLES

1. Four Year Averages for Agricultural Crops of Niger

2. Cultivars of Research Interest Grown in Niger

3. Staffing Plan for INRAN Scientists, Short Term and Long Term

SUGGESTED LONG-TERM PLAN FOR INRAN AGRONOMY PROGRAM

I. INTRODUCTION

Agricultural scientists are trained first as general biological scientists and then specialize in a discipline. They then begin to work with a specific crop or crops in their research discipline. The tendency is to immerse oneself in that discipline and crop to the exclusion of others. This approach must be strongly discouraged in the INRAN research program. If research is to help resolve the major constraints of the producer, then it must be interdisciplinary in scope and applied in practice. For each major commodity, INRAN must develop a team approach to addressing major research topics.

The following section presents a long-term plan for developing a comprehensive, interdisciplinary INRAN agronomic research program for each major crop. Information presented includes (1) a description of the importance of the crop in Niger, (2) present staff, (3) a summary of the current research program, (4) long-term staffing objectives, (5) suggested future research sites and, (6) a suggested interdisciplinary program of research to include breeding, agronomy, entomology and pathology. The order of discussion of crops will be millet, cowpea, sorghum, peanut, rice, maize, wheat and vegetable crops. Research themes are identified in order of priority.

A. MILLET

Millet is the most resistant to drought stress of all cereal grains. It is the best adapted to conditions in Niger and should be grown in the lower rainfall zones. It is the most widely grown cereal in Niger, sown on approximatively 3.3 million hectares annually, (see Table 1.) The only country in Africa with more area in millet is Nigeria which averages 4.1 million hectares annually. Sahelian and sub-Sahelian Africa plants 14.4. million hectares of pearl millet annually which is the largest concentration in the world. Yields of millet are low worldwide, and Niger is no exception, with average annual yields of approximately 460 kgs/ha.

1. Present senior staff consists of three millet breeders. The breeder at Kolo is also station director and the two breeders at Tarna are Associate Director of the station and Director of pilot projects, respectively. There is no agronomist, however the second breeder is also in charge of the agronomy trials sent from Kolo. There are too many scientists involved in breeding of millet, all of whom are supposed to be following the same research guidelines.

There has been a strong emphasis on studying, purifying and distributing local varieties. However, the local varieties are heterogeneous, and some of them are also susceptible to insects and diseases. They should be replaced by higher yielding, more pest resistant cultivars released in the early 1980s.

(Refer to Table 2 for information on rainfall zones, yield potential, etc.) It is the breeder's responsibility to provide Mo and Mi seed for multiplication and also to advise on stopping multiplication of susceptible or less productive varieties. The list of varieties in Table 2 is too extensive for the present multiplication structure.

There is an entomologist at Tarna involved in administration, classification and directing two assistants in field research. He has little personal involvement in the field. Finally, there is also a pathologist stationed at Tarna.

2. Proposed staff for millet at Tarna

Niger needs only one full-time scientist in millet breeding. This breeder should obtain a Ph.D degree in breeding and genetics and be responsible for all phases of hybridization, selection, evaluation, testing and initial multiplication. Because of the environmental and ecological diversity within the country, a junior "selectioner" who has received short-term training at an international center, should be located at Kolo in the long-term. He would manage the breeding nurseries for the senior breeder. The immediate staff directing the interdisciplinary research in millet at Tarna should be:

Senior		Junior
Millet Breeder	- full time	Research Assistants (Kolo and Tarna)
Cereal Agronomist	- part time in other crops	Research Assistant
Entomologist	- part time in other crops	Research Assistant
Pathologist	- part time in other crops	Research Assistant

With the exception of the breeder, the other scientists will also be involved in similar types of research on a cooperative basis with cowpeas, sorghum and peanuts. Refer to the short term staffing plan in Table 3.

3. Testing sites

The representative stations, substations and points d'appui of INRAN where testing of millet should be conducted under conditions similar to those found in the major producing zones include :

a) Western region: Tillaberry, Ouallam, Kolo and Kalapati;
b) Eastern region: Konni, Tarna, Magaria and Diffa.

7/6

4. Research Topics

a. Breeding

- The program of genetic improvement by composites and synthetics should be continued; however, recommend introducing more new genetic diversity into the populations. Testing of S1 generation material is encouraged. Introduce new diversity in first year of the project. Selection will require six to eight years before yield testing can be begun. Progress should be measured by the number and quality of populations advanced.

- Encourage close cooperation with ICRISAT to obtain introductions from various locations worldwide, and to observe and select additional parents for hybridization. Request germplasm through ICRISAT, millet CRSP, regionally. Progress can be measured by a review of the number of new accessions obtained yearly for five years.

- Emphasize selection for earliness for low rainfall, stress areas; Select early parents and hybridize. Progress can be assessed by tallying the numbers of crosses and populations segregated for earliness being evaluated annually.

- Develop a screening test for selection of genetic tolerance to high temperatures and drought stress. Suggest using continuous high temperatures during early plant development with supplemental irrigation, then eliminate the moisture, followed by measuring plant survival over time. This can be done during the hot, dry season. Suggest developing material cooperatively with ICRISAT to screen large number of accessions. Progress can be measured by determining the numbers of accessions screened and advanced annually for further evaluation.

- Continue developing and testing shorter, dwarf millets for intercropping systems. Cross tall varieties x dwarfs & select dwarfness for intercropping. Progress can be measured by determining the numbers of crosses & segregating populations.

- Selection of cold tolerant genotypes of millet for off-season production. Suggest screening a widely diverse collection of germplasm at a location known to have cold winter temperatures. The best performing accessions should be continued over 2-3 years in trials and used as parents, if improvement is required. Progress can be measured by the numbers of accessions screened, selected and used as parents in crosses.

b. Agronomy

- Stand establishment is a major constraint to increased yield potential in millet. Applied field research should systematically address the following variables in different ecological zones in order to resolve the problem of stand establishment:

a) Proper date of seeding;
b) Proper depth of seeding;

c) Proper rate of seeding to reduce thinning time and seed loss;
d) Influence of varying quantities of stubble per hectare on soil structure and available soil surface moisture.

a), b), and c) Variables should be evaluated in first year of research across ecological zones. Progress can be determined through a review of annual research data.
d) Accumulate varying rates of stubble in years 3 and 4. Progress: Measurements of soil structure and moisture.)
e) Effect of varying row number and harvest of fodder with the objective of leaving as much stubble as possible on the surface. The cowpea vines are cut for forage and some millet fodder is cut for forage, fuel or building materials.

Suggested comparative trials are the following; let M = Millet row, C = Cowpea row, and (X) = Rows cut for vines and fodder.

M	M (X)	M	M (X)	M	M (X)	M	M (X)	
			VS.					
M	M (X)	M	C (X)	M	M (X)	M	C (X)	**Note**: Recommendation is to leave as much M fodder as possible
			VS.					
M	C (X)	M	C (X)	M	C (X)	M	C (X)	

The standing fodder as stubble will serve to control wind and water erosion and should improve soil surface structure over time. The recommendation is to seed between the rows of standing stubble.

-Establish trials as outlined. Progress can be measured through results of stand establishment and differences in soil movement across treatments.

f) Compare stand establishment and yield response to planting on 1) animal traction built ridges vs. level surface and 2) animal drawn row seeder vs. hill planting on the ridges. Develop the four variables in replicated experiments. Improvements in stand establishment, plant development and yield results comprise measures of progress.

- Evaluate response in millet production and water use efficiency (WUE) with varying rates of phosphorus (P), rates and time of nitrogen application (N) and NXP interactions. Implement experiment with suggested variables. Yield responses & statistical analysis of N x P interactions as well as results of plant & soil anaylysis for WUE provide measures of progress.

- Compare the placement of N and P for optimizing use. Suggested variables are:

a) General broadcasting;
b) Broadcasting over the hill;
c) Sidedressing to the side of the hill;
d) Placement of small quantity with the seed in the hill or row.

Establish experiment with four application variables x 4 reps. Progress is measured by yield response and plant development recorded in results.

- Comparative trial for improved soil organic matter content using the following treatments:

a) Remaining stubble only as check;
b) Millet stubble with 10 kgs urea to offset the effect of stubble;
c) Green manure crop turned under;
d) Barnyard manure. Establish variables in replicated plots and uniform crop. Measure yield and O.M. content through soil analysis over 5 year period.

c. Entomology

- Assess crop loss due to head borer (Sesbuva albipunctella) by measuring time of infestation and prevalence in the head; Collect data on number of infected heads during the season and compare yield differences from equivalent head sizes of infested vs. non-infested. This will require 3-4 seasons of data collection.

- Develop experiments with method of chemical application using different spray techniques. It has been suggested that the larvae can be killed when inside the head by using high volume sprayers. Research should develop various spray applications and chemical dosages. Measure progress by evaluating the numbers of insects remaining after various treatments.

- Understand the life cycles and develop biological or chemical procedures for the other important insects that attack millet heads such as Oxycaccus volkeri (red battle grain sucker), Rhinoxatia infuscata (large beetle eating anthers and flowers) and Pachnoda interrupta (beetle eating anthers and flowers); Design methods for control of these insects. Progress: Data collection to compare methods control.

-Develop experiments using biological and chemical variables to control the stem borer (Acigona ignefusalis). Also control measures for Lema planifrons (leaf eating insect). Select parasites for insects and apply control vs. varying numbers of parasites in cages. Test chemical treatments of different rates vs. control should be carried out as well. Progress is measured by the success in reduction of insect pests.

- Evaluate the millet stover to determine if insects are being harbored in a resting stage which provide new infestations. If so, develop control measures. Collect random samples of sections of stubble lying on fields at varying periods during the off-season. Incubate them and observe if any hatch of insects. Progress may be measured by the positive or negative determination of the presence of insects.

d. Pathology

Study the Striga spp in view of finding biological or genetic control methods. Screen large number of diverse accessions in heavily infested Striga area. Observe genetic resistance and signs of natural predators. New accessions with resistance or evidence of resistance to striga will provide evidence of progress.

B. COWPEAS

The second most important crop in total cultivated area in Niger is cowpea, averaging 1.7 million hectares annually. Since most of the cowpeas are intercropped with millet, and there is three times as much millet as cowpea, approximatively one-third of the millet area is intercropped with cowpea. Cowpeas are being produced either for forage or for grain. Cowpeas generally adapt better to higher temperatures and lower rainfall conditions than most of the legumes. Several of the varieties listed in Table 2 can be grown in regions having only 300 mm of annual rainfall. Also note that there is a wide range in length of growth cycle from seeding to harvest.

1. Present senior staff for cowpeas consists of one breeder who is also the Head of the Department of Agronomic Research of INRAN. Presently, he is being assisted by research assistants at Kolo and Tarna and agronomic support from the PARA agronomist.

2. Proposed staff for cowpeas at Kolo

A full time breeder is needed for cowpeas and should eventually obtain a PhD degree in breeding and genetics. He should direct all research in hybridization, selection, evaluation, testing and preliminary multiplication. A junior selectioner, given short-term training at an international center, should be assigned to Tarna as shown in Table 3. He would receive all protocols and experimental seed from the senior breeder and would conduct the research as instructed. In the immediate future, the staff directing the interdisciplinary research in cowpea at Kolo should include :

Senior	Junior
Cowpea breeder - full time	Research Assistant (Kolo and Tarna)
Legume Agronomist - part time	
Entomologist - part time	
Pathologist - part time	

All scientists, except the breeder, will be involved in similar cooperative research with millet, sorghum, and peanuts.

3. Testing sites

There are a number of INRAN locations where cowpeas have been tested in the past. It is suggested that research on eight sites that represent the major cowpea production areas would be ample. They should be:

a) Western region: Tillaberry, Ouallam, Kolo, Bengou
b) Eastern region: Konni, Tarna, Magaria, Diffa.

4. Research Topics

a. Breeding

- Selection for early maturation in cowpea for limited rainfall areas should be a priority. To determine progress in this research, make an annual review of numbers of crosses and segregates for life of the project.

- Selection for tolerance to heat and moisture stress in diverse germ plasm is a second priority. This would improve varietal stability. Evaluate by the number of selections advanced annually.

- Selection of genotypes with cold tolerance to adapt to winter crop cycle.

- Selection for indeterminate flower type for longer season when required, and for better recovery ability after drought stress, etc. Number of selections made and rate of advancement toward use as varieties are determinants of progress.

- Encourage INRAN to obtain diverse cowpea germplasm from ICRISAT and test it for desired agronomic, disease and insect resistant characters. ICRISAT/IITA breeding objectives include incorporation of resistant genes to the major insect pests of cowpeas. There are 12,000 accessions in the world cowpea collection. Some will certainly be of interest to Niger. Measure progress by the number and origin of introductions and new parents annually identified.

41

b. Agronomy

- Continue yield trial testing on research stations, on-farms and in collaboration with ICRISAT. Evaluate results, statistical significance and coefficient of variation. Review annually for life of the project.

- Design experiments to measure the water use efficiency, light interception and competitive ability of spreading (prostrate) vs. intermediate vs. erect growth habits of cowpeas. Measure degree of WUE with variable grown cover due to degree of vegetation. Review annually for four years.

- Evaluate the influence of cowpeas on millet and millet on cowpeas by:

a) Rotation of sole crop vs. intercropping for optimization of legume effect in variable rainfall zones. Compare plant development and yield over rain fall zones annually.

b) Geometry (plant structure) of cowpea with prostrate, intermediate and erect vines and of tall and dwarf millet cultivars. (Determine which combinations of millet and cowpea are most compatible and non-compatible. Conduct for 3-4 years.

c) Shading influence of millet on cowpea yields. Use heavy canvas, wood or metal shelters to reflect light for various time periods and measure transpiration and photosynthesis with and without shade. Design shade and record levels of transpiration and photosynthesis with and without shade. Conduct these experiment over the life of the project.

d) Photosynthetic activity compared to nitrogen fixation rate of cowpeas being intercropped. Measure both responses with cowpeas intercropped and in sole crop stands.

e) Application of phosphorus to the cowpea crop to evaluate the effect on the millet crop. Evaluate whether millet is responding to P in cowpea rows as compared to millet in sole crop treatments. Compare results over a two year period.

c. Entomology

- Develop experiments to determine the best timing, dosage and time of application of the chemical for control of thrips (*Megalurothrips sjostedti*). Also screen for genetic resistance. Measure the response in controlling the thrip infestation in the different treatments by counts, damage and final yield. Review results annually.

- Determine time of chemical application to control the virus transmitting aphid (*Aphis gracciverce*). Also screen for genetic resistance. Measure degree of reducing aphid populations. Review results annually.

- Screen for genetic resistance and experiment with chemical control for the grain weevil (oruche; *Callosobruchus maculatus*) which attacks and perforates grain. Measure progress in finding an effective control in stored grain. Review annually for five years.

d. Pathology

- Study the mode of infection and possible control of the bacteria (*Xanthomonas Campestris* sp. *vignicola*). Review the methods proposed and tested. Determine progress achieved to date.

- Determine a method of evaluating cowpea germplasm for tolerance to *Striga spp.* Assess methods used and numbers of new accessions tested annually to determine research progress.

C. SORGHUM

The third ranked crop in Niger (based on area sown) is sorghum, which is planted on 1.1. million hectares annually, as noted in Table 2. Sorghum normally has a higher yield potential than either millet or cowpea, and is recommended for regions having higher annual rainfall or irrigation. The local population prefers millet, which has a more desirable flavor than sorghum. The flavor in sorghum is influenced by level of tanins in the seedcoat. As a result millet has moved into many higher rainfall zones that are better adapted to sorghum.

1. Present senior staff includes a sorghum breeder who is also the Director of the CNRA Tarna research station, and the expatriate sorghum breeder who is also the acting Team Leader for the Purdue-Alabama university scientists in Niger. The latter also represents INTSORMIL interests in Niger. There is one research assistant in Tarna and two assistants in Kolo supporting the breeding research. There are no agronomists working with this program.

2. Proposed staff for sorghum at Tarna

The future of the sorghum breeding program in Niger is in doubt. The present Director at Tarna is leaving for four years of study toward a PhD degree at Purdue University. The expatriate breeder has asked to move out of the sorghum position to spend full-time as Team Leader. Purdue has been searching for a replacement expatriate breeder to direct the sorghum breeding program at Kolo. None has been located to date. A Nigerian sorghum breeder is sorely needed to fill the position vacated at Tarna.

The project design team recommends that no expatriate breeder be sent to Niger to take the place of a Nigerian scientist. The expatriate breeder will however coordinate breeding programs to which Nigerian breeders are assigned and are active in research. It is recommended that one of the three millet breeders be transfered to the sorghum breeding program. A junior selectioner, following short-term training at an international center, should be assigned to monitor the sorghum program at Kolo. The near term staff directing the interdisciplinary research on sorghum at Tarna should be:

Senior	Junior
Sorghum breeder - full time	Research assistant (Karna and Kolo)
Cereal Agronomist - part time	
Entomolgist - part time	
Pathologist - part time	

All scientists, except the breeder, will be involved in similar cooperative research programs for millet, cowpeas and peanuts.

3. Testing sites

Testing sites presently being used for sorghum research trials adequately represent the zone of commercial production. These locations are:

a) Western region: Lossa, Kolo, Bengou and Kalapate
b) Eastern region: Konni, Tarna, Magaria and Diffa.

4. Research topics

a. Breeding

- Evaluate the 500 Nigerien accessions in the following annual rainfall environments: 300 mm, 600 mm, 900mm, and on dune, well-drained, river recession and puddled heavy soils. All available commercially cultivated varieties should be included in these tests. Test varieties over two years and two replications using three row plots. Adapted genotypes should surface by location. Review the locations where tested, data collected on each accession and those selected of interest to further research and extension.

- Continue the population improvement program using random mating and recurrent selection methods. Discontinue present hybrid sorghum breeding program since the present breeders are leaving the program. The seed multiplication program will not be able to consider multiplication and distribution of hybrid sorghum or millet varieties during the life of the NCR project nor NAARP. A limited scientific effort should continue to develop available parental material, and to select local and introduced segregation populations. For evaluation purposes, review numbers of different populations developed and segregating populations advanced every two years. Ten years are required to reach multiplication from the original cross.

- Continue various inheritance studies for genetically controlled characters of sorghum. Several Nigerien and US graduate students are already involved in field research studies. Review the data generated and results published bi-annually.

b. Agronomy

- Continue the various varietal yield trials designated for specific ecological zones and disease and/or insect evaluation. Evaluate results, statistical signifigance and coefficient of variation. Review them annually over the life of the project.

- Develop experiments to measure stand establishment and water control in high rainfall and under irrigation on heavier soils. The variables examined should include furrow vs. tied-ridge vs. level surface. Stand establishment is also a common problem with sorghum. Research on this theme has been initiated at Kolo. It should be expanded to other research stations equipped to develop these variables. To measure progress, evaluate plant numbers and yield response among the variables being tested. Review annually and continue into the second phase of NAARP.

- Study the influence of phosphorus (P) and nitrogen (N) fertilizers and the NXP interactions on sorghum production and water use efficiency (WUE). To evaluate review the statistical analyses of these variables. Continue the program for three years.)

- Evaluate the effects of dates, rates and depths of seeding sorghum for optimum stand estaplishment. Sorghum, like millet, suffers yield loss from reseeding to obtain proper crop stands. To measure progress in this program, compare results of stand estaplishment and yield across treatments. Review results annually for 3-4 years.

c. Entomology

- Study possible techniques, either genetic, chemical or biological, to control the following insects causing damage to sorghum, a) stem borer (Maimbachia_ignifusalis), hessian fly (Contarinia_sorghicola), stem fly (Atherigona_sp) and head bug (Eucystylus_sp or Campylomma_sp). The latter is being studied by a post-doctoral student from the US at the Tarna station during the present crop season. To evaluate this program compare the methods being applied and analyze the data being accumulated. Review research results annually.

d. Pathology

- In cooperation with the breeder, develop a collection of local and introduced sorghum varieties known to have resistance and susceptibility to long smut (Tolyposporium_ehrenbergii). Cross these parents and observe the F1 and F2 generations to determine genetic inheritance of the character; the breeder can maintain the resistant progeny in the breeding program. (Observe the number of accessions selected and degree of resistance.)

45

D. PEANUTS

Peanuts are ranked fourth in importance among major crops in Niger, being sown on 100 to 150 thousand hectares annually. The central and eastern regions are the primary producing zones. Average yields are very low (200-300 kg/ha) for the varieties presently being grown, and substantial year to year fluctuation in acreage indicates the presence of some agronomic problems.

1. Present staff for peanuts consists of a peanut breeder and a research assistant located at Tarna. This is a good location for the main breeding program.

2. Proposed staff for peanuts at Tarna

A peanut selectioner, after short-term training at an international center, should be placed in charge of the peanut breeding program at Kolo. As for the previous crops, the protocols and prepared experimental nursery seed will be sent from the senior breeder, and the experiments in the western region will be conducted by the selectioner.

For the immediate future, the staff directing the interdisciplinary research on peanuts at Tarna should include :

Senior	Junior
Peanut breeder -full time	Research assistant (Tarna and Kolo)
Agronomist - Legumes part time	
Entomologist "	
Pathologist "	

In addition to the breeder, representatives of the other disciplines should provide research support in topics relating directly to their field of expertise.

3. Testing sites for peanuts are:

a) Western region: Kolo, Bengou
b) Eastern region: Kowara (Konni), Maradi, Magaria. These locations are all within the isohyetes of 400-700 mm annual rainfall recommended for peanut production.

4. Research topics

a. Breeding

-Continue soliciting introductions from ICRISAT, Peanut CRSPs and within the region for initial screening nurseries. Evaluators should observe the number of newly selected parents in hybrids. Review the program every two years.

- Develop F1 hybrids and select individual plants using the pedigree system from the F2 generation onward. Evaluators should observe the number of crosses and segregating populations advanced.

- Select for early maturation for lower rainfall regions. Review the number of crosses & segregates for early maturation advanced in the program.

- Select for drought stress by early and late planting dates in the lower rainfall zone and for good stand establishment. Assess progress by determining numbers of selections with good stand establishment results. Review the program annually.

- Select for genotypes having the characteristic of clinging tightly to the vines for ease in pulling without loss of pods. Assess the number of populations proven better than the local control, and review the program every two years.

b. Agronomy

- Continue adaptation yield tests for selected advanced lines and varieties. For evaluation purposes, assess numbers of locations, statistical precision of data and improved lines vs. local control, and review results annually.

- Evaluate the three recommended cultivars, 55-437, 47-16, 28-206, and several of the more promising new selections at variable, within row spacings of 20 to 60 centimeters, and the standard 20 cm between rows. Measure numbers of pods and total yield. To measure progress, review the results of pod numbers and total yields/plant and yield/row annually.

- Compare three rates of phosphorus, high, recommended, and low in a replicated experiment using the highest yielding variety and observe differences in yield, percentages of protein and oil content. Evaluate the yield results and precision of the research to determine progress.

- Develop a similar experiment as the previous one, but substitute nitrogen. Evaluate the same parameters. To measure progress, evaluate the yield results and precision of the research. Determine economics of higher rates of N.

3. Entomology

- Evaluate available germplasm for resistance to the rosette virus carried by aphids (*Aphis gossypii*). To determine progress, review the number of accessions evaluated and number observed to be resistant.

- Determine the time of major infestation of the aphid and evaluate the effect of timely spraying with insecticides. (Review timing of treatments and levels of control. Precision of applications determine level of infection. Review bi-annually.)

d. Pathology

- Evaluate the germplasm for level of infection from Cercosporiose and rust diseases and provide the resistant parents to the breeder for hybridization. Determine number of accessions evaluated and results obtained every two years for evaluation purposes.

E. RICE

Although the present area of rice being sown is only 20 thousand hectares annually, the GON seeks to greatly expand this area in new irrigated perimeters along the Niger river. Rice production is divided into a main crop season when 13 thousand hectares is planted and the off-season when 7 thousand hectares is planted. The rice area is also divided between approximatively 6000 hectares of paddy rice grown in shallow water on diked perimeters, and floating rice of two types:

a) Shorter stem grown in 0.60 cm and
b) Longer in 60-150 cms of water along rivers and inland lakes.

There are two rice species: Oryza sativa L. and Oryza glaberrima Steud in West Africa. Traditional varieties of both species exist; however, the O.sativa types are superior yielding and more disease resistant, thus a decline in O.glaberrima.

As noted in Table 2, all of the presently cultivated variaties are quite old, having been imported from major rice areas throughout the world. Several of the variaties, both paddy and floating, have good yield potential with good management yielding 8-9 tons/ha in experimental trials. A variety has now been identified by the INRAN rice breeder that is more suited to dry season cold. It has ample tolerance to low temperatures, wind and cold water. In Niger, these conditions are restricted to the Tillabery region. However, the late flowering periodicity of this variety often causes pollen sterility because of the arrival of hot winds. Cooperative regional cold tolerant trials are being received from Senegal.

1. Present staff for rice includes a breeder and a research assistant located at Kolo (Niamey). Three rice technicians from Japan are working with the program as plant pathologist, soil scientist, working specifically on soil evolution under the influence of organic matter, and microbiologist working on the N-fixing properties of Azolla sp.

2. Proposed staff for rice at Kolo

Near term staff directing the interdisciplinary research on rice at Kolo should include :

Senior		Junior
Rice breeder	- full time	Research Assistant
Agronomist-cereals	part time	
Entomologist	"	
Pathologist	"	

3. Testing sites

There is minimal rice research on INRAN experiment stations. Most of the trials are conducted on the better farmers' fields in the rice perimeters. The locations extend along the Niger river from Tillabery to Say. These trials are mostly monitored by ONAHA through an INRAN technician who lives and works in the assigned perimeter. The protocols and seed of new entries are sent out to them from Kolo. Seed of any local varieties, fertilizer, etc, are provided by the local cooperative. Following is an example of the trials conducted on a perimeter cooperative: The technician assigned to the perimeter of Namarigoungou near Tillabery was interviewed and he presented the protocol for the following trials:

- Early cycle rice variety trial - 12 entries
- Medium cycle rice variety trial - 10 entries
- N fertilizer trial using NH_4^+, NO_3^- forms
- Cold tolerant regional trial - 4 entries
- Plot size is 6 rows x 10 m x 4 reps harvesting 4 center rows.

More frequent visits by the breeder to the test sites is strongly recommended. Station directors, technicians and regional personnel for all INRAN research projects express this concern. Technicians are sent protocols to conduct the trials, and are expected to return the results to the project leaders. However, they rarely, if ever see the researchers during the crop season. How can they interpret the results if they haven't visited the trials? If a researcher cannot visit his trials at least twice a year at a given location, they should not be planted.

4. Research topics

a. Breeding

- Request newer, advanced breeding lines from IRRI/Phillipines, for dwarfness, goods tillering ability, head size and type, disease and insect resistance, and screen this material in three locations, Tillabery, Kolo and Say. This international center has developed a large collection of promising genotypes containing the above mentioned characteristics. For evaluation purposes, determine the numbers of accessions evaluated and selections made for advancement as well as the numbers used as parents in crosses.

- Continue crosses among and between genetically diverse cultivars of indica and japonica biotypes. For evaluation of research progress, review numbers of crosses made and diversity of parents.

- Screen the introductions from IRRI for susceptability to Manganese, Iron and Aluminum toxicity in flooded soils. To evaluate research progress, evaluate numbers of accessions tested, level of response to minerals and total yield response of replicated cultivars. Attention should be paid to the statistical precision of results.

b. Agronomy

- Experimentally evaluate plant response to three nitrogen rates : current recommendation, 50 kg N/ha lower, and 50 N/ha higher than the current recommendation. Also use three variables in time of application: 21,42 and 63 days after planting. Measure the effect of rates and time of application on yield and the percentage of protein in the grain. Measure yield response, statistical significance and coefficient of variation to determine research progress.

- Design an experiment in a heavy paddy soil to compare the direct effect during the crop season, and residual effect over five years of the following one-time fertilizer applications: no Phosphorus, 30 kg P2O5, 30 kg Tahoua rock phosphate with 50% acidification, 30 kg P2O5 without acidification, 10 ton barnyard manure, 20 tons of barnyard manure. This would give a clear comparison of residual response and crop need for Phosphorus. For evaluation purposes, compare yield response and plot observations over time and review results annually.

- Review the list of available herbicides and select those that should be experimentally tested for control of the major weed species in the standing rice crop. Review the data collected and recommendations made for chemical product and rate of application annually.

c. Entomology

- Evaluate all local and introduced germplasm at the Namarigoungou location for tolerance to whitefly (Aleurocybotus indicus). Write directly to IRRI, attention Entomologist, explaining the need for rice cultivars resistant to white fly infestation. Evaluate the numbers of accessions screened, level of infection and selections advanced for further testing in order to assess research progress.

- Screen the germplasm for resistance to stem borer (Chilo zacconius) of rice and also request resistance from IRRI. Evaluate germplasm tested and results of observations as compared to those obtained by IRRI.

d. Pathology

- Locate a high moisture site known to have heavy infection of the fungus pyriculariose (Pyricularia oryzae). Systematically screen the local and introduced germplasm for resistant qualities that can be used in the breeding program. Also screen for resistance to the bacteria (Zanthomonas) which can reduce yields of rice.

F. MAIZE (CORN)

The total annual area sown to maize is approximatively 7 thousand hectares. Most of this crop area is located on deep, fertile valley soils, cuvettes and terraces. These zones are in the 600 mm isohyète and most are irrigated. The largest acreages are in the Niamey and Dosso regions. The optimum temperature for rapid germination and stand establishment of maize is 28-30 degrees C. Maize production is most common in the off-season and the major consumption occurs in the late milk to early dough stage. The only registered variety, P3 Kolo, noted in Table 2, is a flint type corn, of short stature (1.5 m) and cycle (90 days). It has an optimum yield of 3000-4000 kg/ha.

1. Present staff for maize includes no Nigerien scientists; however, short-term (2-3 year) expatriate technicians are working with maize trials in Kolo and Tarna.

2. Proposed staff for maize

A major selectioner should be assigned to direct the research. For the present, a student with 2-3 years of agricultural school or a B.S. degree could be sent to CIMMYT's maize breeding short-course to learn breeding techniques, assemble seed to bring to Niger and collect publications of interest. Upon initiating the program of breeding and agronomic research, the expatriate breeder would assist in developing the guidelines for experimental nurseries and develop protocols for designated research sites.

The research themes for maize must be developed after initiating screening nurseries of introduced germplasm at several locations within Niger. Normally, the optimum LAI (Leaf Area Index) for maize should coincide with the onset of grain development. To ensure this, research on seeding dates, rates, tillering ability and fertility levels will be required. Progress can be measured by numbers of accessions screened, locations where tested, and recommendations from tests. Test the germplasm in screening nurseries for two years and in yield trials the third year.

G. WHEAT

The wheat area in Niger varies between 1000 to 2500 hectares annually and is concentrated primarily on small irrigated surfaces. The major regions presently growing wheat are Tahoua (Keita), Maradi (Madarounfa), Zinder (Goure Myrrian), Diffa, and Agadez. The average yields range from 1000-3000 kg/ha in the different zones. The only variety registered for production is the old

french variety Florence Aurore, noted in Table 2, which was introduced from Tunisia years ago. This is a tall, awnless variety requiring approximately 100 days to maturity. Under production conditions greater than three tons, this variety will lodge. Other varieties such as Lerma Rojo (Mexico), Dar Bata (Nigeria), Tousson ex AN6 (Morocco) and Mexipak or Siete Cerros (Mexico) have been introduced and tested. Mexipak has given good results. The varieties from Mexico and Morocco, listed above, are semi-dwarf and have yield potentials of 6000 kgs/ha without risk of lodging. Recommended seeding rate is 100 kg/ha in hills 15 x 15 cm or two rows seeded on a ridge with 40 cm between ridges.

1. Present staff for wheat includes no Nigerian scientist. There is one short-term (2-3 years) expatriate working with wheat at Kolo. It has been recommended that they contact CIMMYT for germplasm.

2. Proposed staff for wheat at Tarna

A wheat selectioner should be assigned to direct wheat research at Tarna which is nearer the areas of production. For the present, a student with 2-3 years of agricultural training or a B.S. degree should be sent to the short-term wheat breeding program at CIMMYT/Mexico. He would receive classroom and applied field instruction and participate directly in the wheat breeding program. He would have opportunity to select germplasm of interest and all pertinent publications for use in Niger. Specific emphasis for the past six years at CIMMYT, has been placed on breeding tropical wheats with resistance to high temperatures and disease problems that occur during the flowering and grain filling period. CIMMYT encourages countries, such as Niger, to request this nursery for screening in the local environment.

If requested, a CIMMYT wheat scientist would visit the nurseries in Niger to discuss and assist in resolving breeding and production problems related to wheat.

There is no need to develop research themes for wheat at present. It is first necessary to request and screen germplasm in the wheat zones to identify the constraints to production. Progress can be measured by reviewing the numbers and origin of germplasm tested, locations where tested and recommendations forthcoming annually. Test two years and develop yield trials the third year.

H. VEGETABLE CROPS (HORTICULTURE)

Although the recorded area planted to vegetable crops ranges between 1500-3200 hectares annually, these produce are important in local consumption and provide cash. Horticultural crops are primarily grown on small irrigated surfaces. There are several crops to which a relatively large area is devoted such as Onion, Tomato, Potato, Sweetpotato, etc.

1. Present IRAM staff includes no Nigerian scientist working on vegetable crops. There is a short-term (2-3 year) expatriate technician conducting trials on vegetable crops at Tarna.

2. Proposed staff for Vegetable crops at Tarna

A Nigerian scientist trained in Horticulture should be directing the work at Tarna. If there is no one available with the specific training required, it is recommended that a student with 2-3 years of agricultural training or a B.S. degree be sent during the summer months to a Horticulture Department at an American University for applied training in vegetable crops. Progress in developing a program of horticultural research can be measured by reviewing the numbers and origin of germplasm tested over two years, selected and placed in yield trials the third year.

I. Implementation Table for Agronomic Research

Input	Output	Time Frame
Millet Breeding		
Hybridization w/new genetic diversity.	Number & quality of populations advanced after five years.	Begin yr.1 10 years to multiplication
Obtain introduction through ICRISAT, select new parents for hybrids.	Number of new accessions yearly.	Begin yr. 1 Review yearly for 5 years.
Selection for earliness.	Number of crosses and segregating populations for earliness.	Begin yr 1 Review bi-annually
Develop dwarf millets for	Numbers of crosses & segregates.	Begin yr. 1 Review annually
Test for temperatures & drought stress	Numbers of accessions screened and advanced annually.	Begin yr. 2 Review annually
Screen & select for cold tolerance	Number of accessions screened, selected and crossed.	Begin yr. 3 Review annually
Millet Agronomy		
Initiate dates, rates & depths of seeding	Results over ecological zones	Begin yr. 1 Review results annually
N&P methods of application	" "	Begin yr. 2 Review results annually
Comparison of leaving & harvesting stubble for erosion control	Results annually over years	Begin yr. 3 Conduct for 3-5 yrs
Influence of stubble on soil structure & moisture	Second contract period	Begin yr. 4 (new contract)
Stand establishment comparisons w/animal traction & ridge variables	" "	" "
N,P, & NxP rates influence on production & WUE	" "	" "
Compare improved organic matter w/stubble plus forms of fertilizer	" "	Requires 5 yrs
Millet Entomology		
Crop loss from head borer	Review data collected annually	Begin yr. 1 Review annually for 4 yrs
Biological & chemical control of stem borer	Annual reports of progress	Begin yr. 2 Review annually
Evaluate insect infestation	Report of findings	Begin yr. 3 Review at season end

Spray technique for insect	Results in numbers of insects after treatments	Begin yr. 4 Review annually Continue for three years
Evaluate control of other insects	Results of methods of study & data collection	Begin yr. 4 Continue for 2nd contract
Millet Pathology		
Search for Striga control	Tests being conducted & annual results	Begin yr. 1 Review each of 5 years
Cowpea Breeding		
Selection for earliness	Number of crosses & segregates for earliness	Begin yr. 1 Review bi-annually for life of the project
Selection for heat & stress tolerance	Number of selections advanced	Begin yr. 1 Review annually
Test diverse introduction for new parents	Numbers & origin of introductions, new parents	Begin yr. 2 Review annually
Selection for interminate flower type	Numbers of selections and advancement	Begin yr. 3 Review annually
Cowpea Agronomy		
Yield trial tests over ecological zones	Results, statistical significance coefficient of variation	Begin yr. 1 Review annually throughout project
Effect of rotating sole vs. intercrop	Compare plant development and yield over rainfall zones	Begin yr. 1 Review annually
Apply P to cowpea and observe millet	Is millet responding to P in cowpea row only. Compare yields	Begin yr. 2 Review annually for two years
Geometry influence of millets & cowpeas	Which combinations of millet & cowpea are most compatible & non-compatible	Begin yr. 3 Review annually for 3-4 yrs
Experiments to measure light interception	Degree of WUE w/variable ground cover by vegetation	Begin yr. 4 Review yearly for 4 yrs
Shading influence on transpiration & photosynthesis	Design shade & record levels of transpiration & photosynthesis	Begin yr. 4 Review annually for life of project
Compare photosynthesis and nitrogen fixation	Measure both at set times through the crop season	Begin yr. 5 Review annually for life of project

Cowpea Entomology		
Measure control of things	Best control response from variables	Begin yr. 1 Review annually
Develop control for grain weevil (bruche)	Progress in finding an effective control in stored grain	Begin yr. 2 Review annually for 5 yrs
Apply insecticide over time & varied rates	Success in eliminating aphid populations	Begin yr. 3 Review annually
Cowpea Pathology		
Develop control for bacterial wilt	Review methods attempted and progress toward goal	Begin yr. 2 Review annually
Sorghum Breeding		
Develop random mating and recurrent selection populations	Number of populations developed & segregating populations advanced	Begin yr. 1 Review every two yrs Requires 10 yrs for release
Determine inheritance for agronomy & pest control characters	Review data and published results	Begin yr. 1 Review every two yrs
Evaluate Nigerian collection over broad ecological zones	Review locations tested, data collected accession selected	Begin yr. 2 Review annually
Sorghum Agronomy		
Yield trials designated for ecological zones	Results, statistical coefficient of variation	Begin yr. 1 Review annually for life of project
Stand establishment & water control	Evaluate establishment numbers and yield response among variables	Begin yr. 2 Review annually and continue into new contract
Evaluate dates, rates & depths of seeding	Compare results of stand & yield	Begin yr. 3 Review annually for 3-4 yrs
Effect of N,P, & NxP on production & WUE	Review results of yield and statistical analysis of variables	Begin yr. 4 Continue for 3 yrs
Sorghum Entomology		
Chemical, genetic & biological control of insects	Methods being applied and data being accumulated	Begin yr. 2 Review annually
Sorghum Pathology		
Screen for smut resistant genotypes from diverse collection	Numbers of accessions selected & degree of resistance	Begin yr. 2 Review annually
Peanut Breeding		
Evaluate introductions for hybridization	Number of new parents in hybrids	Begin yr. 1 Review every two yrs

Selection for earliness	Number of crosses & segregates for earliness	Begin yr. 1 Review annually
Select for drought tolerance & stand establishment	Assess numbers of selections with good stand establishment data	Begin yr. 1 Review annually
Select for tightly clinging vine to pod	Number of populations proven better than the local check	Begin yr. 2 Review every two yrs
Peanut Agronomy		
Adaption tests for improved lines	Numbers of locations, results compared to check variety	Begin yr. 1 Review annually
Spacing density if local & improved cultivars	Review results of pod numbers and total yield/hill & row	Begin yr. 2 Review annually
Compare P levels on high yielding variety	Results of replicated trial for yield	Begin yr. 3 Review annually
Peanut Entomology		
Screen for resistance to rosette virus	Numbers of accessions evaluated & number proven resistant	Begin yr. 1 Review every two yrs
Peanut Pathology		
Screen for Cercosporina rust resistance	Number of accessions evaluated and results obtained	Begin yr. 1 Review every two yrs
Rice Agronomy		
Screen diverse germplasm for new parents	Numbers of accessions evaluated and selections made. Then numbers used in crosses.	Begin yr. 1 Review annually
Make interspecific crosses w/indica & japonica	Numbers of crosses	Begin yr. 1 Review annually
Screen for toxicities	Numbers screened, level of response, yield response	Begin yr. 2 Review annually
Rice Agronomy		
N rates & dates of application	Yield responses & statistical signifigance, coefficient of variation.	Begin yr. 1 Review annually
P residual study over years	Compare yield response and observations.	Begin yr. 2 Review annually
Test Herbicides for major weeds	Data collected and recommended product & rate.	Begin yr. 3 Review annually
Rice Entomology		
Screen for white fly resistance	Numbers of accessions screened, level of infection, selections.	Begin yr. 1 Review annually
Rice Pathology		
Screen for resistance to pyriculariosa and bacteria	" " "	Begin yr. 1 Review annually

Maize Program				
Introduce and screen advanced lines and varieties over diverse ecological zones	Numbers of accessions and locations. Recommended entries for yield trials			Begin yr. screening two yrs. and yield test the third year
Wheat Program				
(Same as for maize)	"	"	"	
Vegetable Program				
(Same as for maize)	"	"	"	

J. Summary Comments for Field Research

The five year extension of the present Niger Cereal Research Project (PACD 11/87) continues the three specific research programs initiated in 1982. These are:

a) An interdisciplinary team research program of crop improvement for each major crop. These interdisciplinary research teams for each commodity crop have been described above. The research activities will be conducted primarily on the INRAN research sites as specified.

b) A production research program which will develop systems of ultural practices adapted to ecological zones and farmer enterprises. This research will concentrate more specifically on understanding and developing recommendations for intercropping, fertilizer use, time of planting, density and spacing, weeding, and pest control including cost/return and related management analyses. This will require addition of the Agricultural Economist and Economic Anthropologist to the interdisciplinary team. This research activity will be conducted at research stations, substations, points d'appui and selected farms.

c) A resource management (farming systems) program, which has already conducted farmer surveys and is presently conducting on-farm trials, will be continued. These trials must be designed with input from all research scientists keeping them relatively simple and using selected technologies that should be promoted at the farm level. These trials will be placed on selected farms in several villages.

It is strongly recommended that the agronomy trials and on-farm trials, presently directed by the NCR expatriate agronomist and agricultural economist, be continued without interruption as the NCR project terminates in November, 1987 and the NAARP project begins. This recommendation comes with the stipulation that INRAN counterpart scientists be assigned to new expatriate staff. Table 3 lists the short-term staff expected to be assigned upon initiation of the new contract.

II. Technical Support Services

Agricultural research cannot be effectively conducted without the participation of certain support services. Finances have been provided for operation and purchase of required equipment during the present contract and must continue in the new contract. Following is a brief review of and suggested improvements for each support service:

A. Plant and Soil Analysis

INRAN already has a well equipped laboratory for soil analysis in the Ecology Research Department, and there are several trained soil scientists currently employed there. They conduct soil analyses for the research sections of INRAN and also receive samples from other regions and agencies in the country. A fee is charged for provision of analyses for non-government agencies. Expanded research onto on-farm trials has increased the number of samples received for analysis.

The same laboratories and personnel also conduct limited plant tissue analyses. The demand for these analyses will increase as the research effort expands; the laboratory will be required to become more organized and efficient. NAAR Project funds will be needed to purchase supplies, maintain equipment and support staff training.

B. Cereal Quality Analysis and Testing

A Cereal Quality Section has been established beside the aforementioned laboratories at the Soils Laboratory complex in Niamey. Needed equipment and supplies have been purchased and the laboratory is fully functional. The Nigerien director is a trained cereal chemist and has received additional technical support from a short-term expatriate assistant. It will be essential to analyze the quantity and quality of grain protein of the breeding lines and varieties for the main staple crops millet, cowpea and sorghum.

The peasent farmers of Niger have a preference for local cereals varieties which have lower yield but better drought stress tolerance than the higher yielding varieties. Experimental tests have been developed to analyze each variety. The first two-years work has concentrated on sorghum and rice. The first procedure was to provide a complete morphological description of the local and improved varieties including seed color, texture, size and shape, endosperm color and texture and percentage of protein content. The second experiments were conducted in the field to compare two local vs. two improved varieties. Four women pounded flour over a set period of time. The four women worked four days, each milling four varieties; thus, four replications for analysis. The third experiment was conducted in the laboratory where small dough balls were prepared for testing. Ten people were chosen, and over four consecutive days, each person tested each of four varieties as follows:

1) Taste test rated as 1 = good and 4 = bad
2) Feel test (blindfolded)-same rating

3) Sight test -color- "
4) Taste test with and without sauce-same rating
Statistics were used to analyze the data.

The main conclusions drawn thus far from two years of cereals quality experiments are:

a) Improved variaties as compared to the local variaties have harder endosperm, inferior digestibility, but acceptable color;

b) Taste, color, ease of milling and conserving quality are the most important characteristics identified by the taste panelists.

Similar experiments have been conducted for rice, but have not been as conclusive. Little work has been initiated as yet on millet and cowpea.

It is recommended that priority be placed on getting this work started. Experiments have been proposed to mix varying quantities of cowpea with the cereals in an attempt to increase the level of protein in food. This would be especially important as a way to develop supplements for malnourished babies, young children and nursing mothers.

Financial support will be needed to continue the work of the cereals quality lab, purchase supplies, maintain equipment and support some additional training.

C. Data Analysis and Statistical Consultion

A central support program in statistics has been developed in one of the laboratory areas of the soils laboratory complex. Four computers have been installed and are functioning well. There is a capable INRAN director of the center, two assistants and an expatriate assistant on short-term assignment. Some TDY assistance was also provided by the NCRP and has proved beneficial. The director has also had some recent short-term training in the US. Continued project technical and financial support will be required to further strengthen this center. Additional training for junior staff will be needed.

A computer room has also been established at the CNRA-Tarna station. Two computers have been installed, Compaq and Burrough portables with printer and power source. The room is kept clean and cool is closely monitored by the NCR Agricultural Economist and a short-term expatriate assistant.

D. Seed Bank and Long-Term Seed Storage

A large, enclosed metal box-type, walk-in, refrigerated, cold chamber has been installed and is working at the Tarna station. There is no dehumidifier installed but a tube outlet drains the water from the refrigerated unit at present. The diesel engine on the backup generator is not working and reportedly needs minor repair. This chamber is adequate to store small quantities of a large number of accessions for all of the commodity crops.

62

There is also a newly constructed cold storage building at Kolo that is not in operation. The building was built out of block and the insulation is inadequate. That, however, is not the major problem. Two refrigerated air-conditioners and a double door on the front were installed to keep the building cool, but there is no electrical hookup to the building. The room is full of seed but the room is often left open and insect control is neglected. Drastic improvement is needed in maintenance habits. This problem needs immediate attention. Project funding would be required to provide low cost maintainence and to send two short-term trainees (one from each station) to an international center to learn how to properly catalog, store, inventory and multiply seed accessions in INRAN collections.

F. Technical Training for Research Assistants

The most crucial support to a research leader is the research assistant. The day-to-day direction and care of research is normally the responsibility of the assistant. This assistant must understand the basics of the research program for which he works, if he is to be fully effective. This knowledge can be taught by the project leader over time, if he or she is willing to take the time with the assistant.

There is however a very effective means of providing this basic information to technicians. Short-term training courses at one of the international centers are designed for this purpose. Table 4, entitled Training at International Centers, provides a list of the centers and the areas of training offered at each. It is strongly recommended that all (levels A3-C1) be sent for additional training. Most of the courses are no longer than six months. It is recommended that senior staff also participate in these courses when possible. Project funding would be well spent on training to upgrade junior staff.

III. Relationship of INRAN to International Research Centers

The major role of INRAN is to serve as the center of excellence for Niger in research, training and documentation related to any phase of agriculture in this country.

The major role of the International Research Centers is to serve as centers of excellence for their crop specialties for the world. The international centers are centrally funded by a large group of donor agencies. They have developed large, well-organized and productive research centers, conducting research in all crop related disciplines. They are an excellent source for short-term training of scientists from any country. There are a broad range of subject areas available for training as shown in Table ____. These centers are also prolific publishers of documents on crop specialties and most of these are free upon request. You need only to write to Publications at each center requesting that you be placed on their mailing list and you can receive pertinent back issues. It is suggested that copies

be requested for the documentation centers in Niamey and C.N.R.A. - Tarna, Maradi. (A list of centers, complete with addresses, telephone & telex is attached). These centers also generate various nurseries for distribution upon request, for each of their major crops. They consist of such nurseries as Crossing Blocks, Segregating Populations, Observation nurseries of advanced lines, Yield trials and specific nurseries, such as disease and insect resistance or heat tolerance.

Seed of genetic material for a given crop can also be requested from the CRSP programs located in the United States.

The international centers have also established regional centers in certain areas to better service their needs. Such a center is ICRISAT-Niamey located in Niger for the West African region. This center was started in 1981 and, although conducting research for five years in dryland millet and cowpeas, they are still in the process of developing their research station (40 kms south of Niamey) and constructing the main buildings. They are concentrating research on millet, sorghum, cowpeas, and peanuts which are th primary crops in West Africa. They have employed an excellent team of scientists to focus research on the major constraints to increased production of these crops in the region. Included at ICRISAT is a large soil chemistry, agronomy research program, directed through the IFDC, that is also involved in cooperative research with INRAN. Good relationships exist between comparable scientists of INRAN and ICRISAT and these should continue to be strongly encouraged. The ICRISAT center is a valuable source of genetic diversity and breeding lines for the major crops grown in Niger and results of research are made readily available. ICRISAT is not developing potential varieties of major crops for release in Niger, but rather, the germplasm is disseminated as advanced breeding lines for use by cooperators throughout the region of West Africa. The objective of ICRISAT is to develop genetic diversity and technology, not to release variaties. It is the responsibility of INRAN scientists to select the best potential varieties from their program, that of ICRISAT or other introductions and to multiply them for naming and release in Niger.

It is the intention of ICRISAT to provide short-term training at their center in Niger, when the construction of buildings has been completed. This is estimated to be another two to three years.

CENTER DIRECTORS		CROPS
CIAT	Centro Internacional de Agricultura Tropical Apartado Aereo 6713 Cali, Columbia Phone: 680111 (Cali), 27344 (Palmira) Telex: 396-05769 CIAT CO	cassava field beans corn rice
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo P.O. Box 6-641 Mexico 06600, D.F. Mexico Phone: 595 421 00, (905) 592-5011 Telex: 1772023 CIMTME	corn wheat barley triticale
CIP	Centro Internacional de la Papa Apartado 5969 Lima, Peru Phone: 350266/350342 Telex: 394-25672 PE	potato
IBPGR	International Board for Plant Genetic Resources Food and Agriculture Organization of the United Nations Via della Terme di Caracalla Rome 00100, Italy Phone: 5797-4772 Telex: 843-610181/610127 FAOI	germplasm
ICARDA	International Center for Agricultural Research in the Dry Areas P.O. Box 5466 Aleppo, Syria Phone: 550465/551230/557399 Telex: 924-331206/331263 331208 ICARDA SY	small grains lentils broad beans corn sorghum
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics ICRISAT Patancheru P.O. Andhra Pradesh 502 324, India Phone: 224016 Telex: 953-152203 ICRI IN 953-1556366 ICRI IN	millet sorghum peanuts chick peas pigeon peas

63

IFPRI	International Food Policy Research Institute 1776 Massachusetts Avenue, N.W. Washington, D.C. 20036 USA Phone: (202) 362-5633/4 Telex: 440054	Food Policy
IITA	International Institute of Tropical Agriculture PMB 5320 Ibadan, Nigeria Phone: 221466/221963 Telex: 937-4333	cassava yams cowpeas lima beans soybeans pigeon peas corn rice
ILCA	International Livestock Center for Africa P.O. Box 5689 Addis Ababa, Ethiopia Phone: 183215/183222/182455 Telex: 976-21207 ILCA ADDIS	Production Marketing
ILRAD	International Laboratory for Research on Animal Diseases P.O. Box 30709 Nairobi, Kenya Phone: 592311 Telex: 953-22040	Diseases
IRRI	International Rice Research Institute P.O. Box 933 Manila, Philippines Phone: 742-0580/742-0717 Telex: (ITT) 45365 RICE INST PM (ITT) 40890 RICE PM (Los Banos)	rice
ISNAR	International Service for National Agricultural Research P.O. Box 93375 2509 AJ The Hague, Netherlands Phone: 472991 Telex: 344-33746	Strengthening Programs

WARDA	West Africa Rice Development Association P.O. Box 1019 Monrovia, Liberia Phone: 221466/221963 Telex: 937-4333	rice

TABLE 1

FOUR YEAR YIELD AVERAGES FOR AGRICULTURAL CROPS OF NIGER

Culture	Area Seeded (Ha)	Average Yield (Kg/ha)	% of Total Production
Millet	3,204,905	460	51
Cowpea	1,747,921	210	28
Sorghum	1,108,170	510	18
Peanut	150,655	332	** 3
Rice (season)	13,100	2,000	
Rice (off-season)	7,043	3,000	
Maize	7,122	1,500	
Wheat	2,261	2,428	
Sweet Potato	4,927	7,970	
Onion	3,697	18,000	
Cotton	2,626	1,000	
Potato	1,083	11,000	
Sugar Cane	3,629	23,000	
Tomato	250	10,000	
Vegetable Crops	3,176	6,500	
Tobacco	613	950	
Cassava	25,429	9,362	
Groundnuts (Bambara)	17,549	450	
Cyperus (tuber)	4,220	600	
Fonio (Digitaria)	5,000	212	
Squash	620	20,000	
TOTAL	6,319,001		100

**Total of 3% for all of the cultures combined from peanuts through squash.

Cultivar (Pennisetum typhoideum)	Recommended Rainfall (mm)	Location of Origin	Year	Days Seeding to Harvest	Yield potenial (kg/ha)	Spike length (cm)	Important Diseases (T=Tolerant, M=Moderate S=Susceptible, R=rare)
HRP-P1	>300	Tarna	1981	85-90	2000-2500	150	Mildew-M, Smut-M,
DK-P1 (Dan Gombe)	>250	"	1981	85-90	1500-2300	55	Mildew-M, Smut-T
CP-P1 (Guerguera epuree)	450-650	"	1981	90-95	2500	75	Mildew-M, Smut-M
H-80-10-CP (Hative Guergera)	300-400	"	1981	80-85	2300	55	Mildew-M, Smut-T
Da Angoure (Badenji)	400-500	"	1982	90-100	1000-1200	42	
Moro (Dan Arba'in)	200-300	"	1983	70-80	1000-1600	48	
Ankoutes	300-350	"	1982	80-90	900-1000	28	
CIVT (Comp Int'l Tarna)	450-650	"	1976	90-95	2500-2800	80	
HKP (Hainikire precoce)	350-500	Tera	1974	80-90	2000	60	
P3Kolo (IPRT)	500-600	Tarna	1962, 1974	90-95	2500	65	
3/4 HK (Hainikire)	450-650	"	1974	80-90	2000+	60	Smut-T
HKP3 (tres precoce)	280-350	"	1980	70-75	900-1500	45	Mildew-M, Smut-M
TIB-L	>250	"	1981	85-95	2000-2500	200	Mildew-M, Smut-M
ITMV 8001	400-500	ICRISAT	1980	80-85	2500	65	Mildew-M, Smut-T
ITMV 8002	300-400	Tarna	1980	85-90	2500	55	Mildew-M, Smut-T
ITMV 0304	300-400	"	1981	80-05	2500	35	Mildew-M, Smut-T

Other local varieties: Zanfarwa, Zongo, Chinin Bajini (Maradi); Zongo Kolo local (Kolo); HKBTIF (Bengou); Tamangagi (Dan Mallaoua), Gamoji (Zinder); Boudouma (Diffa); Ostoukouche (Da Damargue, Mirria); Guerguera (Maggia); Maiwa or Somno (Matameye)

SORGHUMS

Cultivar (Sorghum bicolor)	Recommended Rainfall (mm)	Location of Origin	Year	Days Seeding to Harvest	Yield potenial (kg/ha)	Spike length (cm)	Important Diseases (T=Tolerant, M=Moderate S=Susceptible, R=rare)
Bahadia Fara		Magaria	Old				
Bagoba		Filingue	Old				
L30	400-600	Niger	1972-74	90-100	3000		Diseases T, insects-
1/2 MSR	550-900	Senegal	1975-76		3500		Diseases T
RADA A-2-3	300-600	Niger	1973-76	85-90	2500		

Other Varieties: N'Gabiri Kime (Lake Chade, Komadougou); Gourma (River region); El Dalo (Maradi); Jan Jara (Ader region); Bagoba (Western Niger)

Best Available Document

TABLE 2. CULTIVARS OF RESEARCH INTEREST GROWN IN NIGER (continued)

RICE

Cultivar (Oryza sativa)	Recommended Rainfall (mm)	Location of Origin	Year	Days Seeding to Harvest	Yield potenial (kg/ha)	Height (cm)	Insects & Diseases (T=Tolerant, M=Moderate S=susceptible, R=rare)
NDU 770-7-2		India		125	5500-6000	85	Disease-T
P951-46-5		Bangledesh		129	5000-6000	107	Disease-T
IR22		Phillipines	1970	140-150	5000-8000	80	Borer-S, Brown aphid-S,
IR1529-680-3		"	1971	125-135	6000-7000	100	Disease-T, Piricular-S
D52-37		Sierra Leone	1952	130-145	5000-6000, paddy	130	Disease-S, stemborer-
Sitane Diofor					4000-6500, Float.	200	Other insects-T
Nang Kiew (62-06)		Senegal	1954	120-150	4000-5000, paddy	120	Disease-M, stemborer-M
					2500-3000, Float.	"	Other insects-M
B690-2		Viet Nam	1962	160	6000	220-300	Piricular M, Insects-S
					5000-6000	120	Disease M
		Sri Lanka	?	120-160	8000 potential		

Notes: All are indica types

COWPEA

Cultivar (Vigna unguiculata)	Recommended Rainfall (mm)	Location of Origin	Year	Days Seeding to Harvest	Yield potenial (kg/ha)	Height (cm)	Insects & Diseases (T=Tolerant, M=Moderate S=susceptible, R=rare)
TN 5-78 (Lanfougno)	300-600	Tillaberi	1978	70-75	medium		Diseases & Insects-S
TN 27-80 (Dan Matara)	300-600	Uogo (Zinder)	1980	75-80	3000		
TN 3-78 (Dan Hausa)	600-800	Maradi	?	85-90	2500-3000		Diseases & Insects-M
TN 88-63 (drought tolerant)	300-600	N'Guigmi	1963, 1975	short cycle semi-erect	3000-3500		Bacteria-S, Insects-S
TN 36-64	300-500	Senegal	?	inter-cycle, semi-erect	3000		Insects-S
TN 98-63 (Farin wake)	600	Maradi	?	long cycle spreading	3000		Good forage crop
TN 4-69	600	Tarna via Senegal	?	inter-cycle semi-erect	2500		

Other cultivars: 2-78, 97-80

GROUNDNUTS

Cultivar (Arachis hypogaea)	Recommended Rainfall (mm)	Location of Origin	Year	Days Seeding to Harvest	Yield potenial (kg/ha)	Vine characs.	Insects : Diseases (T=Tolerant, M=Moderate S=susceptible, R=rare)
55-437	<550	Senegal (So. America)		90	1200-2050		Cercosporiose S
47-16	550-650	Senegal (India)		110-120	1200-1500		
28-206	>650	Senegal (Mali)			2500-2900		
796 (Zenit)	<600	Russia		90	800-2000		
TS 32-1	400-700	Burkina Faso		90	3400 at Tarna 3300 at Tarna		Virus carrying aphids-T
Others cultivars: 57-422, 28-204, 48-37							

MAIZE

(Zea mays)							
P3 Kulu	500-600 or irrigate	Niger		90	3000-4000		Stemborer S

WHEAT

(Triticum aestivum)							
Florence aurore	700 or irrigate	Tunisia		115	1000-6000		

TABLE 3

STAFFING PLAN FOR INRAN SCIENTIST
SHORT TERM AND LONG TERM

Short-term (Beginning of NAA32) Location		Long-term (10-15 Years) Location	
Kolo	Tarna	Kolo	Tarna
Field Manager	Field Manager	Field Manager	Field Manager
Rice Breeder	Sorghum Breeder	Rice breeder	Rice Selectioner
	Peanut breeder		
Legume Agronomist		Millet Selectioner	Millet Breeder
Cereal Agronomist			
Entomologist	Entomologist	Sorghum Selectioner	Sorghum Breeder
Pathologist	Pathologist	Peanut Selectioner	Peanut Breeder
Agricultural Economist (Sr)	Agricultural Economist (Jr)	Maize Selectioner	Maize Breeder
Economic Anthropologist			
	Maize Selectioner	Wheat Selectioner	Wheat Breeder
	Seed Multiplication Director	Root and Tuber Selectioner	Root and Tuber Breeder
		Agronomist-Rice, Maize (Sr)	Agronomist-Rice, Maize (Jr)
Vegetable Selectioner	Horticulturist		
			Cereals Agronomist(Millet Sorghum) (Sr)
Cereal Quality Lab. Dir.	Agricultural Machinist	Agronomist-Millet, Sorghum (Jr)	
Soil fertilizer Lab. Dir.		Legume Agronomist (Sr)	Agronomist Legume (Jr)
		Weed Control Specialist	Weed Control Specialist
Statistician		Horticulturalist (Sr)	Horticulturalist
		Physiologist	Physiologist
		Entomologist (Vegetable, Legumes)	Entomologist
		Pathologist (Legumes/Vegetables)	Pathologist (Cereals)
		Agricultural Economist (Sr)	Agricultural Economist (Jr)
		Economic Anthropologist (Sr)	Economic Anthropol. (Jr)
		Cereal Lab. Dir	Seed Multip. Dir
		Soil Fertility Lab.dir	Agr. Machinist
		Statistician	
		Microbiologist	
		Gene Bank Curator (Jr)	
		Gene Bank Curator (Sr)	

Note:

Senior researchers or team leaders should have at least a B.S. degree. Selectioner and/or Junior (Jr) staff can have a two-year high school degree with agricultural background and have taken a short-term training course in their discipline at an International Agriculture Research Center.

ANNEX D

RESEARCH IN IRRIGATION AGRONOMY: WATER, SOIL AND CROP MANAGEMENT

by

C.O.Gwathmey
Irrigation Agronomist

CONTENTS

List of Tables

List of Figures

I. INTRODUCTION AND OVERVIEW D-1

II. THEMATIC RESEARCH PRIORITIES AND STRATEGIES D-2
- 2.1 Commodity approach vs. cropping system approach. D-2
- 2.2 Suitability of irrigation system types to research approaches. D-2
- 2.3 Potential Research Themes D-4
  - 2.3.1 Irrigation water management. D-4
  - 2.3.2 Irrigated soils management. D-7
  - 2.3.3 Irrigated crops management. D-9
  - 2.3.4 Allied agronomic research themes. D-10

III. PHYSICAL RESOURCES FOR IRRIGATION AGRONOMY RESEARCH D-11
- 3.1 Infrastructure D-11
- 3.2 Equipment D-15

IV. HUMAN RESOURCES FOR IRRIGATION AGRONOMY RESEARCH D-15
- 4.1 Staffing and training needs D-15
- 4.2 Technical assistance and counterparts D-20
- 4.3 Institutional organization D-23

V. RESEARCH IMPLEMENTATION D-25
- 5.1 Prerequisites and timing D-25
- 5.2 Diagnostic study D-27
- 5.3 In-station experimentation D-28
- 5.4 On-perimeter, on-farm trials D-28
- 5.5 Benchmarks, Evaluation, and EOPS D-29

BIBLIOGRAPHY D-32

Appendix Tables and Figures D-35

LIST OF TABLES

Number	Title	Page
D-1.	Representative Agronomic Research Themes Pertaining to the Dedicated Rice Perimeters of the Niger River	D-3
D-2.	Estimated Dry Season Vegetable Crop Production in Niger, 1984	D-5
D-3.	Existing Fertilizer Recommendations for Crops Produced in the Irrigated Sector.	D-8
D-4.	Summary of INRAN Irrigation Research Facilities and Field Infrastructure	D-12
D-5.	Illustrative Research Station Network for Irrigation Agronomy Field Experiments under the NAAR Project	D-14
D-6.	Medium-Term Staffing Objectives for INRAN in Irrigation Agronomy: Part I: Core Research Team	D-17
D-7.	Medium-Term Staffing Objectives for INRAN in Irrigation Agronomy: Part II: Allied Research Specialties	D-18
D-8.	Medium-Term Staffing Objectives for INRAN in Irrigation Agronomy: Part III: Chief Technicians	D-19
D-9.	Illustrative Short-Term Technical Assistance for Irrigation Agronomy and Allied Research	D-24
D-10.	Representative Benchmarks of Progress in Implementation of the Irrigation and Soils Agronomy Program	D-31

LIST OF FIGURES

Number	Title	Page
D-1.	Geographic Distribution of the Major Irrigation Systems in Niger.	D-21
D-2.	Scope of Research by Thematic Category for Long-Term Technical Assistance in Irrigation, and Transfer of Research Responsibility Returning Researchers in Training.	D-22
D-3.	Illustrative Implementation Calendar for Irrigation Agronomy Research, 1987 - 1994.	D-26

I. INTRODUCTION AND OVERVIEW

The Niger Applied Agriculture Research project component in irrigation arrives at a propitious moment in Niger's experience in irrigated crop production. While construction of diverse irrigation system types accelerated during the 1970's and 80's , INRAN's research efforts in irrigation agronomy have waned, ever since the closing of the SEHA irrigation research station in 1970. In recognition of the contributions and limitations of the breeding-based approach to commodity crop improvement which has predominated INRAN's research strategy ever since, the NAAR Project will bring a cropping systems approach to improving the overall productivity of irrigated crops and the efficiency of water application. The timelines of this approach is marked by the entry of INRAN's Ecological Research Department into irrigation research from its solid base in soil and environmental sciences.

Of the four major irrigation system types in Niger, the cropping systems approach is most applicable to the multi-cropped, surface irrigated perimeters of the Ader-Doutchi-Maggia (ADM) and Maradi Regions, where water is supplied by surface resevoirs or by ground water pumping. By contrast, the dedicated rice perimeters of the Niger River are better served by strengthening INRAN's existing rice breeding program. The needs of the micro-irrigation systems, however, call first for assistance to assure the supply and distribution through appropriate well and pump technology development, and second, improvement to the varietal and horticultural aspects of their vegetable gardening systems.

While providing support to research related to these latter two system types, the NAAR Project will deliver the major thrust of its technical assistance to applied research addressing the needs of farmers and water managers of the larger, multi-cropped "inland" perimeters of south central Niger. An irrigation agronomist and a soils agronomist specializing in irrigation will both be posted at or near the major INRAN research center at Tarna, close by Maradi. These two research agronomists will initiate a program of applied research in water, soil and crop management to address the major constraints to productivity and water economy in no fewer than nine ONAHA-managed perimeters of the ADM-Maradi region. Using a multidisciplinary team approach, they will begin by studying the details of current water, soil and crop management practices in representative perimeters, in order to identify these constraints and to refine hypothetical solutions to solve them. The irrigation agronomy team will then test these hypotheses in a network of irrigation research station facilities. Technologies which have proved most promising in terms of yield, economy, or ease of management will then be tested in extension-managed on farm trials to be conducted jointly by INRAN and ONAHA.

Because INRAN will be starting afresh in irrigation agronomy research in the ADM-Maradi region, both human and physical resources to execute these and future research programs will be provided through the NAAR Project and companion funding.

II. THEMATIC RESEARCH PRIORITES AND STRATEGIES

The difference between the dedicated riverain rice perimeters, the multi-cropped inland perimeters, and the diffuse miicro-irrigation systems call for a different research approach in each case. The strategies outlined below are intended to build upon and complement ongoing INRAN research, and provide the most efficient means for INRAN and NAAR to address the main constraints of each perimeter type, given limited resources.

2.1 Commodity approach versus cropping system approach.

The classical commodity approach partitions crops by species (sorghum, rice, etc.) or by groups of like species (cereals, legumes, root and tuber crops, etc.) "Vertical" linkages between researchers develop under the leadership of the breeder for each major commodity. For example, a typical team might be composed of a breeder, agronomist, plant pathologist, entomologist and grain quality analyst. Emphasis is typically placed on overcoming environmental constraints to productivity by incorporating genetic resistance, tolerance or avoidance of environmental stresses.

By contrast, the cropping system approach partitions sectors* of crop production by environmental variables (e.g. climate, soils, other crops) that determine or limit the range of crops which can be produced, as well as their sustainable productivity. The approach is most useful where a number of different crops are produced simultaneously or successively; e.g. intercropping, relay cropping or rotational cropping. "Horizontal" linkages between researchers develop within each sector in which a general agronomist or crop ecologist provides leadership. In the irrigated sector, a team might be composed of an agronomist, irrigation engineer, weed scientist and soil scientist. Emphasis is placed on alleviating environmental limitations to productivity of the entire range of crops in production by optimizing cultural operations and rotations (e.g. crop residue management, relative seeding dates, water application cut-off, etc.) Cropping system research can be seen as a subset of farming systems research.

Both approaches are desirable in a well balanced research program, and both are obviously predicated on teamwork; the elusive "rapport entre chercheurs." INRAN has retained the commodity approach left by IRAT in its Agricultural Research Department (DRA) (INRAN, 1984). With the possible exception of DECOR (Ly et al., 1985), no evidence of the cropping systems approach is presently apparent within the Institute. However, the framework for one does exist in the context of the Ecological Research Department (DRE). This question is further discussed in section 4.3.

2.2 Suitability of irrigation system types to research approaches

In the irrigation sector, the commodity-based approach appears most appropriate for research on dedicated paddy rice systems of the Niger River. A Nigerien rice breeder is in place at Niamey, conveniently adjacent to the soils laboratory, but presently lacking complementary researchers in agronomy

---

* These sectors may be thought of as supersets of recommendation/testing domains.

TABLE D-1

- Representative agronomic research themes pertaining to the dedicated rice perimeters of the Niger River.

Variable	Research Themes
Water	Timing and amount of pre-irrigation relative to puddling technique to be used.
	Optimum water depth by season and growth stage of promising new varities (BG 90).
	Possibilities of water draw-down during vegetative growth stage to save pumping costs.
	Influence of date of irrigation cut-off and surface drainage on yield and grain quality, as a function of soil moisture capacity.
Soil	Comparison of puddling techniques (hand methods, bullock plowing, moto-culteur) for cost effectiveness, and feasibility relative to plot size.
	Influence of puddling techniques on cultural calendar, plant growth and deep percolation losses.
	Development of inexpensive animal drawn floats or drags to smooth surface irregularities.
	Influence of flooding and drainage on the availability of P applied in rock phosphate forms.
Crop	Use of inexpensive shelter materials to protect winter seedling nurseries from cold air drainage, and use of water warming ponds.
	Feasibility and interest of growing leguminous forages on residual soil moisture after second rice crop.
	Assessment of yield loss due to nutsedge and other hydromorphic and aquatic weed species, and development of integrated weed control strategies.

and entomology. Attached annexes include proposals to reinforce the rice improvement program from the standpoints of staffing and training (Annex K) and irrigation engineering (Annex G). Table 1 lists representative agronomic research themes which have been relatively neglected to date in the dedicated rice perimeters, which a rice agronomy specialist may wish to investigate.

Research applied to micro-irrigation systems calls for a different approach. Given the diversity of vegetable crops produced (Table 2), and the ecological and geographical dispersion of these systems, it is not evident that a commodity approach will be practicable in the near future. Nor is it evident that the cropping systems approach will be suitable, since the unit scale of production (0.16 to 0.33 he res, per USAID, 1984) suggests gardening instead of agronomic production.

Available data and field observations suggest that the major constraint to the development of these micro-systems is related more to the hydraulics of water supply, lifting and distribution than by horticultural factors. Annex G proposes a research strategy to develop water lifting devices intermediate between traditional systems and modern small motorpumps. Once water supply and delivery have been assured, then research attention can turn to horticultural themes through INRAN's "Division des Cultures Maraicheres", or Vegetable Crops Division. Reinforcement of this division through training is proposed in Annex K and through short-term technical assistance in section 4.2 of this annex.

The cropping systems approach appears most suitable for research on the mixed-cropped inland perimeters, whether irrigated with pumped groundwater or with resevoir-stored runoff. With unit scales of production more appropriate to irrigated field crop techniques, a cropping systems research program can be designed to cover the broad categories of water, soil and crop management specific to this irrigation subsector. Since the crops receiving supplemental irrigation in the rainy season are also produced in the dryland sector, horizontal linkages with existing and future DRA commodities programs can maximize effectiveness of limited research resources.

2.3 Potential Research Themes

The following sections describe some of the technical themes which merit investigation on the inland perimeters in the context of the broad categories of water, soil and crop management. The representative themes are intended to illustrate hypotheses or avenues of research to be looked into during the diagnostic study phase (cf. section 5.2). They do not represent a definitive "research agenda."

2.3.1 Irrigation water management

Water relations (Soil-plant-atmosphere) research is needed to rationalize the irrigation calendar with respect to evaporative demand, crop consumptive use, and soil moisture holding capacity. Such research lays the groundwork for increasing irrigation water application efficiency. Most inland perimeters presently schedule irrigations primarily in function of system supply capacity and the perceived need to supply all fields equitably within a

TABLE D-2

Estimated dry season vegetable crop production in Niger, 1984-85 a.

CROP	AREA ('000 Ha)	PRODUCTION ('000 MT)	YIELD (MT/Ha)	MAJOR PROD. b DEP'T.	AREA ('000 Ha)
Maize c	4.5	4.6	1.0	Diffa	0.9
Manioc	18.4	182.4	9.9	Zinder	6.4
Sweet potato	6.8	68.4	10.0	Tahoua	5.0
Cowpea	14.1	8.1	0.6	Tahoua	8.2
Irish Potato	1.6	15.2	9.3	Niamey	0.8
Tomato	2.3	24.6	10.5	Tahoua	1.7
Onion	2.1	40.8	19.3	Dosso	1.0
Other veges	4.7	53.1	11.4	Dosso	2.1

a. Source: Direction Services Agriculture (1985).
Statistics do not distinguish between perimeter, micro-irrigation. and recessional production of these crops.

b. Major producing administrative Department, based on area and production.

c. Major portion of which is consumed as green ears (USAID, 1984).

fixed time frame. The result is frequent over-irrigation. Applied water relations research can provide perimeter directors with the practical means to schedule irrigations in function of demand as well as supply.

Fortunately, Jean Charoy's results (Charoy 1971; IRAT 1968, 1970 a.) provide useful baseline data for further water relations research. These data include measured and estimated ETo and ETp in the Goulbi de Maradi, ETc for seven major irrigated field crops, Epan measurements and Kpan calculations for the Colorado type pan as used at the time by ORSTOM. Norman (1986) found these data useful in studying irrigation efficiencies in the Maggia Valley, although adjustments need to be made for measuring evaporation with Class A pans and for the consumptive use patterns of more recent varities. Adjustments based on published data (e.g. FAO Irrigation Paper No. 24) will probably suffice for practical purposes.

Although ONAHA perimeter directors are aware of climatic and pan-based methods for estimating ET and water balance, they find these methods cumbersome, impracticable, and of little utility in scheduling irrigations. They would prefer basic irrigation frequency and rate guidelines for different crops and soils. Among the more practical field techniques proposed are the early detection and use of water stress symptoms expressed by each crop, and estimates of soil moisture status based on manual feel of samples taken by soil auger.

Research into water application efficiency at the farm field level will translate into water savings by farmers only if a price is put on water. In surface reservoir systems, that price might be measured in terms of gains or losses in land area irrigable in the dry season in function of water savings made in both seasons. In ground water pumping systems, it might be measured in terms of electricity bills, which constitute about 50% of the perimeter dues paid by farmers. To the extent that ONAHA would be willing to reduce perimeter dues in function of water cost savings, farmers may be motivated to irrigate more efficiently to increase their profit margins. Models need to be developed to estimate the profitability of water application efficiency for each of these perimeter types.

Meanwhile much can be done to increase the efficiency of within-field distribution of the water applied. For basin-irrigated crops, corrugations might be cut to gain distributional uniformity. For row crops supplementally irrigated by furrow, more uniform distribution might be achieved by cutting furrows with animal traction prior to seeding rather than by hand after seeding. Water flow down furrow, whether from rain or from the irrigation source, might be better regulated by cross-tieing ridges or placing rocks at intervals along the furrow length, in function of slope and infiltration rates. General guidelines for adjusting furrow slope (by cutting them on the bias to the field slope) and furrow length, in function of infiltration rate and flow rate, appear to be lacking. At present, flow rate to the field appears to be fixed at the maximum allowable, as each farmer attempts to apply as much water as possible during his period of water access.

2.3.2 Irrigated soils management

Table 3 lists existing fertilizer recommendations for major crops in Niger. Most of the INRAN recommendations were established by IRAT or IRCT researchers for the dryland sector, were based on or derived from cotton fertilizer requirements, and were not refined or adjusted for use on different soil types or under irrigated double cropping conditions. These shortcomings have been widely recognized in INRAN and ONAHA, and have led FAO to embark on a multi-local fertilizer response testing program. To date no new fertilizer recommendations have been forthcoming for the irrigated sector. ONAHA has derived interim recommendations of its own, varying perimeter to perimeter, while waiting for more specific recommendations from research (DEPSA, 1986)

An obvious need is thus to test response to available sources of nitrogen, phophorus and potassium under existing irrigated cropping systems, not only to establish guidelines for long-term fertility maintenance, but also to develop yield response and net profitability curves by crop and soil type. Beyond that, the mode of fertilizer placement and timing relative to the irrigation calendar may well influence the efficiency of mineral element assimilation relative to application. Also of potential interest is the influence of irrigation on the availability of phosphorus (the most commonly limiting element) from locally avaiable Tapoa rock phosphate, both in natural or in partially acidulated form.

Of interest to the DRE of INRAN is the extension of themes currently under study in the dryland sector over into the inland irrigated perimeters. Such topics include crop residue management, the role of organic matter in soil fertility maintenance, and the evolution of soil fertility over the long term. Another long-term concern to the DRE is the risk of soil salinity and sodicity (from natron: sodium carbonate) buildup in perimeters irrigated from ground water.

Soil physical properties affect not only plant growth but also the efficiency of irrigation water use. Infiltration rates vary considerably within perimeters and fields, occasionally due to improper land planing which has exposed the subsoil, which frequently has very different moisture holding characteristics than the topsoil. Hence characterization of the chemical-physical properties of representative soil profile types in the perimeter toposequence is needed to establish soil management "recommendation/testing domains."

Management of soil physical properties involves not only tillage practices but also soil amendments in the form of animal manure and crop residues. Current tillage practices underexploit the potential of animal traction with respect to the range of implements drawn. Potential payoffs appear most promising for research and development of animal drawn floats or drags (to smooth surface irregularities), furrow cutter-shapers, and row seeders. Various models of seeders of the Ebra and Super-Eco type have been introduced over the years but have been retained by farmers only for use on large-seeded upland crops like peanut. Additional prototype testing and development is needed to adapt seeders to small seeded crops and to heavier bottomland soils,

TABLE D-3

Existing fertilizer recommendations for crops produced in the irrigated sector.

Crop	NPK 15-15-15	N Urea	P SSP/TSP a	Total units N-P2 05-K2 0
	Kg/Ha			
Rice (nursery) b		200	-/200	46-48-124 d
Rice (nursery) c	150	50	-/1	46-23-23
Rice (paddy) b		100+100	e	92-90-0
Rice (paddy) c	150	200	-/-	69-23-23
Sorghum b,f	-	100	-/-	46-0-0
Sorghum g				
- Konni perimeter	100	50	-/-	38-15-15
- Ibohamane	100	50	-/-	38-15-15
- Djiratawa	200	100	-/-	76-30-30
Cotton g				
- Konni Perimeter	150	50	-/-	46-23-23
- Ibohamane	200	50	-/-	53-30-30
- Djiratawa	200	100	-/-	76-30-30
Wheat b	-	75+75	-/-	69-0-0
Wheat (Djiratawa)g	200	100	-/-	76-30-30
Onion (bulbs) b,i	-	50	100/-	23-16-0 h
Tomato (nursery) b	-	200	200/-	92-32-0 h
Tomato (field) b	-	50	-/50	23-23-0
Cowpea b,f	-	-	100 or 50	0-16-0
Peanut b,f	-	100 j	75/-	46-12-0 j
	- or	50 k	-/-	23-0-0 k
Peanut(Djiratawa)g	-	-	100/-	0-48-0

Notes to TABLE 3 (fertilizer recommendations)

a. Simple superphosphate (16% P2 05) or Triple superphosphate (48% P2 05)
b. INRAN (1985 a) recommendation.
c. ONAHA (1982) recommendation.
d. Potassium to be provided as KCl at 200 kg/Ha, equivalent to 124 kg K2 0.
e. Phosphorus source unspecified; 90 units P2 05/Ha recommended.
f. Recommendation not specific to irrigated production.
g. ONAHA recommendation cited in DEPSA (1986).
h. Plus 20 MT/Ha animal manure incorporated pre-plant.
i. INRAN makes no fertilizer recommendation for onion seed production.
j. For fields which have never been fertilized.
k. Following cereal fertilized with 100 kg/Ha urea plus TSP.

particularly with respect to seed-soil contact and the physical properties of the emergence zone.

The use of bullocks and donkeys for animal traction in the perimeters also increases the concentration of animal manure available for soil amendment. The potential for expanding the use of manure beyond horticultural crops (INRAN, 1985 a.) is well worth investigation.

2.3.3 Irrigated crops management

Rainy season crops grown under supplemental irrigation generally receive cultural practices similar to those grown under dryland conditions. In sorghum for instance, the density of hills is frequently low (ca 15,000/Ha) but the plant concentration per hill remains high (ca 3 or more per hill after late thinning). Farmers may have excellent reasons for retaining traditional practices given their capital and labor constraints, but the productive potential of the perimeters suggests a positive return to investment in animal drawn inplements to substitute for labor. The refinement of cultural practices based on such implements, described in the preceding section, appears to be the most promising strategy to improve crop productivity. For instance, the proper use of row seeders would advance seeding dates, improve stand establishment, improve plant density and distribution, and facilitate thinning, weeding and ridging. It would also facilitate improvements in field water application and distribution efficiency under furrow irrigation.

There is also much room for improvement in cultural practices of dry season, basin-irrigated crops. In wheat for instance, hand broadcast of seed may prove a faster and more effective way to establish a satisfactory stand than the hill planting technique recommended by INRAN (1985 a.). In the absence of grain drills, achievement of 400,000 hills/ha. by hand severely limits the area each farmer can afford to plant to wheat. It also retards the planting operation, resulting later in floral sterility and poor seed set due to increasingly high temperatures at flowering.

The most evident defect in the present crop rotation and succession pattern is the absence of a leguminous crop on many perimeters, particularly those irrigated from surface reservoirs. Normally cowpea or peanut grown in the hot, dry season is to follow cotton planted in the preceding rainy season. But water shortages combined with severe environmental stresses of the season (insect pests, heat damage) have discouraged farmers from pursuing this recommendation. They prefer instead to continue to irrigate cotton, an indeterminate perennial, into the dry season to harvest the last decreasing increment of boll production as much as 8 months after planting. They then fallow the cotton plots before rotating to sorghum with the next rainy season.

Two themes are therefore suggested: investigation of the optimal cut-off date for cotton harvest relative to the following crop (in terms of total farm profit); and evaluation of potential forage legumes (such as forage mung bean, Phaseolus lunatus, available locally) which will perform better in the hot dry season than the presently-available cowpea and peanut cultivars. High quality forage is a critical need before and during the onset of rains, for proper

feeding of traction animals. Simmons (USAID, 1984) has pointed out that the value of haulms (foliage) exceeds the value of grain from leguminous crops on a dry weight basis.

2.3.4 Allied agronomic research themes

Researchers investigating the three core areas of water, soils, and crop management will find the need to draw upon the expertise of their colleagues in INRAN's commodity-based programs to fully exploit the power of the cropping systems approach. Available data and field observations suggest three major areas where additional technical intervention will be needed: varietal improvement, insect pest management, and weed control.

The four major irrigated field crops which appear most likely to benefit from varietal improvement are wheat, maize, cowpea and peanut. The major wheat variety, Florence Aurore, has stood the test of time, is very hardy and relatively bird resistant (INRAN 1985 a.), and has a yield potential in excess of 4 MT/Ha (W. McCuistion, personal communication). Its main weakness is intolerance to high temperatures at flowering -- a stress it is subject to when delays in the cultural calendar push flowering into the hot, dry season (INRAN 1985a).

The only recommended maize variety, P3 Kolo, has also stood the test of time but was selected by IRAT on the basis of rainy-season performance (IRAT, 1977). Its poor performance under dry-season irrigation, and its need for frequent and ample irrigations, have discouraged farmers from growing much of it in the off-season. The reasons for its poor performance remain unclear, but may be related to its photoperiodic (short-day) flowering response.

The recommended cowpea varieties, all bearing TN (Tarna Niebe) numbers, appear not to have benefitted from the breakthroughs made at IITA in improving this crop. For hot, dry season use, their main weaknesses appear to be susceptibility to insect pests (particularly Aphis craccivora) and to heat damage at flowering. Sources of aphid resistance through antibiosis are available through IITA, and tolerance to heat stress (which causes male sterility) is available in two strains TVu 4552 and Prima (Hall, 1986).

Peanut suffers from many of the same problems as cowpea when grown in the hot, dry season. In addition, aphids transmit rosette virus, to which all varities currently in multiplication are suceptible (INRAN 1985 a.; 1985 d.). Annex K presents a strategy for developing INRAN's capacity to conduct research in varietal improvement of both rainfed and irrigated crops.

While waiting for crop improvement programs to provide genetic insect tolerance or resistance, classical pest control methods can be implemented on the irrigated perimeters to good effect. But while insect pest control may not entail much research on the inland perimeters, weed control most likely will. Available data and field observations indicate a serious chronic infestation of nutsedge, Cyperus rotundus, on most inland perimeters (USAID, 1984). The noxious perennial weed is one of the most difficult in the world to control (Terry, 1983). Mechanical techniques are generally ineffective if

not counterproductive, and the only highly effective chemical hericide is glyphosate. A yield loss assessment from nutsedge at Konni and/or Djiratawa would help define the range of control treatments to be considered.

This sampling of allied research topics is intended to underscore the need for collaborative research between disciplines. The necessity for additional technical intervention, and the nature and extent of that intervention, will become apparent during the diagnostic study phase. But it is equally apparent from this discussion that the core team of irrigation agronomy researchers will have a full research agenda in front of them. They would be ill advised to personally undertake, for instance, a varietal testing program on wheat, maize, or any other irrigated crop. Although diagnostic study may reveal that nutsedge or aphids are more limiting to yields than, say, soil fertility, the recommended approach consists of proposing the intervention of specialists specific to the problem identified. Ways and means of doing so are discussed in sections 4.2 and 5.3.

III. PHYSICAL RESOURCES FOR IRRIGATION AGRONOMY RESEARCH

Outside of INRAN's present rice improvement program, the institute has little in the way of irrigation research infrastructure or equipment, particularly in the ADM-Maradi region of the country. Through means provided by the Niger Applied Agriculture Research Project and companion funding, USAID will assist INRAN in creating this infrastructure and equipping it to conduct applied irrigation research, essentially from scratch. This chapter summarizes INRAN's present physical resources in irrigation and proposes ways to equip its researchers with the tools they will need to test hypotheses arising from the diagnostic study phase.

3.1 Infrastructure

Table 4 summarizes several key features of INRAN's irrigation research facilities and field infrastructure as of 1986. Three of those listed are within the ADM-Maradi region which comprise the perimeter types of primary interest.

The irrigation system at the CNRA - Tarna is set up to provide supplemental sprinkler irrigation to rain-fed trials and to irrigate dry-season seed multiplication. About 15 hectares of flood plain soils are available for irrigation, but not always used for that purpose. The portable pipe is occasionally run up the slope to irrigate upland fields instead. The portability of the pipe makes for a greater apparant irrigable area than the well and pump capacity (10 lps/well) would indicate. No gated pipe is present with which to furrow irrigate, nor do any fields appear to have been planed for that purpose. The number of functional wells is at times less than four when pumps are pulled for repair or replacement.

The SEHA (Experimental Irrigation Station) Facility established by IRAT in the early 1960's, is located about 3 km SE of CNRA in an area of somewhat heavier floodplain soils. The station, which was last used for experimental

TABLE D-4: Summary of INRAN irrigation research facilities and field infrastructure, 1986

Name	Location (Department)	Topological Site	Irrigated Surface (Ha)	Source	Irrigation System: Supply	Irrigation System: Conveyance	Application
C.N.R.A. a only Center	Tarna (Maradi	Goulbi Flood Plain	est 20 net	4 wells	est. submers. pumps	6" pipe	sprinkler
S.E..H.A. b Station	Tarna (Maradi)	Goulbi Flood Plain	10 net	2 wells	elect. submers. pumps. c	buried and raised aqueducts	surface
Station	Kolo (Niamey)	Niger Flood Plain e	est 30 net	River access channel d	Large diesel pump	Lined canals e	surface
Point d'appui f	Konni (I) (Tahoua)	open plains	10	ONAHA surface resevoir	gravity	Lined canals (ONAHA)	surface
Point d'appui	Lossa (Niamey)	Niger River Terrace	24	River pumping	Large diesel	Lined canals	surface
Station	Tillaberry (Niamey)	Niger River Terrace	26	River pumping	"	Surface pipe	surface
Perimeters (Riziculture)	Libore; Saga; Saadia; Seberi; Tara: Namari	Niger River Flood plains goungou	1-5 ha/site	"	"	Lined canalsunlined tertiaries	" " " " "

a. Centre National de Recherches Agricoles
b. Station Experimentale d'Hydraulique Agricole
c. Not in operating condition, 7/86.
d. Not fed with water, 7/86.
e. Some secondaries unserviceable, 7/86.
f. Scheduled to be upgraded to station status by FAO for ag. mechanization research.

purposes in 1969-70, is now in complete disrepair. Some of its fields had been used for occasional irrigated seed increases until the second of the two pumps failed early in 1986. Other fields had evidently been abandoned years before.

Jean Charoy, the chief IRAT researcher at SEHA from 1963 to 1970, found almost all of the soils there to be too heterogeneous over short distances to continue conducting surface irrigation experiments (Irat, 1968). Joseph Ogier later added that salinity had increased in the SEHA soils over years of groundwater pumping (PDR Maradi, 1983 b.), and that they could no longer be used for research purposes (PDR Maradi, 1983 a.) These problems appear to be related to the relatively high water table (3-4 m) and the extremely slow internal drainage rate of the gley-type soils (IRAT 1970 b.).

The support station at Konni contains 10 Ha of relatively well draining, surface-irrigable soils in the OHAHA- managed perimeter. Irrigation water is available only during, and shortly after the rainy season, as the reservoir water is usually exhausted within several months of the end of the rains. INRAN has posted a single technician at Konni to execute trials sent out by the researchers. For the 1986 season, this technician was charged with executing 38 separate field operations, most of which were to be conducted in the non-irrigated portion of the site.

As described in section 5.4, the irrigation agronomy team will require a highly functional and representative set of INRAN-managed field trial sites in the ADM-Maradi region by the end of Year 3 of the NAAR Project. Therefore the sites described above are to be technically reviewed and overhauled in the process of establishing an entire decentralized network of surface-irrigated station research sites in the ADM-Maradi region.

First and most importantly, the irrigation agronomy team will need a "base station"; an INRAN-run location where they can conduct a broad range of intensively managed and relatively sophisticated experiments. Such a base station is critical since for many, if not most, experiments, INRAN researchers will need to control the water source and delivery, something which may not be possible in an ONAHA managed facility. In addition, the irrigation agronomy team will require ready access to a full range of station-level technical staff. As a rough measure, the net field area needed will be on the order of 10 to 15 Ha of bottomland, irrigable either by basin or by furrow, with moderate rates of internal drainage and better than average soil uniformity over short distances.

Several of the more obvious sites which must be carefully prospected from engineering and soils viewpoints include:

a. CNRA - Tarna bottomlands near the Goulbi;
b. SEHA - Tarna;
c. Pilot farm (12 Ha) of Djiratawa (PDR Maradi)*
d. A new groundwater site near the Goulbi de Maradi and the CNRA - Tarna.
e. None of the above.

---

*PDR Maradi (1983 a.) specifically suggested this option.

TABLE D-5

Illustrative research station network for irrigation agronomy research under the NAAR Project a.

Location	Function to research	Net irrig. area (Ha)	Topologic position	Irrigation system		Perimeter management entity
				Perimeter type	Application	
1. CNRA Tarna	"Base station"	10 to 15	Bottomland; Flood-plain	Groundwater pumping	Furrow, basin, & sprinkler	INRAN
2. Djiratawa	"antenna station" (Point d'appui)	5	"	"	Furrow, basin	ONAHA
3. Galmi	"	"	Bottomland	Surface resevoir	"	"
4. Konni 1	"	"	Open plains	"	"	"
5. Ibohamane	"	"	?	"	"	"
6. Moullela	"	1 to 2	Bottomland	"	"	"

a. Subject to technical prospection. See section 3.1.

The antenna locations, or "Points d'Appui" should also be technically prospected at the same time. The main technical criteria for selection of perimeters and fields within perimeters should be representativeness of irrigation systems type and of soil type within perimeters, respectively. Table 5 illustrates an example of a base station + antenna station network for irrigation agronomy research under the NAAR Project.

Costs of developing the base station facility (prospection wells, pumps, land planing, structures, etc.) have not been included in the illustrative budget for the NAAR Project, since these costs are to be met by companion funding (USAID, 1986 b.). However, a small allowance is made in the budget for antenna station development, including locally-contracted land planing if need be.

3.2 Equipment

INRAN's equipment status is somewhat mixed with respect to the types of equipment already on hand, and which might be of use in the research of topics discussed in section II. Not surprisingly, INRAN has little of the equipment necessary for water management research themes, but considerable unused equipment exists for soil sampling and analysis. However, this latter equipment is stored at the soils Lab in Niamey and not at Tarna, where DRE (soils) has no representation at present. Until and unless an equipment inventory is taken, and negotations concluded with DRE (and DRA) Directors, there is no assurance that existing underutilized equipment will be made available for use by the irrigation agronomy team.

Thus the illustrative list of major equipment included in the procurement plan is directed toward establishing self-sufficiency in material needs of the nascent irrigation unit, so that competition for material at critical periods does not become a source of friction between research units . An additional practical consideration pertains to the physical distance which may exist as a result of eventual siting of the base station relative to CNRA-Tarna.

IV. HUMAN RESOURCES FOR IRRIGATION AGRONOMY RESEARCH

The cropping systems approach to research is predicated on two key human resources: analytical ability and team spirit. To help infuse these characteristics among the Institute's future researchers, the NAAR Project will capitalize upon the nascence of the irrigation agronomy training to young Nigerien researchers and technicians on the one hand, and technical assistance in the form of experienced, systems-oriented agronomic scientists on the other. The Project will also capitalize on the ecological orientation of the DRE to orient INRAN's irrigation researchers to work across commodity lines.

4.1 Staffing and training needs

At present INRAN's human resources available to conduct a program of applied research in irrigation is limited to a single irrigation agronomist who returned in 1986 from a B.S. program at Oklahoma State University. No

other future researchers in irrigation agronomy or water management are currently in advanced training programs. Thus, like the physical resource base for irrigation, INRAN has practically to start from scratch in developing its future human resources. As much attention needs to be paid to technical support staff as to research personnel.

Tables 6 and 7 present medium-term (5-7 year) staffing objectives at the researcher level for the core team in irrigation agronomy and allied research specialties, respectively. A total of eight researcher specialists are proposed to cover the range of topics included in the three broad categories of water, soil and crop management in irrigation. An additional seven researchers are needed in the allied areas of vegetable crops (for the micro irrigation subsector), weed science and entomology. Plant breeding needs are discussed in Annex K, and irrigation engineering in Annex G.

In the interest of establishing a trained core team for the irrigated sector as soon as possible, two strategies are recommended. To encourage Nigerien students presently studying overseas to orient their programs toward the needs of the irrigated sector; and to aim new training scholarships towards the B.S. and M.S. levels during the first phase of the NAAR Project.

Other Annexes (F and K) propose ways of implementing time-saving stategies (including the use of short courses at the IARCs), as well as the benefits which will accrue to both the young researchers and to the research program. However, gaining time in the medium-term may risk trading away the development of analytical research skills which are not formally taught but which often accrue in the course of a doctoral degree. Such skills include the ability to discern research priorities, to assess yield-limiting factors, to formulate meaningful hypotheses, to design experiments, to test them, and to fully interpret the implications of the data.

To mitigate this risk, M.S. thesis programs are emphasized for appropriate disciplines, in which field research may be conducted in Niger under the supervision of senior technical assistance researchers, who can also guide the student towards topics relevant to the research priorities of the irrigation sector.

Table 8 proposes a total of 23 chief technicians to support and help execute the irrigation agronomy program and allied research. Of these, five will require two years of practical training similar in nature to an American Vo-Ag program, to gain adequate technical competence. The remaining specialties are appropriate to the type of short-term training for technicians offered periodically by the IARCs. Examples of such programs are listed in Annex K. The use of institute facilities based in Africa increases the chances that the techniques tought will be appropriate to Niger, and eases cultural and language difficulties. The International Irrigation Center at Hassan II (Morocco) is particularly appropriate to water management needs.

TABLE D-6
Medium-term staffing objectives for INRAN in irrigation agronomy.
Part 1: core research team in water, soil and crop management.

Thematic category	Title per Academic Discipline	Specilization	Academic Training level	Number per team
Water Management	Irrigation Engineer	- Irrigation Water Mgmt. and Surface Application Methods.	M.S. (non thesis)	1
	Agro-climatologist*	Evaporative demand: Instrumentation and Technology; weather stations.	A.S. (technical) a/	1
	Crop Physiologist	- Plant water relations and consumptive use.	M.S. (thesis) b/	1
Soil Management	Soil Scientists	- Soil and Water Chemistry.	B.S. (technical) c/	1
		-Soil fertility and Fertilizers.	M.S. (thesis) b/	1
		Applied soil physics and soil tillage techniques	M.S. (thesis) b/	1
Crop Management	Field crop agronomists	Cultural techniques; irrig. grain and row crops.	M.S. (thesis) b/	1
		Multiple cropping systems and production agronomy.	M.S. (non thesis)	1

* Research associate
a. Equivalent to American Vo-Ag degree. (2 year).
b. Thesis research to be conducted in-country.
c. Polytechnic Ag program. (4 year).

TABLE D-7
Medium-term staffing objectives for INRAN in irrigation agronomy.
PART II: Allied research specialties (not including Irrigation Engineering)

Title of Academic Discipline	Specialization	Academic Training level	Number per Research Cente
Horticulturists (vegetable crops) d/	- Intensive small scale methods	M.S. (thesis) b/	2
	- Commercial vegetable production technology	B.S. (technical) e/	1
Weed Scientists	- Integrated weed management	M.S. (thesis) b/	1
	- Herbicides and application technology	M.S. (technical) c/	1
Entomologists	- Insecticides and application technology	B.S. (technical) c/	1
Plant breeders	(see Annex McC)		
Irrigation engineers	(see Annex JK)		

a. Equivalent to American Vo-Ag degree (2 year)
b. Thesis research to be conducted in-country.
c. Polytechnic Ag program (4 year).
d. To specialize in micro-irrigation system research.

TABLE D-8

Medium-term staffing objectives for INRAN in irrigation agronomy:
PART III: Chief Technicians.

Technical Title	Specialization	Irrigation Research Supported	Number per Program	Suggested training e/ Type	Duration
Statisticians	Experimental Design and Analysis	All	1	A.S. a/	2 years h/
	Microcomputer Statistical packages	All	1	short course	2-6 mos.
Irrigation Technologists	Surface application techniques	Water Mgt.	2	A.S. a	2 years
Soils Analysts	Laboratory chemical-physical analysis	Soil Mgt.	2	A.S. a/	2 years
Agricultural Mechanics	Tractor implement technology	Soil Mgt.	1	short course	2-6 mos.
	Animal draft-implement	Soil & Crop Mgt.	2	"	"
Ag. Chemical Technicians	Chemical handling and Application technology	Soil Mgt. (Fertilizers)	1	"	"
	"	Weed Sci (Herbicides)	1	"	"
	"	Entomol. (Insecticides)	1	"	"
Ag. Technician 1. f/	Field plot technique and data recording	All	6	"	"
Ag. Technician	On-farm trial methods	All	3	"	"
Seed Technologists d/	Vegetable seed production and landing	Hortic.	2	A.S. a/	2 year

a. Equivalent to American Vo-Ag degree. (2 year).
d. To specialize in micro-irrigation system research.
e. Post IPRD-Kolo or from research technical staff.
f. To become INRAN irrigation trial executors in base station or antenna facilities.
g. To become INRAN on-farm trial roving monitors.
h. For existing INRAN technician.

4.2 Technical Assistance and counterparts

While long-term training of Nigerien irrigation researchers is in progress, the pressing need to initiate an applied program of research suggests the provision of technical assistance. In the area of irrigation agronomy, both long and short-term assistance will be provided to INRAN by the NAAR Project. Factors limiting the numbers and duration of assistance include the present absorptive capacity of INRAN, logistical considerations and budgetary constraints.

By way of long-term assitance, the Project will provide two expatriate research agronomists to initiate the program of water, soil and crop management research. As specified in the Project Identification Document (USAID, 1986 b.), one is to be an irrigation agronomist and the other a soils agronomist with experience in irrigation. Assigned to INRAN, the two will work in equal partnership and in collaboration with other INRAN researchers to develop a cropping systems, team approach to research in the irrigated perimeters. Terms of reference for the soils and irrigation agronomists are presented in Annex J.

Inherent limitations on the domain of research activity arise from the dispersal of irrigation system types in Niger (see Figure 1), which imposes severe practical and logistical constraints on conducting research applied to their needs. For example, a single research team might address either the needs of the irrigated rice perimeters of the Niger River or those of the multi-cropped "inland" perimeters, but not both at the same time. Given the relative needs and suitability of each for irrigated cropping systems research (cf. section II), the irrigation agronomy team will be based at or near the CNRA at Tarna (Maradi) during the first phase of the NAAR Project. During this period, the soils and irrigation agronomists will limit the geographic and thematic intervention of their team to the groundwater pumping and surface reservoir systems in Maradi Department and Ader-Doutchi-Maggia region. No fewer than nine ONAHA-managed perimeters of these types fall within a 220 km radius of Tarna (Figure 1).

As described in Annex G, NAARP will also provide an expatriate irrigation engineer to INRAN. That person's scope of research will overlap to some extent with that of the irrigation agronomist. Figure 2 illustrates the relationships in scopes of research among the three irrigation related technical assistants; between the irrigation agronomist and engineer in the category of water application efficiency, and the area of crop management between the soils and irrigation agronomists. Such overlap is designed to encourage teamwork, to provide for synergism, and to generate the level of "critical mass" necessary to develop impact.

Themes which develop in areas of overlapping responsibility may be addressed by both researchers in concert or divided between them at their mutual options. (Such options are to be stated in their research proposals.) For instance, the optimal cut-off date for cotton might be investigated by the irrigation agronomist, while tests of prototype furrow cutters might be jointly conducted. Section V discusses in greater detail the procedures for research implementation.

Fig. D-1 GEOGRAPHIC DISTRIBUTION OF THE MAJOR IRRIGATION SYSTEMS IN NIGER

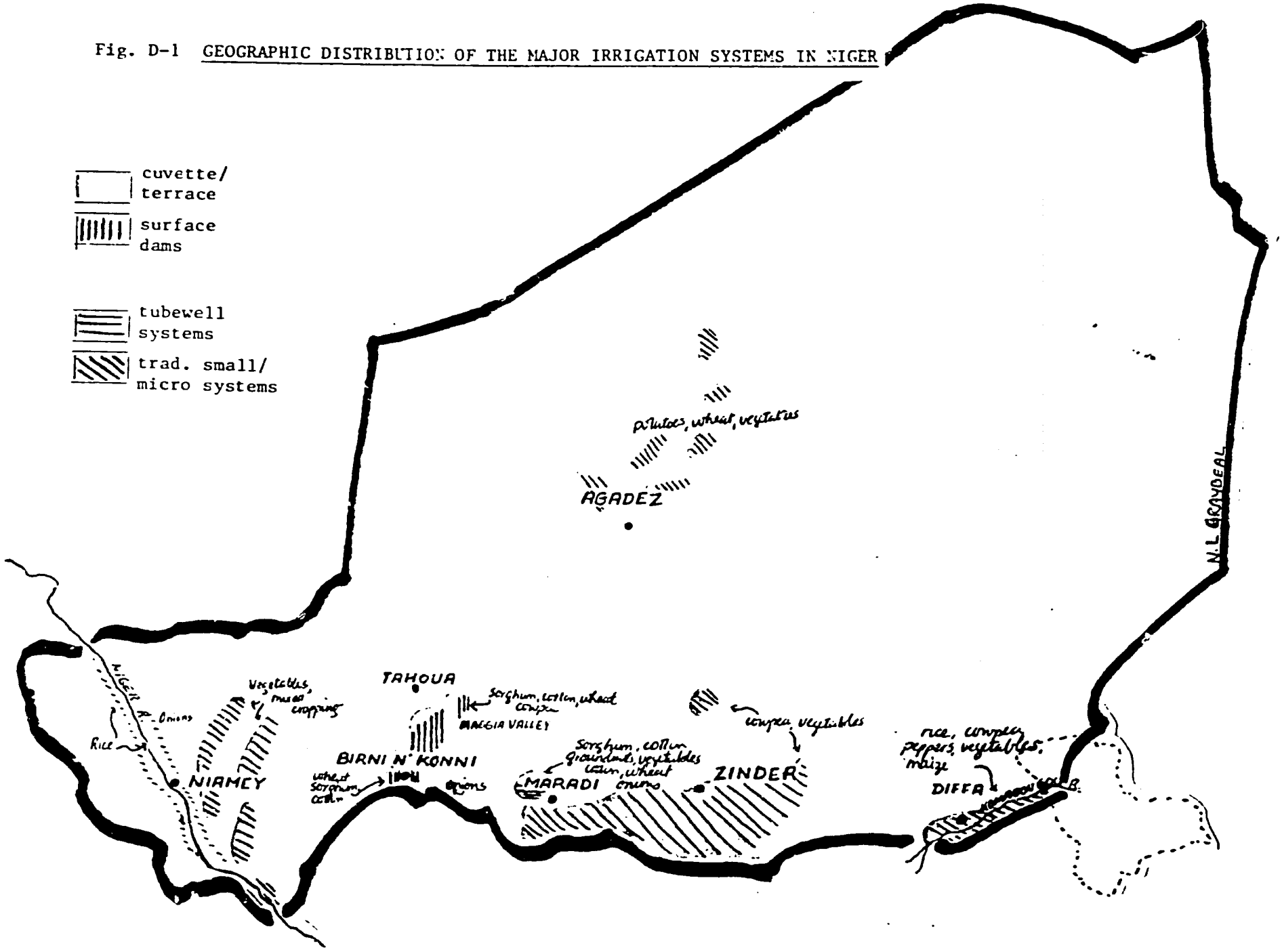

Figure D-2: Scope of Research by Thematic Category for Long-Term Technical Assistance in Irrigation, and Transfer of Research Responsibility to Returning Researchers in Training.

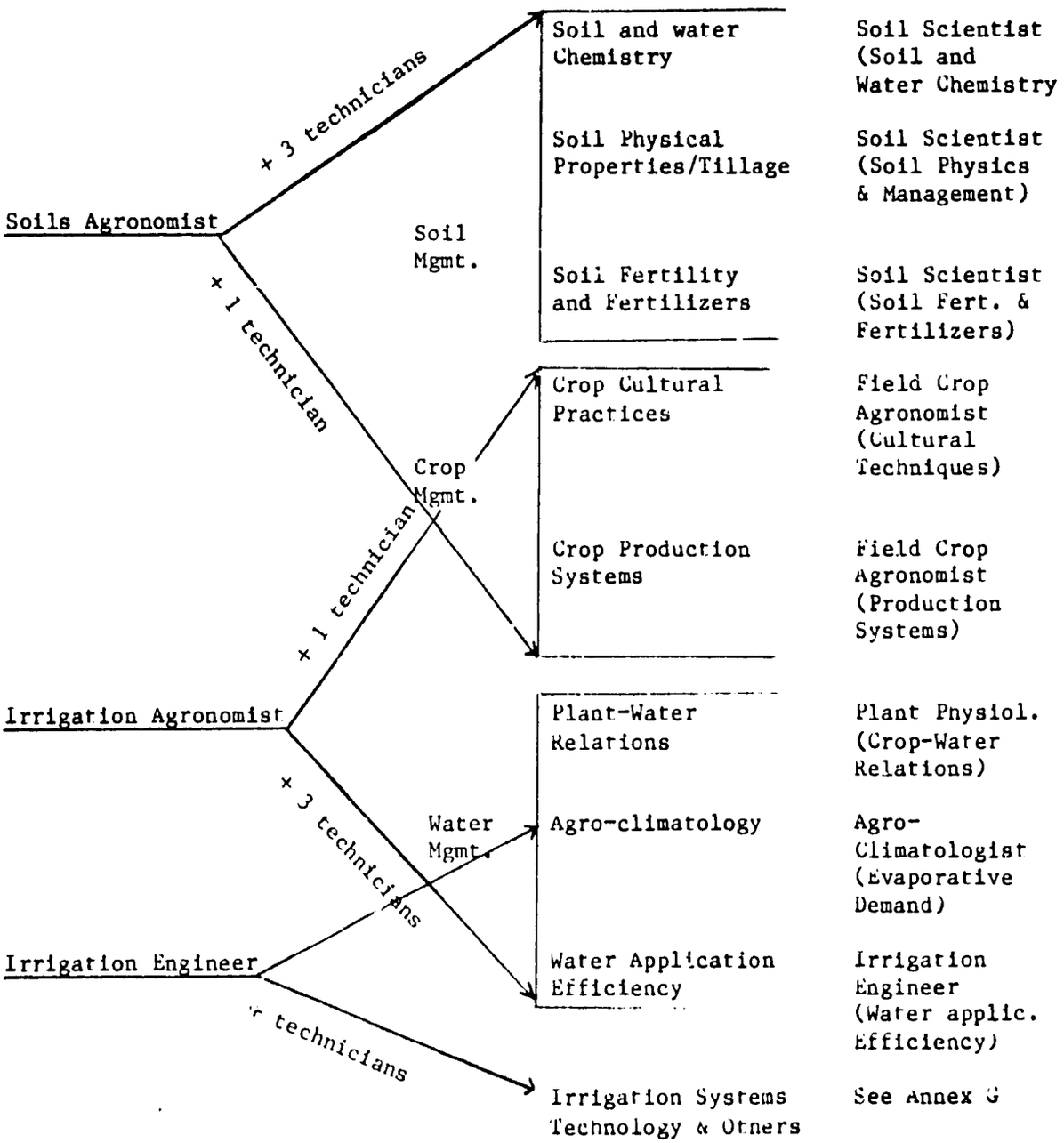

Figure 2 also illustrates the transfer of thematic research responsibilities from the soils and irrigation agronomists to Nigerien researchers. The time frame will be a function of the assignment of qualified counterparts to the program, in turn a function of progress in training in the research specialties indicated. Under worst-case conditions, if no potential counterpart is reassigned from existing research ranks, nor is selected from among those currently in training, then chances are slim that the soils and irrigation agonomists will begin field research with qualified counterparts assigned to their program. However, a minimum condition precedent to the posting of these technical assistants is the nomination by INRAN of counterpart candidates to USAID/Niamey, including all relevant biodata and a projection of the date of assignment into the program. A go/no-go decision on recruitment of technical assistance will need to be taken accordingly.

Regardless of the point at which true counterparts are posted to the irrigation agronomy program, the team will have need of a technical support staff, including general technicians, field assistants, and others listed in Table 8. These too should be subject to a similar condition precedent to deployment of the technical assistants since they will act as de facto counterparts until such time as researcher-level counterparts are assigned.

By way of short-term technical assistance, the NAARP makes provision for ten person-months in technical disciplines. The long term TA's in the irrigation sector will use the perimeter diagnostic study to determine how to make best use of this resource. Table 9 illustrates possible interventions to address known constraints in the irrigated perimeters and micro-systems. Emphasis is placed on the the production of punctual extension recommendations for problems amenable to quick fixes, since recommendations for long-term research will require a cadre of local research staff to implement. Until training provides that cadre, such research may not prove feasible.

4.3 Institutional organization

According to its director, the Ecological Research Department (DRE) has initiated the creation of a new research section for irrigation, initially staffed by a Nigerien irrigation agronomist with B.S.-level training. The new division is to replace the defunct "Section Hydraulique Agricole", which had been placed under the DRA (Agricultural Research Department) to run the SEHA facility at Tarna (INRAN, 1984). For consistency with Annex G, the new unit is referred to here as the Field Water Mangement and Technology Section, or FWM&T.

By whatever name it eventually goes, it is the most appropriate seat for not only the irrigation engineer but also the irrigation agronomist. The soils agronomist will be well placed in the existing Soil Chemistry and Fertility Section, although his work will pertain to some degree to the Soil Physics Section as well.

TABLE D-9

Illustrative short-term Technical Assistance for irrigation agronomy and allied research.

Specialty	Possible Interventions	Possible Products
Vegetable crop horticulturist	Identify yield-limiting factors in veg. crops produced in micro-irrigation systems.	Establishment of research priorities for INRAN's Veg. Crop Section (Cultures Maraicheres).
Seed Technologist	Study onion seed storage difficulties and reasons for low seed viability or germinability.	Extension reccommendations bulletin (fiches techniques) on improved seed storage practices for onion.
Plant breeder/pathologist	Conduct yield loss assessment due to virus diseases of irrigated manioc and tomato in micro-irrig systems.	Establishment of breeding/ screening strategies for resistance; recommen germ-plasm sources.
Insect pest control adviser or Entomologist	Investigate reasons for ineffective-ness of present spraying practices in controlling aphids on cowpea.	Extension recommendations bulletin to improve spraying or select more effective insecticides. OR: Recommendation of appro-priate research program.
Weed Scientist	Conduct yield-loss assessment due to nutsedge (Cyperus rotundus) in irrigated perimeters of ADM-Maradi.	Establishment of research strategies for control within economic limits of loss. OR: Extension of recommendation bulletin on the application techniques of glyphosphate for best effects.

As of 1986, the entire DRE arm of the Institute is based at the Soils Laboratory in Niamey, with no representation at CNRA-Tarna. Moreover, irrigation research will mark DRE's first involvement in agronomic research, which has long been the sole property of DRA. Historically, DRE's role has been more oriented towards passive measurement and study of the crop environment, while DRA has exerted itself in more action-oriented research. Hence the establishment of a DRE irrigation agronomy team at Tarna, which is under DRA direction, will entail the creation of new lines of authority, responsibility and interdepartmental teamwork. Annex A addresses these issues in detail.

As the long-term training program progresses, the irrigation research ranks will include specialties that do not presently figure in INRAN's organization. The allied fields of crop water relations and agro-climatology for instance, suggest the creation of a Crop Ecology section within DRE. On the other hand, researchers specialized in irrigated crop management aspects such as cultural practices or production systems would most naturally sit in the General Agronomy section of the DRA. Such dispersal of researcher assignment across the administrative arms of INRAN poses no inherent problem if no bureaucratic impediments arise to prevent researchers from working efficiently and closely in the conduct of field research. The Perimeter Irrigation Diagnosis and Management section proposed for DECOR (see Annex G) should constitute an interesting test case.

V. RESEARCH IMPLEMENTATION

If forethought and planning have been devoted to the physical and human resource requirements discussed in the preceding chapters, then implementation of field research should prove relatively straightforward if no bureaucratic obstacles arise. Field research involves two basic activities: study and experimentation. For effective research in soil, water and crop management on irrigated perimeters, three steps are followed in recurrent cycle: on-perimeter diagnostic study, on-station experimentation, and on-farm trials. In the time frame of the first phase of the NAAR Project, it may be possible to accomplish one complete cycle if everything goes according to plan.

5.1 Prerequisites and timing

Figure 3 illustrates the target implementation calendar for irrigation agronomy research during and following the first phase of the NAAR Project. The irrigation field research year corresponds to the seasonal cycle, starting with the first rains in June and ending the following May. The key to the interpretation of Figure 3 is an imaginary diagonal transect which begins at "Research Station Infrastructure" and runs to "On-farm Trials - 1".

The first year of field research in crop-soil-water management roughly corresponds to the third year of the NAAR Project. Technical assistance is to arrive about six months earlier to settle in, complete formalities and gear up for the season. This offset relative to the beginning of the NAAR Project is due to time required to fulfill the prerequisites to research implementation,

FIGURE D-3:

Illustrative Implementation Calendar for Irrigation Agronomy Research, 1987-94

Calendar Year	-1987-		-1988-		-1989-		-1990-		-1991-		-1992-		-1993-		1984	
NAAR Project Year (Fiscal) a/		-1-		-2-		- 3-		-4-		- 5-		(6)		(7)		
Growing Seasons b/	RS	DS	RS	DS	RS	DS	RS	DS	RS	DS	RS	DS	RS	DS	RS	DS
Irrig. Field Research Year c/				(T.A. arrive c/	-1-		-2-		-3-		(4)		(5) TA starts phasing out h/		(6)	
Research Station Infrastructure d/		.Prospection .Decision	.Bid.. (Order...)		Construction .Equipment (Recruit, Train).	Staffing	Operational for in-station trials.				Operational-					
Field research activity					Diagnostic Study e/		-Ongoing diagnostic study									
							In-Station d/ trials-1		In-Station trials -2 On-farm trials-1 f/		In-Station trials-3 On-farm trials-2		In-Station trials -4 On-farm trial -3 First hard products g/		Ongoing Ongoing	
Training: Long-Term i/		Depart j/ for oversea training	B.S. Students overseas M.S. non-thesis students overseas M.S. thesis students overseas						B.S. return k/ M.S. thesis projects		B.S. at post k/ M.S. non-thesis return k/		at post k/ at post k/		Ongoing L.T. Trai.	
Training: Short-Term (Chief Technic.)		Agro-cli. Tech.	Irrig. Technologists		Ag Tech I l/ Ag Mechs.		Ag Techn II. m/ Ag Chem Tech. Stats.		Soils Anal. Seed Tech.		- On going s.t. training -					

Notes to Figure 3 (Implementation calendar)

a. Fiscal year of July 1 to June 30.
b. RS = Rainy season (June - October); DS = Dry Season (October - May).
c. TA to arrive in January to year up for diagnostic study beginning in May - June.
d. Including base station and antenna facilities (Points d'Appui).
e. ONAHA perimeter - and farm-level studies (See Section 5.2).
f. Timing assumes Working Agreement provisions (See Annex EMOFTs).
g. Timing assumes positive results from minimum 2 years each station and farm testing.
h. Timing in function of posting of long-term trainee posting and status of hard products.
i. Based on trining of new IPDR-Kolo graduates. Does not include reorientation of current trainees towards irrig.
j. Based on departure in time for 1987/88 academic year.
k. Assumes one year between return and posting for national service and/or special short-term training.
l. Training in field plot technique and data recording to become irrig. trial executors at INRAN facilities.
m. Training in on-farm trial methodology to become INRAN roving monitors.

to advance the training and return of Nigerien researchers and staff relative to technical assistance, and to allow INRAN and OHAHA time to put their administrative houses in order to properly receive the irrigation component of the project.

The major prerequisite to implementation is the assignment and/or creation of research station and antenna facilities for irrigated experiments which will begin with the second season of irrigation field research. For the base station discussed in section 3.1, major construction may or may not be required depending on the results of the prospection. But prospection, soil and water analyses, site decision, site improvements, equipment, and staffing will require an estimated 2 1/2 years from the beginning of NAARP. If delays occur, it may be advisable to postpone the arrival of the soils and irrigation agronomists by a yearly step, since their field work will need to be aligned with the seasons.

A second major prerequisite is the nomination of qualified counterparts and support staff, discussed in section 4.2. Though the nominees may not be posted by the time that the technical assiatants arrive due to training programs, commitment to their assignment should be secured prior to fielding the technical assistance team.

A third prerequisite is the arrival of key equipment which may be needed for the diagnostic study phase, beginning around the end of Year 2 of the NAAR Project. Equipment needed is listed under the headings "Plant-soil-water relations", ET equipment, and "Irrigation efficiency study equipment" in the list attached to this Annex. Other equipment on the list is for experimental purposes, and will need to be updated in function of availability of equipment existing at the site chosen for the base station.

5.2 Diagnostic Study

The first phase of field research will consist exclusively of a year-long, intensive study of the details of water, soil and crop management in representative ONAHA-managed perimeters in the ADM-Maradi region. This study, an indispensible first step in establishing the future research agenda, will be conducted in the conduct of the Permiter Irrigation Diagnosis and Management Team (Annex G). This interdisciplinary team is composed of the irrigation engineer and agronomist, the agricultural economist and anthropologist, and perimeter level cadres. Thus, while the irrigation agronomist is investigating perimeter-level issues as part of this team, the soils agronomist will personally witness and chronical the details of farm-level crop, soil, and water management through one complete double-cropping cycle.

One objective of these studies is to generate and prioritize research hypotheses which have the highest probability of extendable payoff and technical feasibility. Investigation of the themes discussed in section II will likely lead to some hypotheses. Others not mentioned here will likely arise from field observations, measurements taken, and discussions with

farmers, extension agents, cooperative leaders, and perimeter directors. The rapport developed with these people will allow diagnostic study to continue beyond the initial year of intensive investigations.

While the generation of testable hypotheses will be relatively easy, their prioritization will prove more difficult. The soils and irrigation agronomists will need to discern the factors which most limit yields, quality, and efficiency of operations on the irrigated farm level. Although some excellent technical hypotheses will result, they will likely remain too numerous to properly test them all. The irrigation and soils agronomists should avail thelves of the multidisciplinary nature of the DECOR diagnostic team to rule out those which have a low probability of yielding extendable results due to economic, institutional or sociological factors. The mechanics of conducting the diagnostic study are further discussed in Annex E.

In addition to field study, there will be a need to investigate historical records and to review the available literature on the irrigated perimeters. The bibliography included at the end of this annex will provide a useful springboard into the literature.

The irrigation and soils agronomists are cautioned against becoming overly distracted by the development of in-station and on-perimeter test sites which may be occuring simultaneously.

5.3 In-station experimentation

The testable hypotheses refined during the diagnostic study phase may be classified by thematic category as in Figure 2. Given these eight categories, it may be logistically feasible to test only the highest priority theme in each category during the first year of in-station testing. Depending on the nature of the hypothesis, it may be suitable to test components of each only at the base station, only in certain antenna stations (*Point d'appui*) corresponding to irrigation system type, or both. The research proposals submitted by the soils and irrigation agronomists should so specify.

The station trials will use classical statistical design and field plot technique to measure the impact of a broader range of biological, physical and chemical factors on soils, crops and water than will be possible in farmers fields. Moreover, station facilities are large enough and have sufficiently intense management to test a wider range of treatments with greater replication. Since the first year of in-station testing will likely mark the first time these facilities will be used for irrigation agronomy experiments, the bulk of researchers' time will be devoted to personally executing the trials together with the support staff assigned for this purpose. The object is to assure that as many of these experiments as possible yield statistically valid and interpretable results. Annex E discusses aspects of the in-station trial program which particularly concern ONAHA.

5.4 On-perimeter, on-farm trials

If in-station experimentation has succeeded in identifying or suggesting test treatments which look promising in terms of yield, quality, efficiency or

profitability, then the research team may wish to propose testing of these treatments on the farm level in ONAHA-managed perimeters. If not, then diagnostic study and in-station testing continue until such promising test treatments appear. The earliest season in which on-farm trials could be conducted corresponds to the third year of irrigation field research and to the fifth and last year of the NAAR Project, Phase 1. Even then, there is no guarantee that the irrigation agronomy research program will have reached the on-farm trail stage by the end of NAARP year 5.

Annex E discusses the mechanics of conducting extension managed on-farm trails (EMOFT) in collaboration with ONAHA. Attention will need to be paid to the key assumptions and conditions governing how and when such trials are conducted. The EMOFT model is recommended to the soils and irrigation agronomy team, since, as of 1986, conditions appear favorable to its implementation.

5.5 Benchmarks, evaluations, and end-of-project status

Figure 3 is indicative of the stages of development that the irrigation and soils agronomy program can achieve in each Project year if critical steps are achieved according to plan. As mentioned in section 5.1, the most critical steps include the timely establishment of research station infrastructure, the arrival of research equipment, and the assignment of trained and qualified counterparts and technical support staff to the irrigation research program. Delays on any of these counts will risk displacing the whole field research block forward in time by yearly intervals. Within the field research block, progress to on-farm trials and eventually to hard products is further governed by the results of the preceding research activity.

Table 10 presents representative benchmarks of progress by year of the first five-year phase of the NAAR Project, in terms of implementation of the irrigation agronomy program. It corresponds to the calendar illustrated in Figure 3. From these indicators, it can be seen that the first five years of the project will but initiate the applied research program in irrigated soil-water-crop management, which is no mean accomplishment in itself given the obstacles to overcome. By the end of NAARP Year 5, INRAN will have a fully-functioning network of irrigation research station facilities in the ADM-Maradi region, and a solid working model of irrigated cropping systems research involving ongoing perimeter-level diagnostic study, in-station experiments, and on-farm trials conducted in collaboration with ONAHA. In addition, INRAN's human resources for irrigation research will have been reinforced by five research-level and 23 chief technicians at post, with Masters-trained researchers nearing completion of their training.

However, the real payoff in terms of hard product, notably extension recommendations and technology, will probably remain at least a year in the future for the irrigation sector by Year 5. A minimum of two sucessful years of in-station and farm level testing are required to achieve the confidence (statistical and otherwise) required to issue solid recommendations for extension.

104

Evaluation, programmed for NAARP Years 3 and 5, needs to be oriented accordingly. The Year 3 evaluation needs to assess the progress of infrastructural development relative to the progress of field research, as well as to verify the status of training and research equipment. The Year 5 evaluation can turn its attention more to the substance of the research program, its methodology, preliminary results, and progress towards developing a cropping systems approach for research in the irrigation sector.

TABLE D-10

Representative Benchmarks of progress in implementation of the irrigation and soils agronomy program: NAARP Project Phase 1.

End of NAARP Year a	Component	Benchmarks
1.	Research station Infrastructure:	Sites prospected, soils analyzed sites decided, and eventual construction let for bid.
	Research Equipment:	Equipment needed for diagnostic study ordered.
	Training:	Long-term trainees departed.
2.	Research station Infrastructure:	Necessary construction, land improvement and water works in progress.
	Technical assistance:	Arrived at post. Diagnostic study initiated.
	Short-term training:	Agro-climatology technician at post (Diagnostic study) Irrigation technicians in training.
	Research Equipment:	Remainder of equipment needs ordered; diagnostic equipment deployed
3.	Research station Infrastructure:	Operational for in-station trials.
	Field research activity:	Diagnostic study results reported. In-station trials initiated.

	Short-term training:	Ag Techs I, Irrigation Technologists and Ag Mechanics at post. (In-station)
	Field Research:	In station trial (1) results reported. On-farm trial program initiated if station results so indicate.
	Long-term training:	B.S. students received degrees. M.S. thesis projects decided.
Short-term training:		Ag Techs II, Ag Chemical Techs, Stat techs all posted.
5.	Field research:	In-station (2) results reported On-farm trial results (1) preliminary reported if conducted.
	Long-term training:	B.S. researchers posted, M.S. thesis projects underway.
	Short-term training	Soils analysts,

VI. BIBLIOGRAPHY

CHAROY, J.1971. Les cultures irriguees au Niger: Resultats de sept annees de measures et d'experimentation (1963-1970) a la station Experimentale d'Hydraulique Agricole (SEHA) de Tarna dans le Goulbi de Maradi. L'Agronomie Tropicale 26 (9) p.979-1002.

DEPSA. 1986. Retrospective study of fertilizer supply and demand in Niger. (H.P. Josserand, Ed.) Direction des Etudes, de la Programmation et des Statistiques Agricoles. Ministere de l'Agriculture, Niamey. August 1986.

Direction des Services de l'Agriculture. 1982. Rapport Annuel: Statistiques. Ministere de Developpment Rural. Niamey. 84 p.

Editions J.A. 1980. Atlas du Niger. (Serie des Atlas Jeune Afrique) Sous la direction de E. Bernus et S.A. Hamidou. Groupe J.A., 51 Avenue des Ternes, Paris. 63p.

FOUNIER, A. 1986 La recherche agronomique nigerienne: Presentation - synthese des recherches - Suggestions. Mission USAID/NIGER, 16 Janvier 1986. 68 p + 8 Annexes.

Genie Rural. 1986. Amenagements Hydo-Agricoles au Niger. Direction du Genie Rural, Service Central des Etudes Techniques. Janvier 1986, unpaginated.

HALL, A.E. and P.N. PATEL. 1986. Cowpea improvement for semi-arid regions of Sub-Saharan Africa. Paper presented at the International Drought Symposium on Food Grain Production in Sub-Saharan Africa; Nairobi, Kenya. May 1986. University of California, Riverside, 14 p.

INRAN. 1983 a.Organisation d'un programme de production de semences de riz au Niger. Cellule de Recherche-Vulgarisation. 19 p.

INRAN. 1983 b. Techniques de semis direct et de repiquage du riz. Moumouni Ousseini, Direction Generale INRAN, Janvier 1983, 5p.

INRAN. 1983 c. Synthese des travaux de la reunion annuelle de la recherche agronomique (INRAN). 14-19 Mars 1983, Maradi. 54 p.

INRAN. 1984. Note d'Information sur l'INRAN. Institut National de Recherches Agronomiques du Niger. 17 p. + 5 annexes. Septembre 1984.

INRAN. 1985 a. 56 Fiches Techniques Vulgarisation: Actulisation des resultats de recherches. 3 eme Edition, Janvier 1985. Tome I (DEP, DRA, PTV). Division Etudes et Programmes. (not paginated).

INRAN. 1985 b. 40 Fiches Techniques Vulgarisation: Actulisation des Resultats de Recherches. 3 eme Edition, Janvier 1985. Tome II (DRZ, DRF, DRE). Division Etudes et Programmes. (not paginated).

INRAN. 1985 c. Culture mararchere contre-saison. (Informations techniques). Cellule Recherche - Vulgarisation. Mars 1985. 35 p.

INRAN. 1985 d. Catalogue des varietes recommandees de mil, sogho, niebe et autres cultures du Niger. Cellule Liaison Recherche - Vulgarisation, Mars 1985. 66p.

INRAN. 1985 e. Synthese des travaux de la reunion annuelle de la recherche agronomique (INRAN) 25 Mars-3 Avril 1985, Maradi. 111p.

INRAN. 1985 f. Inventaire national de la recherche agronomique et des Etudes de developpement rural: Institutions, chercheurs, programmes, et operations, bibliographies - resultats. (A. Fournier, ed.) Janvier 1985, 1-ere Edition. Division Etudes et Programmes. 252 p.

INRAN. 1985 g. Observations sur le projet propose par l'USAID concernant la "Recherche Appliquee et Coordination en Irrigation." (Groupe de Travail "Cultures Irriguees") Niamey. 23 Septembre 1985. 5 p.

INRAN. 1985 h. (Groupe de Travail Irrigation) Compete rendu de la reunion du 8 Octobre 1985. 4 p.

INRAN. 1986 Contribution de l'INRAN au seminaire des directions du Ministere de l'Agriculture. Maradi, 3-14 Mars 1986. 19 p.

IRAT. 1968. Station Experimentale d'Hydraulique Agricole de Tarna: Rapport de fin de campagne 1966-67. Institut de Recherches Agronomiques Tropicales et des Cultures Vivrieres, Paris. (Document INRAN No. 1786. 118 p.

IRAT. 1970 a. Station Experimentale d'Hydraulique Agricole de Tarna: Rapport de fin de campagne 1968-69. Institut de Recherches Agronomique Topicales et des Cultures Vivrieres, Paris. (Document INRAN No. 1783) 148 p. + Annex (sep. vol.) 101p.

IRAT. 1970 b. Exploitation des mesures effectuees pour l'etude des relations in situ eau-sol-plante. Compte rendu de la campagne de mesures du 1 Oct. 1968 au 1 Oct. 1969 (J. CHAROY) Document INRAN No. 1137. 23 p. + figures.

Ly, S., R. Denison, M. Goube, G. Numa, C. Reddy, et S. Swinton. 1985. The evolution of farming systems research at the National Institute of Agricultural Research of Niger. Paper presented at the Symposium on Farming Systems Research and Extension held at Kansas State University, Manhattan, Kansas, October 13-16, 1985. 27 p.

NORMAN, W. R. 1986. Gestion de l'eau dans l'Amenagement Hydro-Agricole de Moullela: Une presentation des donnees de la campagne de 1985. Universite Cornell/WMS II. 61 p.

ONAHA. 1982. Aide-memoire du directeur de perimetre et de l'encadreur rizicole. (J.F. Van Laere) Division Mise en Valeur, Office Nationale des Amenagements Hydro-Agricoles. 124 p.

ONAHA. 1985. Rapport d'activite pour l'exercise 1984-1985. Office National des Amenagements Hydo-Agricoles. Min de l'Agriculture. 32 p.

ONAHA. 1986. La gestion des amenagements hydro-agricoles: Participation des producteurs: Problems et perspectives. Fevrier 1986. 26 p.

PDR Maradi. 1983 a. Note de reflexion sur la recherche appliquee. Projet de Developpment Rural de Maradi, 4 Mars 1983. 4 p.

PDR Maradi. 1983 b. Service de recherche appliquee: Bilan sommaire des actions cenduites de 1977 a 1983. Projet de Developpement Rural de Maradi. Oct. 1983. 41 p.

PDR Maradi. 1985. Perimetres irrigues villageois: Evaluation et perspectives. Projet de Developpement Rural de Maradi. 21 Janvier 1985. Not paginated.

PDR Maradi. 1986. Rapport annuel d'activities 1895-1986. Projet de Developpment Rural De Maradi, Direction Technique. 46 p.

SHANER, W.W. et al. 1982. Farming systems research and development: Guidelines for develc ing countries. A consortium for International Development Study. We. tview Press, Boulder, Colorado. 414 p.

TERRY, P.J. 1983. Some common crop weeds of West Africa and their control. USAID Regional Food Crop Protection Project. Dakar Senegal. 132 p.

USAID. 1984. Niger Irrigation Subsector Assessment. (T. Zalla et al, Eds.) U.S. Agency for International Development, Niamey. 57 p. + 10 Annexes.

USAID. 1986 a. Country Development Strategy Satement: FY 1988, Niger. Annex C: Irrigation Update. 32 p.

USAID. 1986 b. Project Identification Document: Applied Irrigation Research and Coordination (683-0250). USAID/NIAMEY 20 p. + 6 Annexes.

ZANDSTRA, H. G. E. C. Price, J.A. Litsinger and R. A. Morris 1981. A methodology for on-farm cropping systems research. International Rice Research Institute. Los Banos, Philippines. 148 p.

APPENDIX TABLES AND FIGURES

Tables

D-11	Characteristics of the Major Irrigation Perimeter Types in Niger, Part I	D-36
D-12	Characteristics of the Major Irrigation Perimeter Types in Niger, Part II	D-37
D-13	Indicative Yields of Rainy Season Crops Grown with and without Supplemental Irrigation	D-38
D-14	Existing INRAN Irrigation Recommendations for Major Dry Season Crops	D-39
D-15	Illustrative Equipment List for Irrigation Agronomy	D-41

Figures

D-4.	Geographic Distribution of INRAN-Managed Research Facilities with Irrigation Facilities, 1986.	D-40

TABLE D-11: CHARACTERISTICS OF MAJOR IRRIGATION SYSTEM TYPES IN NIGER, PART I a

	WATER		LOCATION				
SOURCE	DELIVERY	APPLIC'N METHOD	GEOGRAPHIC	TOPLOGIC	NUMBER OPERATING PERIMETERS a	COLLECTIVE AREA (Ha)	% TOTAL IRRIG. AREA
1. River	Large Pumps	Basin	Niger River	Flood plain	18	5041	36
2. River	Large Pumps	Furrow; Basin;	Niger River	River terrace	5	362	3
3. Surface runoff; Reservoirs	Gravity	Furrow Basin;	A.D.M. b	River botom or open plains	8	3831	27
4. Groundwater; tube-wells	Medium sub. Pumps	Furrow Basin	Maradi Dept.	River bottom lands	1 c	500 c	4 c
5. River and Polders	River flood and pumps	Basin	Komadougou River	Flood plain	3	212	2
6. Groundwater; open wells	Hand lift; small pumps	Basin; Furrow	Diffuse	Bottom lands	(d)	est. 4000 e	est. 29

a. Source: ONHAHA, cited by USAID (1986 b). Statistics from 1985.
b. Ader-Doutchi-Maggia Valley region of Tahoua Department.
c. Not including Aderawa, Moderawa and other small groundwater pumping schemes.
d. Individually managed "micro-realisations," not organized as perimeters.
e. Estimates range from 3000 ha (USAID, 1985) to 22,000 Ha (Direction Services Agriculture, 1982). USAID (1966 a) cites 3000-4000 Ha.

TABLE D-12: CHARACTERISTICS OF MAJOR IRRIGATION SYSTEM TYPES IN NIGER, PART II. a

IRRIG. SYSTEM TYPE	CROPS CULTIV/SEASON RAINY - DRY	AREA CULTIV/SEASON b RAINY (Ha)	DRY	NUMBER OF FARMERS	AREA/ FARMER (Ha)	AGE OF PERIM. (years) d
1. River pumping (basin) e	Rice - Rice	4,245	4,245	12,003	0.39	18
- Largest: Namari Goungou		1,316	1.319	3,242	0.48	7
- Smallest: Kouretere		13	13	32	0.41	13
- Oldest: Koutoukale		320	324	720	0.47	53
2. River pumping (terrace)	Multiple-Vegetables	NA	NA	NA	NA	14
3. Surface resevoirs	sorghum-wheat/veges f + cotton-fallow	3,410	1,204	3,595 g	0.66 g	13
- Largest: Konni I and II		2,384	505	1,175 g	1.13 g	8 and 3
- Smallest: Tounfafi		23	11	69	0.35	18
- Oldest: Moullela		63	14	124	0.58	20
4. Groundwater Pumping - Goulbi de Maradi	sorghum-wheat/veges + cotton-cowpea/peanut	483	97	691	0.77	4
5. Komadougou River	NA	164	NA	AN	NA	7
6. Micro-irrig systems	fallow h-vegetables	NA	est 4,000i	est. 12,000 i to 24,000	est. 0.16 i to 0.33	NA

a. Source: USAID (1986 b.) except where noted.
b. 1985 season data.
c. Based on total cultivatable (nominal) area, Mean of hectares/farmers by perimeters.
d. Source: Gemie Rural (1986); age in 1986 from year construction started.
e. Totals or means of 16 perimeters.
f. Primarily onions and tomatoes.
g. Not counting Konni II (date unavailable).
h. Land may be fallowed, rainfed cropped or be flooded out in rainy season.
i. Estimated from data in (USAID, 1984).

TABLE D-13

Indicative yields of rainy season crops grown with and without supplemental irrigation.

Crop	Year	Statistic	Supplemental Irrigation With(location)	Without(location)
Cotton a	1982	Mean	1.8	0.5
		Highest	3.0(e)	0.7(g)
		Lowest	1.1(f)	0.2 h)
Cotton b	1983	Mean	1.9	0.7
		Highest	3.0(i)	2.8(k)
		Lowest	1.2(j)	0.1(l)
Cotton b	1984	Mean	1.7	0.7
		Highest	3.9	1.8(k)
		Lowest	1.2(j)	.0(m)
Cotton b	1985	Mean	1.6	0.5
		Highest	3.1(n)	1.3(p)
		Lowest	1.3(o)	0.2(q)
Sorghum c	1983	No fertilizer	0.8	0.3-0.5(see t)
		With(see r)	1.0	0.5-1.0 "
		With(see s)	1.7	0.7-1.1 "
Sorghum d	1984	Mean	2.0	

Notes for Table (indicative r/s yields)

a. Source: Direction Services Agriculture (1982)
b. Source: CFDT (unidentified document)
c. Source: FAO/Landez, cited in DEPSA (1986)
d. Source: ONAHA (1985)

Locations:
e. Ibohamane perimeter
f. Madarounfa perimeters
g. Gaya (Dosso)
h. Madarounfa non-irrig.
i. Guidan Magagi perimeter
j. Konni I perimeter
k. Angoulamata (Madarounfa)
l. Kawara Abdou (Illela
m. 5 cooperatives in Talnoua Department (crop failure)
n. Tounfafi perimeter
o. Konni II perimeter
p. Maraka (Madarounfa)
q. Guidan Magagi non-irri.

Notes
r. 225 kg super simple phosphate/Ha
s. 225 kg super simple +150 kg urea/Ha
t. First figure=rainfed
second figure=valley bottom (recessional)

TABLE D-14

Existing INRAN irrigation recommendations for major dry-season crops. a

Crop	Growth Stage (days after planting)	Water applied each irrig. (mm)	Interval of Application
Wheat	0-45 days	30	weekly
	45-75	30	bi-weekly
	75-90	20	weekly
Onion (seed)	preplant	50	one pre-irrig
	0-harvest	30	weekly
Onion (bulbs)	pre-transplant	50	one pre-irrig
	transplant-75 b	32	weekly
	75-115 (flowering)	30	weekly
	115-140 (maturation)	25	weekly
Tomato	pre-transplant	50	one pre-irrig
	transplant-35 c	35	weekly
	35-90	25	bi-weekly
	90-135	35	weekly

a. Source: INRAN (1985 a)
b. Days after seeding. Transplanting to field is recommended at day 40.
c. Days after transplanting.

Fig. D-4 GEOGRAPHIC DISTRIBUTION OF INRAN-MANAGED RESEARCH FACILITIES WITH IRRIGATION INFRASTRUCTURE

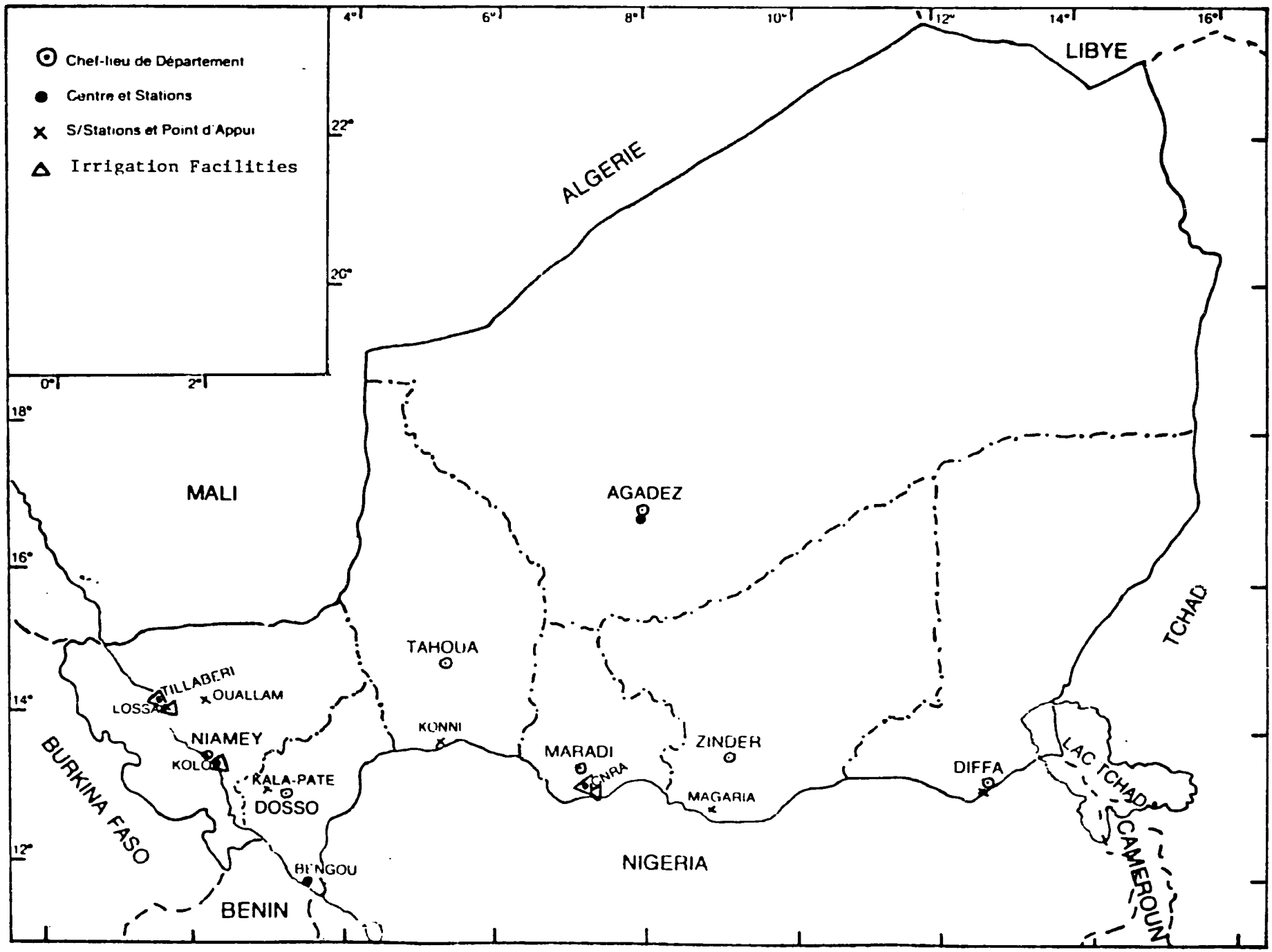

Table D-15
ILLUSTRATIVE EQUIPMENT LIST FOR IRRIGATION AGRONOMY
(WATER - SOIL - CROP MANAGEMENT) RESEARCH PROGRAM
BASED IN TARNA OR VICINITY

I. PLANT - SOIL - WATER RELATIONS EQUIPMENT

1 - Digital leaf porometer with data module (Rs)
1 - Infrared canopy temp. gun
1 - Pressure chamber apparatus (leaf)
20 - Tensiometers of different sizes (matric)
2 - Sling psychrometers (air)
2 - Neutron moisture probes with transport cases: digital memory modules.
50 - Access tubes with caps for neutron probes.
10 - Soil sample augers for core samples:
- 5 Willardson - Taylor type
- 5 Large bulk density sample type with drivers, with spare inserts.
10 - Soil probes - graduated T-bar type.
500 - Core sample storage/transport containers (hermetic)
5 - Soil thermometers - digital with data module; multiple depth probes.
1 - Set plans and materials to build stationary lysimeters (concrete basin type)

II. ET EQUIPMENT

10 - Class A evaporation pans
5 - Integrated automatic weather stations with data modules (temperature, vapor pressure, radiation sensing; and self-dumping rainfall recording.); spare modules
20 - Direct-reading rain guages with stands, with metric constant graduation internal markings

III. LINE-SOURCE EXPERIMENT EQUIPMENT

40 - Sections 6-meter pipe with risers and couplings
40 - Rain-bird cone distribution sprinkler heads w/spec. nozzles.
2 - Line pressure gauges with couplings.
200 - Graduated sprinkler water collection cans.
2 - Spare submersible pumps 220V 10 liters/sec x 10 meter head

IV. IRRIGATION EFFICIENCY STUDY EQIPMENT

10 - Cut-throat flumes (fiberglass) w/level bubbles - 25 cm throat.
100 - Pcs siphon tubing of various diameters.
100 - Pcs steel gated pipe with controlled orifice control, w/couplings, 6 meter lengths (other eqpt. as specified above for P-S-W relations)
5 - Stopwatches.
10 - Reels 50 meter surveyor's chain
5 - Double-ring infiltrometers
5 - Portable weirs with canvas dams
5 - Stream gages - pitot - tube type w/travel cases
-1 - Set builder's level and metric surveying rod. HD travel cases.

V. GENERAL FIELD EQUIPMENT

- TRACTOR OPTIONS: 1) Two new 60 HP tractors (3 pt hitch PTO, full hydraulics)
  or 2) One new 60 HP tractors + one flat-bed (tilt-bed) trailer
  or 3) Repair two or three existing INRAN tractors.

-1 ea: tandem disc set, single tooth ripper/subsoiler, furrow cutter-shaper, vibra-shank cultivator, ridger, float, spike-tooth harrow

-4 pairs oxen and donkeys w/yokes draw bars, tool bars, plows, ridgers, weeders

-4 sets row seeders for same, "SUPER-ECHO" w/complete disc sets

1 - Backpach manual-level action spray rig w/cone and fan nozzles.

1 - Shallow-bin dumping trailer - (hydraulic lift) -

2 - ULV battery-powered spray rig (CFDT-type) (insecticide use)

1 - boom sprayer

VI. LABORATORY EQUIPMENT

(220v 50H_2)

2 - Micro-computers, IBM-compatible, desk-top, 512K byte RAM, dual 5 1/4" floppy drives, B/W monitors, standby power source/protection.

2 - Ea. receptacles for downloading data modules from weather stations, leaf porometer, neutron moisture probe, soil thermometers.

1 - Soil/leaf sample drying ovens, 220v, automatic timer

2 - Digital analytic balances, 1000g capacity, 220v

2 - Digital analytic balances, 10kg capacity, 220v

2 - Portable beam balances, 100kg capacity.

1 - PH meter w/2 spare electrodes, 220v, KCl extractant reagent.

1 - Electrical conductivity (mho) meter, 220v

1 - Pressure plate apparatus

1 - Set soil textural analysis equipment (mortar/pestle, granulometric screens, cylinders and plungers.) Spare cylinder.

1 - Seed counter, digital, stop setting adjustment:

1 - Plastic bag sealer (hot iron), 220v.

- Seed packets
- Rolls of H.D. plastic bagging material, various widths.
- Misc. glassware: graduated cylinders, beakers, flasks, etc.
- Shipping containers for soil, foliar, and seed samples.
- Plastic storage jars, wide-mouth.

ANNEX E

EXTENSION-MANAGED ON-FARM TRIALS:

AN ALTERNATIVE TO CLASSICAL FSR APPROACHES

by

C. Owen Gwathmey
Irrigation Agronomist

CONTENTS

I. BASIS AND OBJECTIVES OF EXTENSION-MANAGED ON-FARM TRIALS E-1

II. KEY ASSUMPTIONS AND CONDITIONS FOR CONDUCTING EMOFTS E-2

III. KEY STEPS IN CONDUCTING EMOFTS: AN INRAN-ONAHA MODEL E-3

IV. ILLUSTRATIVE CALENDAR FOR AN EMOFT PROGRAM E-10

V. TECHNICAL COMPONENTS OF AN INRAN-ONAHA WORKING AGREEMENT E-10

VI. ELEMENTS OF AN EMOFT PROTOCOL. E-17

I. BASIS AND OBJECTIVES

1.1 Classical FSR methodology describes two major approaches to conducting on-farm trials (OFTs): researcher-managed and farmer-managed OFTs. Both approaches tend to overlook or underutilize a valuable field-based technical and human resource: the agriculture extension agent. In recent years, agronomic researchers based in West African national programs have developed and refined extension-managed approaches to OFTs which combine the best of both classical approaches. This alternative is worthy of consideration in planning and implementing the Niger Applied Agriculture Research Project. It is intended as an option to, not a replacement for, the OFT approach used by DECOR under the Niger Cereals Research Project.

1.2 The objectives of classical FSR approaches are generally to analyze socio-economic or combined agronomic-economic effects of research-generated technologies on the farm level. Research-managed trials test treatment effects in the bio-physical environment of the farm, while farmer-managed trials test treatment effects by farmer management interactions without benefit of extension agent advice and guidance. Extension-managed OFTs include the influence of the latter to test (technical treatment) x (farmer x extension agent effects) x (bio-physical farm environment effects). Thus the method inherently tests the extendability of the technical treatments and identifies technical constraints which will need to be addressed if and when a treatment is proposed for extension through the same service.

1.3 Extension-managed on-farm trials (EMOFTs) are designed by agronomic researchers, managed by field extension agents, and carried out by participating farmers. They are experiments, not demonstrations. Compared to classical FSR themes, EMOFTs focus more narrowly on agronomic effects of treatments. Thus the design of the network and unit OFTs can be optimized for collection of statistically valid, quantitative agronomic data as well as some qualitative (farmer reaction) data. However, the design and protocol of each unit EMOFT must be simplified to the extent necessary to assure that the trial can be conducted by each (extension agent x farmer) unit. To achieve scientific validity, it may thus be necessary to extend the OFT testing phase over more locations and/or years than would be the case with more intensively managed FSR methodologies.

1.4 Traditional agronomic researchers have been reticent to conduct OFTs because they tend to believe that the farm environment imposes too many uncontrolled or unmeasurable variables for proper research, that requirements for both statistical validity and trial feasability cannot simultaneously be met, that extension agents are not qualified to manage trials, or that they will require too much researcher supervision. The model presented here is intended to allay such misgivings. The key is in proper planning and preparation before the season begins, since if the program is set up properly, EMOFTs can to a considerable extent "run themselves" as far as the researcher is concerned. The model includes failsafe mechanisms and redundancy to reduce the most common risks of trial failure arising from human error. The payoff for all this attention to detail comes in the form of proving or disproving the technical and biophysical viability of technological improvements in the hands and fields of farmers, when extension agents themselves are the vehicle for technology transfer.

II. KEY ASSUMPTIONS AND CONDITIONS FOR RUNNING EMOFTS

The model assumes:

2.1 The existence of technical treatments (single variables or combined packages) that:

a) have been successfully tested within the research station network in which their potential interest in terms of yield, quality or economy has been measured;

b) have a reasonable probability of being extendable;

c) have been preliminarily evaluated, if not yet tested, for potential labor savings or profitability to farmers;

d) have been hypothetically matched with recommendation domains (although this may be a test hypothesis of the EMOFT network);

e) are likely to be influenced in their interest or technical feasability when managed by the (extension agent x farmer) unit. This is the major test hypothesis.

2.2 The presence of agronomic researchers who:

a) Are disposed to, and skilled at designing, conducting and analysing the results from a network at EMOFTs themselves;

b) Are commmitted to following through on conducting EMOFTs over years and locations;

c) Have sufficient time, organizational skills and logistical support (vehicles, support staff) to do so in light of their other responsibilities.

Researchers who wish to have on-farm trials conducted, but who do not meet thes conditions, would do better to delegate their OFT work to another research entity (e.g. DECOR) specialized in this area. They need then accept the experimental design and methodological approach of that entity, and be prepared to accept the quality and quantity of data produced by that entity.

2.3 A willingness and ability of extension agency (e.g. ONAHA) supervisors to:

a) Review EMOFT proposals from researchers and act on them in timely fashion each year;

b) Select and assign its agents to managing OFTs, to the point of including OFT management in the regular work schedule of the field agents that they select to participate;

c) Administratively supervise and pay these agents (for which financial reimbursement to ONAHA by INRAN might be arranged for in the working agreement between these two agencies),

d) Assure that the agent's time alotted to trial management is actually devoted to this purpose;

e) Recruit and assign additional extension agents if needed to manage an adequate number of EMOFTs each year and to send their agents to INRAN-organized training/instruction meetings.

III. KEY STEPS IN CONDUCTING EMOFTS: AN INRAN-ONAHA MODEL

The following 20 steps decribe a chronological procedure for conducting EMOFTs on irrigated perimeters of Niger, where INRAN is the national research institute and ONAHA is the perimeter management and extension agency. The main steps are reiterated on a yearly cycle, but many require half-yearly amendment for trials pertaining to only one half of the double croping season (e.g. dry-season only). The basic model is readily adaptable to the dryland sector as well, for which the Ministry of Agriculture (DPA) is the extension body, and in fact the model appears considerably simplified in the latter case. The model can also be adapted to private sector (cooperative) managment, but becomes administratively more complex and less efficient.

3.1 On-perimeter and on-farm diagnostic studies by researchers

The objective of these studies is to generate and refine research hypotheses which have a high probability of extendable payoff and technical feasibility. This can only be accomplished properly if researchers personally witness and chronicle the details of both perimeter-wide water management and farm-level crop, soil and water management. A small but representative sample of both perimeter design types and farmers within perimeters are selected by researchers on the advice of ONAHA Regional Director and ONAHA Perimeter Director, respectively. These studies are conducted in parallel across perimeters throughout at least one entire double-cropping cycle. They continue during the station testing phase, and strongly condition the design of the EMOFTs. The studies may also reveal that ONAHA fields an insufficient number of extension agents to manage an effective network of EMOFTs. In this case, the working agreement might be drafted to provide, for instance, for ONAHA recruitment or hire-back of additional field agents at INRAN (project) expense.

3.2 Execution and Distribution of INRAN-ONAHA Working Agreements

The basic document is drafted by the INRAN Directorate in consultation with researchers most interested in conducting EMOFTs. Its provisions are subsequently negotiated and revised in meetings between the two Directorates. (Examples of key technical provisions are listed in section V of this annex.) The basic document spells out in as much detail as possible exactly what

resources each party is committed to provide, and what services each will perform. It is designed to be amended annually or semi-annually to specify more precisely the season's program. Upon execution (signature) by the two Directors General, each distributes copies to all parties concerned within his agency.

3.3 Delineation and selection of recommendation/testing domains

An important by-product of the diagnostic study phase is the delineation of recommendation domains according to factors such as water source, water application method, cropping system, or predominant soil type. Depending on the hypothesis proposed for EMOFT testing, the researchers will wish to select and specify the appropriate domain in his proposal to the extension service.

3.4 Determination of numbers of locations and trials per location

In designing a network EMOFTs, the researcher must integrate known and estimated treatment differences with requirements for replication in space and time to provide for statistical distinction of treatment effects and interactions. By working across perimeters, cooperatives, or soil types he hopes to partition known sources of variance and measure treatment environment interaction. Environment may be further partitioned to bio-physical effects and management effects. His proposal of number of locations (perimeters...) and trials per location will be conditioned accordingly. The need to test over years is also taken into account, but the prudent researcher may wish to avoid commitment to test over years in the case that all treatments prove unpromising early on. Other factors conditioning the locations and numbers of EMOFTs proposed include the researchers's own logistical capacity and the accessibility of the locations, as well as his estimate of the number of ONAHA extension agents in a position to manage the trials.

3.5 Preliminary design of the unit EMOFT

The factor most likely to limit the design complexity of each unit EMOFT is the technical capacity of the extension agent to manage it without making procedural errors, given the time he has available to devote to the trial. Allied to this limitation is the possibility of spontaneous procedural errors by the participating farmer. A secondary limitation arises from the proportion of the farmer's land and time which he can reasonably risk devoting to experimental purposes. The land area is further governed by variability in soil type, microclimate and biotic factors within his field which risk masking treatment effects. All of these considerations suggest limiting the number of treatment per trial to less than six, the number of replication per field to one (or in rare circumstances two), the trial area per field to less than 20% of the farmer's average total and the number of trials per extension agent to one or two at the outset. Simple rather than compound treatments are suggested for design and management simplicity.

3.6 Written EMOFT proposals by INRAN researchers to ONAHA

INRAN researchers who wish to conduct a network of EMOFTS with ONAHA draft proposals for ONAHA Directors' consideration. The proposals include concise summaries of the objectives of the particular EMOFT program, the precise

nature of the treatments, justification for testing them with farmers (including reference to key results from station testing); specifications of testing domains, numbers of locations (perimeters) and trials per location, and specifications of the unit EMOFT, including a diagram of plot layout with dimensions. The number of extension agents needed and an estimate of the amount of their time that the trial will require should also be clearly stated. Finally, no-loss guarantee provisions designed to protect the farmer in case of crop failure should be included. Each proposal need run no longer than 3 pages. All such proposals for a given season are collected by the INRAN Directorate for presentation to the ONAHA Directorate by a deadline specified by the working agreement, such as April 1 for rainy-season and year-long trials and August 1 for dry-season trials.

3.7 Review and approval of proposals by ONAHA

On review of the collective proposals, the ONAHA Directorate may decline to participate in researching certain themes on the farm level or may return certain proposals to INRAN researchers for clarification or modification. In the event that the total number of trials proposed exceeds the number of ONAHA field agents available to manage them, the ONAHA Directorate may wish to reduce the number of EMOFT units per theme or defer others to future years. The assignment of locations is best made by ONAHA Regional Directors who better know their agents and perimeters. The General Directorate may wish to defer other key decisions to the regions as well. All such issues are best negotiated in a joint INRAN-ONAHA meeting 10 days after submission of the proposal, but final decisions on these points remain with ONAHA. A deadline for decision (ca. 20 days after submission) is spelled out in the working agreement, at which point the working agreement itself is also amended to spell out the details of the season's program.

3.8 On-site interviews with extension supervisors and trial managers

Researchers conducting EMOFTs promptly visit their assigned perimeters, armed with a letter from the ONAHA Directorate, copies of the amended working agreement, the approved trial proposal, clearly written criteria for selecting farmers to participate, qualities of the field space to be reserved for the trials, and invitations for managers and their supervisors to attend the group instruction session for the field trial manager. One of the researcher's goals here is to size up the working relationships between the named ONAHA trial manager and his supervisor, and the readiness of the executor to manage the trial, in order to better tailor the detailed protocol to his needs. ONAHA field staff are to complete farmer and field selection before attending the instruction session, explaining clearly the test treatments and the no-loss guarantee provisions to the farmer.

3.9 Preparating of EMOFT protocols and data logs; other material supplies

Researchers prepare sets of written instructions which will guide the managers in conducting the trials with farmers. The protocols provide simple, straightforward, step-by-step procedural details of plot layout, cultural practices and data collection to be performed, including diagrams where

appropriate. Data sheets are included for agents's recording of such quantitative data as rainfall, dates of operations and observations, and plant stand counts, and such qualitative data as the farmer's reactions to various aspects of the test treatments. (Each researcher must assess which data may be reasonably collected by the extension agent and which he might prefer to collect himself). Other initial materials prepared by the researchers might include the test treatments themselves (seed packets for variety trials; fertilizer packets for fertilizer trials, etc.), plot labels and the like. Color coding helps keep treatments, plots, and data logs straight.

3.10 Group instruction of trial managers: provision of materials

Gathering trial managers (preferably with their supervisors) together who will be working on a common theme serves to impart information more efficiently, to contribute to morale and to draw out questions which might not otherwise be asked. The instruction sessions, which might last one to three days, could be held at ONAHA Regional Directorate locations as provided for in the working agreement. Researchers present, talk through and demonstrate key steps in the trial protocol. The material supplies provided by INRAN are given and explained to the agents at this point, and logistical modalities are addressed. The Research-Extension Liaison Unit may wish to participate in the sessions.

3.11 Selection of field plot location within farmers' fields

Depending on the trial design and treatments, this critical step may or may not require researchers' presence. A clearly written protocol helps. The objective at each unit EMOFT site is to situate the plots in such a way that variability in micro-environmental factors (termite hills, trees, pathways, sandy and low spots. etc) do not mask treatment effects. Traditional field plot technique calls for increased replication to overcome these factors, but this is not practicable within a unit EMOFT. Increased care in siting the plots or use of subplot sampling techniques can mitigate these factors. The sequence of cultural operations may call for land preparation before staking and labelling of plots, but the site should have been prospected beforehand.

3.12 Field operations by farmers and data recording by extension agents

Given the geographical dispersal of the EMOFTs and the timeliness required for proper cultural technique, it is with land preparation and seeding that the burden of trial management shifts to the extension agent. For each operation in the cultural calendar, the protocol will specify the degree to which the farmer will operate of his own free will versus the degree to which the agent will intervene and guide the farmer. If the protocol has been clearly written and attention has been paid to the other steps described above, chances are improved that the trial will "run itself" as planned. However, provision needs to be made in the working agreement as to measures to be taken by ONAHA supervisors (perimeter directors) to continue the trial in the event that an extension agent becomes absent for any reason. It is prudent to have provided the perimeter director with a spare copy of the protocol.

A well-designed EMOFT will not require a significant increase in the amount of casual labor that the farmer is obliged to engage.

3.13 Monitoring and trouble-shooting by INRAN researchers

The working agreement specifies a minimum number of visits to be scheduled by researchers to assure that the trials remain on track. A researcher heavily invested in EMOFTS may wish to visit "his" trials frequently, particularly if he is uneasy about the extensionists' ability to manage them properly. But he needs to temper this urge by the realization that his presence on site will to some extent perturb the testing of the extension management hypothesis, and perhaps lead to management levels and cultural practices which are "too good". The researchers distinguishes early in the season those field agents who have matters in hand from those who will require more frequent intervention, and schedules his tournees accordingly. At each visit, he agrees on a date for the next visit in order to assure finding the field agent (and possibly the farmer and/or the perimeter director) on site.

3.14 Additional data collection by INRAN researchers

The researcher will have determined in the design and protocol stage if more data would be useful in interpreting the results than that collected by the extension agents. Such data might originate from soil and foliar sampling, identification of pests and diseases, neutron moisture probe studies and the like. If so, the researcher schedules visits in the manner described above for himself and/or for his INRAN staff. He may also consider temporarily posting staff to the farm site for this purpose. As the season progresses, the researcher is also assessing the "interpretability" of the data from each unit site (i.e. whether the treatment effects are being expressed or masked) and picking sites suitable for the upcoming field tour.

3.15 INRAN organized field tour for service directors

The objective of the field tour is to show directors of participating and allied services, as well as financial sponsors, samples of the type of research which they have been supporting. Sites and date of the field tour are selected by researchers for clarity of treatment effects, as well as for logistical feasibility.

For many treatment types, the best time is shortly before or after plant maturity. The number of sites and their distance are kept to a strict minimum in order to impart a few good lasting impressions, fatigue not one of them. An illustrative group of participants might include the Directors-General of INRAN and ONAHA, Regional Director of ONAHA, Department Director of INRAN, INRAN's Research -Extension Unit, NAAR Project Team Leader, USAID Project Officer and the participating researchers. At each unit EMOFT, they meet the ONAHA Perimeter Director, Cooperative and GMP directors, the ONAHA extension agent and the farmer. The Research-Extension Liaison Unit may also wish to participate in this activity. Throughout, it need be recalled that the EMOFT is an experiment, not a demonstration.

3.16 Harvest and post-harvest operations

As the harvestable portion of the test crop(s) becomes detached from its field plot, the chances of procedural error increase markedly. Researchers may consider harvesting so critical that they arrange to be present (or send their staff) for this operation. Care must be taken to avoid spontaneous harvesting by farmers. The protocol should spell out clearly the movements of the bags post-harvest. In keeping with the no-loss guarantee to farmers, the best policy is to have the farmer store the harvest and to conduct all post-harvest processing and data collection "chez lui".

Research staff thus bring harvest weighing scales to site. The farmer, extension agent, and researcher should all witness the final weighing operation since these figures form the basis for in-kind reimbursement for any loss incurred by the farmer. For instance, the no-loss guarantee might reimburse the difference in kind (by commodity) between each test treatment and the farmer's local practice (check treatment), plus any extra losses incurred due to unplanted alleyways between plots, harvest samples taken for quality analysis and the like.

3.17 Copy and distribution of raw data

Once all data is recorded in the field agent's data log, the researcher takes and photocopies it. Copies of the raw data from each unit EMOFT are distributed back to the extension agent; his supervisor (perimeter director) and the Regional Director of ONAHA. This exercise ensures that multiple copies of raw data exist in case of accident and allows ONAHA to proceed with its own data analysis if it so desires.

3.18 Preliminary data compilation and report

Since a complete analysis and report on the results from a network of EMOFT's will take some time to produce, it is worthwhile for the researchers to rapidly compile the quantitative results across a set of EMOFT's. Quantitative data collected both by the ONAHA extension agent and by INRAN research staff is included. Analysis is limited to taking means of measured parameters within and across unit EMOFT's, disaggregated perhaps by GMP, cooperative or perimeter.

A very brief, non statistical, non-interpretative report of these data provides a sufficient data base for planning and budgeting purposes relative to the next season's program, while more time is taken with the complete analysis. The preliminary report is distributed to Regional and Central ONAHA Directors, INRAN Department Director and Programming Director, and other involved in the OFT research planning process.

3.19 Final data analysis and report

Once the statistical analysis of data is complete, a more interpretative report can be prepared by the researcher for presentation at the annual INRAN-extension meetings. In the case of an ongoing theme, data from previous years' EMOFTs can be included in cumulative analyses of variance. Qualitative

data may be transformed for quantitative analysis and/or descriptively summarized. The resulting interpretation sets the stage for recommendations by the researcher for continued testing, possible modification of test treatments, socio-economic analysis, or extension-demonstration.

3.20 Presentation of results at the annual research-extension meeting

The analytic reports prepared by INRAN researchers who have conducted EMOFTs the previous year are formally presented to research colleagues and extension representatives at the annual meeting, normally held in March. Because of the number of presentations, the oral report of each researcher is very brief. There is limited time in the working groups for detailed discussion of the future program, refinement of OFT methods, modification of treatments or of the working agreement, and the like. A follow-up meeting of key participants may be required to establish the future plan, which allows participants time to study the analytic report and researcher recommendations. Such a meeting establishes which step in the iterative process described above, is appropriate for the researcher to return to in preparing for the upcoming season.

IV. ILLUSTRATIVE CALENDAR FOR AN EMOFT PROGRAM

The following calendar illustrates how the components described in the preceding section are integrated into an annual work schedule which is coordinated with the growing season. This particular example supposes an EMOFT agronomic theme such as fertilizer response of rainy season sorghum under supplemental irrigation. For a dry-season irrigated trial, most of the calendar may be shifted to align with the planting date of the test crop. However, certain elements such as the annual research-extension meeting will remain fixed.

COMPONENT	MONTH
1. On perimeter, on-farm diagnostic study (year long)	June-Nov. *
2. Execution of INRAN-ONAHA basic working agreement	December
3. Selection of recommendation/testing domains	December-March
4. Determination of numbers of trials and locations	December-March
5. Preliminary design of the unit EMOFT	December-March
6. Proposal of EMOFT program theme to ONAHA Direction	March-April
7. Review approval and referral of proposals by ONAHA	April
8. Amendment of working agreement	April
9. On site interviews with ONAHA field agents and Director	April-May
10 Preparation of protocols, data logs and supplies	April-May
11 Group instruction of extension agents	May
12 Selection of field plot location in farmer's fields	May
13 Field operations and data recording by extension	June-October
14 Monitoring and trouble-shooting by research	June-November

* Portion pertaining to rainy-season sorghum example.

15	Additional data collection by INRAN	June-November
16	Field tour for service directors	September
17	Harvest; post-harvest operations/data recording	Oct-November
18	Copy and distribution of raw data	November
19	Preliminary data compilation and report	December
20	Final data analysis and report	January-March
21	Presentation of results at annual meeting	March

V. TECHNICAL PROVISIONS OF AN INRAN-ONAHA WORKING AGREEMENT

There are two major components of a functional working agreement: the basic document which defines the general obligations of each party in the conduct of collaborative research, and periodic amendments which spell out the modalities of conducting specific research programs (studies or experiments) for a specific season. The following example describes the key technical provisions of the basic document only. The provisions of each amendment will depend entirely on the nature of the research theme. Examples of common amendment provisions for conducting EMOFTs are listed in Article 6.9. below.

ILLUSTRATIVE INRAN-ONAHA WORKING AGREEMENT: TECHNICAL PROVISIONS

NB: Where not otherwise specified in the following text, "INRAN" refers to the INRAN Director General or his designee, and "ONAHA" refers to the ONAHA Director General or his designee. Designees will be specifically named in amendments to the working agreement.

1. INRAN and ONAHA agree to collaborate in conducting applied research in the following technical disciplines, with the object of sustaining and increasing productivity, quality, efficiency and ease of management in the ONAHA-managed irrigated perimeters of Niger:

1.1. Irrigation water management, including pertinent aspects of water-soil-plant relations, water balance, evaporative demand, irrigation scheduling irrigation water pumping, distribution and application, with the object of increasing efficiencies and ease of management in these latter operations at both the irrigation system (A.H.A.) and consumer (G.M.P.-farmer) levels;

1.2. Irrigated soil management, including pertinent aspect of soils and water chemistry; soil fertility maintenance; consequences of fertilizer and organic matter application; improvement of soil physical properties; and mechanics of soils tillage operations;

1.3. Irrigated crop management, including pertinent aspects of manual and mechanized cultural techniques, weed control, pest control, varietal adaptation and selection, and cropping systems,

with the object of increasing the yields, quality, or ease of management of the major crop commodities produced within the perimeters;

1.4. Irrigation system engineering aspects pertaining to the above mentionned subject areas, with emphasis on possible improvements to the design and operation of existing systems (A.H.A.s);

1.5. Socio-economic factors pertaining to the above-mentioned subject areas.

2. While continuing to support and pursue pre-existing and ongoing collaborative research endeavors, INRAN and ONAHA agree to concentrate their research resources on priority topics pertaining to the ONAHA-managed perimeters in the administrative departments of Tahoua and Maradi during the initial phase of research to be conducted in the context of this agreement. "Priority topics" refers to those avenues of research which have the highest probability of yielding results which will lead to extendable recommendations to improve the yield, quality, facility or profitability of perimeter crop production, or the efficiency or facility of perimeter water management.

3. Two types of research activity are recognized for the purposes of this agreement: field studies and experiments, the latter including field trials which may be conducted within the boundaries of ONAHA-managed perimeters (A.H.A.).

4. INRAN and ONAHA agree that intensive diagnostic field studies are an indispensible first step in establishing, refining and prioritizing the technical hypotheses subject to experimentation. To this end, each party agrees to the following general provisions, subject to amendment describing specific modalities:

4.1. INRAN will field a multidisciplinary diagnostic team at its own expense, composed of researchers specialized in soils and irrigation agronomy, irrigation engineering, and socio-economics, for the above-mentioned purposes. This team will study A.H.A. systems operations as well as cooperative and GMP-farmer operations in selected, representative perimeters during at least one complete cropping cycle;

4.2. The INRAN Directorate will submit a written proposal of the diagnostic study program to the ONAHA Director General or his designee for approval prior to implementing the study;

4.3. ONAHA will advise INRAN as to specific perimeters which are representative of various system design and cropping system types, and to review and promptly act on INRAN's written proposal of the diagnostic study program, advising the team on points of technical and logistical feasability;

4.4. ONAHA will allow the INRAN diagnostic team free access to the perimeters that ONAHA selects for intensive study, and will instruct

its Regional and Perimeter Directors to cooperate with the team in providing technical information and in measuring or sampling phisical, biological, and chemical processes in the perimeters. Physical processes include hydraulic and hydrological processes. Biological processes include crop growth, development, and yield;

4.5. ONAHA will direct the diagnostic team to sources of historical records pertaining to A.H.A. design and construction, soil surveys, hydraulic and hydrologic data, perimeter field layout, cooperative and GMP organization, and other records as may be required for the team to complete its mission; and will assist the team in interpreting these records;

4.6. ONAHA Perimeter Director will assist the team in identifying a small number of representative cooperatives, G.M.P's and farmers, which team members will follow throughout at least one complete cropping cycle to study the details of farm-level soil, water and crop management, and by way of introduction, explain the team's mission to leaders on each of these levels;

4.7. INRAN will provide the ONAHA Director General, and Regional Directors, with quaterly activity reports describing the progress and problems encountered by the study team;

4.8. INRAN will provide the ONAHA Director General and Regional Director(s) with a summary technical report of the findings and recommendations of the study team following completion fo the initial diagnostic investigation, and of eventual follow-up studies. Recommendations will include, but may not be limited to, proposals of hypotheses or technical treatments to be tested by INRAN;

4.9. ONAHA will review the activity and technical reports of the diagnostic team, offering constructive suggestions in case of problems, and evaluations of the team's recommendations, particularly on matters related to technical, logistical and socio-economic feasability of implementing the recommendations.

5. INRAN and ONAHA agree that technical hypotheses generated during the diagnostic study phase are to be tested first in appropriate INRAN-managed research facilities. Such facilities may consist of existing INRAN research stations or "points d'appui". For reason of environmental similarity, some types of experiments may require the creation of new INRAN "points d'appui" on certain ONAHA-managed perimeters. A separate agreement addresses this issue.

5.1. INRAN will provide ONAHA with researcher's proposals to conduct in-station research on topics described in Article 1. INRAN will solicit and consider ONAHA reactions to the proposals, but the final decision to conduct such in-station research, including that conducted at INRAN-managed "points d'appui", remains with INRAN.

5.2 INRAN will organize an annual "irrigation research open house" at selected INRAN facilities where and when such research is being conducted, and will invite ONAHA to attend.

5.3. INRAN will provide ONAHA with copies of the analytic reports of all research results pertaining to irrigation, as described in Article 1, at the annual INRAN-extension meetings organized for this purpose.

6. INRAN and ONAHA agree that test treatments (technologies) which have proved promising in terms of crop yield, quality, facility or profitability to the farm enterprise when tested by INRAN researchers, should also be tested by farmers before being proposed for extension. Since extension agents will be the vehicle for any eventual transfer of technology to the farmers, it is appropriate to test the extendability of new technology by conducting extension-managed on-farm trials (EMOFTs). In the case of irrigated perimeters, the extension agency is ONAHA, such EMOFTs are thus joint INRAN-ONAHA trials.

6.1. INRAN will inquire among its researchers in January of each year as to the number, type, and location of EMOFT's they propose to conduct in irrigated perimeters starting with the following rainy season. INRAN will promptly transmit this information to ONAHA for planning purposes by January 15.

6.2. ONAHA will make a preliminary assessment of its field extension manpower available to manage the trials (For this assessment, a ratio of one agent to two trials is indicative.) In the event that the number of trials exceeds available manpower capacity, ONAHA will explore the following possible solutions:

a) rehire former ONAHA extension agents whose job performance was satisfactory but who were laid off during the "compression" of personnel;

b) hire new IPDR-Kolo graduates as extension agents cum on-farm trial managers;

c) engage the services of cooperative-employed extension agents for this purpose.

6.3. INRAN will reimburse ONAHA for salary and other direct expenses incurred by ONAHA in the exercise of options to increase extension manpower indicated in Article 6.2., in proportion to the time that the additional extension agents spend on managing EMOFTs, as provided for an amendment to this working agreement. INRAN will draw upon NAAR Project credits for this purpose;

6.4. ONAHA will present in writing its extension manpower plan for INRAN (NAARP) approval by February 15, the reply to which is due by

February 28. ONAHA will promptly act to engage and assign the necessary personnel by the date for the group instruction of extension agents who will be conducting EMOFTs;

6.5. ONAHA will incorporate trial management into the regular work schedule of the field agents it selects to participate, will administratively supervise and pay these agents, and will assure that the agent's time allotted to trial management is actually devoted to that purpose;

6.6. INRAN will collect written proposals from its researchers who wish to conduct EMOFTs with ONAHA, and submit them by April 1 for ONAHA review, approval and referral. The proposals, which are limited to three pages each, will include:

a) the name and post of the INRAN researcher proposing the trial program;

b) a concise summary of trial objectives;

c) the precise nature of experimental treatments, including the control treatment;

d) justification for testing treatments with farmers (including reference to key results from in-station testing);

e) specification of testing domains (e.q. types of perimeters);

f) specification of numbers of perimeters, trials per perimeter, and total number of trials for the season;

g) specifications of the unit EMOFT;

h) a diagram of plot layout with dimensions;

i) estimates of the number of extension agents needed and the amount of their time the trial will require;

j) key provisions of the no-loss guarantee to protect farmers.

6.7. ONAHA will promptly review the proposals and in turn propose one of the following actions regarding each of them by April 10:

a) approve the proposal and advise the INRAN researchers and the ONAHA Regional and Perimeter Directors concerned of this action;

b) approve the proposal but reduce the number of locations or trials per location. Advise per (a) above;

c) approve the proposal but defer its realization until a future year;

d) return the proposal to INRAN researchers concerned for clarification or modification;

e) decline to participate in conducting the proposed research. In this case, ONAHA will provide INRAN with full written explanation of its action.

6.8. ONAHA will organize a meeting with INRAN on April 10 to discuss its proposed actions. ONAHA will solicit and consider INRAN reactions, but the final decision, due by April 15, remains with ONAHA.

6.9. INRAN will draft amendments to this working agreement based upon the EMOFT program retained by ONAHA. The amendments will include the approved EMOFT proposals and the modalities of conducting the research in the field. Executed by April 30, each amendment will specify:

a) all provisions of the approved proposal, per Article 6.5;

b) lists of materials to be provided and paid for by INRAN and ONAHA (and eventually cooperatives and farmers), and deadlines for providing each;

c) names of perimeters where the EMOFTs will be conducted, names of ONAHA extension personnel who will manage the trials, and the number each will manage;

d) arrangements for the group instruction session;

e) a tentative program of field visits by INRAN researchers to each site, and the objectives of each visit;

f) a list of data to be taken from EMOFTs by INRAN staff, and the modalities of taking those data.

6.10. ONAHA will provide letters of introduction to its Perimeter Directors for INRAN researchers conducting EMOFTs, instructing them to cooperate with and facilitate the researchers' efforts to get the trials underway.

6.11. INRAN will organize and conduct at its own expense a group instruction program for ONAHA extension agents who will be conducted EMOFTs and their supervisors. The instruction sessions will be held on or about May 15 of each year. INRAN will provide transportation, or reimburse costs of transportation and per diem, for ONAHA extension agents attending the sessions.

6.12. ONAHA will assure that named extension agents attend the group instruction sessions.

6.13. INRAN researchers conducting EMOFTs will prepare detailed written protocols for the ONAHA extension agents conducting trials. The protocols will specify all physical and cultural operations and data collection for which the agents are responsible, and will provide data registers for the latter. INRAN will provide ONAHA Perimeter and Regional Directors with spare copies of the protocols.

6.14 ONAHA will provide clear instructions to its Perimeter Directors as to measures to be taken to assure continuation of the trials in the event that any named trials manager fails to manage his trial(s) for any reason.

6.15. INRAN will assure that its research staff visits the trials per the tentative visit program, and will provide ONAHA with quarterly activity reports written by its researchers describing in the progress made and problems encountered in the conduct of the EMOFTs.

6.16. INRAN will organize and conduct at its own expense one or more field tours for service directors to visit selected EMOFTs, to which ONAHA General and Regional Directors will be invited.

6.17. ONAHA Perimeter Directors will mediate any disputes arising from exercise of the no-loss guarantee provisions protecting participating farmers.

6.18. INRAN will recover, photocopy and distribute to concerned ONAHA extension agents, Perimeter and Regional Directors, copies of all raw data recorded by ONAHA trial managers. This will be done within 30 days of the final entry in each data log.

6.19. INRAN researchers will effect a preliminary data compilation across EMOFT locations within 30 days of recovering the last data log from the field. INRAN will prepare a brief, non-analytic report of these data (including data collected directly by INRAN research staff and provide same to ONAHA General and Regional Directors.

6.20. INRAN researchers will prepare annually an analytic, interpretive report of results from the EMOFT program. This report will be presented to ONAHA no later than the next annual INRAN-extension meeting, allowing for a three month interval following recovery of all data for researchers to analyze data and to produce the report.

6.21. ONAHA will review preliminary and analytic results from the EMOFT programs, and will meet with INRAN as needed to decide future actions to be taken jointly and severally in function of the results. These actions may include, but are not limited to:

a) further diagnostic study by INRAN;

b) additional or revised in-station testing by INRAN;

c) continued or revised EMOFT testing by INRAN and ONAHA;

d) extension demonstration by ONAHA field agents.

VI. ELEMENTS OF AN EXTENSION-MANAGED ON-FARM TRIAL PROTOCOL

The list which follows again uses the example of a fertilizer response trial on rainy season sorghum under supplemental irrigation. The protocol, as prepared by researchers for each unit EMOFT and provided to extension agent/trial manager, includes cultural operations which he will manage together with the farmer, and data collection for which he is responsible. It clearly distinguishes the cultural operations in which the farmer acts of his free will, from those in which the extension agent intervenes and the extent of that intervention. INRAN-collected data from the same trial is listed separately. The protocol is written in clear, simple, unambiguous French (or local language if appropriate), and is hardbound in a single volume which will stand up to rough handling in the field.

1. Table of Contents
2. Concise list of trial objectives
3. Trial specification sheet (list of experimental treatments, treatment specification, treatment plot assignment, dimensions of trial and unit plot. etc)
4. List of materials to be provided by INRAN, ONAHA, farmer
5. Diagram of trial and plot layout, with dimensions
6. Diagram of unit plot and stake layout, with dimensions
7. Criteria and procedures for farmer selection, with deadline for selection
8. Statement of no-loss guarantee provisions for farmer
9. Criteria and procedures for field selection, with deadline
10 Criteria and procedures for situating plots within field, with deadline
11 General information log (names of farmer, extension agent, perimeter director; village, GMP, cooperative, perimeter, etc)
12 Field history log (cultural precedents, previous fertilizer application etc)
13 Farmer history log (age, position, ethnic affiliation, years on perimeter, off-perimeter enterprises, etc)
14 Extension agent history log (including training and professional experience)
15 Rainfall data log
16 Irrigation water application data log
17 Reference calendar
18 Chronological list of all trial operations for entire season, including post-harvest (cultural operations and data collection), with log for expected and actual dates of each. Expected dates are expressed relative to planting date
19 Detailed instructions for operations and data collection to be managed by extension agent, in chronological sequence

20 Data log for all quantitative data to be collected by extension agent
21 Data log for all qualitative data to be collected by extension agent
22 List of data to be collected from trial by INRAN research staff
23 Open-ended log for visits by INRAN research staff and others, with space for instructions and date for next visit
24 (Optional) Time and activity log for extension agent, vehicle use log, etc.

The sign of a good protocol is a positive answer to the following question: "If INRAN researchers were never to visit the trial, would the trial "run itself" successfully to completion insofar as ONAHA field agent data collection is concerned?"

A separate protocol and data log is drafted for INRAN research staff data collection from the same trial.

If all this attention to detail appears over-blown or nitpicking, it should be recalled that these details spell the difference between a sloppy set of trials which yield inconclusive results (or worse yet, trial failure followed by the inevitable recriminations), versus a sharp set of trials which yield interpretable results. Only the latter can advance the research program towards its objective of perfecting and delivering truly extendable recommendations. When detailed forethought and planning have been incorporated into the working agreement and trial protocol, collaborative interagency field research can be conducted efficiently and yield results that all the participants can take pride in.

ANNEX F

RESEARCH - EXTENSION LIAISON

CONTENTS

I. PRESENT CONDITIONS AND PROBLEMS

1.1. The Extent of Research - Extension Interaction

1.2. The Existing Structures and Organizations Involved in Research Liaison

1.3. Perceived Problems: The Farmer and the Technical Package

1.4. Perceived Problems: The Extension Side

1.5. Perceived Problems: The Research Side

II. CONSTRAINTS TO EFFECTIVE RESEARCH EXTENSION LIAISON

III. AIMS AND OBJECTIVES OF RESEARCH LIAISON COMPONENT OF NAAR

3.1. Output Statement:

3.2. Verifiable Indicators

IV. COURSE OF ACTION

4.1. Interaction of NAAR"s Institutional Research Program Development Objectives and Research-Extension Liaison.

4.2. Timing of Implementation of REU Activities

V. INPUTS

I. PRESENT CONDITIONS AND PROBLEMS

1.1. The Extent of Research - Extension Interaction

1.1.1. At present, horizontal links between extension services and research exist largely through attendance at annual meetings convoked by the Ministry of Agriculture, although March 1986 was the first time that research, ONAHA and the Ministry of Agriculture technical services actually met together at the same place and time. Researchers present the results of their trials at these meetings and extension representatives voice their needs. In principle, the researchers then tailor their programs to accommodate the needs expressed by extension workers in subsequent group meetings at INRAN.

1.1.2. Multi-locational trials include a number of different types. Some of them are standard packages from IARC's and the CILSS trials, while others are applied trials. They take place primarily at research posts and are executed primarily by extension agents, rather than being true farmer field trials. In principle, multi-locational trials are requested by extension at the annual meetings. INRAN then prepares the research protocols which are sent to the Arrondissement extension service branches (or ONAHA for irrigation trials) for implementation. The results are of mixed quality (See below).

1.1.3. The formal process for INRAN and GON approval of extension recommendations is muddy. Not many recommendations have been formally released recently, but there should be several soon. In theory, a research committee based in INRAN presents a recommendation of a new/revised technical improvement at the annual meeting of the Agriculture Technical Services, who then give their approval/disapproval. There is little interaction between researcher and agent. Sometimes the recommendation is approved as a general recommendation and not modified for ecological zones/soil types. In the past this has resulted in inappropriate broad recommendations on technical packages which have left much to be desired (See Ithaca International's 1984 study on Economic Analysis of Agriculture Technical Packages). The present process involves primarily INRAN, with a role probably being played by the newly formed committees or working groups on irrigation, dryland crops and farming systems (which have representatives from the services). INRAN prepares technical handouts or fiches techniques of variable quality which are distributed down to the departmental service levels. Extension then has to distribute these further. The system is obviously in need of revitalization and reorgaization which includes stronger input from users.

1.1.4. In the past, INRAN has made little effort to evaluate recommendations once they were passed to Extension for diffusion. Similarly, the extension services have not, until recently, expended much effort on informing INRAN of their experience with the recommendations. A partial exception may have been the Niamey Department Development II project's efforts to evaluate the animal traction technical package components.

1.1.5. The administrators of both the research and the extension services are aware that poor communication between the two services have led to many of the problems discussed below. At issue is the question of how to resolve the problems within the structural constraints imposed by the national administrative system.

1.2. The Existing Structures and Organizations Involved in Research Liaison

1.2.1. Research

1.2.1.1. The approach thus far has been to create formal institutions. A research liaison unit, located at INRAN's national headquarters, was created under phase I of the National Cereals Research Program. (1975-1982). At INRAN, the Research Extension Unit (REU) is now sited under the Research Studies and Programming Section (See organization plan). This is the umbrella unit for the Divisions of Program/Project Study and of Planning/Evaluation. An INRAN staff member with a B. Sc. in seed multiplication is the division head of REU.

1.2.1.2. REU's current tasks, according to the organizational description of the Research, Studies and Programming Section are:

1. Collection of published research results;
2. Preparation of technical handouts for diffusion of results;
3. Monitoring and supervision of the application of research results by the extention service(s) and other users;
4. Survey of research needs expressed by the extension services;
5. Organization of seminars to review research activities.
6. Maintain institutional relations with research organizations within and outside of Niger to keep INRAN informed about research results from similar programs.

1.2.1.3. Much of REU's activity to date has been directed at preparation of technical handouts (fiches techniques) summarizing recommendations based on INRAN sponsored research or on information collected from third country institutions. It has also been involved in seed multiplication programs.

The basic problem is that REU does not have the wherewithal to carry out its functions properly.

1.2.2. INRAN's Clients

INRAN has a number of clients (extension services) * working under differing organizations and conditions that need technologies to transfer to producers. Some clients will eventually be integrated into the National Extension Services, and many will not be able to afford full scale research liaison/extension information units. Under the Director-General of Agriculture, are the extension service (which covers rainfed agriculture and micro scale irrigation), the Departmental agricultural offices, the Productivity Projects, the National Cereals Program Génie Rural (rural public works) and the Plant Protection Service. Eventually the productivity projects

are supposed to be integrated into the National Extension Services. The Ministry of Agriculture supervises the irrigation parastatal, ONAHA, which should obtain its research technologies from INRAN. The Institute for Practical Rural Development (IPDR) at Kollo needs to feed research recommendations from INRAN into its curricula and syllabi. Although not within the domain of this project, INRAN's mandate also includes livestock and forestry research, so INRAN needs a focal point which the Ministries of Animal Resources and Environment and Hydrology can use to obtain research results. The staff of Animation who report administratively to Education also need a contact point in INRAN to help them with their work in running the Farmer training centers. The more developed cooperatives and the input distribution agencies will also need access to research results, and a place to bring specific problems for solutions.

These clients complain about the lack of readily available and comprehensible results that they can transform into extension materials for widespread dissemination in the vernaculars.

1.2.2.1. Agriculture Production Service

When USAID authorized the Agriculture Production and Support (APS) Project in 1982 as one part of Phase II National Cereals Program, it concentrated on upgrading the ability of the national agriculture services, especially the Directorate of Agricultural Production, which includes the seed multiplication service, extension service, and cooperative support service. The Directorate has responsibility for delivering services for rainfed crops and small scale irrigation. The extension service has a national level center for assistance to extension that was started under APS. It is described as providing support to extension personnel working on the ground and to serve as a link with other national services, more particularly with agricultural research. It has the following units.

-- A documentation unit which prepares, reproduces and distributes documents as well as teaching material which should be used by extension personnel. The technical input depends heavily on INRAN's work under the National Cereals Project;

-- A unit for programming and evaluating on the job training for extension staff;

A unit to develop and evaluate extension methods;

-- A unit which will have the job of maintaining a closer liaison, between research and extension and obtaining a much greater interaction of actions in the field. (See Institutional Analysis Annex for a more detailed description of the Directorate of Agricultural Production's services)

Unfortunately the APS extension liaison advisor position was not filled until June 1986, and the workplan for this APS component is currently under review. The assistance is planned to phase out with the

rest of APS in FY 1989. Based preliminary on review of the general orientation of INRAN activities which are aimed at a broad range of clients, the APS activities are complementary and mutually reinforcing rather than competitive with those of INRAN. The APS project envisages institutionalizing the research extension linkages by joint participation of research and extension personnel in the analysis and planning of their respective programs. Extension personnel will participate in the annual evaluation of the research program and in developing the goals of research, and inversely, research personnel will participate in the annual evaluation of extension results and in developing the research programs.

A system of close interaction in the field between research and extension will be established. This interaction is essential for carrying out programs based on the concepts mentioned above. The final result will be a program of research that is oriented especially towards problem solving and integrates social economic constraints in the formulation of research programs. This also means achieving direct participation of extension personnel and that of farmers themselves in applying the results of research experiments and demonstrations.

The Liaison Unit of the Agriculture Extension service sees itself as participating with researchers and others on the systematic diagnostic studies of extension activities and preparation of technical materials which are provided to the services (such as Fiches_Techniques). They will work with researchers and INRAN's Research Liaison Unit to improve the basic technical handouts, but will also prepare more specific extension information material for ecological zones and in local languages with the documentation and the extension methods unit. They will help other units prepare and train extension agents to transmit the information. The APS unit will also work with INRAN's REU in integrating extension agents on farm trials into and improving implementation of multi-locational trials for rainfed crops and micro-scale irrigation.

The seed Multiplication service should also be a key extension agent, in that it needs to obtain the products of research, multiply them (including farmer multiplication of M3 seeds) and market their produce. The seed products are well placed to give their own feedback to researchers as well as relay the observations of their clients. This process is not functioning smoothly at present. There are proposals afoot to revise and strengthen the seed multiplication advisory commitee, expand it into regional subcommittees, and encourage much more active participation of researchers, extension staff, cooperatives and the private sector. An active seed advisory committee can be a valuable means of strengthening extension - research liaison.

1.2.2.3. Extension services in ONAHA are in a period of transition. ONAHA staff normally are personnel seconded from Agriculture Production and other Ministry of Agriculture Directorates, including Rural Public works (Génie_Rural). With the exception of Génie_Rural staff, most extension workers have almost no training in any aspect of irrigation agronomy and water management. There is little continuity since the ONAHA staff normally go back to their home directorate after completing their excursion tour.

Extension work (and linkage with research) comes under the Mise en Valeur or Operations Directorate of ONAHA. Since ONAHA is supposed to hand over most of the operational management of perimeters to cooperatives, the cooperatives must organize the extension or technology transfer functions themselves. Under a European Development Fund project, ONAHA is supposed to strengthen its extension information generating capacities, and, it is assumed, the extension research linkage capacities as well. The IBRD-Caisse-KFW Irrigation rehabilitation project also has extension agronomy within its cooperative training program.

1.2.2.4. Génie Rural As water management and other irrigation research comes on stream, it will become increasingly important that linkages be established between INRAN and the Génie Rural Directorate. Génie Rural has ultimate responsibility for approving project design, although most medium size perimeters are designed and executed by a few firms. Génie Rural is also responsible for technical review/design of small and micro-irrigation activities to which NAAR will contribute as the project moves into the area of research on Water Management and pumping technologies.

INRAN will need to maintain close working linkages with Génie Rural. The INRAN Research-Extension unit should facilitate the task. It has been proposed that Génie Rural second a few staff members to INRAN to work on water management related research issues.

1.3. Perceived Problems: The Farmer and the Technical Package

The technical packages outlined in the extension handouts are constructed as a collection of interdependent themes which have the cumulative effect of the conditions necessary for achieving the desired increase in productivity. In practice, Nigerien farmers can, --and do-- disaggregate the package and adopt isolated themes from the total package. Researchers should adjust their technical recommendations to fit the reality of differential adoption rates. The packages should be broken out into subcomponents as appropriate, so that farmers can select among parts with the assurance of benefits from adoption. If such breakouts are not feasible technically, then the packages should be developed for the various use patterns.

For instance, recommendations for use of an improved millet variety could include seed treatment of fertilizer and pesticides, mechanical seeding and weeding using animal drawn equipment, and side dressing of urea. Not all farmers will have access to equipment drawn by animal traction, nor will they necessarily opt for both fertilizer applications (especially in years of spotty rainfall). Even if only part of the package is adopted and optimum results are not produced, researchers must be realistic in what they propose.

1.4. Perceived Problems: The Extension Side

Many researchers have doubts about the ability of extension service personnel to carry out on farm trials properly, and consequently they are unwilling to work with them. Often the research protocols are not

as specific in their experimental methodology as they might be (there are many traps that inexperienced researchers may fall into), with the experiment being so affected by exogenenous variables and insufficiently rigorous scientific method that distortions appear in results. In such cases the results may reflect some effect different than what the researcher intended to measure. The extension agents in the multilocational trials may often have insufficient academic background and training (as well as insufficient experience) which skaes results and measurements. The agents may be dragged off to do other chores at the key stages of the experiments and thus devote insufficient time as well as erratic attention to the trials. The agents currently have little role in shaping the trials they execute.

On the other hand, the extension agents receive insufficient training by researchers on how to execute the trials and what to look for, and then the researcher cannot (or will not) provide adequate supervision while the trials are being executed. DECOR has given up and hires its own trial conductors instead of using the extension agent. This practice may tend to cut the researcher out from the line service with which he must interact for valid and successful OFT's on the serious problems which the farmers face. As the services expand and upgrade their staffs, it should be possible for a limited number of extension agents to spend more time on supervising and implementing on farm trials.

1.4.1. The extension services face severe manpower, equipment and logistic constraints which decrease the impact of the extension efforts. APS has a component designed to increase the effectivenass of the extension programs for rainfed agriculture. In the irrigation sector, ONAHA's Operations Division is charged with carrying out trials on perimeters of ten hectares or more. Many of the extension functions should be transfered to the Cooperative representatives as perimeter self-management is put into effect. The IBRD-Caisse-KFW irrigation rehabilitation project is training perimeter directors and cooperatives under the rehabilitation project for Niger River perimeters and some inland perimeters in the Maggia, while the European Development Fund is running a three year program on other perimeters (primarily on the Niger River).

1.4.1.2. The technical handouts prepared by INRAN are poorly adopted to the technical and educational level of most extension agents. Many agents have some secondary school training at most, and others are only graduates of farmer training centers. The style of presentation and level of detail in extension materials should fit the educational level of its users and be adapted to its intended use as training, reference or audio-visual aid. Most extension staff below the upper B level do not have sufficient training or skills to be able to draw useful information from the <u>fiches techniques</u> for farmers and grass roots extension agents to use in their extension activities.

1.4.1.3. Extension staff usually have not had sufficient training in extension methodology, and communications to present the technologies clearly, and inform the end user effectively on how to apply it. Again, a top down, rote reiteration teaching methodology tends to dominate the extension process. On top of this, about 95 percent of the population is not functionally literate in French (the language used in training extension agents above CPT level). Many B and C level cadre find themselves assigned to field extension positions in regions where they cannot function in the vernacular.

1.4.2. Extension staff, particularly the Agriculture staff at the Departmental level and below, have a great many things to do. Many of their activities are not related to extension per se. The district worker or agent technique has many tasks, but not the means to realize them in his territory which may include 30 villages. He lacks transport. He monitors the work of canton (township) and village level assistants (where they exist) and reports problems to the arrondissement level. He may run the rural training center in his area and may conduct multi-locational trials. He collects agriculture production and other statistics for annual reports and other reporting requirements. These tasks eat up considerable time and may often take priority over extension activities and thus reduce the effectiveness of extension agents as providers of extension information.

The Arrondissement level agricultural officer is usually a B level civil servant. These individuals must monitor and supervise the district and village agents, arrange crop protection actions, attend department level meetings, coordinate special agricultural projects such as micro-level garden projects and contract farmer seed multiplication.

1.4.3. The Extension Service(s) are typical GON organisms. They are divided into small units controlled by individual managers. Downward communications are facilitated and expected of staff, lateral and upward comunications are discouraged. Lateral communications through the hierarchies are contrary to administrative rules and procedures, unless the process is cleared beforehand. If jurisdiction is unclear, action often is not taken. The predominance of vertical hierarchical linkages and communication channels within individual rural development services over the horizontal linkages often results in routine program implementation with minimal or non-specific information sharing between the staff of the services in the field. The systematic exchange of information occurs only in formally institutionalized encounters, such as the annual agricultural conferences.

1.4.4. Great stress is laid on formal education attainment and years of service, yet most agriculture extension staff have had relatively little training. At the arrondissement level, most of the Ministry of Agriculture's extension staff have had three years of upper secondary training at IPDR, or a year of specialization after the core courses. Irrigation extension staff usually have not had much specialized training. District level staff may only have had two years of general training and canton level agents may only be graduates of CPT's and CFJA's. Their effectiveness as field agents conducting agricultural trials is therefore often weak because of insufficient technical and methodological background.

1.4.5. Materials/Logistical Management. Urgent needs in other sectors frequently result in diverting resources destined for specific purposes and programs. The Extension agent may not have equipment, supplies or transport.

1.4.6. Due to frequent turnover of staff, there is little institutional memory, and what there is happens to be fragmented because of bureaucratic protocol.

1.5. Perceived Problems: The Research Side

1.5.1. Extension agents are not fully convinced of the value of recommendations in the fiches techniques received from the research institutions and consequently they are not strong advocates of their adoption. This is because most of the recommendations and technologies are of questionable technical, economic or social viability. Negative experience with previous attempts at collaborative research have led most institutions to be wary of committing themselves to new research programs. It has led many of the productivity projects, most notably the Maradi and Niamey projects, to establish and finance their own applied research activities. ONAHA complains that the research conducted by INRAN tends to be overly theoretical, that the results are often unsuited for practical applications, or that the technology failed to produce the anticipated results when put into practice in the field.

1.5.2. Extension agents may not be convinced of the value of recommendations that are valid both technologically and economically, because they have never seen them demonstrated properly.

1.5.3. Recommended technologies are often not well adapted to Niger's diverse ecological conditions. The typical recommendation approved in the past was often characterized for very broad agro-ecological conditions (e.g. it covered both sandy soils and clay soils - which must be handled differently - as well as wide variations in rainfall).

1.5.4. The recommendations may require use of inputs which farmers can ill afford in a high risk environment on low value crops, such as using nitrogenous fertilizer on rainfed cereal crops (especially millet) in low rainfall zones. Recommendations may stipulate the use of inputs such as fertilizers or animal drawn traction, which many farmers can not afford if payments must be made in cash. Farmers may not be able to obtain the recommended inputs at the time when their use is advocated.

1.5.5. The extension workers have had a problem in that, until quite recently, research recommendations addressed only crops grown in pure stands, whereas farmers frequently mix crops in their fields to reduce risk. Interplanting requires modification of planting densities and spacing, plant nutrient needs, and a number of other changes.

II. CONSTRAINTS TO EFFECTIVE RESEARCH-EXTENSION LIAISON

INRAN has a Research and Extension Cell which is not yet fully effective.

In a more developed institutional context where extension staff and researchers interact fully, the role of a REU would be less activist, and farmer to farmer spread of extension technologies would play a larger role. Lateral contacts are not well developed in Niger, the extension services are small and have inexperienced staff, and adult literacy rates are appallingly low. Twenty years from now the functions of REU may have become, quite properly, a focal point for exchange of information and documentation, rather than a catalyst for interactions of researchers and extension staff on field testing organization, transmission of research results and prescriptive ideas. This would result from the insitutional internalization of the extension linkage into ongoing research program activities.

2.1. INRAN needs an effective broker to market its product to its clients * (extension services) and to actively facilitate information on client needs and client reactions to researchers and the researchers results to the clients.

2.2. The extension services need a flow of accurate, tested and precise technical information. Many recommendations need review and retesting, as well as improving the clarity and applicability. While INRAN does not and should not have the resources to produce extension information material, it should be the focal point for facilitating the preparation (by researchers) of technical handouts (fiches techniques) for relaease of approved recommendations. The clients then use these to prepare teaching and informational material for widespread extension and use by lower level extension and cooperative members who have limited training.

Researchers and extension workers talk different languages. They may use the same terms (such as "methodology") while talking about very different things. The scientist or researcher means the methodology by which he has designed and is executing his research; the extension worker is discussing ways and methods of communicating the improved technology and extending it to people who had not been using it previously. Consequently researchers and extension staff exist on different planes, preceeding from very different assumptions, and trying to talk about the same subject (or so they think). An interpreter who understands both languages would help.

---

* Note: Extension services, in this context, mean any government or service actively engaged in transmitting technologies and/or practices. The term includes the national extension service, productivity projects, ONAHA, Genie Rural, cooperatives, agro-industries and voluntary agencies engaged in agricultural development. It also includes the IPDR at Kollo where extension staff are trained, because IPDR needs to incorporate research results into, the curricula.

2.3. The researchers need a broker to help them make contacts for implementation of on-farm trials among the client agencies and farmers. The researcher may not know enough about the extension services to know how to start finding extension staff in appropriate places for conducting field trials, or have much experience in instructing extension workers on conducting experiments and recording data. The extension staff may not know to whom/with whom he should discuss research needs to solve particular problems.

2.4. INRAN needs a contact point for dealing on a daily basis with exchange of information, and maintenance of research documentation with other institutions conducting agriculture related research in Niger, such as the Universities, IARCs, the productivity projects, scholars, donors, etc. It needs a key working level contact point for interchange with the IARC's and research institutions in neighboring countries.

2.5. At least temporary reinforcement is needed for Research Liaison with extension services (See Niger CDSS). Both the traditional narrow based social hierarchy and the government structures require mounting and descending chains of command in order to effect contacts between individuals working on similar problems. Given the socio-administrative context as well as administrative ordinance, the exchange of information between researchers, extension agents and end users, simply will not occur unless administrative changes are made and very deliberate reinforcing structures are built into agricutlure projects which permit the establishment of the structural bonds for exchange to take place. The existence of a formal Memorandum of Understanding is not sufficent to create the necessary interchange unless the organizations and their staffs are also convinced that such an interchange will facilitate the desired results.

Researchers and extension staff are sufficiently territorial at present so that, although the circles of activities overlap, the more common result is curdling and clotting into constituent parts, rather than becoming homogenized. Once the habits of interaction are established and institutionalized, the direct role of REU will gradually be able to lose its intensity and REU will then function as a "transmission belt."

III. AIMS AND OBJECTIVES OF RESEARCH LIAISON COMPONENT OF NAAR

3.1. Output Statement:

By the end of Phase I, the REU will be sufficiently developed so that it is actually coordinating and facilitating the transmission and marketing of research results to the extension services who then disseminate the technologies to farmers. REU will function as a broker between research and the extension services which transmit the products of research to farmers. It will market the technologies to the services which have end users in the farmers engaged in specific production activities. The REU will then transmit back to INRAN the results of "market research" in terms of problem

areas defined by the farmers which are passed on through the extension services. The REU serves as the coordinating point to direct requests for assistance in resolving problems or prospective research needs coming from the farmers or extension services. It maintains the documentation center and infromation regarding the resources, basic research and research results of the IARC's, other research organizations active in Niger and research organizations in neighboring countries. The documentation center also maintains a library of extension recommendations.

3.1.1. As mentioned above, the GON has already established a Research-Extension Cell (Cellule de Recherche et Vulgarisation) in INRAN and assigned it a coordinating role.

3.1.2. The REU outputs should be considered as improving REU's capability to carry out a number of functions to facilitate interaction between "research" and "extension." The degree of effectiveness in carrying out the liaison functions is difficult to measure in quantitative terms. REU facilitaties the necessary interactions of researchers and other agriculture agencies which are required for effective diagnostic studies and planning, execution and eventual utlization of agricultural research results. REU itself does not direct research planning, nor does it actually execute on farm research trials, nor does it prepare "end product" extension materials which lower level extension agents use. However, it has an important role in facilitating all three. To state that a major objective is the establishment of memoranda of understanding between INRAN and an extension agency is a very important output objective is incomplete, because memoranda of understanding are devices which set up the formal framework for interaction and execution of OFT's that involve both researchers and extension agency staff. A better indication that the liaison is actually functioning would be if there are memoranda of understanding in place under which increasingly larger numbers of researchers and extension agents are working together in carrying out on farm trials in several ecological zones, and that a greater number of farmer/extension agent problems and prescriptive rasearch needs are actually incorporated into the research program agenda of INRAN.

3.2. Variable Indicators

By the end of this project (1992), the REU will be sufficiently developed to carry out the following functions and activities. These activities are ranked in order of their importance, but they do not indicate the order in which REU undertakes activities.

3.2.1. Marketing research results to extension services

3.2.1.1. Reviews research results/papers and markets the recommended technologies to the appropriate extension and other services, and provides advice to extension information on preparation of detailed extension and teaching materials that are suitable for lower level extension agents and cooperative agents to use in local languages.

--Provides advice to extension information personnel of extension services on preparation of detailed extension and teaching materials

suitable for lower level extension agents and cooperative agents to use in the local language. [Verified by evidence of meetings and advice in correspondence with extension services, and the publication of materials based on the technical information in INRAN research recoomendations.]

-- Faciliitates researcher verification and technical review of information contained in extension teaching materials. It should be noted that REU will not prepare and print teaching materials or location specific detailed extension materials. This will be done by extension service(s) and/or institutions such as IPDR. REU will contract out all printing and publication. [Verification will be done through examination of recent extension publications to observe whether the recommendations and practices contained in them are technically sound and whether evidence exists that researchers did review the and product.]

3.2.1.2. Fulfill the role of executive secretariat to the revamped research recommendation approval committee that is charged with approval and release of agricultural research recommendations to the extension services and for general implementation.

--Has completed the task of coordinating the work of researchers and extension staff that review existing fiches techniques to determine retention, revision, revalidation through on farm testing or rejections of the recommendations. (This is actually an outgrowth of the researchers diagnostic survey of research status which involves the extension agencies as well) [Verification is done through review of reissued and revised fiches techniques based on the validation programed notes of committee proceedings.]

-- Edits and coordinates preparation of fiches techniques for newly released recommendations. (All of these are reviewed by researchers for technical validity). [Verification is done by reviewing the newly issued fiches techniques.]

3.2.2. Acts as "marriage broker" and advisor for on farm trials (especially the Extension-Managed on Farm Trials or EMOFTS) for researchers who want to conduct extension managed on farm trials. The REU plays a more modest role of outside advisor on the full scale DECOR managed on farm trials and the direct INRAN multilocational trials (See EMOFTS annex for details).

3.2.2.1. Helps facilitate and coordinate negotiations of INRAN scientists and Extension services officials in negotiating interagency working agreements or Memoranda of Understanding which establish working framework and lays down lines of (sanctioned) communication for establishing specific research protocols between scientists and extension service staff. [Verifiable indicators include the existence of approved Memoranda of Understanding with the principal GON agencies which carry out agricultural extension functions on irrigated and dryland crops. Other indicators are working agreements between research, extension and farmers which govern the individual jointly executed research activities.]

3.2.2.2. Acts as advisor to researchers on extension service contact points for organizing EMOFT's. Helps researchers plan and organize logistical execution of EMOFT's, provides advice when requested by scientists (along with DECOR) on feasibility of sites selected/test layout. [Verifiable indicaators would include notes on research protocols and internal INRAN memoranda. It is anticipated that REU will have facilitated the work of researchers and extension staff to the point where extension managed on farm trials are underway in at least two dryland zones as well as on irrigation perimeters scheduled for year 5.]

3.2.2.3. Helps verify feasibility of service personnel carrying out on farm research protocols and the suitability of questionnaires/forms to gather accurate information for researchers. [Verifiable indicators will include notes and comments on research proposals, letters, and other internal documentation of INRAN.]

3.2.2.4. Helps organize and plan training programs for on farm trials (EMOFTS, but also DECOR model tests) which are led by researchers, using facilities and assistance of INRAN and Extension service training units. [Verifiable indicators would include research notes and records of trainers and training programs themselves.]

3.3.2.5. Organizes the annual research site visit field program for on farm trials of all types. [Verifiable indicators would include documentation for the research site visit, internal INRAN correspondence and correspondence with the extension agencies and local field personnel.]

3.2.2.6. Prepares summary digests and consolidated non-technical reports for planning and budgeting of following year's EMOFT's. [Verifiable indicators would be the summary digests and reports themselves.]

3.2.3. Acts as coordinator for transmitting farmer technical practices and unresolved problems identified by field to appropriate researchers.

3.2.3.1. Coordinates for INRAN the systematic gathering of knowledge on farmer originated field practices and matching the technology with an appropriate researcher for verification and possible replication. [Verifiable indicators include INRAN records and correspondance, extension agency correspondence, and the records of the diagnositc analyses prepared for dryland and irrigated agriculture problem areas by the NAAR project.]

3.2.3.2. Acts as a coordinator for feeding to researchers "problems" or prescriptive research needs coming from farmers/technical services. [Verified by records of REU and research program proposals which show inclusion of problem and subject matter research areas initiated in response to field requests.]

3.2.3.3. Participates in diagnostic reviews/surveys of extension and farming practices and recommendations. [Verified by evidence in the reviews and surveys that REU participated in the process.]

3.2.3.4 REU facilitates establishment and preparation of memoranda of understanding for joint program with extension services to evaluate performance of recommendations which have already been extended to farmers. Development of this program depends on progress made by extension services and it might not be implemented until the next phase. [Verification by MOU and reports on the evaluation.]

3.2.4. Helps maintain documentation center which contains.

3.2.4.1. INRAN generated research [Verified by documentation center having a full inventory of these activities.]

3.2.4.2. Other research carried out in Niger, including University and productivity projects. [same as 3.2.4.1]

3.2.4.3. IARC generated research - basic research information [Verified by documentation center inventories.]

3.2.4.4. Research done in neighboring countries [Verified by documentation center inventories.]

3.2.4.5. Library of local extension materials and recommendations [Verifield by documentation center inventories.]

3.2.5. Maintains linkages and contributes into networks with IARC's and other agriculture research institutions. [Verified by correspondence, participation of INRAN staff in networking activities, and in the researcher exchange process.]

IV. COURSE OF ACTION

4.1. Interaction of NAAR's Institutional Research Program Development Objectives and Research-Extension Liaison.

4.1.1. INRAN's roles in research extension liaison are complex. Responsibility for carrying them out is shared by INRAN'S research departments (whose scientists increasingly must interact with extension agency field personnel and farmers), the Research Extension Unit (which has a facilitating role) and the training division (which carries the burden of teaching extension and other personnel how to execute on farm trials). INRAN's role as a whole in the research-extension process, may be described as follows:

- to keep itself constantly informed of important constraints expressed by farmers (often through the medium of the extension services);

- to develop and execute research programs and specific activities that provide solutions to production problems to the satisfaction of the farmer;

- to synthesize technical recommendations into a format which the extension services can use for preparing extension materials for field use by lower level agents and for farmers, and then verify the technical content of these materials;

- to evaluate the field performance of extended recommendations and modify them when necessary.

The NAAR project will help INRAN carry out these actions and develop strong research extension linkages by encouraring increased participation of extension services in planning and executing agricultural research, and in development, approval, delivery and evaluation of technical recommendations.

4.1.2. Prioritizing, Planning and Evaluating Research

4.1.2.1 The role of REU in planning and evaluating research will be that of primary drafter and negotiator of the formal Memoranda of Understanding (MOU) between INRAN and the various extension services . Each MOU will outline clearly the purpose of jointly conducted research activities and the respective roles and responsibilities of INRAN and the participating institution. The MOU will also sanction direct contact and interaction for carrying out the activities listed in the MOU between INRAN staff and staff of the extension agencies without requiring that contacts and requests pass through all the hierarchical channels.

4.1.2.2. As a part of the planning process, INRAN, will set up "diagnostic" working groups which involve INRAN researchers, REU staff and extension agency practitioners. These subject matter research diagnosis groups will review farmer and extension agent problem area concerns for incorporating field level problem solving research into research plans. They will also interact with technical services and donors and conduct field surveys to help them define key constraints to agricultural production that could be reduced by applied research. They will review thoroughly INRAN's existing collection of technical recommendations (fiches techniques) for technical validity, farmer acceptability and clarity of presentation of information. The diagnostic working group will revise useful recommendations when necessary and it will remove inapplicable recommendations.

Once the MOU's are in place, the extension services will follow up on research themes which they have identified and request that REU bring these problem areas to the attention of the diagnostic working groups. They in turn will analyse the proposals and decide whether or not to include them in research plans.

REU will organize working group sessions when needed between researchers and agriculture/extension service personnel to finalize plans for research activities on farm and multi-locational trials.

4.1.2.3. REU will be available to assist and advise researchers in their task of preparing annual working agreements which govern specific joint research activities with extension agencies and agents. The working agreements describe the objective of research, identify the roles and responsibilities of each participant, the inputs required, location, budget, and any other pertinent information needed for successful implementation of the EMOFTS.

4.1.2.5. Evaluation of the performance of technical recommendations is an integral part of research planning, and feeds back into the process of selecting research priorities. REU will develop a program with the researchers and extension services to monitor and evaluate the performance of the technical recommendations. REU will have a key facilitative role in these evaluations, although the major burden must be carried by the researchers themselves working with the extension services. This activity may or may not be launched during the course of this phase of the NAAR project, depending on the progress made in field trials and in releasing technical recommendations.

4.1.3. Execution of Research. Classical FSR methodology describes two major approaches to conducting on-farm trails (OFT's): research managed and farmer managed OFT's. Both approaches tend to overlook or underutilize a valuable field based technical human resource: the agricultural extension agent. In recent years, agronomic researchers based in West African national programs have developed and refined extension managed approaches to OFT's which combine the best of both classical approaches.

4.1.3.1. The general objectives of classical FSR approaches are to analyze socio-economic effects of research generated technologies on the farm level. Research managed trials test treatment effects in the bio-physical environment of the farm, while farmer managed trials test treatment effects by farmer management interactions without benefit of extension agent advice and guidance. Extension managed OFT's or (EMOFTSs) include the influence of the latter to test (technical treatment) + (farmer and extension agent effects) + (biophysical farm environment effects). Thus the method inherently tests the extendability of the technical treatments and identifies technical constraints which will need to be addressed if and when treatment is proposed for extension through the same service.

EMOFTs probably have relatively less usefulness for analysis of the more complex socio-economic effects of technical experiments; however, OFT's which test a relatively limited number of technical treatments are probably better suited to the extension managed approach.

4.1.3.2. Execution of Research: Multilocational Trials. These trials are executed primarily by extension agents at research posts. They are usually requested by extension services during the annual agricultural meetings. INRAN researchers prepare the protocols which are sent to arrondissement level extension services branches for execution. The quality of results from these trials varies widely; the extension agents many not receive adequate briefing on how to execute the trial and receive

insufficient supervision during the course of the trials; often INRAN does not make the required inputs available in a timely fashion; often the agents simply have too many other responsibilities to execute the trial correctly. The NAAR research advisors and the Extension Liaison advisor will assist INRAN researchers, administrators and REU to evaluate the multilocational trial program with an eye to obtaining better results. They will report to the INRAN Director and the Director general of Agriculture so that both INRAN and the technical ministries will take actions to train extension agents and reduce the number of trials in order to imrpove monitoring and support of multilocational trials.

4.1.4. Synthesis, Release and Marketing of Research Recommendations.

4.1.4.1. The Director of REU will organize working group sessions or seminars with researchers and extension personnel to review research findings and discuss new technical recommendations. Once research recommendations are ready for extension, they are synthesized by REU into technical recommendations handouts (fiches techniques). The resultant materials must be reviewed by researchers for technical accuracy. The REU will develop extension materials which will be used by extension and other agricultural services as basic technical references, which can in turn be modified by the extension agencies to suit a particular media, extension technique, user group, or national language. REU's responsibility is to deliver to extension services the essential technical information in a clearly described, technically complete and unambiguous form.

Users of REU documents might include departmental or arrondissement agricultural chiefs and agricultural extension methodologists. REU is not responsible for developing extension materials geared to peasant farmers or village level agricultural agents; this responsibility properly falls within the domain of the extension services. However, REU will collaborate with the appropriate agents or units of the extension services in preparing these materials in order to verify that they are technically sound. Similarly, REU will work with the extension services to ensure that INRAN documents present their information clearly. The Director of INRAN and the head of each Extension service will agree in Memoranda of Understanding to clear descriptions of each agency's role and responsibilities in the production of extension materials.

The revised technical recommendation approval process will set forth procedures to ensure that only those recommendations which have been proven technically and economically viable through OFT's will be released and delivered to the extension services. Where applicable, new technical recommendations developed by INRAN will present sets of options that farmers can employ according to their means.

4.1.4.2 Marketing Research Results: One of the most important roles of the REU is that the Unit must be the chief marketer of INRAN research recommendations to the technical services. This is an especially important role for REU's continuing relationship with clients such as the seed multiplication service, the general agricultural technical service, ONAHA, and genie rural (which has a most important task in the design and

155

execution of small scale irrigation systems, water management systems, and pumping methods). Marketing is a constant ongoing interaction with INRAN's clients at several levels, and it must be a constant preoccupation of the REU staff members if improved technologies are to be transferred to the peasant farmer as the end user, and if the technologies are going to actually contribute to increased productivity. If INRAN cannot effectively market its products, the chances for the National Research System to reach its subsector and sector level goals and objectives are sharply diminished.

4.1.4.3 Technical Training for Extension Agents: In cooperation with extension services and INRAN's training division, REU will organize in-service technical training for extension agents to provide clear explanations of recommendations and how to execute them. REU will also coordinate specialized training for agents participating in irrigated OFTs and multi-locational trials. Upon request from DECOR, REU will assist with training of DECOR- selected rainfed OFT executors. Training will cover agronomic techniques, trial methodologies and data collection.

4.1.5. Documentation and Linkages with Other Organizations Conducting Agricultural Research.

4.1.5.1. REU will maintain information on research being conducted in Niger. This activity will be conducted with INRAN's documentation center. After updating the inventory of INRAN-sponsored research, REU will compile a data base on non-INRAN research . (Alain Fournier's report can be used as a starting point). This information will provide a valuable resource for researchers and will form the basis of a structure through which INRAN can coordinate research in Niger.

4.1.5.2 REU will maintain linkages with the other institutions and agencies carrying out agricultural research in Niger (the University, productivity projects, donor sponsored applied research activities outside of INRAN, and PVO's). It will maintain linkages and engage in networking activities with the International Agricultural Research Centers (particularly ICRISAT's Sahelian station outside Niamey) as well as research organizations operating in nearby countries.

4.2. Timing of Implementation of REU Activities

The Research Liaison Advisor is not scheduled to arrive until year 2 of the NAAR project. This is due primarily to the fact that relatively little research is reacly or deigned for EMOFTs activities and what dryland cereals research is ready for OFT's is already organized for field work either the multi/occational trial system or the DECOR system. EMOFTs will start slowly and require that researchers tailor their research protocols specifically to that type of OFT. This requires time. It will be three or four years before irrigation research undertaken in NAAR will be available for EMOFTs. (Rice breeding and fertilizer recommendations might be an exception). While we expect that a number of technical recommendations will emerge in the next two or three years for drylands cereals crops in particular, it will be even longer before REU will be able to market most irrigation and water control recommendations.

This section gives chronology of research-extension liaison activities. It should be understood that by year 5, REU will be involved simultaneously in almost all of them.

4.2.1. Diagnostic of extendable reommendations and technologies

4.2.1.1. Even before the Research Extension Advisor arrives in about February 1988, INRAN researchers and NAAR project research advisors will involve REU in a systematic joint diagnosis and review of extendable recommendations and technologies with the extension agencies. The first reviews will be those for dryland cereals, cowpeas and related farming systems. The reviews will take advantage of the work done by INRAN with the assistance of the Purdue team.

REU will make an inventory of recommendations and technologies which have been verified by INRAN researchers as ready for extension and translated into extension materials, such as technical handouts, or those already in the pipeline for future extension. This will entail a review of rasearch programs, of multi-locational and on-farm trials and of results which have been extended. DECOR will be called upon to lead in the review, with the participation of the contract agricultural economist, the socio-economist and the Extension Liaison advisor.

The DECOR led working group will then reevaluate the extendability of the recommendations. Criteria used will include whether or not on-farm or equivalent adaptive trials were conducted, an assessment of the quality of technical research, and any socio-economic analysis of the validity of the recommendation and signifiance of results of on-farm trials.

4.2.2.2. This review will be supplemented by an evaluation of the technical content and presentation of materials used by extension services. These evaluations chaired by the REU, will be conducted jointly by researchers and the extension services. They will involve field interviews with groups of farmer representatives and extension staff at the arrondissement and lower levels. This will result in rating of recommendations or technologies and media included in extension programs.

In addition, REU will prepare a list of problems which the extension services and/or farmers identify as needing additional research or improvements.

4.2.2.3. The combined output of the review will be a master list of recommendations being extended in the field. The list will be broken down into tecnnical recommendations which need no additional research input, those which are being extended but need additional research input, those which need fine tuning to fit local circumstances, and problem areas for research program to develop new technical recommendations. The last could in fact be parts of existing technical packages with farmes treat as isolated practices and thus should be researched as such.

The review should identify recommendations which were released without adequate OFT and thus request further research before release of a revalidated recommendation.

It is possible that a recommendation which was proven technically and economically viable through on-farm trials is given a low extendability rating by the extension services. The reasons for the discrepancy should be investigated. It may also be necessary to suggest returning to multi-locational or on-farm trials to demonstrate the advantages of the recommended practice when it is applied properly. In other cases the technical handouts should be revised and/or alternative extension media approachs should be examined, along with the use of in-service workshops for extension agents.

4.2.2.4. INRAN needs to conduct exhaustive reviews of research programs and extension materials at the onset of the project, starting with the dry land sect. This activity should be carefully coordinated with the APS Project extension and seed multiplication components as it is possible that much groundwork will already have been completed by the APS team. A joint review of irrigated agriculture research will be conducted by irrigation researchers extension workers and REU as part of starting up irrigation research.

Subsequent reviews will be necessary but will center on updating previously established lists. Updating activities will entail attending the internal sessions at INRAN, arranging review sessions with extension services and scheduling periodic observation of on-farm research.

4.2.3. Execution of Research Activities: Among the more effective means to convince farmers and extension workers of the viability of recommendations and to obtain feedback is by integrating them into the research process. The REU will use an indirect approach to increase their exposure to research activities and initiate dialogue among representative extension workers and farmers. The direct approach will entail the participation of extension services and farmers in the research process. Extension agent input will be obtained by helping to select off-station research activities, and by programming their location. Both extension agents and farmers will help implement and evaluate research trials.

4.2.3.1. Participation in multi-locational and on-farm trials. INRAN's OFTs run by DECOR do not significantly involve the extension services. We assume that DECOR managed OFT's will continue using the same principles and methods as those presently employed, since they are quite well suited to detailed analysis of socio-economic effects associated with the more complex technical trials. This system trains and supervises temporary trial executors, which circumvents the problem of using local extension agents who are not always available do to a number of other tasks competing for their time.

INRAN and the extension services implement multi-locational trials jointly at the request of the extension services. Experience to date with these (extension run) trials is uneven, because extension workers are often poorly prepared and equipped, and they receive inadequate resources and supervision from researchers.

The on-farm trials proposed for the irrigated sector will be integrated from the start with the extension services of ONAHA and Extension (for micro scale irrigation). Yearly arrangement using the Memorandum of Understanding and annual working agreements will be worked out with ONAHA by the REL and the INRAN irrigation working group to provide ONAHA with project funds for hiring additional field workers to execute the trials. Similar agreements will be conducted with other extension services for work on the micro-realization sites. Project funds will be made available to the extension services to fund logistical support and inputs needed for the multi-locational trials.

The extension services will provide advise on identifying needed trials, to locate their sites, to select trial executors, and to participate in evaluation and review sessions. REU will encourage extension service representatives to attend planning meetings for the annual program and evaluations of past programs.

ONAHA will be deeply involved in trials on the inland perimeter, particularly the department of Agricultural Production, the Adaptive Trial Section, and the Monitoring and Evaluation Unit. The Director of ONAHA will designate ONAHA's principal representative for OFT's.

The extension services' involvement in research will concern multi-locational rainfed trials and research related to the micro-realization sites. This will require negotiations of separate MOU's for micro-irrigation crop trials. The REL will help facilitate the negotiations, but the originating research and/or extension agent must retain an active role in negotiation and implementation. The specific units of Agricultural Production Directorate involved in trial programs will be Extension Training, Research Extension Liaison and its national and regional branches. Programming decisions, such as site locations and distribution of trials among the executors, will be decided by the annual research action plan, and based on criteria established in the MOU's. INRAN researchers, and the extension services will establish the nature of the proposed trials during review and planning sessions.

REU will help with training of executors for on-farm trials in the irrigated sector and for the multi-locational trials. The training itself will be conducted by INRAN's researchers and its training unit, while REU provides some advice and assistance. REL will also cooperate upon request from DECOR in training activities for the dryland on-farm trials, providing suggestions for improving methodology, data collection and eliciting farmer feedback.

Training will be conducted before each crop season. The content of the proram will cover agronomic techniques, trial methodology, data collection, and feedback generation. The first training exercise wil be conducted in year 2 after the REU advisor arrives, and be limited to an easily manageable number of less than 20 trainees. Training for the next season would involve a short refresher course for the earlier participants, and a more complete training for a new group of up to 20 trainees. As the number of trial executors increases, it will be necessary to schedule repeated refresher courses.

Preliminary site observations should be made before developing the initial training programs. REU, INRAN's training unit, and researchers subsequently will conduct periodic visits to trial sites to evaluate the effectiveness of their training of trial executors. While the observation visits are not to be considered as evaluations of the agronomic content of the trials, the information and insights gained by REL will be used in their own assessment of research results.

The REL will be an active participant in the research review process and in the development of subsequent multi-locational and on-farm trial research programs.

Indirect participation of extension workers and farmers in research will entail field visits to trial sites, both on and off station. Visits will be scheduled by REU so that INRAN representatives knowledgeable about the research are available to interact with the visitors, to describe the objectives and methodology of the trials and to elicit their observations and feedback.

4.2.4. Preparation and Marketing of Extension Materials for Dissemination of Recommendations

4.2.4.1. Based on the initial examination, and subsequent updating reviews of extendable results, REL will coordinate production of technical information sheets.

There will be a sharing of responsibility for preparation of extension materials. INRAN will concentrate upon preparing the technical handouts for the use of central and upper level extension staff. Working level material for mid and lower level extension agent (and cooperative and farmer use) must prepared by the extension information units such as exist in Documentation/Media unit of (dryland) agriculture production service and similar cells in INRAN and some productivity projects. Most material production will be done by these units, who may contract out printing to IPDR at Kolo. MOUs will be prepared to clarify the roles and responsibilities of the parties concerned. REL and NAAR should concentrate on agressive marketing of extenstion messages, as described below.

4.2.5. Liaison with other Research Activities in Niger: After the inventory of INRAN sponsored research and extension materials is completed, the REL will inventory non-INRAN agricultural research in Niger. This will help institutionalize the exchange of research results among all researchers active in Niger.

4.2.5.1. Initially, specific activities will include negotiation of an agreement between the General Director of INRAN and other organizations proposing to implement agriculture research of any type in Niger. This would inculde research sponsored by donors (and the IARC's active in Niger), adaptive research conducted through the Productivity Projects as well as research conducted by the University of Niamey. The agreement will require non-INRAN researchers to provide REL, on behalf of INRAN, with copies of research proposals and research results and/or publications. REL will enter these into the documentation center. REL will also take action to assure that non-INRAN researchers are invited to INRAN and Ministry of Agriculture sponsored professional meetings.

Site visits among INRAN and non-INRAN researchers will be arranged by the REL, with formal agreement by the Director General of INRAN, in order to stimulate professional exchange among researchers from all branches of INRAN.

4.2.5.2. To keep abreast of develoment in agricultural research, the REL, in conjunction with the INRAN Documentation Center, will maintain an inventory of agricultural projects in Niger which includes some aspect of research. The inventory will contain information on sponsors, major expenditure line items (to indicate the relative importance of these), geographic location and participating services and institutions. Development of this inventory will be facilitated by the Fournier inventory (1985) and through use of the computerized inventories of projects compiled by the Ministry of Plan.

4.2.5.3. The REU will be the main working level focal point for INRAN's contracts for research network activities involving the IARC's and activities of national research organizations of nearby countries and other African countries with similar ecological zones.

V. INPUTS

Inputs into the research extension liaison components of the NAAR project include the provision of a long term research extension liaison advisor beginning in year two of the project, on the job training for REU staff, two training courses of six to nine months each at one of the International Agriculture Research Centers, some computer equipment and software, and local costs.

ANNEX G

IRRIGATION ENGINEERING AND WATER MANAGEMENT

by Jack Keller
Irrigation Engineer

CONTENTS

List of Tables

	Page
I. INTRODUCTION	G-1
II. PERIMETER IRRIGATION DIAGNOSIS AND MANAGEMENT UNIT	G-2
2.1 Proposed Staffing Pattern	G-2
2.2 Diagnostic Strategy	G-2
2.3 Proposing Management Solutions	G-3
2.4 Testing Management Solutions	G-3
2.4.1. Water Allocation	G-3
2.4.2 Flow Management	G-4
2.4.3. Maintenance, Repair, Improvement	G-4
2.5 Specific Research Topics	G-4
2.5.1. water Quantity and Crop Water Requirement	G-5
2.5.2. Efficiencies of Water Application	G-5
2.5.3. Surface Storage Schemes	G-5
2.5.4. Groundwater Schemes	G-6
2.5.5. Socio-Economic Themes	G-6
2.5.7. Groundwater Resources	G-7
III. IRRIGATION SECTION - FARM WATER MANAGEMENT AND TECHNOLOGY	G-7
3.1. Proposed Staffing Pattern	G-7
3.2. Field Study Strategy	G-7
3.3 Proposing Solutions	G-8
3.4 Field Studies on Jointly Managed Schemes	G-8
3.5 Field Studies on Micro Schemes	G-8
3.6 Specific Research Topics	G-9
3.6.1. Well Hydrology and Construction	G-9
3.6.2. Small and Micro-Scale Water Lifting	G-9
3.6.3. Water Distribution	G-1
3.6.4.Field Applications	G-1
3.6.5. Scheduling Irrigation at the Field Level	G-1
3.7 Prototype Development Fund	G-1

LIST OF TABLES

Number		Page
G-1	Staffing Pattern for the PID & M Unit	G-2
G-2	Staffing Pattern for Irrigation/FWM&T Section	G-7

I. INTRODUCTION

Under the NAAR project, INRAN's Rural Economy Unit (DECOR) and the Irrigation Section of the Division of Ecological Research (DRE) will work closely with ONAHA's Division of Applied Research (Division Mise en Valeur) and the Rural Engineering Service to initiate a multi-disciplinary attack on the priority problem areas of irrigation water quantity and quality control, water application methods and water application efficiency. System and farm level efficiencies in each of these areas will be a central focus of research.

The project will develop within DECOR a "Perimeter Irrigation Diagnosis and Management" (PID&M) Unit. At the outset this unit will be charged with diagnosing the performance of the jointly managed storage and groundwater irrigation schemes. The diagnosis will concentrate on the critical water management issues and constraints to improving the economic and productive efficiency of irrigated agricultural production. The unit will then select, prescribe and test (through action research) appropriate improved (both hardware and software) water management systems for better perimeter performance. An interdisciplinary approach will be used to study and find solutions for the perimeters selected. A "bottom-up" focus will be used. Prescribed solutions will include water allocation decision theories, hydraulic operation procedures, and recommendations for repair, maintanence and betterment.

In addition, the PID&M Unit will carry out a set of applied research studies (both desk and field). These will be designed to provide the knowledge base necessary for developing prescriptions for improving water management on the jointly operated schemes. Insights for selecting these studies will be gained from the diagnostic activities.

The project will initiate research activities within the Irrigation Section of the DRE. These activities will address problems in "Farm Water Management and Technology" (FWM&T). This Section will be charged with micro scheme management; on-farm (field channels and application) irrigation techniques for both micro and jointly managed schemes; small scale pumping plant technologies; and mini tube and dry well construction techniques and hydrology.

A multidisciplinary field study approach will be used to identify successful indigenous and other irrigation and small water lifting techniques being used in Niger. The field studies will also diagnose the constraints to improving agricultural production at the farm/field level of jointly managed perimeters and micro schemes. The irrigation scheduling, management, pumping and application techniques which appear most successful will be analytically described and codified so that where possible they can be extended. Furthermore, field research will be carried out to improve on current practices and discover new ones.

The basic division of tasks between the two sections is: the PID&M Unit will deal with the civil, financial, and institutional issues which are specific to jointly managed perimeters; the Irrigation/FWM&T Section will deal with the agronomic, engineering, micro economic and social issues faced by the individual irrigation farmers on the perimeters as well as those who

own/operate their own micro systems. The Irrigation Section will work closely with the PID&M Unit in diagnosing, solving and testing at the field irrigation level on the jointly managed perimeters. An expatriate agricultural/ irrigation engineer based in the DRE will provide technical assistance to both the PID&M Unit and the Irrigation/FWM&T Section.

The purpose of these sections' activities is to find practical solutions to existing problems and to put these solutions at the disposal of those in a position to implement them. The emphasis is on synthesis, implementation, testing and referring solutions. Most work will not include discovery or invention of new knowledge or technology, but will draw upon what exists around the world and is practical for the situations encountered in Niger.

II. PERIMETER IRRIGATION DIAGNOSIS AND MANAGEMENT UNIT

2.1 Proposed Staffing Pattern

The proposed initial staffing pattern for the Unit is given in parentheses. The ultimate recommended staff composition is the sum of numbers in and out of parentheses.

Table G-1

Staffing Pattern for PID & M Unit

Discipline	Grades and numbers of Staff				
	A	B	C	D	X
Agricultural Engineer - Chief	(1)				
Agricultural Economist - Deputy Chief	1/2				
Agricultural Engineer	1	(1)	2		
Agronomy (Irrigation)	(1/2) 1/2	(1)	2		
Rural Sociology	(1/2) 1/2	(1)	2		
Agricultural Economics	(1/2)	(1)	2		
Support Staff				(5) 5	(5) 5

2.2 Diagnosis Strategy

An interdisciplinary approach will be used in studying and finding solutions for each perimeter's water management problems. This diagnostic approach will begin by addressing water management issues at the farmer/field level. It will then move upstream through the GMP's on the small scale perimeters, and on to the overall perimeter management on the medium scale perimeters. Based on this bottom-up approach, the diagnostic study team will recommend cost effective solutions emphasizing software over hardware approaches to improving water management at each perimeter. The diagnoses will take about one week on the small-scale perimeters, to several weeks for the larger medium-sized perimeters. However, the Agronomist and Sociologist will make repeated visits to the perimeter to collect more complete sets of

data representing the entire cultivation calendar. As experience is gained with the various types and sizes of perimeters in the different ecological zones and social settings, the diagnostic phase can be speeded up.

A diagnostic team will include an INRAN agronomist, an INRAN agricultural economist, an irrigation engineer seconded from the Rural Engineering Service, a rural sociologist/anthropologist and their counterparts on the technical assistance team. Other members will include the ONAHA perimeter director and/or his principal assistant, the cooperative or GMP head and ONAHA and Genie Rural (GR) technicians. The initial focus will be on the jointly managed surface dam schemes and groundwater pumping systems. Study of the riverine systems will begin when the Unit has sufficient manpower to staff two diagnostic teams. Any diagnosis of the jointly managed river cuvette (rice) systems will be preceded by a thorough analysis of other donor activities, to avoid duplication of effort and identify possible areas of cooperation.

2.3 Proposing Mangement Solutions

The diagnostic process will identify constraints to improved perimeter performance. The constraints and proposed solutions will be prioritized according to overall cost effectiveness and probability of success. Recognition of the tradeoffs between labor, capital, energy, management and benefits derived from improved water use will be considered in developing recommendations. Proposed solutions will be jointly prescribed by the entire team.

2.4 Testing Management Solutions

Prescriptions for improving perimeter irrigation performance are only hypothetical until they have been tested and evaluated; prescriptions will need to be adjusted as experience is gained.

2.4.1. Water Allocation

At the perimeter level the primary challenge is the design of an effective water scheduling program. Water scheduling refers to the entire package of hardware and software needed to apply the required amount of water to a crop at the right time. Hardware includes water measurement, conveyance and control structures. Software includes a water balance model taking into account all the significant factors governing the decision to irrigate and the amounts to apply. These factors include climate (potential evaporation and actual rainfall), crop characteristics (water use coefficient, stage of growth, root zone depth) and soil characteristics (available moisture capacity, infiltration rate).

It is impractical to treat each farm individually, so the decision for water allocation must be based on a set of estimated aggregate demands at some level of the perimeter, for example, the groupement mutualiste de progres (GMPs). The decision theory in turn is based on immediate weather continium, the aggregrate at individual field crop calendars, physical site and system characteristics, available water and the socio-economic situation. The diagnostic team may be able to suggest an improved decision theory for scheduling deliveries. However, action research is required to test and modify the proposed decision theory under actual perimeter operating conditions.

2.4.2. Flow Management

The second challenge to perimeter operations is effective overall management of flows in accordance with the allocation decisions. At any point in time, flows must be managed throughout the entire systems whatever its current status. Thus, the allocation decision can only be realized within the hydraulic and flow management capacities of the existing system state and operating personnel at the primary secondary and tertiary levels. While the diagnostic study may spot flow management problems, solutions to them must be field tested and adjusted.

Once the water reaches a GMP or a given tertiary canal the connected group of farmers must receive it according to some schedule. Then it is the responsibility of individual farmers to apply the water to their fields. Therefore, as part of the perimeter diagnosis, the equitability and effectiveness of sharing between the GMP farmers and the accuracy of deliveries to a representative sample of GMPs will be studied before prescribing solutions and testing them. Furthermore, the management of irrigation applications on a representative set of farm fields/plots will also be studied and analyzed with assistance from the Irrigation/FWM&T section.

2.4.3. Maintenance, Repair, Improvement

Perimeter cleaning, maintainance, repair and improvement programs are also important. The maintainance, repair and improvement needs of the water supply and delivery systems will be identified and prioritized during the diagnostic study phase. These improvements will not curtail real rehabilitation. The improvement activities will involve testing of such items as improved canal outlet modules, measuring devices, and possibly simple control structures.

In Niger, medium sized perimeters include all three of the operational management levels discussed above: perimeter-wide, GMP-level and individual farm level. Small perimeters have only the latter two levels of organization. Micro schemes (which will not fall within the operational domain of the PID&M Unit) have only the individual farmer level of operational management (or at most a small, closely knit cluster of farmers). (For further reference to the framework of management entities and activities and their organization aspects see Chapter I of Irrigation System Management: A Synthesis of Water Management Synthesis II Project Studies - which is still in draft form).

2.5 Specific Research Topics

In addition to the diagnostic/action research activities of the PID&M Section, specific research studies will be undertaken. These research activities are important for developing recommendations to improve perimeter performance. An illustrative list of potential topics for the jointly managed surface storage and groundwater schemes follows:

2.5.1. Water Quantity and Crop Water Requirement

a. Irrigation Water Scheduling and Management

- Use of climatic data to estimate ETo. (Develop easier demand-oriented guidelines for perimeter directors to use than the class A pan.)
-Conversion of Charoy's crop consumptive use data (Kcrop) for easier use with ETo.
-Development of basic irrigation frequency and rate guidelines and options for perimeter directors.

b. Drainage

-Effects of water excess due to poor drainage on yields of principal crops.

2.5.2. Efficiencies of Water Application: Distribution

a. Economic costs of inefficiency and benefits of efficiency

-Minimum yields/ha by crop as a function of water delivery costs/m^3, to pay cooperative dues.
-Development of models which illustrate the gains in dry season area cultivable by water economies made in rainy season, (for surface dam schemes).
-Development of models illustrating how water user fees can be lowered, and net profits raised, through savings in water pumping costs (for groundwater pumping schemes).

b. System-level efficiencies

- Development of procedural recommendations for perimeter directors to monitor their own effiencies (NORMAN-type studies).

2.5.3. Surface Storage Schemes

a. Storage

- Waterhead treatment to reduce erosion.
- Rate of reservoir siltation under different site conditions.
- Silt removal prior to and after reaching the storage pond.
- The value of recession agriculture after heavy siltation.
- Waterhead runoff and runoff probabilities.

b. Delivery System

- Alternative canal-lining and crack repair materials and techniques.
- Lined canal losses in various states of repair and soil conditions.
- Controlled modular canal outlets.
- Canal flow regulation techniques.

c. Operating rules

- Strategies for optimizing water release allocations for the wet and dry seasons.
- Potential for conjunctive use of groundwater.
- Strategies for wet season supplemental irrigation deliveries to conserve water after heavy rains.
- Economic impact of pre-planting water delivery.
- Estimation of the area of dry season crop that can be irrigated based on reservoir levels at the end of the wet season.

2.5.4. Groundwater Schemes

a. Well Hydrology and Pumping Plants

- Economic analysis of drawdown and recharge potentials in various aquifers.
- Systematic water level modeling and data analysis techniques.
- Well drilling and construction techniques and costs under local conditions.
- Optimum pumping plant maintenance schedules for minimizing capital, repair and energy costs.
- Optimum well depths and screening for minimum capital and energy costs.
- Appropriate/optimum economic selection of pumping plants.
- Potential for conjunctive use in surface storage schemes.

b. Distribution Systems

- Physical and economic analysis of various pipe and canal distribution systems for different well capacities, soils and cropping patterns.
- Modular outlets for individual fields.

2.5.5. Socio-Economic Themes

- The relationships between farmers, GMPs and perimeter managers for water allocation decisions, hydraulics, repairs and maintainance.
- Farmer participants and coop managers as institutional organizers.
- Viable social and institutional farmer organizations in different social settings.
- Labor constraints to timely farm irrigation activities resulting from competition for labor with rainfed farming.

Many of the illustrative research activities cited above are essentially desk studies which can be carried out using secondary sources of information. We neither suggest that the list is complete nor that everything mentioned will be studied. Note that the study of field irrigation techniques is not included here as this is part of the activities of the Irrigation/FWM&T Section, discussed below.

2.5.6. Groundwater Resources

In addition to the research themes identified above, short-term technical assistance may be provided to investigate the extent of the groundwater resources in the Maggia Valley. This work would be executed via a Memorandum of Understanding between INRAN and the Ministry of Environmental and Hydrology. It appears that there may be considerable potential for development of jointly managed and micro-irrigation schemes in this region. An advantage of groundwater development is the avoidance of the siltation problems associated with surface storage. A basic disadvantage is higher pumping costs. However, given (1) the considerable sunk cost savings of groundwater over surface storage development, especially in view of watershed protection costs and needs, and (2) the relatively short life expectency of the surface schemes, life-cycle costing should favor groundwater development where lifts are not excessive. This is especially true where human, animal wind or other renewable energy resources can be used for lifting water.

III. IRRIGATION SECTION: FARM WATER MANAGEMENT AND TECHNOLOGY

3.1 Proposed Staffing Pattern

Below are recommended staffing patterns for the Irrigation/Farm Water Management and Technology Section. Initial staffing is shown in parentheses. Full staffing is the sum of the numbers in and out of parentheses.

Table G-2

Staffing Pattern for Irrigation/FWM&T Section

FARM WATER MANAGEMENT AND TECHNOLOGY SECTION (FWMBT)	GRADES & NOS.					
	A	B	C	D	X	
Agricultural Engineer - Chief	(1)					
Agricultural Economist - Deputy Chief	1/2					
Agricultural Engineering		(1)	(1) 1			
Agronomy (Irrigation)	(1/2)	(1)	2			
Rural Sociology	(1/4)	(1/4)	1/4 1			
Agricultural Economics	(1/4)	(1/4)	1/4 1			
Support Staff				(5)	5	(5)

3.2 Field Study Strategy

Field studies will employ a multidiciplinary approach. The purpose of the studies is to identify contraints to improving agricultural production at the farm/field level of perimeters and micro schemes. The section will also identify the more successful local irrigation and water lifting techniques used in Niger. Farm/field diagnostic studies of jointly managed perimeters

will be executed in collaboration with the diagnostic activities of the PID&M Unit. Initially the Irrigation Section will focus on irrigated cereal and horticultural crops. Research on paddy rice systems will begin when the PID&M Section begins its work on the jointly managed river (rice) systems.

3.3 Processing Solutions

Solutions that directly affect farmers will be tested thoroughly and adjusted to local conditions before recommendations are extended. Recommendations will take into account tradeoffs between labor, capital, energy and management.

3.4 Field Studies on Jointly Managed Perimeters

On jointly managed perimeters, farmers encounter problems with delivery, in-field conveyence and uniform application of water. Also, during the rainy season, supplemental irrigation is carried out on some perimeters; this may result in insufficient water supplies during the dry season when major irrigated crops are raised. Farmers need techniques which will optimize rain infiltration while permitting supplemental irrigation. In general, understanding problems from the farmer's viewpoint in terms of labor, financial and physical constraints and degree of know-how is critical to finding practical solutions for improved production through increased irrigation efficiency.

3.5 Field Studies on Micro Schemes

At the micro-irrigation level farmers manage the water supply. While the farmer exerts greater control over irrigation, he also has a larger work and management load. Field studies of micro-irrigation will examine not only physical irrigation techniques, but also the synergistic relationships involved.

Some preliminary investigations and field observations on micro-irrigation systems indicate low efficiencies and a large potential for improvement. Some general causes of inefficiency are: (1) applications which are too light; (2) frequent over-irrigation; (3) large conveyance loss; and (4) poor uniformity due to extremely small stream sizes.

Field studies on micro schemes will concentrate on the following areas:

- Well technology
- Pumping technology
- Water convayance technology
- Water application techniques and technology
- Irrigation scheduling techniques.

Innovative well construction, water pumping and lifting technologies that should be examined for applicability in Niger are described in detail by Dan Jenkins in the document Niger Applied Irrigation Research and Coordination: Pumping and Water Management. Of particular interest is the "sludger" method tubewell. Conveyance technologies which will be studied include: unlined channels, various types of canal and pipe linings, and carrying water from the supply to

the crop in containers. Study of application techniques and technologies will include comparison of new methods of furrow border and basin irrigation with the traditional short furrow or level basin methods. In addition, variations of hose-and pipe-fed basin or buried clay pot irrigation techniques may be of interest. Insights into scheduling techniques may be gained by studying the practices and methods used by the more successful local farmers. In addition, the study of early crop water stress symptoms to determine when to irrigate, and the use of simple soil probes to determine when to stop should prove fruitful.

Techniques/technologies will first be tested under controlled conditions before being taken to farmers' fields for full operational testing and evaluation. Only those techniques/technologies which hold significant promise for improving irrigation efficiency and meet farmers' selection criteria such as cost and labor savings will be considered for extension.

3.6 Specific Research Topics

In addition to the general field studies, specific research and studies will be undertaken by the Irrigation/FWM & T Section. These activities are important for developing the knowledge base necessary for improving on-farm irrigation performance. An illustrative list of potentially important research topics on the farm level of jointly managed perimeters and micro-irrigation systems follows:

3.6.1. Well Hydrology and Construction

a. Well Hydrology

- Study water table drawdown dynamics in selected fields of shallow wells to determine development limitations.

b. Well Construction:

- Test the economic and physical suitability of the simplified well drilling techniques used in Bangladesh and small bore concrete pipe machine dug wells.
- Develop and test water spreading techniques for recharging shallow aquifers using intermittent streams.

3.6.2. Small and Micro-Scale Water Lifting

a. Human Powered Pumps and Lifting Devices

- Analyze the energetics and economics of calabash and shadouf water lifting water for different well capacities and lifts.
- Analyze the energetics and economics of the many new hand pump technologies being tried in Niger and elsewhere for different well capacities and lifts. Compare with the calabash and shadouf.

b. Animal Powered Pumps and Lifting Devices.

- Conduct comparative studies of traditional dallous with any new techniques used in Niger and other promising lifting or pumping techniques.

c. Diesel Powered Pumps

- Field test existing diesel engine driven pumps under the range of local site conditions at which they are currently being used.
- Obtain a few optimally selected engine/pump combinations for the dominant flow/lift situations and compare them one-on-one (measuring fuel impact against water delivered) against the farmers' own pumpsets at various typical sites.
- Analyze and find remedies for pump and plumbing hardware corrosion problems.

d. Wind and Other

- Categorize and carry out simple in situ evaluations of wind and other renewable water lifting devices under trial in Niger.

3.6.3. Water Distribution

a. Open Channels

- Test low cost indigenous tertiary canal lining materials.
- Development of oxen drawn implement to construct tertiary and field channels.

b. Conduits

- Study socio-economic effectiveness of aluminum, rigid plastic and lay-flat plastic gated pipe.
- Study socio-economic effectiveness of flexible hose for distribution of the small flows associated with micro-irrigation.

c. Distribution Strategies

- Analyze water trading at GMP or tertiary level to improve flexibility of rotational distribution.

3.6.4. Field Applications

a. Basin Irrigation

- Determine optimum basin sizes for various flow rates and soil types taking into account water and labor use efficiency.
- Study use of corregations in basins.
- Develop guidelines for determining application duration.

b. Furrow Irrigation

- Develop techniques and implements for using animal traction to construct furrows and set up furrows prior to seeding.
- Comparative analysis of planting in or on furrows and using dikes in furrows to retain rainfall with typical rainfed planting techniques.
- Develop guidelines for adjusting flow rate and duration as a function of furrow slope, soil type and length of furrow.
- Research the use of hand-set operated surge flow as a means of improving furrow irrigation efficiency.
- Develop guidelines for determining duration of irrigation for proper depth of application.

c. Other Methods

- Comparative socio-economic study of sprinkle can versus hose basin micro-irrigation.
- Determine comparative water use efficiency of sprinkle can, hose basin and clay pot irrigation.
- Develop and test innovative small diameter hose transmissions to spaghetti hose, application methods of micro irrigation.

3.6.5 Scheduling Irrigation at the Field Level

a. Determining when to Irrigate

- Develop guidelines for early detection and use of water stress symptoms in crops for scheduling irrigations.
- Develop basic irrigation frequency and rate guidelines for different crops and soils.

b. Determining when to Stop Irrigating

- Develop guidelines for using a simple soil probe (a 10 mm diameter rod 1 m long with a simple T handle) to determine when the depth of an irrigation is sufficient for different stages of crop growth and soil conditions.
- Develop guidelines for determining the most economic timing for irrigation of different crops on different soils.

c. Scheduling Strategies

- Develop strategies for allocating limited water supplies between different crops at various stages of growth at the individual farm level.

d. Other

- Study the effects of excess water (due to poor drainage) on yields of principal crops.
- Determine cropping program for best (most economic) use of dug well seasonal capacities.

3.6.7. Jointly Managed Niger River Rice Perimeters

The above illustrative research agenda for the Irrigation/FWM&T Section does not include specific issues which are only related to paddy rice irrigation. As stated earlier, the initial focus of irrigation enginnering and water management work will be on the jointly managed surface dam schemes and micro systems of central Niger. Study of the riverine systems will begin when INRAN has sufficient manpower to staff two diagnostic teams. Any research on the jointly managed river cuvette (rice) systems will be preceded by a thorough analysis of other donor activities, to avoid duplication of effort and identify possible areas of cooperation. Site visits to Niger River rice schemes and discussions with farmers, researchers and perimeter managers suggest a number of potential topics for research:

- Development of better puddling/cultivation techniques to reduce percolation losses and/or labor.
- Study of special soil salinity problems.
- Study affects of low spots with poor drainage in terms of water grass infestation.
- Study use of various legume (forage) crops to use residual soil water after the second rice crop.
- Determine yield impact of letting paddies run out of standing water between irrigations to save water, and
- Study economic feasibility of pumping back drain water.

3.7. Prototype Development

Since a number of the potential research topics of the FWM&T section involve hardware improvements the project will need prototype development capabilities. Rather than develop this capability in INRAN at this time, it would be more cost-effective to establish a subcontract with existing Ministry of Agriculture's Agricultural Machinery Research Division, ARMA. This division has been financed by USAID and already has an impressive array of machine tools and significant expertise. (In the future, this entire unit may be moved to INRAN.) An appropriate subcontract set aside for ARMA would be in the order to $150,000 to $250,000 for the first five years of the project. These funds are included in the budget.

ANNEX H

FINANCIAL ANALYSIS

CONTENTS PAGE

LIST OF TABLES

I. FINANCIAL MANAGMENT AT INRAN
- 1.1 Local Procurement Procedures H-1
  - 1.1.1 INRAN Purchases from Project Funds H-1
  - 1.1.2 Petty Cash Purchases H-3
  - 1.1.3 Purchases by the Technical Assistance Team (PARA) H-3
- 1.2 Bottlenecks in Current Procedures H-4
  - 1.2.1 Exoneration of the TVA H-4
  - 1.2.2 Inadequate Accounting Support at INRAN H-4
  - 1.2.3 Limited Financial Autonomy of Research Departments and of Researchers H-5
- 1.3 Other Problems H-
  - 1.3.1 Uncertainty of the Research Budget H-
    - 1.3.1.1 At the Level of the Researcher H-6
    - 1.3.1.2 At the Level of the Institution H-7
  - 1.3.2 Multiple Clearances H-8
    - 1.3.2.1 At the PCMU H-8
    - 1.3.2.2 At the Ministry of Plan H-8

II. FINANCIAL REPORTING UNDER THE PROJECT H-8
- 2.1 External Controls H-8
- 2.2 Internal Controls at INRAN H-9
- 2.3 Financial Reporting at INRAN H-9

III. FINANCIAL CONSIDERATIONS RELATING TO IMPLEMENTATION H-10

IV. RECURRENT COST ANALYSIS H-10
- 4.1 Operating Support for the Research Program H-12
- 4.2 Projected INRAN Staffing H-12
- 4.3 Recurrent Cost Implications of the NAARP H-16
  - 4.3.1 Effect of Staffing and Training H-16
  - 4.3.2 Recurrent Costs Continuing After the NAARP H-22
  - 4.3.3 Summary H-24

LIST OF TABLES

		PAGE
TABLE H-1:	ALLOCATION OF INRAN'S RECURRENT BUDGET BY EXPENDITURE CATEGORY: 1972-1986	H-11
TABLE H-2:	ESTIMATED RECURRENT EXPENDITURES FOR INRAN RESEARCH, BY SOURCE: 1972-1986	H-13
TABLE H-3:	PROJECTED STAFFING AND TRAINING PROGRAM FOR INRAN RESEARCHERS UNDER PHASE III AND IV OF THE NAARP	H-14
TABLE H-4:	SALARIES AND AVERAGE ANNUAL INCREASES FOR INRAN RESEARCH CADRE: 1986-87	H-17
TABLE H-5:	PROJECTED PERSONNEL COSTS FOR INRAN RESEARCH CADRE: WITH AND WITHOUT THE NAARP, 1986-97	H-18
TABLE H-6:	PROJECTED REQUIREMENT FOR RESEARCH OPERATING EXPENSES NECESSARY TO EFFECTIVELY UTILIZE RESEARCHERS CURRENTLY PROGRAMMED FOR ASSIGNMENT TO INRAN, 1986-1997	H-21

I. FINANCIAL MANAGEMENT AT INRAN

At the present time the effectiveness of INRAN and NCR researchers is seriously impaired by cumbersome procurement procedures and slow accounting for expenditures. The expenditure approval process takes 15-90 days and this delay causes the project to accumulate unreimbursable expenses that consume an ever larger portion of its outstanding advances. This further reduces the working capital of the project. The cumulative effect of all these factors has caused a shortfall in expenditures for research operations in spite of a chronic shortage of research supplies. During the 1985 fiscal year INRAN was able to spend only 77% of what it had originally budgeted, presumably reducing the effectiveness of its research efforts accordingly. Moreover, expatriate researchers spend an inordinant amount of their time pushing documents through the system in order to get critical supplies as soon as possible.

1.1 Local Procurement Procedures

1.1.1 INRAN Purchases from Project Funds

INRAN has responsibility for purchasing vehicles and for purchasing all inputs for field research operations except vehicle maintenance. The procedures it must follow to effect such purchases include the steps listed below. These procedures apply to any amount in excess of 10,000 FCFA and under 200,000 FCFA ($600) per unit, or one million FCFA per order. Beyond these limits, INRAN and the Project must obtain competitive bids.

1) The official of the project who needs the material prepares a requisition form (*bon de demand*) that is signed by his Chief of Section.

2) He takes the form to the Chief of Materials Service who checks his inventory. If he has it he transfers the material. If he does not he prepares a purchase order and obtains a pro-forma invoice from a supplier. He then sends all three documents to the INRAN accountant.

3) The accountant verifies availability of funds, signs the purchase order and sends the requisition form and the purchase order to the Director General for approval. The D.G. or his delegate must sign for all purchases.

4) The signed purchase order is returned to the accountant who then prepares a request for exoneration of taxes: exoneration of the TVA in the case of locally available goods and exoneration of customs duties in the case of imported goods.

5) A messanger hand delivers the request for exoneration of the TVA to the *Direction des Contributions Diverses* and for exoneration of customs duties to the *Direction des Douanes*.

6) If there is nothing unusual about the request, a messenger can pick up the authorization for exoneration from customs duties within 48 hours. The exoneration from the TVA takes anywhere from 15 to 90 days. Someone must go to the authorizing office periodically to see if the approval is ready.

7) Once he has the exoneration, the Chief of the Materials Service takes it and the purchase order to the supplier who delivers the materials against the purchase order. The Chief of Materials Service (or the person receiving the goods) signs the purchase order or a separate bon de livraison indicating he has received the goods.

8) To obtain payment the merchant prepares an invoice and sends the invoice along with a copy of the purchase order and the bon de livraison, if separate, to INRAN for payment.

9) The accountant sends the invoice to the Chief of the Materials Service who certifies that he has received the goods as stated on the invoice. For purchases exceeding 200,000 FCFA the signature of the Chief of the Materials Service is not deemed sufficient proof of receipt. Instead, the accountant must prepare a procès verbal de réception. This is a document listing the items and quantities being invoiced and is signed by the National Cereals Project Coordinator, the Chief of the Materials Service, the accountant and the merchant, each certifying the quantity and the quality of what was ordered and delivered.

10) The accountant prepares an ordre de paiement or an ordre de virement authorizing payment to the supplier. He takes this to the D.G. of INRAN, along with the invoice, for his signature, certifying that the goods were actually received and authorizing payment. An ordre de paiement is for payment to a physical person. An ordre de virement is for payment to a legal person.

11) The accountant sends the procès verbal de réception, the invoice, the purchase order and the ordre de paiement or ordre de virement to the Ministry of Plan, Direction de Financement et d'Investissement for signature.

12) Plan sends the original of the ordre de paiement or ordre de virement plus a copy of the invoice to the Treasury, and returns a copy of the order plus the original of the invoice to INRAN.

13) The Treasury reviews the documents and proceeds to make payment or to authorize the BDRN to make payment against the project account.

1.1.2 Petty Cash Purchases

INRAN operates two types of petty cash funds. The General Directorate operates a petty cash fund for expenditures from the national budget. In addition, each of the two research stations, Tarna and Kolo, operates a petty cash fund for project expenditures. Each of the petty cash funds amounts to only 100,000 FCFA.

The petty cash fund for national expenditures authorizes expenditures of up to 25,000 FCFA while the two project petty cash funds financed by USAID allow expenditures of no more than 10,000 FCFA. The petty cash funds are used for three types of expenditures; temporary labor, pharmaceutical supplies and operating expenses. They operate as imprest funds in the following way:

1) The researcher initiates the request for an expenditure by means of a letter to the D.G. of INRAN or the station director, depending on the source of financing.

2) After obtaining agreement from the director, the researcher goes to the regisseur de petite caisse who proceeds to purchase the requested material for the researcher or advance him the money for paying the temporary labor. Usually the regisseur will accompany the researcher and make the payments himself.

3) After effecting the purchase or making a payment, the regisseur assigns a number to the receipt and registers the expense in his petty cash journal (livre de caisse).

4) When the petty cash fund is 75% used the regisseur requests reimbursement for expenses incurred to date. He prepares the receipts and sends them to the INRAN accountant.

5) The accountant prepares a bordereau d'emission, a mandat and a bon de caisse to submit to the D.G. for signature.

6) The D.G. certifies the receipts, signs the documentation and returns them to the accountant.

7) The accountant then sends these documents to the Treasury, in the case of expenditures from the national budget, and to USAID for project expenditures. Each then replenishes the respective petty cash fund by the amount of the receipts submitted.

1.1.3 Purchases by the Technical Assistance Team (PARA)

The Purdue Chief of Party is responsible for making and accounting for all expenditures for personal and project vehicle spares and maintenance; for futniture, improvements and maintenance for staff housing and project offices; and for operating expenses for the project office. The process for making such expenditures is less cumbersome, primarily because the project is able to effect payment directly from its own bank accounts.

The first nine steps are essentially the same as for purchases by INRAN from the national budget with the exception that the Purdue Chief of Party may give approval and sign off on documents, with the D.G. of INRAN exercising ex-post review and control only. The accountant takes the invoice and delivery note (bon de livraison) to the Chief of Party who authorizes payment. The accountant then prepares a check which the chief of party signs. He notes the number and amount on the purchase order which also serves as a payment record. The Chief du Service Materiel then takes the check and the invoice to the supplier who stamps the invoice paid.

The Purdue project petty cash fund operates much the same as does the INRAN petty cash fund with the exception that the Purdue Chief of Party accounts directly to USAID for such expenditures. USAID has fixed a 100,000 FCFA limit on this petty cash account as well and allows only expenditures under 10,000 FCFA ($30.00) to be made from it. The project also makes cash advances directly to researchers from the petty cash fund rather than requiring those expenditures to be made by the person responsible for the petty cash account. This allows a more flexible mode of operation. The principal problem with the system is the low level of purchase that can be made from the account.

1.2 Bottlenecks in Current Procedures

1.2.1 Exoneration of TVA

The process of obtaining exoneration of the TVA may take up to 15 days or more, and can take up to 90 days. The exoneration is given for the specific invoice for which exoneration was requested. If the delays caused by obtaining the exoneration result in the product being out of stock, or a new model only being available, the entire process must begin anew with a new invoice and a request for the currently available material.

The problems caused by the TVA are relatively recent. The tax was first enacted in mid-85. The Ministry of Finance has been trying to cope with a whole range of unexpected, but not unpredictable, problems. The USAID mission is optimistic that the NCR and successor project will eventually obtain exonerations. However, as recently as three months ago, The Ministry of Finance reportedly told INRAN in quite emphatic terms that it would not grant a blanket exoneration. Each transaction must be separately scrutinized. In the meantime, soon approaching a full year, project execution and effectiveness is being seriously compromised.

1.2.2 Inadequate Accounting Support at INRAN

The accounting unit of INRAN is inadequately staffed, having only one accountant and two aides, none of whom are permanent employees of INRAN. The unit's staff did not increase with the advent of the NCRP. This was in spite of the fact that the process of accounting for project expenditures is considerably more complex than for those from the national budget. This unit

will need a major input of resources from the NAAR project, especially considering the almost doubling of technicians and field research expenditures over NCRP that will occur over the life of the project.

Since the beginning of 1986 and the exertion of effective managment control by the new Director General, INRAN, with assistance from the controller's office, had managed to submit 100 million FCFA of expenses as of July 31. During the previous 12 months INRAN submitted only 94 million. These figures compare with budgeted expenditures of 219 million, 143 million, and 202 million FCFA for the years 1984, 1985 and 1986, respectively.

In spite of this improvment, much more needs to be done. The project needs to address the inadequacies which led to the problem in the first place. The chief accountant needs to demand more discipline from his secretarial staff for daily office support. He needs at least two additional aides, one to handle banking, exonerations, delivery of paperwork and transaction logs, and another with computer skills to concentrate entirely on posting project expenses and preparing vouchers. This will free some of his time for strategic planning and for on-site spot checks of station and sub-station bookkeeping systems. He needs a major influx of operating resources to carry out his supervisory duties responsibly. The accountant would also benefit from short-term training in operating a computerized accounting system. He will need some technical assistance for getting it established. Precise needs should be worked out between the DG of INRAN, the research managment advisor and the Administrative and Financial Services unit during the first three months of project implementation.

1.2.3 Limited Financial Autonomy of Research Departments and of Researchers

At the present time, the Directors of the INRAN's research departments do not have expenditure authority and to not have their own petty cash funds. All purchases require the signature of the Director General. Moreover, individual researchers have no control over resources with the effect that they must engage the lengthy procurement procedures whenever an unanticipated expenditure arises. This impedes the efficient execution of research and wastes inordinant amounts of researcher time as they personally take charge of the procurement process in an effort to expedite purchases. Moreover, the plethora of inconsequential purchases which the Director General must supervise takes time away from his more important strategic planning, research managment and institution development responsibilities.

Decentralizing expenditure authority at INRAN may be difficult under its existing legal status. As an *etablissement public de caractère administratif*, it is not evident that the D.G. can delegate accountability for expenditures along with authority for making those expenditures. Legally, the DG is, in effect, making a personal loan and is personally held accountable when funds are found missing or misused.

81

Apparently, the statute of INRAN will need to be changed, authorizing the D.G. to delegate certain financial responsibilities before he will feel free to do so. With the change in statute, the person exercising the delegated authority rather than the D.G. is held accountable for the use of funds. The D.G. needs only to provide reasonable supervisory oversight. Should he then discover a misuse of funds by a subordinate, he can activate well established procedures for dealing with the situation.

With financial responsibility clearly established, the Director General of INRAN has indicated a willingness to consider delegating authority to incurr expenditures up to some reasonable amount to department heads and station and sub-station directors. Obviously, the amount will be a function of how effectively INRAN can establish and monitor budgets extablished for the respective research departments, research programs and research stations. A minimum target would be to give authority for authorizing expenditures under 100,000 FCFA to department heads and under 200,000 FCFA to the Chief of Administrative and Financial Services. In all cases, the D.G. would get copies of approvals as soon as they are given and could take ex-post corrective action, if he should feel that to be necessary.

INRAN research departments and research stations and sub-stations also need greater autonomy for making petty cash purchases. In project negotiations USAID should push for a GON constituted petty cash imprest fund for each department, research station and sub-station. This is the level at which the need for an input is most acutely felt and the sense of urgency is the greatest.

1.3.1.1 At the level of the researcher: At the level of the researcher, INRAN has no system of program budgeting that allocates a specific budget to individual research programs. Researchers prepare their annual budgets and the Station Chief reviews them, suggests modifications where neccesary, and then synthesizes the requests into a golbal budget. When the station is notified of its final budgetary allocation, the station director gives researchers an indication of the shortfall (usually quite substantial) and then proceeds to disburse funds piecemeal fashion in an effort to keep all planned research activities operating at least at some level. The first thing to get cut out appears to be researcher travel and site visits. This has a direct negative impact on the quality of the trials. Moreover, researchers never know just what resources they have so that they might allocate them more effectively.

Although the PP design team found no instances of experiments being abondonned in mid-season due to lack of operating resources, there is ample evidence that the overall effectiveness of research would be better served by more fully funded research programs. With the current system, a researcher has no incentive to economize since he competes whith all other researchers for available resources. When the money is gone, it is gone for everyone, with the exception of a certain reserve the station managers hold for emergencies.

To provide better research managment, more adequately funded research programs, and to give individual researchers more certainty with respect to available resources, the research managment specialist will assist INRAN install a program-based budgeting system for research expenditures. Once the research program is accepted, budgeted and adjusted to fit available resources, it should recieve its own separate assured budget against which researchers working on the program would make expenditures after obtaining the approval of the director of that particular research program. With this system, each research program director could define a work program consistant with a known amount of resources.

1.3.1.2. At the level of the Institution: INRAN faces uncertainties over the available research budget from two sources: inadequate attention to processing reimbursement vouchers and the timing and execution of the national budgeting process.

Because of its past inability to process reimbursement vouchers for NCRP operating expenses, INRAN has been unable to obtain new monies for research. As a result, it has managed to spend only a fraction of its budgeted allocation. INRAN underspent its FY85 project budget allocation by almost 25% and will probably underspend its FY86 allocation by a similar percentage. This means that anticipated resources have not, in fact, been available. Strengntening the accounting system as described above should correct this problem.

The national budgeting process presents another set of problems that promise to become more acute in the future. The GON fiscal year begins on October 1st. That makes it very convenient for USAID projects in general, but it comes at harvest time for most of INRAN's experiments. This means that each year's research program must be initiated without knowing whether next year's budget will contain adequate resources to complete it as planned. In practice, INRAN'S budget allocation has been fairly constant so the overall allocation has not presented major problems thus far.

Periodic end of year budget cuts required to bring public expenditures into better balance with receipts pose additional problems. These hit INRAN when it has its greatest need for operating resources. Moreover, the next year's budget does not usually become available until mid-November. This creates a 60-90 day period when resource demands are greatest but available resources are most limiting. This problem is compounded by the practice of disbursing the GON budgetary allocation in equal installments. The first payment does not fully cover the proportion of the annual budget actually spent over the period.

Up to now, a unique set of circumstances have prevented the uncertainty and poor timing of budget disbursments and the backlog of unreimbursed expenses from doing more damage to the research program than they might have. Since FY83, INRAN's budget allocation has been well in excess of actual expenditures. The purpose of the sharp rise in FY83 was to allow INRAN to work off over 550 million FCFA of unpaid expenses that had accumulated over the 1978-81 period. It has since accumulated a sufficient reserve to make those payments. This year it is paying them off with the result that this

money will no longer be available to finance operations during the transition period between fiscal years. In anticipation of this eventuality, INRAN has continued to limit recurrent expenditures in order to build up a permenant operating fund. This is a logical solution to this problem but has come at the cost of severly constrained research programs.

1.3.2 Multiple Clearances

1.3.2.1 At the PCMU: The unusually long time period required to make purchases and to reimburse an outstanding advance results, in part, from required clearances that it would make sense to eliminate. Passing the request for advance through the PMCU adds four days to the process. Presumably, passing the reimbursement vouchers through it adds four days to that process. Moreover, when the controller finds an irregularity that needs correction, the return trip is similarly delayed. There are no benefits from this process that are evident to the author.

Originally, USAID and the GON created the Program Management and Coordination Unit to coordinate the disparate activities included in the APS project with each other, and with the National Cereals Research Project. At that time, INRAN was under the Ministry of Higher Education and Research rather than the Ministry of Agriculture.

Since its creation, the PMCU has operated with only a partial staff. It has not lived up to expectations and does not, in fact, provide coordination that is recognizable as such. Under this project, much of what was expected from the PCMU will be done by the Research/Extension Liaison Unit and the accounting unit of INRAN, which the project will stregthen. Although the PCMU is required to sign off on INRAN'S proposad annual budget, there is no obvious reason why the PCMU should sign off on requests for advance or reimbursement vouchers. Under the NAAR project INRAN will submit all vouchers and requests for advance directly to USAID via the Ministry of Plan.

1.3.2.2 At the Ministry of Plan: At the present time, INRAN must obtain ex ante approval from the Ministry of Plan for all expenditures above 10.000 FCFA. This adds about five days to the procurement process and cannot be done until INRAN has funds on hand to effect the purchase. Shifting to an ex post review of INRAN expenditures would expedite procurement and shorten the period for which INRAN needs to carry an advance.

II. FINANCIAL REPORTING UNDER THE PROJECT

2.1 External Controls

To ease the USAID controller's concern over the Ministry of Plan exercising ex post rather than ex ante control over INRAN expenditures, the project will provide funding for a local financial management consulting firm to work with the Administrative and Finance Service of INRAN during the first year of project execution. The same firm will conduct an annual audit of INRAN'S project accounts. If the Director General of INRAN requests it, the Project will pay for a complete annual audit of all of INRAN'S finances, including its recurrent budget from the GON.

At the present time, it is not possible to define the exact type and extent of assistance that the management consultant will provide. Much will depend on improvements the new Director General introduces over the 12 months remaining until the beginning of project execution. Much will also depend upon the qualifications and experience of the research administration technical assistant. He may be able to assist INRAN to straighten itself out without additional outside help. In case he can't, the budget includes funding for three months of short-term management consulting during the first year, in addition to $30,000 per year for the annual external audit. The external audit will also cover local expenditures made by the technical assistance team from independent project accounts.

2.2 Internal Controls at INRAN

The INRAN accountant has not been providing adequate supervision of research station and sub-station bookkeeping procedures and records. With the greater degree of decentralization fostered by the NAAR project, the need for such supervision will increase dramatically. Under the project, the Administration and Financial Service will establish a program of periodic semi-annual visits to the sub-units to review their financial management operations. The project will finance an additional senior accountant to assist with this and to take responsibility for monitoring disbursements under the budgets established for individual research programs, stations and sub-stations. He will work closely with the existing accountant and with the research management technical assistant. The Director General of INRAN will oversee and guide the implementation of this system.

2.3 Financial Reporting by INRAN

Following the installation of program-based budgeting for research expenditures at INRAN during the first year of the project, the accounting unit will provide a monthly printout to the Director General indicating the financial position of the Institute and its research program. This report will include all INRAN expenditures, both within and ouside the project, for which the Administrative and Financial Service has responsibility. It will list expenditures to date by research program and line item; advances requested from USAID by INRAN; sub-advances given to the stations, sub-stations and research departments; expenditures submitted for reimbursement during the month by both INRAN to USAID and by INRAN'S sub-units to the Administrative and Financial Service; the cumulative value of all outstanding advances at all levels; and outstanding bank balances and petty cash balances. INRAN will send a copy of the report to the USAID project manager.

III. FINANCIAL CONSIDERATIONS RELATING TO IMPLEMENTATION

The NAAR project places much more emphasis on strengthening INRAN as a research management institution than did the NCR project. A purpose of the project is to leave behind an institution that can plan, execute and evaluate a research program with maximum effectiveness. Toward this end, this project is providing resources for strengthening internal research and financial managment and is encouraging essential administrative reform to this end.

There are a number of expenditures associated with fielding a technical assistance team that will cease when the project is over. INRAN does not need experience in managing these resources. Examples include providing housing, furnishing, utilities, transportation and vehicles for the expatriate staff. Because vehicle operations were so problematic early in the NCRP, the expatriate team should handle its own vehicle operations. INRAN already has ample opportunity to do this with its current vhehicle fleet.

IV. RECURRENT COST ANALYSIS

4.1. Operating Support for the Research Program

Data reported by INRAN to the GON for accounting purposes indicate that the proportion of INRAN's budget that goes to salaries has increased from 58% in 1978 to 70% in 1986 (Table H-1). In fact, the situation is much worse than these data alone would suggest. An audit of INRAN operations in 1981 revealed over 555 million FCFA in purchases made over the 1978-81 period that had not been paid by INRAN. Most of these went to non-salary expenses. In effect, INRAN was spending an average of 90-100 million FCFA per year more for operating expenses than the accounting data for that period suggest.

To restore INRAN to financial health and to impose a certain financial discipline, the GON increased the recurrent budget allocation for INRAN by over 45% in 1983 but held INRAN responsible for paying its overdue bills. This sharply increased budget any allocation has permitted INRAN to create a reserve for retiring its old debts. About 310 million of these repayments are included in reported expenditures for the period 1982-1985. Consequently, that portion of reported expenditures was not actually for current operations. Thus, the expenditure data for that period actually overstate the proportion of the actual operating budget that went for non-personnel operating costs. At the same time, INRAN has severely restrained expenditures on research operations in order to raise a reserve fund to cover remaining bills, interest and penalties amounting to 271 million as of June 1986. Creating this reserve has removed another 500 million FCFA from the operating budget for the 1982-86 period.

Table H-1

The cumulative effect of all these factors is demonstrated in column G of Table H-2. Over the period 1978 to 1985, the proportion of INRAN's recurrent expenditures from non-project and non-donor sources that went to operations fell from 54% to 15%. The amount of operating resources per researcher provided by the national budget fell by over 80%. Even counting the extra-budgetary resources provided by the FNI and the NRC project, operational resources per researcher in 1984 were less than one half of the level provided in 1978.

The situation at INRAN has improved since 1984. The NCR and the ASDG have provided much needed operating support. Moreover, now that it has paid, or fully funded its arrears, INRAN will have another 175 million FCFA for research operations each year, provided of course, that the GON does not reduce its recurrent budget allocation. This will alleviate its operating resource constraints for the immediate future. However, new fiscal problems will arise toward the latter part of this decade, as large numbers of researchers now in training return to INRAN to begin research programs.

4.2 Projected INRAN Staffing

In order to determine the magnitude of INRAN'S impending recurrent cost shock, Table H-3 projects the effects of current training programs and GON manpower allocation policies on INRAN's research staff over the 1986-1996 period. The number of in-country researchers grows in response to the return of persons now in training and the continuing annual allocation to INRAN of 7-8 entering college freshmen (the without-project scenario).

The data in Table H-3 are conservative. Of INRAN assigned personnel now in training in the U.S., only 65-75% of those who have never before worked for INRAN are assumed to return to INRAN. The GON shifted students to INRAN to take advantage of the plentiful scholarships offered by the NCR project. Many of these will be shifted back to the Ministry of Agriculture once their training is complete. On the other hand, all those now in training who are already on INRAN's payroll are assumed to return to INRAN. So are the seven to nine entering freshmen assigned to INRAN each year. In theory, they become available for research activities six years after beginning University studies. Table H-3 also assumes a net attrition of 5% per year as established researchers retire or find more promising alternatives elsewhere and are not replaced with trained cadre from other services. This attribution is highest among the Ph.D's.

The data in Table H-3 demonstrate that the number of in-country active research staff at INRAN will grow from 30 in 1986 to 66 in 1991 as persons trained under the NCRP return to take up their posts. From 1991 to 1996 the growth rate declines to a more sustainable and supportable 5% per year, reaching 89 by 1997. Nonetheless, this growth, which is already set in motion by current and past policies and projects, will impose enormous recurrent costs on INRAN if the researchers are to work effectively.

Table H-2

Insert Table H-3

Partly to alleviate this impending recurrent cost problem and partly to continue the upgrading of INRAN's research staff, the NAARP will concentrate its training program on upgrading existing INRAN researchers rather than training new ones as has the NCRP. To this end, it will seek to build a strong Masters level cadre that can assume sole responsibility for Niger's National Research Program by the end of Phase IV of USAID assistance in 1997. During Phase III, the project will provide only enough Ph.D. and 3eme Cycle training to replenish the attrition expected from those being trained to this level by the NCRP. During Phase IV, especially from 1993 onward, INRAN will have sufficient Ingenieurs Agronomes and Masters level staff that additional Ph.D. training should be possible without crippling ongoing research programs. Any training done at that time would help restrain demand for research operating expenses as researchers shift to an inactive status while in training.

The NAARP will provide training for three Ph.Ds, seven Masters and seven DEA (one year of specialization beyond the Ingenieur Agronome for a total of six years after the BAC) during the 1987-1990 period. Current and future trainees at the University of Niamey are assumed to complete their studies at the University or in France and to come to INRAN as Ingenieurs Agronome. Additional Training during phase IV will thus draw on a more highly trained manpower pool than is currently available.

Students coming to INRAN directly from the University must first serve a year of national service with the Ministry of Agriculture before entering INRAN. During the period they are neither in the civil service nor on the payroll of INRAN. At the end of their year of national service, they take up their posts and go onto the INRAN payroll. Thus, INRAN's research staff does not grow as quickly as the scheduled return of trainees suggests.

The data in Table H-3 reveal that even without removing additional INRAN staff for long term training, training programs already underway will cause the number of Masters level researchers actually working at INRAN to decline from 10 in 1986 to 2 in 1988 before beginning its sharp rise. Only in 1990 does the number of active researchers with a masters degree begin rising to levels significatly in excess of 1986 levels. The number of B.S. and Ingenieurs Agronomes available begins to increase in 1989. Until that time, it will not be possible to begin upgrading existing staff without further crippling on-going research programs. For this reason, all of the long term degree training is scheduled for the 1989-1991 period.

Table H-3 also projects the research staff that will be available after allowing for the effect of the NAAR project's (Phase III + Phase IV) training program. Because of the training program, the number of B.S. and Ingenieur Agronome trained researchers doing research at INRAN increases very little up to FY 1992. The numbers of M.SC and Ph.D.s. do not change from what they would be without the project until 1994. As a result, INRAN will have fewer active researchers in 1991-1992 than with no project at all. The payoff to the NAARP training program really comes during phase IV when the number of MS level rasearchers increases by almost 40% over the level available during the

last year of phase III. The phase III and phase IV training programs will thus leave behind a relatively stable research environment that will permit consolidation and better assimilation of the rapid growth set in motion during phase II (NCRP). At the same time, NAARP provision of operating funds will help the GON catch its breath to enable remaining researches to utilize their training more fully.

4.3 Recurrent Cost Implications of the NAARP

4.3.1 Effect of Staffing and Training

Under the GON civil service salary scale, anyone who goes for long-term training of one year's duration or more, and who obtains a higher degree, is raised to the next highest Civil Service category and is placed at the step and grade corresponding most closely -but never lower- to what his salary would have been had he not gone for training. On the average, this means the returned trainee will obtain a salary increase of 1.5-2.1% of his/her base salary plus he/she moves into a category with a higher total salary limit and a higher average rate of increase between steps and grades within that category.

For non-degree short-term training of less than two years, the trainee recieves one step increase, instead of the normal step increase which occurs once every two years. This increases the base salary by 2.5-4.3%, but does not affect future percentage increases nor the salary ceiling within the category. Table H-4 shows average salaries and annual rates of increase for the different categories of researchers and technical staff at INRAN.

Of the levels of training indicated in Table H-3, only the B.S. degree holders are classed in the A2 category. The Ingenieurs Agronomes, M.Sc. and Ph.D's are A1. This means that most of the research cadre trained under NAARP will not increase in category since most of the candidates for the M.S. or the D.E.A will be Ingenieurs Agronomes. They will receive a one time salary increase averaging 4.3% of their base salary as a result of obtaining a higher degree.

The most important issue with respect to recurrent costs is the number of researchers assigned to INRAN. Each researcher requires a supporting staff averaging one B level technicien and 1.5 C level technicians. In addition, they need transportation, secretarial support, research materials, auxiliary staff and temporary labor to support their research activities. These costs swamp the modest recurrent cost effects of the limited increases in base salary brought on by the training program.

Table H-5 shows the implications of the evolution of personnal costs at INRAN over the 1986-1997 period with and without the NAARP. The with-project scenario includes the effect of the training program proposed for the second phase of the NAARP which is also the fourth phase of USAID assistance to INRAN. Although the Phase IV training costs are not budgeted in this project

TABLE H-3

ALLOCATION OF INRAN'S RECURRENT BUDGET BY EXPENDITURE CATEGORY:
1979-1986
(Million FCFA)

	Fiscal Year								
	1978	1979	1980	1981	1982	1983	1984	1985	1986 (a)
Expenditure Category:									
Salaries and Wages	201.5	233.4	269.9	214.8	220.8	233.5	260.7	255.3	181.4
Social Charges	12.6	7.1	6.7	37.8	32.9	117.8 (b)	41.1	43.1	31.2
Displacement Allowances	7.6	5.5	7.5	4.2	1.7	2.4	1.3	1.2	0.6
Public Transport	7.4	9.7	6.2	5.2	2.5	2.4	1.1	0.3	0.5
Vehicles and Equipment Operation and Maintenance	26.3	24.0	42.7	45.6	23.7	38.4	32.0	46.4	13.9
Other Consumables	16.0	12.5	16.4	0.0	0.0	0.0	0.0	0.0	0.0
Utilities and Operating Exp.	22.2	22.7	14.7	24.4	31.1	25.8	42.1	52.2	27.0
Maintenance and Repairs	22.1	30.5	36.5	9.0	0.0	0.0	0.0	0.0	0.0
Office and Other Equipment	19.6	19.9	11.6	0.2	2.7	0.2	3.9	0.9	0.2
Building Maintenance	0.0	0.0	0.0	1.7	0.5	0.3	1.2	0.7	1.1
Documentation & Information	0.0	0.0	0.0	1.1	0.8	0.9	0.8	3.0	1.1
Miscellaneous	3.9	0.5	3.1	8.2	3.4	3.6	6.2	7.5	0.3
Totals (c)	342.2	352.7	434.6	338.9	324.1	425.3	410.9	413.2	257.1
Budget Allocation	340.0 (d)	350.2	442.8	347.2	362.6	523.4	518.2	522.9	384.3 (e)
Accumulated Reserve	9.8	7.3	14.8	23.1	61.6	160.0	267.3	377.1	400.2

Source: INRAN monthly financial reports to the Ministry of Finance.

Footnotes:

(a) Includes expenditures up to 6/30/86 only. Fiscal year ends 9/30.
(b) Includes 50 million FCFA paid for pre-1962 arrears on the CNSS.
(c) Column totals may not add properly. Errors are in the raw data.
(d) Estimated
(e) After deducting 103.7 million FCFA paid in 1986 on pre-1982 arrears. INRAN still owes 271 million FCFA of the 559 million in arrears that had accumulated as of 1981. The large reserve has been accumulated for this purpose. The arrears continue to accrue interest and penalties.

paper, the affect of the training program is to substantially alter the recurrent cost adjustment facing the GON vis-a-vis INRAN. It is important to weigh this factor in determining an appropriate design and policy context for NAARP.

According to Table H-5, programming the training as proposed in the NAARP will save INRAN over 540 million FCFA in personnel costs over the first 10 years following project initiation. This flow has a present value of over 250 million FCFA using a 12% discount rate. The additional savings that will occur as a result of a reduced need for operational resources to carry out

TABLE H-4

SALARIES AND AVERAGE ANNUAL INCREASES FOR INRAN RESEARCH CADRE
1986-1987

Category	Number of Cadre	Monthly Salary (FCFA) Beginning Base Salary	Average Base Salary	Average Total Salaries & Allowances	Average Annual Increase from step & Grade Changes	Index Increment For Each Step Increase
A1	22	73,100	117,500	164,500	4,3%	50
A2	8	62,500	93,600	130,300	4,0%	35
A3	3	56,300	68,800	98,900	3,7%	30
B1 & 2	28	49,000	59,500	92,300	3,2%	20
C1 & 2	35	32,800	42,400	70,400	2,5%	10
D1 & 2	9	21,900	39,400	70,800	3.1%	10

Source: INRAN 1987 Budget.

TABLE H-4

ESTIMATED RECURRENT EXPENDITURES FOR INRAN RESEARCH, BY SOURCE:
1978-1986
(Million FCFA)

Fiscal Year	Estimated: As Reported	Estimated: From FNI	Estimated: Arrears Paid From Recurrent Budget	Estimated: Actual Expenditures On Current Operations	Estimated: Expenditures On Personnal	Estimated: Balance Spent On Operations	MCP & MCR Expenditures On Operations	External Counterpart Funds For INRAN (e)	Estimated Total Available For Operations From GOM & USAID (f)	Funds Available From Other Sources
A	B	C	D	E	F	G	H	I	J	K
1978	342.2	n.a.(b)	-125.0	467.0	214.1	253.0	n.a.	n.a.	273.0	n.a.
1979	352.7	n.a.	-125.0	478.0	240.5	237.5	n.a.	n.a.	257.5	n.a.
1980	434.6	n.a.	-60.0	495.0	276.8	218.2	18.1	n.a.	236.3	n.a.
1981	338.9	50.0	-50.0	438.9	248.6	190.3	33.7	30.0	254.0	n.a.
1982	324.1	70.1	20.0	374.2	253.7	120.5	n.a.	n.a.	170.5	n.a.
1983	425.3	67.3	126.0	367.6	271.3	95.3	39.4	n.a.	164.7	n.a.
1984	410.9	23.7	84.0	349.6	301.8	48.8	69.9	n.a.	148.7	n.a.
1985	413.2	28.1	90.0	351.3	298.4	52.9	109.9	n.a.	192.8	n.a.
1986 (a)	257.1	n.a.	0.0 (c)	257.1	212.6	66.4 (d)	175.0 (d)	103.1	344.5	87.6 (g)

Source: Table H-3, INRAN and USAID records and estimates by the author.

Footnotes:

(a) As of 6/23/86 only. Fiscal year ends 9/30.
(b) Not available.
(c) 103.7 million FCFA of arrears were paid from reserves and are not included in reported recurrent expenditures.
(d) Extrapolating results for first nine months to estimate full year's expenditures.
(e) Includes 25.2 million FCFA for new TROPSOILS research program in FY86 and 27.5 in FY87. FY87 total allocation is 96.9 million FCFA.
(f) Assuming an average of 30 million FCFA in counterpart funds for 1981-85 and 20 million FCFA for those years of MCP and MCR for which data are not available.
(g) Includes 29 million FCFA for IDA Forestry Project, 24 million for Projet Tapis Vert and 36.5 million from the Institut Du Sahel for cereals improvement.

TABLE H-5

PROJECTED STAFFING AND TRAINING PROGRAM FOR IN-AN RESEARCHERS
UNDER PHASE III AND PHASE IV OF NAWRP

	Phase II	Phase III						Phase IV				
	FY86	FY87	FY88	FY89	FY90	FY91	FY92	FY93	FY94	FY95	FY96	FY97
Without Project:												
In-country Researchers, By Degree Held:												
B.S	5	5	5	7	7	9	9	9	9	8	8	8
Ingeneur Agronome	10	11	12	15	18	23	22	28	34	41	47	53
M.Sc.	10	6	2	12	14	20	20	21	20	19	18	17
Ph.D./3eme Cycle	2	2	2	2	6	9	9	9	8	8	7	7
Unknown	3	4	4	4	5	5	5	4	4	4	4	4
Sub-total	30	28	25	40	50	66	65	70	75	80	84	89
With Project:												
Researchers Sent For Training, By Project, By Degree Pursued:												
M.Sc./D.E.A.		0	0	5	4	5	0	3	3	3	3	0
Ph.D./3eme Cycle		0	0	0	0	3	0	2	1	0	0	0
Sub-total		0	0	5	4	8	0	5	4	3	3	0
Researchers Currently in Training Under Project, By Degree Program:												
M.Sc./D.E.A.		0	0	5	8	11	9	5	6	7	7	4
Ph.D./3eme Cycle		0	0	0	0	3	3	5	3	3	1	1
Sub-total		0	0	5	8	14	11	10	9	10	8	5
Researchers Remaining For Research Activities, By Degree Held:												
B.S.	5	5	5	5	5	6	6	5	4	3	3	3
Ingeneur Agronome	10	11	12	12	11	12	11	15	19	23	26	32
M.Sc.	10	6	2	12	15	20	24	28	23	29	31	23
Ph.D./3eme Cycle	2	2	2	2	6	9	9	8	11	11	12	12
Unknown	3	4	4	4	5	5	5	4	4	4	4	4
Sub-total	30	28	25	35	42	52	55	60	66	70	76	84

Source: INRAN training documents, authors assumptions.

the research will raise the total net present value of the savings to 500 million FCFA or $1,5 million at today's exchange rate (325 FCFA/$ US). The cost of increased base salaries for the researchers who are trained will amount to an insignifiant one million FCFA more than if training is provided. In effect, the savings in recurrent costs will completely pay for the cost of the training.

Table H-6 projects out to 1997 the total budget that INRAN will need to effectively employ this reduced number of active researchers under the project using the average relationship between the cost of personal and other research costs that prevaled during the 1978-81 period. This was a period when INRAN had relatively ample operating resources since it had essentially unlimited overdraft privileges, in addition to its recurrent budget. This is the minimum target for operational support that USAID should accept as a condition for supporting INRAN. It makes no sense to take on more researchers when those already on the staff are unable to work effectively because of a lack of operating resources.

According to Table H-6, if the GON holds INRAN's budget constant until FY89, and then increases it 8.5% in real terms each year therafter, INRAN has a chance to become self-sufficient by 1997. This assumes that INRAN can attract additional collaborative research programs that increase 10% per year over the 1986 level. This should be feasible if the project succeeds in its purpose of building INRAN into an efficiently managed, effective research institution. In addition, it will require INRAN to reduce by one half the number of new university students assigned to it over the 1987-1990 academic years, while continuing to receive the aforementioned budget increments. This would reduce the number of researchers from 84 to 72 in 1997, and the projected required budget from the 1505 million indicated in Table H-6 to 1290 million FCFA. This is only 20 million FCFA more than the amount provided by the annual recurrent budget plus one half of the funds available from other sources. INRAN would then be able to conduct its priority research program with minimal assistance from donors by the end of Phase II of the NAARP in 1997.

There is some uncertainty over the proportion of funds from other sources that represent net added costs to INRAN. Obviously, there is a limit to the amount of research that one person can do. If a researcher is already fully employed and properly funded so as to enable him to do effective research, as the figures in Table H-6 intend, then a portion of new research monies recieved will release funds previously programmed in the recurrent budget for his other research. In the absence of other information, it seems reasonable to assume that one-half of this new money will, in fact, replace previously programmed funding as budgeted in the first three columns of Table H-6.

TABLE H-6

PROJECTED REQUIREMENT FOR RESEARCH OPERATING EXPENSES NECESSARY TO EFFECTIVELY UTILIZE RESEARCHERS CURRENTLY PROGRAMMED FOR ASSIGNMENT TO INRAN, 1986-1997

(Million FCFA)

Year	Projected Personnel Budget	Projected Operations Requirement 1/	Total Budget Required	Projected GON Budget Allocation 2/	Funds Available From Other Sources 3/	Balance To Be Covered By Donors 4/
1986	300	315	615	523	88	48
1987	329	345	674	520	100	104
1988	335	352	687	520	110	112
1989	366	384	750	568	121	122
1990	401	421	822	622	133	134
1991	472	496	968	733	146	162
1992	484	508	992	751	161	161
1993	535	562	1,097	830	177	179
1994	584	613	1,197	907	195	193
1995	621	652	1,273	964	214	202
1996	670	704	1,374	1,040	235	217
1997	734	771	1,505	1,140	259	236
Average Annual Rate of Growth	8.5%	8.5%	8.5%	7.3%	10.3%	

Footnotes:

1/ Projected at 105% of personnel costs based on the average relationship which prevailed over 1978-81 period.

2/ Assuming a constant allocation until FY 89 when the recurrent budget allocation will begin increasing at the same rate as the personnel budget

3/ Assuming INRAN attracts collaborative research programs that provide operating funds which increase 10% per year.

4/ Assuming that one-half of funds available from other sources actually represent added costs and one half pay for costs that are covered in the recurrent budget but are charged to other sources of funding.

4.3.2 Recurrent Costs Continuing After the NAARP

The above analysis demonstrates the need for recurrent cost financing for INRAN over the 1987-1996 period, while the Institute adjusts to the tremendous increase in research personnel set in motion by the NCRP. Over the period of the NAARP, virtually all of these trainees will return to INRAN to begin research programs. The tremendous growth in staffing that will occur from 1990 onward will require rapid increases in GON recurrent financing for INRAN, as well as continued donor support, if those researchers are to operate effectively. By the end of Phase II of the NAARP, Niger will have had ample opportunity to bring resources and manpower into better balance. At that time the need for donor support for operating costs will arise only from new programs beyond those now anticipated under the NAARP.

Table L-1 in Annex L contains the details of USAID financing proposed for Phase I of the NAARP. It includes recurrent cost financing amounting to 105 million FCFA during the first year of the project, increasing to 160 million by Year 5. This compares with approximately 175 million FCFA provided by the NCRP during FY 1986. The decline represents recognition of INRAN's having fully funded its past liabilities and having created an adequate reserve for funding current operations. It can now utilize its entire recurrent budget for current operations. As explained previously, this has the effect of increasing INRAN's operating resources from the national budget by 175 million FCFA over the levels which prevailed during FY 1986. The 105 million FCFA provided by the NAARP, thus, represents a net increase in total operating resources available to INRAN for FY 1987. It will help INRAN restore a proper balance between operating and personnel expenditures.

Most of the financing provided by the project covers expenses that will not continue after the project ends. Technical assistance will provide a temporary resource for strengthening junior researchers and for beginning research programs in selected new areas panding the return of Nigeriens from training. Both the junior researchers and the future trainees are already either on the INRAN payroll, or programmed to go on it whether or not there is a NAARP. Thus, all technical assistance and project administration costs do not affect INRAN's recurrent budget after the project.

Less than half of the 2.4 million dollars provided for training will finance degree training. The bulk of the training will be non-degree and short-term. This will serve to keep salary increases to a minimum while strengthening the supporting staff essential for effective research. The total increase in salaries due to the project's training program will amount to about one million FCFA per year. This compares with INRAN's FY 1986 expenditures on personnel amounting to 300 million FCFA (See Section 4.3.1).

Of the commodities provided by the project, about half of the four wheel vehicles will be used by the technical assistants and half will replace INRAN's existing fleet. They should actually reduce INRAN's recurrent costs by reducing maintenance and repair expenses on the older vehicles.

100

TABLE H-6

SALARIES AND AVERAGE ANNUAL INCREASES FOR INRAN RESEARCH CADRE
1986-1987

Category	Number of Cadre	Monthly Salary (FCFA)			Average Annual Increase from step & Grade Changes	Index Increment For Each Step Increase
		Beginning Base Salary	Average Base Salary	Average Total Salaries & Allowances		
A1	22	78,100	117,500	164,500	4,3%	50
A2	8	62,500	93,600	130,300	4,0%	35
A3	3	56,300	68,800	98,900	3,7%	30
B1 & 2	28	49,000	59,500	92,300	3,2%	20
C1 & 2	35	32,800	42,400	70,400	2,5%	10
D1 & 2	9	21,900	39,400	70,800	3.1%	10

Source: INRAN 1987 Budget.

Whether INRAN can operate these vehicles is another question. Certainly, during the 1982-1986 period, the continuing financial crisis served to restrict the Institute's ability to utilize its vehicles as much as would have been dictated by effective research. For reasons already explained, these problems are passing and INRAN can now look forword to being able to benefit from a prudent use of vehicles. It is difficult to envision an approach to effective research that does not give researchers a means by which they can communicate with farmers.

The project also provides about $120,000 worth of motorbikes and spares and $220,000 for operating them over the life of the project. These will enable researchers to greatly expand their on-farm trials. Over half of these will go to Ministry of Agriculture extension agents participating in the on-farm trial program. Most of the remainder will go to ONAHA/cooperative employed trial managers/extension agents. Such mobility is essential for running effective on-farm trials. This cost will pass to the GON upon project completion and will increase annual recurrent costs--including vechicle replacement--by about $80,000. This will be a small price to pay if it, indeed, substantially increases the effectiveness of INRAN research programs, as we expect.

The project is providing another $309,000 of irrigation and research equipment and structures. Annual maintenance and repairs, if indeed they are undertaken as required, would add about $30,000 to INRAN's recurrent budget. Most of this will be for maintaining irrigation related equipment and is part of the expected increase in operating costs associated with INRAN's program of increasing researchers and research programs according to the country's needs (see Table H-5). At this time, the GON places top priority on developing a capacity for doing irrigation research. Another $190,000 for equipment storage sheds should actually save more in equipment maintenance and repair than it will cost in maintenance and repair of the buildings themselves.

In terms of personnel, the project will finance three accountants and accounts clerks, and a local machine and equipment manager. INRAN has people in all these capacities, but their performance is weak. The project will upgrade these positions and give INRAN time to find more capable people for the existing slots. Money is also provided for research technicians and DECOR observers to work with the technical assistants and the on-farm trails program. The technicians will transfer to Nigerien researchers when the expatriates are replaced, and are therefore included in the projections of necessary recurrent costs per researcher included in Table H-5. The DECOR observers, on the other hand, are a new cost added by the NCRP that USAID should continue to fund until a more cost effective model is firmly established. At that time, INRAN will be able and, more importantly, interested in covering the cost of the trials from its regular recurrent budget.

The project includes continuing funding for other auxilliary and temporary staff in the amount of $355,000 over the life of the project. This is below the amount provided under the NCRP and reflects the improving short-term financial situation at INRAN.

102

TABLE H-7

PROJECTED PERSONNEL COSTS FOR INRAN RESEARCH CADRE: WITH AND WITHOUT THE NARRP, 1986-97

	WITHOUT PROJECT									WITH PROJECT								
		Cadre on Payroll (1)					Projected Annual Budget for Personnel (Million FCFA)				Cadre on Payroll (1)					Projected Annual Budget for Personnel (Million FCFA)		
Year	Active Researchers	A1	A2,A3	B (2)	C,D (3)	Total	Cadre (4)	Auxiliaries	Total	Active Researchers	A1	A2,A3	B (2)	C,D (3)	Total	Cadre	Auxiliaries	Total
1986	30	22	8	28	45	103	160	140	300	30	22	8	28	45	103	160	140	300
1987	29	23	10	34	50	117	189	140	329	28	23	10	34	50	117	189	140	329
1988	25	24	13	34	50	121	195	140	335	25	24	13	34	50	121	195	140	335
1989	40	37	15	40	60	152	246	140	386	35	37	15	35	53	140	226	140	366
1990	50	42	15	50	75	182	294	150	444	42	43	14	42	63	162	261	140	401
1991	66	52	14	66	99	231	373	198	571	52	54	12	52	78	182	316	156	472
1992	65	51	14	65	98	228	368	195	563	54	54	11	54	81	200	322	162	484
1993	70	57	13	70	105	245	396	210	606	60	60	10	60	90	220	355	180	535
1994	75	62	13	75	113	263	425	225	650	66	65	10	66	99	240	386	198	584
1995	80	68	12	80	120	280	452	240	692	70	72	8	70	105	255	411	210	621
1996	84	72	12	84	126	294	475	252	727	76	77	7	76	114	274	442	228	670
1997	89	77	12	89	134	312	504	267	771	84	82	7	84	126	299	482	252	734

Source: Tables H-4 and H-5

Footnotes:

1) Includes cadre in-training except those who have not yet been appointed to the civil service.
2) Projected at one B level cadre per active Researcher after 1987, with no reductions in personnel permitted.
3) Projected at 1.5 C level cadre for each active B-level Researcher.
4) Projected at 3 million FCFA per year per active researcher but not allowed to decline from the 1986 level.

Funding for overnight allowances, official travel, training materials, research and laboratory supplies, and infrastructure maintenance and repair are all continuing expenses that have been slighted in recent INRAN budgets but which are essential for an effective research program. The project provides limited funding for these line items as part of its recurrent cost support over the life of the project. Their cost is included in the operating support projections of Table H-5 which provide the basis for projecting INRAN's recurrent cost deficits.

The provision of a no-loss guarantee fund and a prototype fabrication fund represent new line items that INRAN does not now have. Yet, both of these items are clearly part of an effective research program. The loss guarantee fund is a small item that one can disregard. The prototype fabrication fund, on the other hand, will have considerable donor appeal if it proves successful. In any case, there does not appear to be much reason to expect that INRAN will have to absorb this type of funding for the forseeable future.

Overall, then, the rising level of recurrent expenditures funded by the project represents, in part, a drop from NCRP levels of funding during the initial years. It also provides a cushion to give the GON time to adjust to the tremendous expansion in the country's research capacity that is about to take place. By the end of Phase I of the NAARP, such funding will still be less than current recurrent cost funding under the NCR Project. Moreover, the GON will be in a capacity to provide real hope that it can fully fund INRAN's recurrent budget at effective levels by the end of the second phase of the Niger Applied Agriculture Research Project in 1997.

4.3.2 Summary

The following are two things the GON must do now to help address the issue of INRAN's recurrent costs during the life of NAARP.

1) The GON must make a committment to a rigid policy of fully funding research programs and keeping the number of researchers and research programs in line with available recurrent financing. Under no circumstances should the ratio of non-personnel expenses to personnel expenses in the official recurrent budget fall below the .75 level included in the FY1987 budget. Moreover, the GON should commit itself to achieving a ratio of 1.0 by the end of the Phase II of the NAARP.

2) The GON must reduce the programming of university students for assignment to INRAN to no more than four per year over the 1987-1990 period. This is about half the number currently being assigned each year. The timing should be such that this cutback reduces the number of researchers on the INRAN payroll from 94 in 1997 to 72.

In return for these committments from the GON, The Project will provide the shortfall in recurrent funding over the life of the NAARP. This would amount to 321 thousand Dollars in the first year of the project, rising to 541 thousand Dollars in the last (other cost line item in the budget).

TABLE H-8

PROJECTED REQUIREMENT FOR RESEARCH OPERATING EXPENSES NECESSARY TO EFFECTIVELY UTILIZE RESEARCHERS CURRENTLY PROGRAMMED FOR ASSIGNMENT TO INRAN, 1986-1997

(Million FCFA)

Year	Projected Personnel Budget	Projected Operations Requirement 1/	Total Budget Required	Projected GON Budget Allocation 2/	Funds Available From Other Sources 3/	Balance To Be Covered By Donors 4/
1986	300	315	615	523	88	48
1987	329	345	674	520	100	104
1988	335	352	687	520	110	112
1989	366	384	750	568	121	122
1990	401	421	822	622	133	134
1991	472	496	968	733	146	162
1992	484	508	992	751	161	161
1993	535	562	1,097	830	177	179
1994	584	613	1,197	907	195	193
1995	621	652	1,273	964	214	202
1996	670	704	1,374	1,040	235	217
1997	734	771	1,505	1,140	259	236
Average Annual Rate of Growth	8.5%	8.5%	8.5%	7.3%	10.3%	

Footnotes:

1/ Projected at 105% of personnel costs based on the average relationship which prevailed over 1978-81 period.

2/ Assuming a constant allocation until FY 89 when the recurrent budget allocation will begin increasing at the same rate as the personnel budget.

3/ Assuming INRAN attracts collaborative research programs that provide operating funds which increase 10% per year.

4/ Assuming that one-half of funds available from other sources actually represent added costs and one half pay for costs that are covered in the recurrent budget but are charged to other sources of funding.

This committment to provide recurrent costs may seem excessive to persons not familiar with the need to build a critical mass of researchers as quickly as possible, in order to realize the payoff from research. This necessarily requires concomitant expenditures for recurrent costs to allow the researchers to operate effectively. There is little possibility of Niger absorbing these costs in the short run. Yet, with the biggest part of a critical mass of researchers now in training, one can look to the future with optimism. The key will be to begin now taking measures to reduce the growth in the number of researchers that will otherwise occur beyond 1992, and to reduce the number of research programs, in order to make it possible for remaining researchers to do effective research. By 1997 if these kinds of problems are faced now, Niger will have a large enough research cadre to be able to conduct effective research on most critical problems facing the country's agriculture.

ANNEX I
ECONOMIC ANALYSIS

CONTENTS

	Page
I INTRODUCTION	I-1
II. METHODOLOGY	I-3
III. RESEARCH OUTPUTS	I-4
3.1. Water Use Efficiency	I-4
3.1.1. Niger River Perimeters	I-7
3.1.2. Inland Perimeters	I-9
3.2. Cultural Practices	I-12
3.2.1. Soil Fertility	I-12
3.2.2. Seedbed Preparation	I-15
3.2.3. Relay Cropping	I-17
3.2.4. Tied Ridging	I-20
3.3. Improved Varieties	I-22
3.3.1 Legumes	I-22
3.3.2 Cereals	I-22
IV. EFFECT OF THE RESEARCH-EXTENSION LIASION UNIT	I-23
V. Economic Impact of the NAAR Project	I-25

LIST OF TABLES

		Page
TABLE I-1:	AREA AND YIELD BY RAINFALL ISOHYET FOR PRINCIPAL CROPS, 1980-85	I-5
TABLE I-2:	IRRIGATED CROP YIELDS AND PRICES ASSUMED IN THE ECONOMIC ANALYSIS	I-6
TABLE I-3:	AREA PROJECTED TO BE UNDER IRRIGATION IN NIGER: RAINY SEASON AREA BY TYPE OF IRRIGATION; 1986-2016: WITHOUT PROJECT SCENARIO	I-8
TABLE I-4:	ESTIMATED NET ECONOMIC BENEFIT ATTRIBUTED TO RESEARCH ON IMPROVED WATER USE EFFICIENCY ON RICE PERIMETERS: 1986-2016	I-10
TABLE I-5:	FARM BUDGET FOR RICE PRODUCTION ON IRRIGATED PERIMETERS AVERAGE OF RAINY SEASON AND DRY SEASON CROPS; 1985-86	I-11
TABLE I-6:	AREA IN CROPS AND ESTIMATED WATER USE ON INLAND PERIMETERS MANAGED BY ONAHA , 1985-1986	I-13
TABLE I-7:	ESTIMATED NET ECONOMIC BENEFITS ATTRIBUTED TO RESEARCH ON WATER USE EFFICIENCY APPLIED TO INLAND PERIMETERS: 1986-2016	I-14
TABLE I-8:	ESTIMATED NET ECONOMIC BENEFITS ATTRIBUTED TO RESEARCH FROM MORE EFFICIENT FERTILIZER USE: 1986-2016	I-16
TABLE I-9a:	NET ECONOMIC BENEFITS ATTRUBUTED TO RESEARCH FROM ADOPTION OF ROW SEEDERS: 1986-2016	I-18
TABLE I-9b:	ESTIMATED VALUE OF PRODUCTION OF ROW CROPS ON DRYLANDS ABOVE 300 MM OF RAINFALL AND ON INLAND PERIMETERS; WITHOUT PROJECT SCENARIO, BASE YEAR	I-19
TABLE I-10:	NET ECONOMIC BENEFITS ATTRIBUTED TO RESEARCH ON RELAY CROPPING OF COTTON AND COWPEAS: 1986-2016	I-21
TABLE I-11:	NET ECONOMIC BENEFITS ATTRIBUTED TO RESEARCH FROM PRODUCTION AND DIFFUSION OF IMPROVED VARIETIES OF MILLET AND SORGHUM: 1986-2016	I-24
TABLE I-12:	SUMMARY OF NET ECONOMIC BENEFITS OF THE NIGER APPLIED AGRICULTURAL RESEARCH PROJECT	I-26
TABLE I-13:	SUMMARY OF THE BENEFITS AND COSTS OF THE NIGER APPLIED AGRICULTURAL RESEARCH PROJECT	I-27

I. INTRODUCTION

Most of the fairly rigorous analyses of the returns to research so often cited in the litterature relate to crops which have a demonstrated high yield potential, in instances where other production inputs are not limiting. Moreover, such crops often cover millions of acres of relatively homogeneous cropland. In such cases, research breakthroughs have immediate applicability to a large production base that can amortize the costs quickly. None of these situations prevail in Niger. As a consequence, one needs to approach the question of returns to research from a more critical perspective than might be called for under other circumstances.

By far, the most serious constraint on crop production in Niger is low and irregular rainfall. Also important is the low level of soil fertility. These two factors are related and severely constrain the range of technological choice which researchers have for developing better crop varieties. Wind blast, the lack--and very high cost--of inputs such as fertilizer, pesticides and herbicides, and public policies that impede the ability of markets to evacuate surplus production all operate to reinforce the generally inhospitibale environment for agricultural production in Niger. What can research do in such a context?

It's important for policy analysts to appreciate that plants, like people, need adequate food and water to prosper. Within more or less narrow limits, research should be able to identify more drought tolerant varieties of key crops. But such variaties often yield less than existing varieties under more favorable growing conditions. Certainly, some output is better than none - indeed, this is the rational for conducting research on shorter season, shorter stem or other variaties that are more able to resist drought. But researchers will probably not find varieties that produce two tons of grain per nectare on 200 milimeters of rainfall with few soil nutrients. Even under more favorable circumstances than these, progress will often be slow when researchers must push the limits of the physiologcal structure of plants as, indeed, they must in Niger.

Even when researchers succeed in identifying improved technologies, the way African farmers adapt to the high degree of risk imposed by a harsh ecological environment limits their level of adoption. Farmers grow several different varieties of staple crops in order to provide for varied consumption needs, income needs and to insure against a total crop failure. They have varieties that are early maturing and those that are late maturing. Some varieties resist lodging in the face of high winds while others do relatively better when rains are thin. Some varieties yield well but are not preferred for food consumption. Others pass the taste test but yield poorly. Some respond well in years of particularly good rain but fail miserably in bad years. Large numbers of farmers plant all these varieties in the same year, so that no matter what the weather may bring, they will usually harvest at

least something. An improved variety that does not meet a multitude of these objectives simultaneously will probably not get planted on a majority of crop land, no matter how well it outyields varieties utilized for other purposes. When all these factors are considered, it would seem that researchers should not expect an improved rainfed crop variety to be planted on more than 15-20% of the land area devoted to a particular crop on an aggregate basis at full adoption, no matter what its yield potential or yield conditions are.

Cultural practices are a different story. In most cases the same practice can benefit all varieties of a particular crop. Although adoption rates may be slower than for improved varieties for reasons explained below, ultimate adoption levels should be higher. Of course, this presumes an effective extension capability for showing farmers how to properly utilize the new technology and for demonstrating its benefits.

While it is argued by many that the green revolution in Asia proceeded without much support from extension, it is hard to see how the same situation could occur in Niger, even if it were true in Asia. With water, temperature and fertility constraints as they exist in Niger, the chances of developing varieties that so far outyield existing varieties that they spread spontaneously are probably small. More likely, progress will involve the application of cultural techniques, varieties and inputs that increase farm level yields by 35-50%, and then only with additional labor. Without an effective extension program, it's hard to see how adoption of such improved technologies will proceed rapidly. Moreover, with the exodus of ablebodied younger men from rural areas, a substantial proportion of rural households are now headed by older persons, women and handicapped individuals. This places a ceiling on potential adoption levels for new technologies, especially those that require changes in cultural practices.

One of the strengths of the existing Niger Cereals Research Project is the on-farm trials program. Though not intended as such, this program demonstrates that when those persons responsible for explaining to farmers how to apply a given technology are properly trained and motivated, adoption of improved technologies can be surprisingly swift, not awaiting the analysis of the results of the trial. Some of the more successful trials concern techniques that have been pushed by researchers for years. Yet, only with the advent of the kind of training and discipline necessary to conduct valid on farm trials have these innovations caught on with farmers. The challenge to the NAAR Project will be to extend this program over a much wider area at a much reduced cost. The challenge to USAID will be to take these lessons and help Niger to build an effective extension program.

The eventual economic returns to the NAARP will be highly dependent on the extent to which such complementary programs and policy changes occur, since they will have a profound effect on diffusion and adoption rates. The present analysis assumes that most essential improvements will take place over the life of the project, i.e., by the end of the NAARP Phase I the institutional structure necessary to capitalize on the project's outputs will be in place. Unless this turns out to be true, the project will probably be just another red herring.

II. METHODOLOGY

Past activities of the Niger Cereals Research Project provide a better base for projecting potential improvements in dryland production technologies than is available for irrigated cropping technologies. The methodology used here assumes that the combination of research activities which seem most promising for dryland agriculture at the present time reflect the rate of increase in production that can be expected from dryland research activities under the NAARP. For research on irrigation systems and irrigated crops, expected rates of increase are higher, reflecting the greater potential of irrigated soils. For both subsectors, research programs are continually in the process of definition. This will occur once again when the NAARP technical assisstance team arrives. For this reason, any projections of likely research outputs are somewhat speculative. This analysis is perhaps better viewed as indicative than a measure of potential outcome.

A key assumption affecting the results of the economic analysis is the rate of adoption of promising new technologies. Hybrid corn in the U.S., for example, started out slowly and took about 10 years to reach a level of use of 40-45%. In Niger, one needs to allow for the fact that hybrid corn in the U.S. was a quantum improvement over other varieties existing at the time. One also must allow for the important role played by seed producers, input suppliers and farm publications in spreading the word; high grain prices due to a war; and a rapid decline in the number of subsistence farms as industrial wages encouraged outmigration of entire farm families--none of which exist in Niger.

Projections of production increases resulting from the project include only that part of the increase that would be sustained without follow-on investments. Genetic material tends to lose its vigor unless researchers make continual efforts to maintain varietal purity and adapt to new pests and diseases. The analysis assumes that the level of adoption for genetic improvements applicable to dryland areas rises to a maximum of 12.5% of crop area by year 20 following introduction, and then continues at that level until the end of the 30 year projection period. Essentially any increased adoption beyond that time is assumed to be offset by existing adopters abandoning the variety because of declining effectiveness. Maintaining production increases above these levels will require additional investments in research in future years. Such production increases are more properly attributed to those future investments. For the sake of simplicity, the analysis uses the same adoption rates for improved cultural techniques as for improved varieties.

The adoption rate on irrigated perimeters increases much more quickly than for dryland agriculture, reaching 50% of crop area by year 15 following introduction. This is reasonable given the greater concentration of production and the greater emphasis on cooperative activity within the perimeters. Adoption rates for the micro-perimeters are about halfway between those for dryland and irrigated perimeters. Their combination of a more dispersed location and greater agronomic potential leads us to assume an adoption rate exactly twice that assumed for dryland areas. For all three situations the analysis assumes that farm level introduction of research done under the project begins in 1992, the last year of NAARP. This will follow one to two years of on-farm testing.

At the present time, the cropping intensity for the irrigated perimeters on the Niger River is 1.94. Because of growing limits on dry season water supply we assume this will decline by 1% per year until the year 2000, when area in rice production will plateau at 13,000 hectares. Cropping intensity on the inland surface dam perimeters is assumed to remain constant at its present 1.25. That for the micro-irrigation schemes should hold at 1.0 since most of this land either grows rainfed cereals or is flooded during the rainy season.

In this analysis we count only one half of all net economic benefits as benefits to research. The other half will accrue to extension and other investments necessary to achieve the output projected for the research program. If these additional investments are not made, then most of the benefits for this project will probably not be realized.

Benefit projections assume a stable base over the payoff period of the project. Although production per unit area appears to be declining in Niger, available evidence suggests this may arise more from extension of production into marginal areas and declining rainfall than from a decline in production on existing lands. It's hard to see how production on most of the country's dryland areas could fall much lower than at present. In any case, this is not an important issue since the methodology emphasizes the increase in production arising from a set of technologies rather than changes in absolute levels of production over time. If the base is declining, only the ultimate absolute level of production will be lower. The increase in production due to research will not change. In any case, the assumptions required to conduct this type of analysis are sufficiently crude that factoring in a 1% secular decline in yields would do little more than to promote spurious accuracy.

The method for projecting the impact of research on dryland crops utilizes MOA data dividing total area in production by crop and by rainfall isohyet. The effect of each technology on yield and/or production is then estimated as a funciton of rainfall available in those zones. Table I-1 summarizes the area and yields of the principal crops by rainfall zone that serve as the basis for estimating production increases. Table I-2 indicates base yields assumed for irrigated crops.

III. RESEARCH OUTPUTS

In order to establish a reasonable order of magnitude for projecting output increases due to research, this section reviews some of the research areas that the design team felt were the most promising. This section includes an estimate of the likely net economic benefit attributable to each potential area of research.

3.1. Water Use Efficiency

Several technicians note the pronounced tendency of farmers on perimeters to over-irrigate. Not only does this waste precious water, it also can reduce yields by leaching nutrients and washing soil away from the root zone. More efficient use of water would save on pumping costs and/or allow a larger area to be put under cultivation during the dry season.

insert Table I-1

insert Table I-2

Poor water use efficiency does not always result from a lack of knowledge by farmers of the proper procedures for irrigating. The structure of pricing water greatly dilutes the incentive for greater economy in its use. Properly preparing the land to permit more efficient irrigation will take more time than present land preparation practices. In addition, the actual process of irrigating will take more time than the current frequent practice of simply opening the gates in the morning and returning in the evening to see how things went. The problems on the Niger River perimeters are different from those on the inland perimeters.

3.1.1. Niger River Perimeters

Water availability in Niger River is much more dependent on rainfall in Guinea and irrigation efficiency in Mali than on anything the Nigeriens cn do. With area under irrigation on the Niger River in Niger approaching 6,000 hectares, expansion of irrigated area will be increasingly constrained by water availability during the dry season. This will set an upper limit on the amount of area that can be economically developed since the proportion of total area that can be double cropped will decline as total area expands.

Because of dry season water limitations that cannot be controlled short of constructing a dam, the primary benefit from improving the efficiency of water use on the riverine perimeters will come from reduced pumping costs and slowing down the rate of loss of irrigated lands arising from abuse of the systems.

From an economic perspective, there will be a tradeoff between maximum yields and minimum pumping costs. Maximum economic yields will be somewhat below maximum yields obtainable from optimal use of water from the point of view of plant physiology. The research program will help to determine such an optimal level. At the same time, the perimeter diagnostic teams operating through DECOR will identify water handling techniques that promise to reduce pumping costs without reducing crop yields. These will probably include such practices as better leveling of fields, introducton of water managemant systems that provide an incentive for economizing on water use, and reducing the amount of run-through on the systems. We estimate that the combination of these practices will reduce pumping costs by 25% of current levels on the Niger River perimeters..

Without the NAARP, Niger will, no doubt, continue to expand the area under irrigation along the Niger River. Official intentions indicate an expansion of 1000 hectares per year for the remainder of the century. This has not been occuring on a net basis except in the unusual year.

Table I-3 projects what we feel is a more realistic rate of growth in the area under controlled irrigation along the river. It assumes increments of 500 hectares per year up to 2000, reaching a plateau. This represents an annual growth rate of 5.1% up to that time. By then, the country will have too much perimeter land not being cultivated during the dry season to make the continued expansion of perimeter area a sensible policy. Because of the Government's commitment to self-sufficiency in rice production, however, this expansion of irrigated area will almost certainly go ahead no matter what NAARP researchers find. Thus the figures in Table I-3 represent the without project scenario against which project benefits are calculated. The principal benefit of the project will be to minimize the cost of producing crops on this land.

insert Table I-3

Table I-4 projects the economic value of NAARP research outputs as these affect production on the irrigated rice perimeters in the Niger River Valley. It assumes that the rate of loss of irrigated lands will decline by 3% less than the current 12% per year. This affects only that land on which the improvements will have been adopted, and has a cumulative effect once adoption takes place. The economic benefit of the project is then the net economic value of the added output from the extra land retained in production, less economic costs associated with producing that output. Table I-5 estimates these benefits for rice production on the perimeters. As with all project benefits, only half of the net economic benefit accrues to NAARP. The remainder will be a return to additional investments in extension necessary to realize the potential created by the research project.

In addition to net value added by rice production on land that would otherwise not be producing, Table I-4 also estimates savings in pumping costs arising from the NAARP. This is simply one half of 25% of current water related costs that are avoided by adopting the new technologies/practices. These savings also come from Table I-5 and amount to 3,910 FCFA/ha for the research portion.

As Table I-4 shows, total benefits from the project's activities as these relate to rice perimeters on the Niger River, reach a plateaux after 20 years following the beginning of diffusion, amounting to about 68 million FCFA per year at that time. There are no benefits from varietal improvements or from research on rice agronomy since the first phase of the NAARP will focus this kind of research on the inland perimeters rather than on the Niger River perimeters. The second phase of the NAARP will address these problems on the river perimeters and for rice. Any benefits from such research would be more appropriately attributed to that package of financing.

3.1.2. Inland Perimeters

Table I-3 also shows the expected evolution of area in inland perimeters over the 1986-2015 period. Because inland areas represent the most underdeveloped of Niger's irrigation potential, we expect their total area to double over the next twenty years. This represents a growth rate of 4.7% per year, net of abondonnements. Also, because of problems associated with the surface dams, we expect two-thirds of this new area to be based on subsurface water sources. As a result, the proportion of total available area that is cultivated during the dry season will increase. This will cause fuel and pumping savings to grow in importance relative to water savings. Against this backdrop of continually expanding irrigated area, research on irrigated crops will take on greater economic importance as time goes on.

We estimate that supplemental irrigation meets about half of crop water needs on the inland perimeters during the rainy season. Up until the time that the storage reservoirs stop overflowing, excess irrigation does not waste water as such. About half of the quantity of supplemental irrigation applied to rainy season crops is applied during such periods. For the remaining quantity of supplemental irrigation water, we estimate that 35% could be saved by more careful application. Of this, almost all would be available for extending cultivated area during the dry season since the amount lost to evaporation in the reservoir should not increase.

Insert Table I-4

Insert Table I-5

Based on area cultivated on the inland perimeters during the 1985-86 rainy and dry seasons, Table I-6 estimates the actual increase in cultivated area made possible by more efficient use of water. Assuming water use efficiency during the dry season increases by the same proportion as for the rainy season, dry season area under production would increase by 35% from the current 1050 hectares. Using the water made availabe by improving efficiency of use during the rainy season would add another 350 hectares. The total increase in dry season cultivation that such research would make possible would come to 720 hectares based on existing perimeters. This amounts to 18% of total rainy season area. This 18% increase is then assumed to apply to all new surface dam systems created over the next 30 year period. In addition, this incremental dry season production should not affect the amount of flood recession cultivation (diecrua) in the reservoirs since they would recede over essentially the same period.

To project the economic value of this increase in dry season cultivation we assume that net economic benefits will be 25% of gross sales, using the crop mix indicated in Table I-6 and the prices in Table I-2. This is a higher percentage than for the Niger River perimeters bacuse this is entirely dry season employment.

For the two-thirds of the inland perimeters supplied from sub-surface sources of water, we assume that project related research will be responsible for a 10% reduction in water costs for both rainy season and dry season crops. Total costs per hectare in the absence of the project are assumed to be twice those found on the riverine perimeters since pumping heads will be much higher. Thus, net savings amount to 6,000 FCFA per hectare per crop season. Half of this accrues to research. We use the same adoption rates as we use for river perimeters. Table I-7 projects the increase in area and the anticipated benefits form the inland perimeters.

3.2. Cultural Practices

Technicians on the design team noted several areas where it appeared that research could provide information that would enable farmers to use inputs more efficiently or to increase their productivity. It probably goes without saying that such promise appears greater for irrigated than for dryland production technologies.

3.2.1. Soil Fertility

Research on soil fertility and fertilizer practices promise to have a considerable payoff. Many observers note a lack of response to potassium. Reformulating recommended doses and formulas could reduce fertilizer costs per unit of output by as much as 20%. Work on the methods of applying fertilizer promises to reduce volitilization of nitrogen from as much as 50% at the present time to no more than 20%. This would increase the economic level of application as well as improve the effectiveness of amounts currently applied. There is also considerable uncertainty over the extent to which locally available phosphate rock increases millet yields on rainfed lands.

TABLE I-6

AREA IN CROPS AND ESTIMATED WATER USE ON
INLAND PERIMETERS MANAGED BY ONAHA (1), 1985-1986

Crop	Rainy Season Area Cultivated	Rainy Season Yield (kg/ha)	Dry Season Area Cultivated	Dry Season Yield (kg/ha)	Proportion of Supplemental Irrigation Water Used By Season: Rainy	Dry
Sorghum	1918	1920	--	--		
Millet	477	1930	--	--		
Cowpeas	50	1000				
Cotton	1632	1550	--	--		
Wheat	--	--	833	3300		
Onions	--	--	113	38000		
Other	--	--	112	--		
Totals:						
Current Situation	4027		1058		66%	34%
Improved Situation	4027		1780		53%	47%
Flood Recession Cultivation	--	--	1373	--		

Source: Annual report of ONAHA technical assistant for Tahoua Region.

Footnotes:
1) Includes perimeters of Ojiratawa, Konni, Ibohamana, Galmi, Moulela, Kawara, Guidan Maggia and Tounafi.

Table I-7

With rainfall levels as erratic as they are in Niger it is doubtful whether use of nitrogenous fertilizers will ever become widespread on rainfed lands in the absence of large subsidies. The risk of loss for both the farmer and the economy is simply too high. Phosphate rock for dryland cereals poses difficult problems with transport costs. It will be difficult to deliver to farmers at an unsubsidized price that will make its use profitable on a widespread basis.

For these kinds of reasons we have projected returns to research on fertilizers to arise only on the irrigated lands. Current application methods in such areas leave much to be desired, while the relative assurance of adequate water promises to make it possible to realize many of the benefits normally expected from fertilizers. Benefits are assumed to equal 20% of the quantity of fertilizer currently applied per hectare (250 kgs.). This would amount to 50 kgs/ha on the perimeters and 25 kgs/ha on the micro-installations. These cost savings would be achieved without a corresponding reduction in crop output. Application rates are assumed to continue at present levels over the entire projection period. Adoption rates for farmers on perimeters are those used for wateruse improvements, with the maximum level attained reaching 50% of the area. This occurs 15 years after the beginning of the on-farm demonstrations by the extension service, year 20 of the project. Maximum adoption levl on the micro-installations is 25% after 20 years. Table I-8 summarizes the one-half of net benefits that go to research.

3.2.2. Seedbed Preparation

Poor stand establishment appears to be a widespread problem for all crops. Rice could clearly benefit from better leveling and puddling. Rainfed millet would probably benefit from phosphate rock so as to encourage more uniform germination and a denser plant population. The quality of land preparation is a problem in many areas that will require more than research to overcome.

The most promising innovation in the area of seedbed preparation is perfection of a row seeder for millet, sorghum, cowpeas and peanuts. The project includes a prototype fabrication fund for experimenting with, and adapting existing equipment from all over Africa. Not only do effective row seeders improve stand establishment and density, but they also reduce time spent weeding while improving the quality of this frequently neglected activity. Better seed establishment and more timely and effective weeding also permit plants to become firmly established sooner. This has the effect of providing a measure of drought resistance for existing rainfed varieties.

In spite of its intuitive appeal, row seeding will require a fairly radical change in farmers' cultural practices. Row seeding took 12-15 years to catch-on in Senegal, where cattle fattening provided a major incentive for owning oxen. This are fewer opportunities for this in Niger, with the result that oxen and associated equipment have not been all that exciting for most farmers. Poorly trained extension agents and poorly designed equipment have usually been other obstacles. On the assumption that the NAARP will take care of the equipment question, and donors will tackle the question of extension over the period of the NAARP, there is cause for optimism that the project can make a contribution in this area.

insert Table I-8

Although stimulating adoption of row seeders is one of the more promising outputs of the project, it is also potentially one of the more problematic -- especially with respect to the tremendous expense of the rainfed crop area. This is one reason for the relatively slow adoption rates projected for the rainfed areas, and the low cap on the maximum area ultimately adopting. For irrigated perimeters adoption rates are higher, but potential benefits are lower. For both areas we assume the project will have perfected a seeder by the end of the last year of the first phase.

In projecting benefits, we assume that use of row seeders will increase average production per hectare by 13% in dryland areas and 9% in irrigated areas. To accomplish this, time saved in weeding will have to be used to improve the quality of weeding on existing land rather than spent poorly weeding a larger parcel of land. Thus the net cost to the farmer of row seeding is the cost of the equipment and animals needed for the operation.

Row seeding on irrigated perimeters will also reduce labor spent on gravity irrigation. This will induce important economies in the Maggia Valley perimeters, but would be less important in the future if a greater proportion of inland irrigation is done by non-gravity means. For the economic analysis, and for the sake of simplicity, we assume that these savings compensate for the lower yield effect relative to the dryland areas. For both types of agriculture, then, we project a gross benefit from row seeders equal to an increase in production of 20%. This increase gets applied to the expanding area of inland systems, adjusted for the differing cropping intensities for surface and sub-surface systems.

We assume that three-quarters of these increases are offset by the costs of the equipment and animals, and the other quarter represents a net benefit to the economy. Of this, half, or 2.5% (.20*, .25*, .5), gets attributed to the NAARP and the rest to extension. This compares to 3.8% for the net return from rice production attributed to adoption of efficient water mangement practices. These relative values are reasonable given that the rice enterprise involves a crop during the dry season when competing economic activities are limited.

Seeders are assumed to be viable only in rainfall areas above 300 mm. They are expected to be used on the four major crops. In addition, some farmers already use row seeders on many of the inland perimeters. In recognition of this fact, we use one half of the normally assumed adoption rates for farmers on the inland perimeters. Table I-9 outlines the expected economic benefits from row seeding attributed to research.

3.2.3. Relay Cropping

The design team's irrigation agronomist feels there is a good possibility of being able to follow irrigated cotton with a 60 day cowpea crop grown largely on residual moisture. This would require that farmers cut-off cotton sooner than at present with the result that cotton yields would decline by about 15%. This last 15% in yield demands a very high labor cost since relatively few bolls are left on the plant during this period.

Insert Table I-9a

225

I-19

Insert Table I-9b

Cotton farmers are particularly attractive candidates for this kind of rotation since they are familiar with the use of insecticides and have the equipment. The major problem at this time appears to be that 60 day wonders from IITA are not yet well adapted to Niger. It is probably only a matter of time before they are. Given the price of cotton relative to cowpeas, it would probably take cowpea yields of close to one ton per hectare before farmers would find this type of relay cropping profitable. Farmers now get such yields occassionally, but intersperses with yields of 500 kgs/ha on irrigated fields. There appears to be some interesting potential in this area.

Though it may be somewhat speculative to include a project benefit for relay cropping of this sort, there will be other instances where unforseen research breakthroughs add to project benefits but do not get counted in this type of analysis. For this reason, we assume that, over time, 50% of farmers producing cotton on perimeters begin relay cropping of cowpeas with cotton on land that is not now used over We also assume a net economic benefit amounting to 20% of the quantity of cowpeas produced. The high benefit, given the loss of 15% of cotton output, arises from the fact that labor has limited opportunity for employment at this time of the year. Table I-10 details the benefits.

Although there will not be a legume breeder on the technical assistance team, INRAN already has a cowpea breeder. He will certainly be enabled to do more effective work under the project since INRAN will have more resources and a better organized research program. In addition, he will be working in close collaboration with the irrigation agronomist on technologies appropriate for the inland perimeters. Cowpeas is certainly one of the more promising of these.

3.2.4. Tied Ridging

Researchers accross the Sahel are becoming enthused with the potential of tied ridging for increasing crop yields. INRAN has some adherents to this point of view. There is little doubt that tied ridging increases yields, usually on the order of 25-35%; some researchers suggest figures closer to 50-60%. Whatever the increase, the disturbing concern is that tied ridging is not new to research stations in the Sahel. But it has never taken off with African farmers. Why not?

The answer to this question appears to be in the amount of labor that it requires, and the time farmers must do the ridging to be effective. The technique requires large inputs of labor at the same time as most rainfed crops. Tied ridging goes the way as planting on time, thinning, weeding on time and a host of other factors that demonstrably increases yields but which farmers do not rush to adopt. If such techniques increase unit yields at the expense of total production for the farm, or with the requirement that farmers provide additional labor, the prognosis for adoption is not good.

Insert Table I-10

2B

This being said, there is some hope that tied ridging will eventually spread through Niger. Researchers at Kamboinse in Burkina Faso have developed an oxen drawn implement that allows construction of ridge ties during the first weeding. If coupled with an effective row seeder, farmers might begin to see the makings of an effective animal traction package that can help them overcome their labor constraints. Although this area certainly deserves to be pursued, it does not seem advanced enough to warrant inclusion as a likely benefit from NAARP research activities.

3.3. Improved Varieties

3.3.1 Legumes

There are several promising areas of varietal research. The above mentioned cowpeas is one. Shorter cycle peanuts to follow cotton on inland perimeters is another. Like cowpeas, peanuts fix about five kilograms of nitrogen per hectare, in addition to providing high quality forage for livestock. Under present circumstances peanut varieties would probably need one spray to control for aphids, but again, spraying is nothing new for cotton farmers. The potential gain would be similar as for cowpeas, and, indeed, these two crops will be competing against each other for position as a suitable relay crop. Both peanuts and cowpeas are attractive because of their more limited need for water in a context where, in the near future, pumping costs will probably be the single most important component of irrigated crop production on the inland perimeters.

3.3.2 Cereals

For rice, INRAN is working on some promising varieties having cold tolerance and white fly resistance. This work will continue under the NAARP, and will certainly benefit from it. But, at best, the NAARP will speed up what would otherwise occur anyway. Heat tolerance on wheat is another area where potential exists, but this will probably not be an area of emphasis under the project. More than anything, these examples confirm that this analysis of potential returns is indicative rather predictive. Not all potential technological breakthroughs are included. Some of those that are, no doubt, will never see the light of day.

The varietal front for dryland cereals is promising. Researchers have identified varieties that consistently outperform existing varieties. In addition, NCRP researchers are currently working on some hybrid sorghums and are optimistic about the potential. It's difficult, however to see hybrids going very far under the soil fertility and rainfall conditions that prevail throughout most of the country. Moreover, the indirect cost of hybrids in the form of miserable yields for he who mistakenly plants second generation hybrid seed needs to be weighed carefully before beginning a full scale release.

INRAN has identified varieties of sorghum and millet that have acceptable taste characteristics and that out yield existing varieties by two or three to one on station trials. The millet variety, CIVT, has already been released. This variety has demonstrated consistent yield superiority of 40-100% in the on-farm trials program under a wide set of conditions. It has good farmer acceptability and is an intervarietal composite that should enable farmers to carry their own seed for an extended period of time.

The new sorghum varieties are in an advanced stage of multiplication. How they will perform under farm conditions is not yet known, especially under low rainfall, low fertility conditions. But with fertilizer application rates of 100 kgs of nutrients per hectare, and with normal rainfall, the varieties yield two to three times existing varieties. It would seem that they should be able to earn a prominent place in the production system, at least for superior performance in normal years. They should perform at full efficiency with rainfall above 500 mm. Between 400-500 mm of rainfall, researchers estimate that farmers should be able to realize between 50% of the potential of of the millet varieties and 30% of the potential of sorghum varieties.

Based on research and on-farm trial results to date, it would not be unreasonable to assume that farmers will achieve incremental yield increases of 50% under favorable rainfall conditions, i.e., rainfall in excess of 500 mm. Table I-11 projects the expected economic benefits assuming 25% of the increased production represents net economic value added and using the adoption rates as for row seeding. These amount to 254 million FCFA attributed annually to research at full adoption.

IV. EFFECT OF THE RESEARCH-EXTENSION LIASION UNIT

The major obstacle to diffusion of research results appears to be the small and weak extension program. In dryland areas, farmers are dispersed and extension agents have difficulty covering even a fraction of the country. Moreover, extension agents do not recieve up-to-date information on new varieties and have few resources to much with it if they did.

The NAARP will address some of these problems through the activities of its Research-Extension Liaison Unit. By facilitating contact between researchers and the extension service in order to conduct on-farm trials, the RELU will significantly increase the pace of diffusion of new research results. But to obtain maximum effectiveness from the on-farm trials INRAN must develop a successful method for working directly with extension agents rather than through a staff of INRAN field observers, as it does at present. Some of the varieties appear good enough to have some hope that they will spread spontaneously once a certain minimum level of diffusion has occured. But getting to that level will require more support and training for extension agents. Other technologies will need continued extension support to increase adoption. The RELU will help in both situations.

The economic return of the NAARP is highly sensitive to assumptions concerning adoption rates. The existence of the REL is expected to generate a quantum upward shift in adoption rates than that which would otherwise occur. The adoption rates used in the preceding analysis presume such a shift. If the RELU is not effective, or if needed additional support to extension is not forthcoming, than few of the expected innovations will reach the farm level. In that case, returns to this project will be close to zero.

insert Table I-11

V. ECONOMIC IMPACT OF THE NAARP

Table I-12 summarizes the benefits of the various potential technologies that the NAARP is likely to develop. These benefits grow slowly, primarily because of the amount of time required to perfect and test promising technologies before extending them to farmers. Once extension begins, the small number of extension agents and the vast areas to be covered operate to retard the speed of adoption. Even with 50-100% increases during the first few years, the small base grows to a measurable impact only after 3-4 years of successful extension efforts. By the 15th year following introduction to farmers, the project will be generating approximately 500 million FCFA in benefits net of farm level costs per year. This rises to 750 million FCFA by year 20 following introduction. Returns essentially plateau at this level.

Almost 78% of total benefits arise from the two technologies aimed at rainfed farming--use of row seeders and diffusion of improved varieties. The relatively small contribution of the irrigated subsector arises from its small size relative to the rainfed sector. Even with reasonably favorable adoption assumptions, research in the subsector is not able to have much impact on value added. The second phase of the NAARP should do more for this subsector since, unlike the first phase, it will devote attention to rice agronomy. The first phase will concentrate on gathering a better understanding of problems in the rice perimeters as a basis for preparing a sound second phase. Its focus on improved water management reflects the general recognition that, whatever other problems plague the rice perimeters, water management is certainly one that deserves immediate attention.

Table I-13 lists total costs and total net benefits for the project, using several alternative assumptions. It includes internal rates of return for the various options and facilitates an evaluation of how sensitive the results are to some of the underlying assumptions. Depending on the assumption, the IRRs vary between 2.4% and 10.5%

The lowest rate of return comes from the analysis of costs and benefits along the lines already discussed in this annex. The 2.4% rate of return reflects what the author feels are a moderately conservative set of assumptions given much of the recent history of agricultural development in West Africa. For those who find the assumptions too conservative, higher rates of return pertain to more liberal assumptions. These include using a 40 year rather than a 30 year projection period, assuming rainfed adoption rates that are twice those used in the base analysis, and costing technical assistance at local rather than U.S. costs. This latter adjustment responds to the argument that including the cost of technical assistance is inappropriate because of the structural disparities that exist between low wage countries and high wage countries. If local researchers were available, it is argued, they would cost only a fraction of the expatriates and require only a fraction of the support and amenities. This more reasonable cost, then, should be used in the analysis. This alternative does this and values T.A. at $7,500 per year, including salary and all allowances.

insert Tabla I-12

I-27

insert Table I-13

Stretching the benefit period out by 10 years causes the IRR to increase from 2.4% to 4.5%. Reducing the cost of technical assistance and eliminating project administration increases the return to 6.2%. Doubling rainfed adoption rates from a maximum of 12.5% by year 20 following introduction, to 25% over the same period, increases the IRR to 5.1%. Combining the higher adoption rate with the removal of technical assistance and related costs raises the rate of return to 9.1%. Lengthening the benefit period by ten years on top of this, gives an internal rate of return of 10.5%.

Under all these assumptions the project is marginal from the point of view of direct returns on investment. This is not surprising in light of the discussion in the introduction to this annex. What these returns say about appropriate investment policy is another matter, in the case of Niger, at least.

Niger does not enjoy a very optimistic horizon with respect to the agricultural sector. Natural constraints severely limit what government can do to improve the sector's productivity. Yet millions of people will continue to make their livlihoods in agriculture. Improving the availability of more productive technologies and the associated inputs is one of the few ways the GON can provide productive solutions to their problems. The alternative is to continue to rely on external aid to feed the country's urban and rural populations in periods of stress. Although this analysis suggests that in narrow economic terms it would be better to do this, in broader economic and political terms this is not an acceptable alternative. Something must be done. Research is one of the more promising alternatives.

The returns to this project are not cast in iron. Most importantly, the analysis is indicative only. We can only speculate what researchers will concentrate on and what they will find. The more we allow our imaginations to run free, the easier it is to find sufficient benefits to justify the project. Secondly, USAID can do a great deal to increase the returns to this project by acting on the factors that influence the assumptions used in the analysis. The most dramatic would be to increase the attention it is giving to extension, since the effectiveness of extension is the single most important factor influencing adoption rates under the project. Although the analysis already presumes considerable improvement in extension services, a twenty year adoption period for the improved varieties of sorghum and millet is no great accomplishment. The more this can be shortened, the higher will be the returns to the project.

It will take more than a change in assumptions to reduce this adoption period or to increase the overall adoption rates. It will require donors to search for, and to test new approaches to extension. It will require an infusion of incentives and discipline into whatever system works. Indeed, incentives and discipline may be all that is missing in the present system.

The bottom line, however, is that placing more attention on those aspects of the innovation delivery system that fall outside of the domain of research, may do more to increase returns for the project than anything that can be done from within. From this perspective, the marginal economic rate of return of the project could end up being a greater stimulus to agricultural development in Niger than a project demonstrating returns twice as high. The latter would, no doubt, facilitate continued avoidance of the really difficult issue facing agriculture in Niger and, indeed much of Sub-Saharan Africa.

ANNEX J

NAARP PARTICIPANT TRAINING PROGRAM

CONTENTS

I. Introduction

II. INRAN TRAINING PROJECTIONS

2.1. Academic Programs: INRAN

2.1.1. Suggested Disciplines for Professional Degree

2.1.2. Medium Term Non-Degree Programs

2.1.3. U.S. Term Training

2.1.4. International Conferences for Nigerien

2.1.5. In-country Training

2.1.6. Lower Level Professional Training Programs for INRAN

II. ONAHA TRAINING PROJECTIONS

III. TRAINING FOR GENIE RURAL

TABLE: TRAINING-INTERNATIONAL CENTERS

I. INTRODUCTION

Participant training funded by this project is designed to: 1) strengthen the skills of managers, researchers and technicians currently employed by INRAN; and 2) to provide to ONAHA and Rural Engineering personnel specialized training required to build inter-agency capacity to identify problems and carry out research on Niger's jointly-managed irrigated lands. As lead institution in the research process, INRAN will benefit from the greatest share of training opportunities.

The project will provide funds for short-term training to upgrade the skills of each of INRAN's field and laboratory assistants and technicians. Up to 200 person-months of coursework at IARCs and African institutions will be funded, along with 10 person-months of short course work in the U.S. The project will fund participation of 12 individuals at international conferences. In addition, up to seven person-months of short-term technical assistance will be made available for in-service training.

Advanced professional training will be provided for up to 17 INRAN personnel, 2 ONAHA personnel and 2 personnel from the Rural Engineering Service. Preference will be given to senior personnel needing M.S. or DEA degrees in studies related to irrigated (soil, water and crop management, engineering) and dryland agronomy. Up to 3 persons will be sponsored for Ph.D. studies in the U.S. Funding will also be provided for specialized non-degree training in the U.S. and Africa. This training will be available to personnel from INRAN, ONAHA, Rural Engineering and the extension services. All courses of study will clearly strengthen the GON's capacity to execute priority applied research programs.

Participants will be selected jointly by the sponsoring GON agency, the contractor and USAID.

II. INRAN TRAINING PROJECTIONS

The task of planning training programs at INRAN under the project is complicated by limited systematic long term planning in the past. Sufficient attention has not always been paid to the need to program replacements when existing personnel are taken out for long term training. Nor has there been a strategy for coping with the recurrent cost implications of bringing in newcomes to benefit from scholarships.

The training program outlined here is conditioned by several factors including the following uncertainties: 1) the need to have counterparts in place to work with the technical assistants due to arrive in project year three. This need constrains initiation of training programs early in the project; 2) approximately 40 students destined for INRAN are presently enrolled in degree programs outside of Niger. Most of these are due to returr betwwen 1987 and 1989, and normally should be available to INRAN after completing a year's civil service. However, never in the past have such a large number of foreign trained students returned to INRAN over a such short period of time. Thus, it is not certain that all these students will in fact be assigned to INRAN.

Bacause of the difficulty in planning in the face of these uncertainties, the training program that has been developed will be used as a basis for manpower planning to be conducted just following project start-up. Early in the project, a consultant will be engaged for a three month period to work with INRAN in developing a manpower training profile for the 5 years of the first phase of the NAARP project and beyond.

The manpower training profile will propose to reorient students presently enrolled in academic programs towards disciplines within their general field which will enable them to work with NAARP technicians. In particular, three or four students will be redirected towards study in the irrigated crop sector

No new degree training will be scheduled under the project untill year 3, when the bulk of students presently enrolled return to INRAN after completing their civil service. Exceptions to this condition could be made for candidates that are of the Ingenieur Agronome class, or those students that INRAN is able to guarantee will be replaced with qualified substitues. This condition is necessary to ensure that technical assistants have qualified professionals with whom they can work.

2.1. Academic Degree Programs: INRAN

Manpower training programs will be designed to assure a gradual influx into INRAN of professionals of MS or Ph.D level or their equivalents. It has been estimated that INRAN could be expected to absorb up to 20 new professionals over the 5 years of the project life, in a no-projet scenario.

NAARP will provide 17 scholarships to degree programs for up to 17 INRAN professionals of at least the Ingenieur Agronome level, present INRAN staff granduates of the University pre-programmed for INRAN and for personnel from other key Agriculural services. Ten of the degree candidates will be directec to US institutions; the remaining seven will be enrolled in Francophone institutions in Africa.

US academic degree programs will be comprised of 7 MS and 3 Ph.D Degree programs. Candidates proposed for training must have the academic qualifications required for the intended programs, will be required to follow the program for which they have been selected and have a good previous academic record.

The US project contractor will employ a training coordinator, based in the US, who will be responsible for coordinating academic and thesis programs with INRAN research and training needs. Supervision of thesis programs will entail annual visits to INRAN of a month's duration for the coordinator and/or for thesis advisors to supervise thesis research.

2.1.1. Suggested Disciplines for Professional Degree Programs

A. US Academic Degree Programs

1) Agronomy

2) Horticulture

3) Research Extension

4) Weed Control
   a. integrated weed management
   b. herbicide and application technique

5) Soil Science
   a) soil and water chemistry
   b) soil fetility and fertilizer
   c) applied soil physics and management
   d) soil tillage techniques

6) Agriculture Mechanics

7) Entomology
   a. integrated pest management
   b. insecticide and application technology

8) Plant Physiology

9) Management/Accounting

10) Irrigation Agronomy
    a. Cereals: Sorghum, wheat, maize
    b. Legumes: cowpeas, peanuts, forage crops.

11) Irrigation Engineering

12) Agriculture Economics

TOTAL US DEGREE PROGRAMS

3 Ph.D level

3 persons x 3 years = 9 person years

7 M.Sc. level

7 persons x 2.5 years = 36 person years

240

B. Francophone degree programs in African institutions (Ingenieur Agronome or Ingenieur Agronome, 3ème cycle).

1) Statistics

2) Agricultural Economics

3) Information Management, micro computer statistical applications

4) Irrigation Engineering

5) Agronomy, irrigated crops

6) Irrigation Engineering, emphasis in irragation water managament.

TOTAL FRANCOPHONE DEGREE PROGRAMS

10 persons x 15 person months = 150 person months

C. US Non-Degree Programs (AS and B.Sc. degrees)

1) Agro-climatology

2) Statistic/Experimental Design

TOTAL US NON DEGREE PROGRAMS

2 persons x 24 person months = 48 person months

2.1.2. Medium Non-degree Programs

To a greater extent than under previous projects, NAARP will emphasize specialized medium term training to upgrade the professional, technical and management skills of INRAN personnel. Both professionals (eg. class level B and C) and the technical auxiliaries will be included. Training will be conducted largely through the International Agricultural Research Centers (IARCs) which offer 4-9 months specialized training in selected topics. A list of the programs offered by the centers is attached. Also utilized will be programs offered by rural development centers of francophone Africa.

241

It will be necessary to reinforce INRAN's limited expertise in the area of irrigation management before the arrival of the technical assistance. Training in management and other fields for technicians who will not be expected to work directly with a technical assistant could also begin in the early months of the project. However, selection of candidates for training courses related to dry land crops should be postponed until the arrival of the technical assistants so that they can help identify appropriate courses and participate in the selection process.

Participation in training courses before arrival of the technical assistants will be planned by the manpower consultant engaged just following poject start up, and arranged by the project manager.

Selected topics for the non-degree (IARC) programs.

1) Irrigation technology, emphasis on surface application techniques
2) Soils Analysis, emphasis on laboratory chemical-physical analysis
3) Agricultural mechanics, emphasis on animal draft technology
4) Breeding/selection (cowpea, rice, millet, sorghum, groundnuts)
5) Farm/station management
6) Plant Pathology (cereals, legumes, veg. crops)
7) Seed Multiplication
8) Germ Plasm Bank
9) Research Extension
10) Research Management
11) Entomology
12) Soil Fertility
13) Soil Physics
14) Agricultural Mechanics (field equipment)
15) Management/Accounting
16) On-Farm Trial Procedures
17) Agro-climatology
18) Agricultural Chemical Handling Technique
19) Seed Technology
20) Field Plot Techniques, Data Recording

TOTAL NON-DEGREE PROGRAM 200 person months

2.1.3. US Short Term Training

10 person months, participation in professional meetings and seminars.

2.1.4. International Conferences for Nigerian Researchers

2-3 participants per year or 12 persons total.

2.1.5. In-Country Training

There will be considerable in-country training under NAARP, some of it handled through consultancies or arrangements with private organizations having expertise in particular disciplines, some of it by the expatriate technical assistance staff. The manpower training consultant refered to the above, will develop an in-country training program with details for implementation over the project life. The INRAN manpower training specialist and the Mission will attend to the administrative tasks in setting up program prior to the arrival of the team leader of NAARP.

Important topics for in-country training programs, and numbers of participants, are listed below. Participants will include both professionals and auxiliaries.

A. Management/Accounting:

1 month x 2 times x 10 persons

B. Data Management/statistics/microcomputer applications:

1 month x 2 times x 10 persons

C. Commodity management:

1 month x 2 times x 10 persons

D. Lab technicians refresher course:

0.5 months x 2 times x 10 persons

E. On-farm and multi-location trial methodology:

basic course
0.5 months x 1 time x 100 persons

Refresher course
0.25 month x 2 times x 75 persons

F. Other, yet to be identified

TOTAL IN-COUNTRY TRAINING — 200 person months
7 person month of consultancies

243

2.1.6. Lower Level Professional Training Programs for INRAN

NAARP will also provide for a number of in-country training programs for C and D level cadre at IPDR of Kolo. This will include 10 to 14 scholarships for completion of third year and fourth year specializations at IPDR.

14 person x one year = 14 person years

II. ONAHA TRAINING PROJECTIONS

As a participating institution, ONAHA will be provided academic scholarships and in-country training opportunities as follows:

A. Professional degree programs at African institutions
   Irrigation Engineering: 1 x 15 person months
   Irrigation Management : 1 x 15 person months

B. In-country programs
   On-farm trial methodology: 0.25 month x 2 times x 20 person
   Irrigation management, for perimeter director and cooperative leaders: 0.5 month x 2 times x 40 person.

Professional degree programs will be at Francophone institutions in Africa, such as those in Morocco, Tunisia, Senegal or Ivory Cost.

III. TRAINING FOR RURAL ENGINEERING

Rural Engineering, also a participating institution in NAARP, will benefit from scholarships for degree and in-country training.

A. Professional degree programs
   Irrigation technology: 15 months x 2 person

B. In-country training
   Irrigation technology for field level staff
   1 month x 1 time x 5 person

TRAINING-INTERNATIONAL CENTERS

INSTITUTE & LOCATION	DISCIPLINE	DURATION	INITIATION DATE	$US *1 COST/PERIOD	LANGUAGE
ICRISAT Hydrabad, India	Breeding	6 mo.	May 15 or Sept. 15	$700/mo.	English (Note: 8 week English course, if necessary)
	Production Agronomy	6 mo.	"	"	
	Plant Pathology	6 mo.	"	"	
Crops: Sorghum, Millet, Pigeon peas, Chickpeas	Plant Entomology	6 mo.	"	"	
	Plant Physiology	6 mo.	"	"	
	Resource Management (Farming Systems)	6 mo.	May 15 only	"	
	Agricultural Economics	6 mo.	"	"	
	Seed Production	6 mo.	"	"	
	Agricultural Engineering	6 mo.	"	"	
CIMMYT	Breeding-wheat, barley triticale	7 mo.	Late Feb.	$1300/mo.	English & Spanish
Ciudad Obregon (North)	Plant Pathology-wheat, barley, triticale	7 mo.	Late Feb.	"	
Toluca (South)	Production Agronomy-wheat, barley, triticale	7 mo.	Late April	"	
El Batan, Mexico (70 kms east Mexico City)	Cereal Quality-wheat, barley, triticale	2+ mo.	May 1	"	
	Breeding-maize (corn)	5 1/2 mo.	Dec 1 or June 1	"	
Crops: Wheat, Barley, Triticale, Maize (corn)	Production Agronomy	5 1/2 mo.	"	"	
	Plant Pathology	5 1/2 mo.	"	"	
	Cereal Quality	2+ mo.	"	"	

IRRI Los Banos (90 kms North Manila) Phillippines Crop: Rice	Editing & Publishing Genetic Evaluation & Utilization Soil Fertility & Fert. Evaluation Cropping Systems Stat. Proc. & Computer Appl. in Ag. Res. Agricultural Engineering Upland Rice Integrated Pest Mgmt. Irrigation Water Mgmt. Farming System Socioecon Res	3 1/2 mo. 4 mo. 4 mo. 51/4 mo. 21/2 mo. 3 wks. 4 mo. 41/4 mo. 11/2 mo. 21/4 mo.	Feb 2 or July 20 Feb 2 Feb 2 Feb 2 March 30 May 25 & Nov 16 July 20 July 20 Aug 24 Oct. 5	$750/mo plus $630 for enroute & shipping expesne	English
IITA Ibadan, Nigeria Crops: Root & Tuber crop, Cowpeas Soybeans Maize Rice Plantains, Bananas	Breeding Production Agronomy Farming Systems Soil & Plant Analysis Biocontrol Soil & Water Mgmt. Weed Mgmt. Alley Cropping Tissue Culture	Varying 3-16 wks	Dates of starting vary	$1000/mo.	English & French
WARDA Monrovia, Liberia	Rice Production Farm Equip., Sel, Use & Mgmt. Audiovisual & Extension	5 mo. 2 mo. 1 1/2	June 19 Jan. 20 Feb. 9	$1560/mo. $1800/mo. $1800/mo.	English-French English-French French

Crop: Rice	Post-harvest technology	2 mo.	Apr. 6	$1800/mo.	English-French
	Field Assistants	1 1/2 mo.	May 4	$1800/mo.	English-French
	Seed Multiplication	1 1/2 mo.	June 22	$1800/mo.	French
	Milling Refresher Course	3 wks.	Aug 17	$1350 total	English-French
	Azolta	?	?	?	?
	Project & Water Mgmt	?	?	?	?
	Intergrated Pest Mgmt.	?	?	?	?
	Farm Mechinization & Appropriate Technology	2 mo.	Jan. 20	$1800/mo	English-French
ICARDA Aleppo, Syria	Cereal Improvements	3 1/2 mo.	Mar. 1	$1040/mo	English Also French & Arabic as needed
	Food Legume Improvement	3 1/2 mo.	Mar. 1	"	
	Pasture, Forage & Livestock Improv.	3 1/2 mo.	Mar.1	"	
Crops: Wheat, Barley, Triticale, Chickpeas, Broadbeans, Lentil	Farming Systems Research	1 1/2 mo.	Feb. 15	"	
	Seed Technology	1 mo.	1987	"	
	Seed Quality Control	3 wks	1987	"	
	Soil and Plant Analysis	2 wks	1987	"	
	Fertilizer Efficiency	3 wks	1987	"	

247

IFDC Muscle Shoals, Alabama	Fert. Mkt. Mgmt.	11/2 mo.	Aug. 11	$1200	English +French for soil & fertilizer use programs
	Fert. Quality Control	3 wks	Sept. 22	$ 950	
	Statistics & Economics of Fertilizer	3 wks 3 wks	Sept. 21	$ 950	
	Fertilizer Process Economics	3 wks	June 2	$ 950	
	Maintenance & Production Mgmt.	3 wks	Oct. 13	$ 950	
	Data Collection, Analysis & Projections	3 wks	Mar 16	$ 950	
	Microcomputers for Fertilizer Sector Personnel	3 wks	Request	$ 950	
	Fertilizer Use Efficiency	1 wk	July 27, '87	?	
Held at ICARDA, Aleppo, Syria	Fert. Use Efficiency in in Tropics & Sub-Tropics	3 wks	Nov 9, '87	$ 950	

*1 : All quoted costs include housing, subsistence stipend, insurance, local training supplies. Excluded is international airfare to location.

International Institutes purposely omitted: CIAT, Cali, Columbia - Tropical crops
CIP, Lima, Peru - Potatoes
IBPGR, Rome, Italy-FAO - Genetic Resources
IFPRI, Washington, D.C. - Food Policy
ILCA, Addis Adaba, Ethiopia - Livestock Prod. & Mkt.
ILRAD, Nairobi, Kenya - Animal Diseases
ISNAR, The Hague, Netherlands - Agr. Research

ANNEX K

ACTIVITIES OF OTHER DONORS

ACTIVITIES OF OTHER DONORS

Irrigated Agriculture

In the area of irrigated agricultural development most of the bilateral and multilateral donors are active, a situation which has created a somewhat chaotic pattern of programs, and of donor/GON/farmer relationships as well.

In general, the bilateral and multilateral donors have concentrated on the development of infrastructure although in the past an important sociological component was built in to perimeter development. Lip service is now being given to organizational development and perimeter creation or rehabilitation. Applied research continues to be neglected by the majority of donors. The private donors and service organizations have devoted some attention to developing appropriate technologies, and to indigenous technology transfer, but they are not in a position to conduct basic or applied research. However, they have not done much to popularize their innovations. The technological bias in irrigation development in Niger is now also reflected in the technical bias of ONAHA, which has demonstrated little concern about either the equity, organizational or organic aspects of its perimeters.

Perimeter and Irrigation Development

The European funding agencies, FED, FAC, CCCE, etc, tend to coordinate in staking out their domains of intervention. But they are not currently funding any major research ventures in irrigated agriculture, and this policy is unlikely to change. FED funded sugar cane research at Tillabery ended in 1980 for example. In addition, INRAN is seen as a privileged domain for USAID intervention, and is not likely to receive much attention from these donors.

The IDA/CCCE/KFW Irrigation Rehabilitation project will rehabilitate infrastructure on 16 perimeters, 11 along the river and 5 in the Maggia Valley. Roughly half of the $25 million budget is for rehabilitation, $2.8 million is programmed for strengthening ONAHA's management capability. Aside from its responsability for the river perimeters, ONAHA will assume responsability for conceptualisation of small-scale perimeters employing improved pumping technologies and will supervise construction activities.

In the area of coordination, the Bank intends to retrain 36 perimeter directors, and to extend management, literacy and numeracy training to eleven perimeters through the CCCE and the Centre de Formation des Cadres d'Alphabetisation of the Ministry of Education. Some $4.5 million has been allocated for these activities.

The Office of Regional Development and Small Scale Projects was created in the Ministry of Plan in 1984 with IDA/PPF funding to asure overall

250

responsability for integrated regional planning. Included in its responsabilities is coordination of small-scale gardening sites development.

The FAO has proposed to create a unit of development and technical support for small scale irrigation within Genie Rural with two regional branches serving the Niger and Komadougou rivers. This unit will funnel assistance to Genie Rural to carry out its traditional functions of technical design and construction oversight.

Among the large donors, the World Bank and the FED are furthest along in preparation of funding proposals for small garden sites. FAO has been active in identification and preparation of project proposals. BAD, FIDA, FENU and PNUD have taken an interest in funding such proposals.

In Diffa, the Canadian integrated rural development project is currently experimenting with three or four innovative techniques of water capture and management to increase irrigated agricultural production. However, there is no varietal research going on. Research on rice, corn, improved water lifting and management, markets are all needed. CIDA's is a long term program of support.

The FED has an ambitious program of small irrigation development to be undertaken in 13 arrondissements and coordinated in the field by the AFVP. There is no research component to this project, and they basically intend to extend knowledge of irrigation techniques accumulated over the years by the AFVP. Some effort will be made to synthesize available technical information. Little attention is to be given to varietal testing, but it is felt that the greatest weakness is in the area of extension methodology.

The FED is also undertaking an extensive retraining program of perimeter directors at Kolo to increase their technical competence in irrigation, agronomy, management, and cooperative development. It will also finance management and literacy training of cooperative leaders: GMP heads and comités de gestion on its perimeters. A certain uncertainty about appropriat extension methods persists.

Since 1980, the FAC has renovated one perimeter, SONA II. FAC provides long term technical assistants to ONAHA invarious disciplines, although not i research. FAC has been financing a feasability study of three cuvettes aroun Gaya. The total area under study covers about 3000 ha. Because of uneven relief several types of irrigation system are being recommended, and one cuvette has been proposed for development as a fairly traditional rice parimeter.

The Duch had intended to get involved with retraining of perimeter directors in the Maggia area but certain political difficulties have now to b resolved first.

Over the next five years, the FED, World Bank, and the Belgians are, in fact, going to be extending three different packages of irrigation and cooperative management and literacy training on the perimeters whose development they have funded.

251

Research Activities

There are a number of planned small scale research efforts for the riverine rice systems. The World Bank perimeter rehabilitation scheme intends to subcontract 1) fertilizer trials, 2) new rice variety screening, 3) and production of rice foundation seed to INRAN. The rehabilitation project is also funding a monitoring and evaluation unit at ONAHA.

FAC sponsors a research program at Lossa and SONA II with technical assistance from GERDAT. Trials on irrigation methods, soils fertility managements and the like are conducted with farmers.

Since 1981, Belgian Assistance has developed a perimeter at Say, and a 25 ha rice seed farm. Belgian assistance has engaged two expatriates to work on ONAHA's seed farm at Saadia and has provided related, short term training in France for one Nigerien. This project, which is under the administrative authority of ONAHA, emphasizes seed multiplication over research. However, one hectare at the farm has been set aside for INRAN trials, but INRAN has been unable to mount any activity there.

The Belgian rice specialist at Saadia emphasizes INRAN's financial difficulties and personnel constraints which severely constrain its ability to conduct rice trials correctly. He also identifies the following critical research priorities:

developing short and medium length cycle varieties of rice,
developing cold resistant varieties,
developing varieties which are less photo-periodic,
developing higher yield varieties.

Protocols exist to encourage collaboration between INRAN and ONAHA at the seed farm, but an enlarged role for INRAN would be welcomed by ONAHA.

Interesting applied research on irrigated crops was conducted at the pilot farm on the Djiratawa perimeters developed within the context of the IBRD funded Maradi Rural Development Project. Studies were made of crop water use, and irrigation frequency and irrigation methods. Agronomic trials were conducted on a variety of crops.

FAO/DANIDA, in collaboration with ONAHA has recently undertaken a short-term, narrow focus program on fertilizer trials on rice at several river perimeter sites. The study has been directed at determining the economic optimum of various fertilizer combinations. Demonstration of the fertilizer effects to farmers was one aim of the study, but was compromised by poor design and inadequate extension.

IRFA funds a arboriculture specialist posted to INRAN Niamey.

Japanese technical assistance funds three specialists in various aspects of rice agronomy who are posted to INRAN's Kolo station near Niamey.

Very few studies have been conducted concerning crop water use, irrigatior efficiencies, or of irrigation methods on the surface dam perimeters. IRAT conducted some of the first type of research in the early 60s, but it has since been abandoned. The work recently conducted by WMS II on the latter two topics has stimulated the interest of ONAHA, and Genie Rural personnel. ONAHA has expressed an interest in developing its capacity to conduct similar studies and in developing methods to use this formation for planning purposes.

Dryland Agriculture

In dryland agriculture, the programs most directly relevant to INRAN's activities are those associated with the Crop Protection Service, including programs funded by German, USAID, and Canadian monies, the USAID funded CRSPs, and the ICRISAT Sahelian Center program.

The former program has resulted in the creation of an entomological collection and significant research into millet head borers and a number of cowpea pests. The Germans have funded mobile units which have equiped and trained arrondissement level crop protection services. However, field studies suggest that the link between research and extension remains weak.

The Sahelian Center of ICRISAT is carrying out programs of both basic and applied research on the major crops grown in the Sahel, programs which involve both long-term and short-term components. Very considerable banks of improved germ plasms are being constituted and major studies of fertilization, crop association, cultural techniques, and the like are underway.

In the past, relations between INRAN and ICRISAT have been frosty. Personslity differences and the disparity in resources available to the two institutions have been responsable for this situation. Both parties now seem aware of the value of collaboration, and some modest steps have been taken. ICRISAT has begun to finance in-country and regional field visits for INRAN staff, and there have been exchanges of germ plasm. ICRISAT and INRAN should be encouraged to deepen their relationship. The addition of a training component to ICRISAT's activities during the life of the project should provide one vehicle towards such strengthening. Conduct of joint field trials both on-station and in the field should be encouraged as well.

In general, the NAAR will complement ongoing donor interventions in the agriculture sector. Aside from NCR, no other sustained agricultural research program sited in INRAN is currently underway or planned as far as the project design team could tell.

ANNEX L

BUDGET DETAILS

CONTENTS

I. Budget Details (Summary)

II. Table 1: NAARP Indicative Budget (USAID Contribution)

III. Table 2: Indicative Budget for Long-Term Technical Assistance

IV. Table 3: Short Term Technical Assistance Budget Details

V. Table 4: Niger Contributions To NAARP, 1987-1992

VI. Table 5: NAARP Summary Cost Estimate and Financial Plan

VII. Table 6: NAARP Costing of Project Outputs

VIII. Table 7: NAARP Obligation Schedule

ANNEX L

BUDGET DETAILS

Table L-1 contains details of the summary project budget included in the text of the Projet Paper. Costs relating to technical assistance are detailed in Tables L-2 and L-3. Table L-1 expresses these both as absolute amounts as well as percentages, depending on the instance.

Training estimates are those provided by the mission, with the exception that costs get projected at the same 6% rate as other costs rather than the 11% recommended by the mission. The latter rate strikes the team as a solution to last year's problems rather than a response to current realities. Much of the training will take place in Africa, in any case.

The costs for operating an in-country office in support of the technical assistance team are based on costs actually incurred by the Purdue team for the NCR Project. The estimates allow for operating two offices, one in Niamey and another at Maradi. On campus/headquarters costs are also based on actual costs incurred on the present contract. Costs for personnel at INRAN are based on the most recent budget proposal submitted by INRAN to USAID under the NCRP.

Table L-4 details INRAN contributions to the project. These are mostly in-kind contributions and include physical and price contingencies, the same as for USAID expenditures. Total GON contributions amount to $3.2 million over the life of Phase 1 of the project. This represents just under 14$ of total project costs. Table L-5 shows the breakdown of these costs between local and foreign exchange costs. Table L-6 divides them according to project output. The last table, Table L-7, shows the obligation schedule for USAID funds.

NIGER APPLIED AGRICULTURE RESEARCH PROJECT SUMMARY BUDGET
(U.S. dollars)

Expenditure Categories	Project Year					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
I. TECHNICAL ASSISTANCE						
A. Long Term Technical Assistance	585758	1364298	1638343	1446299	752436	5787133
B. Short Term Technical Assistance	178420	223025	89210	245328	356840	1092823
Subtotal	764178	1587323	1727553	1691626	1109276	6879956
II. PROJECT ADMINISTRATION						
A. In-Country Office	90550	204600	222600	210600	182600	910950
B. On-Campus/Contractor Support	142800	142800	142800	142800	142800	714000
C. Other	136484	170618	172418	171218	168418	819154
Subtotal	369834	518018	537818	524618	493818	2444104
III. TRAINING						
A. Long Term	387500	87500	285300	252700	570600	1583600
B. Short-term	59000	106100	126200	126200	126200	543700
C. Travel for Trainees	31000	34200	40600	50200	75800	231800
Subtotal	477500	227800	452100	429100	772600	2359100
IV. COMMODITIES	163400	266320	116160	128280	38000	712160
V. CONSTRUCTION	308000	0	0	0	0	308000
VI. OTHER COSTS						
A. INRAN	221000	316500	380500	365500	370500	1654000
B. ONAHA / MOA	0	17500	35000	52500	70000	175000
C. Miscellaneous Costs	40000	41000	71000	71000	71000	294000
D. Management	60000	30000	30000	30000	30000	180000
Subtotal	321000	405000	516500	519000	541500	2303000
SUBTOTAL ALL DIRECT COSTS	2403911	3004461	3350130	3292624	2955193	15006319
Physical Contingencies (5%):	120196	150223	167507	164631	147760	750316
Price Contingencies (6%): (a)	144235	371351	639875	864314	999446	3019221
Devaluation Contingency: (b)	203394	246302	257355	274802	240987	1222840
TOTAL PROJECT COSTS	2871736	3772337	4414867	4596371	4343386	19998697

Footnotes:

(a) Price adjustment factor applied to all direct costs. Factors are .06,.1236,.1910,.2625 and .3382 for for years 1 through 5 respectively.

(b) Local costs subject to devaluation amount to the fol 1271213 1539388 1608469 1717514 1506169 7642752
The devaluation contingency amounts to .16 of such costs,
reflecting an expected average exchange rate of 2 0 FCFA/$ S
over the five year life of the project v rsus the
present rate of 325 FCFA/$US.

TABLE L-1
NIGER APPLIED AGRICULTURE RESEARCH PROJECT INDICATIVE BUDGET:
DETAILED BUDGET FOR USAID CONTRIBUTION
(U.S. dollars)

Expenditure Categories	Calculati Modality	Unit Cost (dollars)	Project Year Year 1	Year 2	Year 3	Year 4	Year 5	Total
I. TECHNICAL ASSISTANCE:								
A. Long Term Technical Assistance:								
Number of Contracts			6	3	0	4	0	13
Person Years			1.75	6.75	9.00	7.50	4.00	29.00
1. Salaries:								
Research Mgt.Spec./Team Leader	3 per/yrs	60000	30000	60000	60000	30000	0	180000
Cereals Breeder/Coordinator	3 per/yrs	50000	12500	50000	50000	37500	0	150000
Dryland Agronomist	3 per/yrs	50000	12500	50000	50000	37500	0	150000
Irrigation Agronomist	3.25 per/	50000	0	12500	50000	50000	50000	162500
Soils Water Management Spec.	3.25 per/	50000	0	12500	50000	45000	50000	157500
Irrigation Engineer	3.25 per/	50000	0	12500	50000	45000	50000	157500
Extension Specialist	4.25 per/	43000	10750	43000	43000	45000	43000	184750
Economic Anthropologist	3 per/yrs	43000	10750	43000	43000	38000	0	134750
Agricultural Economist	3 per/yrs	45000	11250	45000	45000	33750	0	135000
Subtotal Salaries			87750	328500	441000	361750	193000	1412000
2. Fringe Benefits	25% of A.		21938	82125	110250	90438	48250	353000
3. DBA & AID Assist	2.5% of A 1		2194	8213	11025	9044	4825	35300
4. Allowances:								
Post Differential	25% of A.		21938	82125	110250	90438	48250	353000
Post Allowance	9% of A.1		7898	29565	39690	32558	17370	127080
Education	29 per/yr	10500	18375	70875	94500	78750	42000	304500
Subtotal Allowances			48210	182565	244440	201745	107620	784580
5. International Travel & Transp.:								
Airfares	contract	9100	27300	40950	13650	18200	18200	118300
R & R	contract	6600	0	39600	19800	0	26400	85800
Education Travel	researche	1200	2100	8100	10800	9000	4800	34800
Miscellaneous Travel Expense	contract	4000	24000	12000	0	16000	0	52000
Air and Sea Freight	contract	20500	123000	61500	0	82000	0	266500
Subtotal Travel & Transport			176400	162150	44250	125200	49400	557400
6. Housing and Utilities	per year	25000	43750	168750	225000	187500	100000	725000
7. Household Furnishings								
New Sets (five houses)	5 sets	12000	60000	0	0	0	0	60000
Replacement Appliances	5 sets	2000	10000	0	0	0	0	10000
8. Administrative Overhead	75% OF A.1 & A.2		82266	307969	413438	339141	180938	1323750
9. Consortium or Management Fee	10% of A.1 to A.8		53251	124027	148940	131482	68403	526103
SUBTOTAL LONG TERM T.A.			585758	1364298	1638343	1446299	752436	5787133
B. Short Term Technical Assistance:								
1. Salaries:								
Technical Disciplines/Computers	10 per/mo	6000	12000	12000	12000	12000	12000	60000
Training Specialist	7 per/mo.	6000	18000	6000	6000	6000	6000	42000
Agr. Machinery Specialist	5 per/mo.	6000	18000	6000	6000	0	30000	60000
Marketing Specialist	6 per/mo.	6000	0	18000	0	18000	0	36000
Evaluation	8 per/mo.	6000	0	18000	0	30000	48000	96000
Subtotal Short Term T.A. Salarie	36 per/mo.		48000	60000	24000	66000	96000	294000
2. Fringe Benefits	25% of B.		12000	15000	6000	16500	24000	73500
3. DBA & AID Assist/SOS	2.5% of B 1		1200	1500	600	1650	2400	7350
4. Travel, Transportation & Misc.	36 per/mo	7000	56000	70000	28000	77000	112000	343000
5. Administrative Overhead	75% of B. + B.2		45000	56250	22500	61875	90000	275625
6. Consortium or Management Fee	10 % of B 1 to B.5		16220	20275	8110	22303	32440	99348
SUBTOTAL SHORT TERM T.A.			178420	223025	89210	245328	356840	1092823

TABLE L-1 (Contd.)

II. PROJECT ADMINISTRATION COSTS:								
A. In-Country Office:								
1. Salaries and Fringe Benefits			27550	55100	55100	55100	55100	247950
2. Local Management Contract			15000	30000	30000	30000	30000	135000
3. Office Supplies & Services			16500	33000	33000	33000	33000	148500
4. Telecommunications			7500	15000	15000	15000	15000	67500
5. Office Equipment & Repair			3500	7000	7000	7000	7000	31500
6. Office Vehicle Operations			4000	8000	8000	8000	8000	36000
7. Miscellaneous Research Expenses	Researche	3000	5250	20250	27000	22500	12000	87000
8. Official Travel (per diem & trans	Researche	5000	8750	33750	45000	37500	20000	145000
9. Training for Office Staff			2500	2500	2500	2500	2500	12500
Subtotal In-Country Office			90550	204600	222600	210600	182600	910950
B. On-Campus/Contractor Support:								
1. Salaries Fringe Benefits			109600	109600	109600	109600	109600	548000
2. Office Supplies			8000	8000	8000	8000	8000	40000
3. Telecommunications			12000	12000	12000	12000	12000	60000
4. Travel			13200	13200	13200	13200	13200	66000
Subtotal On-Campus Support			142800	142800	142800	142800	142800	714000
C. Administrative Overhead	75% of A.1 & B.1		102863	123525	123525	123525	123525	596963
D. Consortium / Management Fee	10% of A Thru C		33621	47093	48893	47693	44893	222191
SUBTOTAL PROJECT ADMINISTRATION			369834	518018	537818	524618	493818	2444104
III. TRAINING:								
A. Long Term:								
1. Degree Training:								
Ph.D. - U.S.	3 persons	75000	0	0	0	0	225000	225000
M.Sc. - U.S.	8 persons	62500	0	0	187500	125000	187500	500000
DEA-Afr. (6 INRAN, 4 G.R.& ONAHA)	10 per./1	11250	22500	22500	22500	22500	22500	112500
2. Non-Degree Training:								
U.S.	2 pers./2	50000	0	50000	0	50000	0	100000
Africa	10 pers/1	7500	15000	15000	15000	15000	15000	75000
3. Thesis Program Guidance	11 person	20100	0	0	60300	40200	120600	221100
4. Continuation of NCRP Training			350000	0	0	0	0	350000
Subtotal L.T. Training			387500	87500	285300	252700	570600	1583600
B. Short-term:								
1. United States	10 pers.	3500	7000	7000	7000	7000	7000	35000
2. Africa	100 pers.	1300	26000	26000	26000	26000	26000	130000
3. International Centers	100 pers.	1300	26000	26000	26000	26000	26000	130000
4. In-Country Training:								
Expatriate Instructors	7 pers. m	20100	0	20100	40200	40200	40200	140700
Per diem & Travel/Participants	200 pers.	300	0	15000	15000	15000	15000	60000
5. International Conferences	12 resear	4000	0	12000	12000	12000	12000	48000
Subtotal S.T. Training			59000	106100	126200	126200	126200	543700
C. Travel for Trainees:								
1. International Air Fares:								
Niger - US	34 trips	2800	5600	8400	14000	22400	44800	95200
Niger - International Centers	25 trips	2000	10000	10000	10000	10000	10000	50000
Niger - Africa	45 trips	1000	9000	9000	9000	9000	9000	45000
2. Misc. Travel Expenses	104 trips	400	6400	6800	7600	8800	12000	41600
Subtotal Travel for Trainees			31000	34200	40600	50200	75800	231800
SUBTOTAL TRAINING			477500	227800	452100	429100	772600	2359100

Table L-1 (Contd.)

IV. COMMODITIES:								
A. Vehicles								
1. 4WD Station Wagons	5 units	20000	20000	20000	40000	20000	0	100000
2. 4WD Light Trucks	6 units	17000	34000	17000	17000	34000	0	102000
3. Sedans	4 units	11000	22000	11000	0	11000	0	44000
4. 125 cc motobikes	25 units	1200	2400	4800	8400	9600	4800	30000
5. 90 cc motorbikes	75 units	900	3600	10800	18900	19800	14400	67500
Subtotal Vehicles			82000	63600	84300	94400	19200	343500
B. Vehicle Spares	20% Of A.		16400	12720	16860	18880	3800	68660
C. Irrigation & Research Equipment			45000	180000	10000	10000	10000	255000
D. Office Furnishing & Equipment			20000	10000	5000	5000	5000	45000
SUBTOTAL COMMODITIES			163400	266320	116160	128280	38000	712160
V. CONSTRUCTION:								
A. Storage Sheds/Office (Pts d'Appui)	3 @ 36 sq	19000	54000	0	0	0	0	54000
B. Equipment Sheds & Irrigation Design:								
1. TARNA		250	170000	0	0	0	0	170000
2. KOLO		250	84000	0	0	0	0	84000
SUBTOTAL CONSTRUCTION			308000	0	0	0	0	308000
VI. OTHER COSTS:								
A. INRAN:								
1. Auxiliary Personnel:								
Accountant	One	4000	4000	4000	4000	4000	4000	20000
Accounts Clerks	Two	3000	6000	6000	6000	6000	6000	30000
Purchasers/Inventory Mgrs	Five	3000	15000	15000	15000	15000	15000	75000
Chief Mechanics	Two	4000	0	0	8000	8000	8000	24000
Chief Research Techs.	One per T	3500	10500	17500	21000	21000	21000	91000
DECOR Observateurs		1500	22500	30000	37500	37500	37500	165000
Research Liaison Technicians	Two	2000	4000	4000	4000	4000	4000	20000
Local Machine & Equipment Mgr	One	50000	50000	50000	50000	0	0	150000
Other Auxiliary Personnel			20000	20000	20000	20000	20000	100000
Subtotal INRAN Auxiliary Per.			132000	146500	165500	115500	115500	675000
2. Temporary Labor			50000	50000	50000	50000	50000	250000
3. Official Travel (Overnight allowances, External Travel & Meetings)			15000	50000	55000	60000	65000	245000
4. Vehicle Operation & Maintenance	4 wheel v	6000	18000	48000	60000	70000	70000	266000
	motorbike	1000	6000	22000	50000	70000	70000	218000
Subtotal INRAN Costs			221000	316500	380500	365500	370500	1654000
B. ONAHA / MOA								
1. On-farm Trial Mgrs/Extension Agts	100 perso	1500	0	15000	30000	45000	60000	150000
2. Displacmnt Allow.for MOA Ext.Agts	cost per'	30	0	2500	5000	7500	10000	25000
Subtotal ONAHA / MOA			0	17500	35000	52500	70000	175000
C. Miscellaneous Costs:								
1. No-loss Guar. Fund for On-Farm Tr.			0	1000	1000	1000	1000	4000
2. Prototype Fabrication Fund			0	0	30000	30000	30000	90000
3. Infrastructure Maint & Repair			30000	10000	10000	10000	10000	70000
4. Training Materials			0	15000	15000	15000	15000	60000
5. Research and Laboratory Supplies			10000	15000	15000	15000	15000	70000
Subtotal Miscellaneous Costs			40000	41000	71000	71000	71000	294000
D. Management:								
1. Annual External Audit			30000	30000	30000	30000	30000	150000
2. Local Management Consultant	3 months	10000	30000	0	0	0	0	30000
SUBTOTAL OTHER COSTS			321000	405000	516500	519000	541500	2303000

Table L-1 (Contd.)

SUBTOTAL ALL DIRECT COSTS		2403911	3004461	3350130	3292624	2935193	15006319
Physical Contingencies (5%):	5% of all costs	120196	150223	167507	164631	147760	750316
Price Contingencies (6%): (a)	6% per annum	144235	371351	639875	864314	999446	3019221
Devaluation Contingency: (b)	280 FCFA/$ US	203394	246302	257355	274802	240987	1222840
TOTAL PROJECT COSTS		2871736	3772337	4414867	4596371	4343386	19998697

Footnotes:

(a) Price adjustment factor applied to all direct costs. Factors are .06,.1236,.1910,.2625 and .3382 for for years 1 through 5 respectively.

(b) Local costs subject to devaluation amount to the fol 1271213 1539388 1608469 1717514 1506169 7642752
The devaluation contingency amounts to .16 of such costs,
reflecting an expected average exchange rate of 280 FCFA/$US
over the five year life of the project v rsus the
present rate of 325 FCFA/$US.

TABLE L-2

INDICATIVE BUDGET FOR LONG-TERM TECHNICAL ASSISTANCE
(U.S. Dollars)

	Annual Costs	Cost per Contract
1. Annual Salary	50000	
2. Fringe Benefits:		
a. Social Security (7.3% of 1)	3650	
b. Retirement Fund (10% of 1 &4.b)	5436	
c. Health Insurance	2600	
d. Group Life, Dental & Disability	500	
e. FUTA	420	
Subtotal Fringe Benefits	12606	
3.DBA + AID Assist:		
a. DBA (@ 2.3% of 1.)	1150	
b. AID Assistance (@ $80/yr)	80	
Subtotal DBA/AID Assist	1230	
4. Allowances:		
a. Post Differential (25% of 1)	12500	
b. Post Allowance (Class 25)	4360	
c. Education Allowance		
- One child at post @ $4200/yr	4200	
- 1/2 child at boarding school @ $12500 per year	6250	
Subtotal Allowances	27310	
5. International Travel:		
a. Economy Air Fare (3.5 round trips/contract/$2600 ea)		9100
b. R & R (3 round trips/contract/$2200 ea)		6600
c. Education Travel (1/2 child @ $2400 round trip)	1200	
d. Int'l per diem (3 pers/two days @ $125/day)		750
Subtotal International Travel	1200	16450
6. Pre-departure Expenses:		
a. Pre-departure physical (3 @ $100)		300
b. Other Expenses		500
c. Communications and Misc.		450
d. Air & Sea Freight:		
1) Air Freight (600 lbs @ $4/lb each way)		4800
2) Sea Freight (HHE & Consumables) (1500 lbs @ $2/lb each way)		10000
3) One-way personal auto shipment		2500
4) Packing and Storage (3 years)		2000
5) Shipment of Professional Books and Equipment		1200
Subtotal Pre-Departure Expenses		21750
7. Housing and Utilities:		
a. Rent	10000	
b. Utilities and Maintenance	15000	
c. Temporary Housing Allowance ($52 x 2 1/2 persons x 15 days)		1950
Subtotal Housing & Utiities	25000	1950
TOTALS	117346	40150

Note:
Indicative budget is for Allowances, Fringe Benefits, Transportation and other costs for a Contractor with two dependants at post, one-half dependent at boarding school and $50,000 in annual salary.

TABLE L-3

SHORT TERM TECHNICAL
ASSISTANCE BUDGET DETAILS
(U.S. Dollars)

	Cost per Month
1. Salary 25 days @ $235 each	5875
2. Fringe Benefits:	
a. FICA (@ 7.3% of 1.)	429
b. DBA (2.3% of 1.)	135
c. AID Assist ($25 per month)	25
Subtotal Fringe Benefits	589
3. Travel & Transportation:	
a. Air Ticket	2500
b. Int'l per diem (2 days @ $125/day)	250
c. 10 kgs Excess Baggage	250
d. Misc. Travel Expenses/Local Travel	520
e. Com., Photocpyg, Secret.Ser.	500
f. Per Diem (28 days @ $105/day)	2940
Subtotal Travel & Trans.	6960
4. Administ. Overhead (75 % of 1 & 2)	4848
5. SUBTOTAL	18272
6. Consortium or Mgt Fee (10% of 5)	1827
TOTAL COST PER MONTH	20099

TABLE L-4

NIGER CONTRIBUTIONS TO NAARP, 1987-1992
(U.S. Dollars)

Contribution	Project Year: Year 1	Year 2	Year 3	Year 4	Year 5	Total
I. Salaries:						
A. Counterparts:						
Researchers	10500	40500	54000	45000	24000	174000
Auxiliary Staff	12775	49275	65700	54750	29200	211700
B. Trainees:						
Researchers	60000	0	30000	48000	180000	318000
Auxiliary Staff	16500	35000	29000	35000	29000	144500
Subtotal Salaries	99775	124775	178700	182750	262200	848200
II. Office Facilities:						
A. U.S. Researchers:						
INRAN Headquarters	12000	12000	12000	12000	12000	60000
Kolo Research Station	3000	12000	12000	12000	12000	51000
Tarna Research Station	6000	12000	12000	12000	6000	48000
B. INRAN Counterparts	9000	24000	24000	12000	18000	87000
Subtotal Off. Facilities	30000	60000	60000	48000	48000	246000
III. Research Facilities:						
A. Laboratory Equipment	50000	50000	50000	50000	50000	250000
B. Field Equip. & Infrastr.	50000	50000	50000	50000	50000	250000
C. Research Plots	50000	50000	50000	50000	50000	250000
Subtotal Research Fac.	150000	150000	150000	150000	150000	750000
SUBTOTAL ALL DIRECT COSTS	279775	334775	388700	380750	460200	1844200
IV. Indirect Costs (75% of I)	74831	93581	134025	137063	196650	636150
V. Contingencies:						
Physical Contingincies (5%)	17730	21418	26136	25891	32843	124018
Price Contingencies (6%)	22340	55592	104832	142722	233254	558741
TOTAL PROJECT COSTS	394677	505366	653694	686425	922947	3163108

Source: Tables H-5, H-6, L-1 and authors estimates.

Note: Coefficients for estimating price contingincies are those in Table L-1.

Table L-5

Niger Applied Agricultural Research Project
Summary Cost Estimate and Financial Plan
(U.S. Dollars)

Cost Category	USAID EX	USAID LC	Niger EX	Niger LC	Total
Technical Assistance:					
Long-term	6,431,692	1,799,545	0	0	8,231,23
Short-term	1,092,923	0	0	0	1,092,82
Training	2,299,100	60,000	0	462,500	2,821,60
Commodities	667,160	45,000	0	0	712,16
Construction	0	308,000	0	0	308,00
Other Costs	220,000	2,083,000	0	2,017,350	4,320,85
Subtotal	10,710,775	4,295,545	0	2,480,350	17,486,67
Physical Contingencies (5%)	535,539	214,777	0	124,018	874,33
Price Contingencies (6%)	1,933,358	1,035,363	0	558,741	3,577,96
Devaluation Contingency *	361,815	861,025	0	0	1,222,84
TOTAL COSTS	13,541,437	6,457,210	0	3,163,108	23,161,80

* For detail on devaluation contingency as applied to foreign exchange costs see Table L-5b. The contengency is applied to only those foreign exchange costs likely to be determined by non-dollar curencies or likely to be purchased from non-U.S. sources.

TABLE L - 5B

LOCAL COSTS AND FOREIGN EXCHANGE COSTS
SUBJECT TO DEVALUATION CONTINGENCY

Line Item:	Local Costs	Foreign Exchange Costs: Subject to Devaluation	Foreign Exchange Costs: Not Subject to Devaluation	TOTAL
Long-Term Personnel:				
I.A.Long Term Technical Assistance				
5. Travel and Transport	0	278,700	278,700	557,400
6. Housing and Utilities	725,000	0	0	0
9. Consortium Mgt. Fee	72,500	27,870	425,733	453,603
Balance L.T. Tech. Assist.	0	0	3,978,630	3,978,630
II. Project Admin. Costs				
A. In-Country Office	910,950	0	0	0
D. Consortium Mgt. Fee	910,950	0	131,096	131,096
Balance Project Admin.	0	0	1,310,963	1,310,963
Sub-Total	1,799,545	306,570	6,125,122	6,431,692
Short-Term Personnel	0	0	1,092,823	1,092,823
Training				
III.A. Long Term Training				
1. DEA - Africa	0	112,500	0	112,500
2. Non-Degree-Africa	0	75,000	0	75,000
B. Short-Term				
2. Africa	0	130,000	0	130,000
3. International Conferences	0	130,000	0	130,000
4. In-Country Training	60,000	0	140,700	140,700
5. International Conferences	0	48,000	0	48,000
C. Travel for Trainees	0	115,900	115,900	231,800
Balance of Training	0	0	1,431,100	1,431,100
	60,000	611,400	1,687,700	2,299,100
Commodities	45,000	667,160	0	667,160
Construction	308,000	0	0	0
Other Costs:				
Research & Lab. Supplies	0	70,000	0	70,000
External Audit	0	150,000	0	150,000
Balance of Other Costs	2,083,000	0	0	0
Sub-Total	2,083,000	220,000	0	220,000
Totals	4,295,545	1,805,130	8,905,645	10,710,775
Price Contingencies	1,085,863	456,315	1,477,043	1,933,358
Sub-Totals	5,381,408	2,261,445	10,382,688	12,644,133
Devaluation Contingency (.16)	861,025	361,815	0	0

TABLE L-6

NIGER APPLIED AGRICULTURAL RESEARCH PROJECT
COSTING OF PROJECT OUTPUTS
(U.S. Dollars)

Cost Category	Output # 1	Output # 2	Output # 3	Total
USAID:				
Technical Assistance	1144	4959	777	6880
Construction	121	187.3	0	308.3
Commodities	67	645	0	712
Training	236	2123.0	0	2359.0
Other Costs	795	3105.0	847	4747.0
Contingencies	794	3652.4	546	4992.4
Subtotal USAID	3157	14672	2170	19998.7
Host Country:				
Other Costs	0	2480	0	2480
Contingencies	0	683	0	683
Subtotal Host Country	0	3163	0	3163
TOTAL COSTS	3157	3157.0	2170	23162

1) Difference from Main Budget Table due to application of flat rate

TABLE L-7

NIGER APPLIED AGRICULTURAL RESEARCH PROJECT
OBLIGATION SCHEDULE
(U.S. Dollars)

FY 88	4757904
FY 89	4093602
FY 90	4505619
FY 91	4469878
FY 92	2171693
TOTAL	19998697

ANNEX M

PROCUREMENT PLAN

CONTENTS

I. COMMODITY PROCUREMENT PLAN.

II. ILLUSTRATIVE EQUIPMENT LIST FOR IRRIGATION AGRONOMY (WATER - SOIL - CROP MANAGEMENT) RESEARCH PROGRAM

III. ILLUSTRATIVE LIST OF NEEDED OFFICE SUPPLIES AND EQUIPMENT

IV. ILLUSTRATIVE LIST OF PROJECT VEHICLES

I. COMMODITY PROCUREMENT PLAN

There are five major types of procurement to be undertaken within the framework of the NAARP.

The first includes household furniture and appliances for the technical assistance team. Timely delivery of these supplies before the arrival of the full team should be ensured. The AID contractor support officer, the project manager and the AID procurement office will initiate this procurement. NCR nonexpendable property, including furnishing for at least five households, will be passed on to the NAARP after the PACD of NCR.

The second type commodities to be procured includes laboratory equipment and supplies (equipment and supplies needed to equip and/or support the cereals quality, plant physiology, plant pathology, seed treatment, and entomology labs). This second type can be sub-divided into two groups: those needed for irrigation research activities and routine lab work, and those needed to continue dryland agricultural research and lab work. Items which fall into the first category, and which are listed in the attached indicative commodities list, will be procured as soon as possible following the start-up of the project through the procedures mentioned below. No new procurement of items in the second category will occur until an inventory assessment and indicative listing of new equipment and materials needs has been conducted by a consultant to the project. A preliminary assessment was done by the design team. The results are on file at the mission, describing the condition of the project's present equipment inventory and INRAN's lack of an appropriate commodity management system. Plans are in process to upgrade INRAN's commodity management capabilities, and the NAARP will strongly urge these plans be carried out to a satisfactory end.

These commodities will be procured by the mission procurement office (with the collaboration of the AID/W procurement office) through and IQC Procurement Supply Agent. The project design team provided some technical details of the commoditiy needs (see attached list), and the principal contractor will provide additional details and an indicative cost proposal as part of their response to the RFTP.

The PIO/C for these commodities will be issued from Niamey as soon as possible after the signature of the Pro Ag., and receipt/review of responses to the RFTP. Financing will be handled by AID/W in conformity with agency regulations governing use of IQC PSAs. The PSA will oversee shipment to Niger in such a manner that this equipment will arrive between the time of arrival of the team leader and the arrival of the irrigation related technical assistance team members. Roughly one year is budgeted for procurement and shipping of sea freight, and six months for air freight items. The technical assistance team, in collaboration with the mission procurement office, will have responsability for receipt and installation of this equipment.

The third type of commodity to be procured includes farm machinery, and irrigation and pumping equipment to be used on INRAN research stations. Technical specifications of equipment needs will be carried out as for the laboratory equipment. Procurement will be carried out in the United States using the IQC PSA procedure. Contracts will be let for bid only to those U.S. firms who have local representation in Niger (i.e. Caterpiller, International Harvester, Massey Ferguson, John Deere, and Ford). In addition, the team will consider developing a supply contract with one of the local firms to stock a supply of spare parts and other heavy use items for this equipment. These local firms will be called on for service after the sale, and the team leader will investigate the possibility of developing a regular maintenance schedule (or the training of INRAN personnel in maintenance) through these firms.

A fourth type of commodity to be procured is vehicles and parts, which will be procured in-country with a standard 611 source and origin waiver for non-U.S. procurement. Included in the waiver will be fifteen vehicles (six 4x4 light pick-up trucks, five station wagon type 4x4s and four sedans). In addition, one hundred small off-road motorcycles for transport of experiment and trial observers will be included in the wavier. Again, as part of the procurement contract, the contractor will provide stocks of spare parts. The USAID mission procurement office should arrange for procurement of these vehicles in a timely fassion, so that they are available as needed.

The fifth and final type of procurement, is for office equipment and supplies. These materials will be paid for from the local currency budget. Shelf items whose value does not exceed dollars 5000 can be purchased directly from the suppliers. Larger orders will require the project to follow a bidding procedure. The time frame for receipt of goods which are obtained through this process can exceed six months. Therefore, the project will consider passing single, large annual orders for office equipment and other office supplies, including standard items like pencils, paper clips stencils and the like. In any case, detailed front-end planning will occur in the first, and each successive year of the project, so that supplies are made available to INRAN (including the technical assistance team) in a timely manner.

270

II. ILLUSTRATIVE EQUIPMENT LIST FOR IRRIGATION AGRONOMY (WATER - SOIL - CROP MANAGEMENT) RESEARCH PROGRAM

A. PLANT - SOIL - WATER RELATIONS EQUIPMENT

1 - Digital leaf porometer with data module (Rs)
1 - Infrared canopy temp. gun
1 - Pressure chamber apparatus (leaf)
20 - Tensiometers of different sizes (matric)
2 - Sling psychrometers (air)
2 - Neutron moisture probes with transport cases: digital memory modules.
50 - Access tubes with caps for neutron probes.
10 - Soil sample augers for core samples:
- 5 Willardson - Taylor type
- 5 Large bulk density sample type with drivers, with spare inserts.
10 - Soil probes - graduated T-bar type.
500 - Core sample storage/transport containers (hermetic)
5 - Soil thermometers - digital with data module; multiple depth probes.
1 - Set plans and materials to build stationary lysimeters (concrete basin type)

B. ET EQUIPMENT

10 - Class A evaporation pans
5 - Integrated automatic weather stations with data modules (temperature, vapor pressure, radiation sensing; and self-dumping rainfall recording.); spare modules
20 - Direct-reading rain guages with stands, with metric constant graduation internal markings

C. LINE-SOURCE EXPERIMENT EQUIPMENT

40 - Sections 6-meter pipe with risers and couplings
40 - Rain-bird cone distribution sprinkler heads w/spec. nozzles.
2 - Line pressure gauges with couplings.
200 - Graduated sprinkler water collection cans.
2 - Spare submersible pumps 220V 10 liters/sec x 10 meter head

D. IRRIGATION EFFICIENCY STUDY EQIPMENT

10 - Cut-throat flumes (fiberglass) w/level bubbles - 25 cm throat.
100 - Pcs siphon tubing of various diameters.
100 - Pcs steel gated pipe with controlled orifice control, w/couplings, 6 meter lengths (other eqpt. as specified above for P-S-W relations;
5 - Stopwatches.
10 - Reels 50 meter surveyor's chain
5 - Double-ring infiltrometers
5 - Portable weirs with canvas dams
5 - Stream gages - pitot - tube type w/travel cases
-1 - Set builder's level and metric surveying rod. HD travel cases.

E. GENERAL FIELD EQUIPMENT

- TRACTOR OPTIONS: 1) Two new 60 HP tractors (3 pt hitch PTO, full hydraulics)
  or 2) One new 60 HP tractors + one flat-bed (tilt-bed) trailer
  or 3) Repair two or three existing INRAN tractors.

1 - ea: tandem disc set, single tooth ripper/subsoiler, furrow cutter-shaper, vibra-shank cultivator, ridger, float, spike-tooth harrow
4 - pairs oxen and donkeys w/yokes draw bars, tool bars, plows, ridgers weeders
4 - sets row seeders for same, "SUPER-ECHO" w/complete disc sets
1 - Backpach manual-level action spray rig w/cone and fan nozzles.
1 - Shallow-bin dumping trailer - (hydraulic lift) -
2 - ULV battery-powered spray rig (CFDT-type) (insecticide use)
1 - boom sprayer
2 - Plant junior hand push seeders w/disk

F. LABORATORY EQUIPMENT

(220v 50H)
2

2 - Micro-computers, IBM-compatible, desk-top, 512K byte RAM, dual 5 1/4" floppy drives, B/W monitors, standby power source/protection
2 - Ea. receptacles for downloading data modules from weather stations, leaf porometer, neutron moisture probe, soil thermometers.
1 - Soil/leaf sample drying ovens, 220v, automatic timer
2 - Digital analytic balances, 1000g capacity, 220v
2 - Digital analytic balances, 10kg capacity, 220v
2 - Portable beam balances, 100kg capacity.
2 - PH meters w/4 spare electrodes, 220v, KCl extractant reagent.
3 - Electrical conductivity (mho) meters, 220v
1 - Pressure plate apparatus
1 - Set soil textural analysis equipment (mortar/pestle, granulometric screens, cylinders and plungers.) Spare cylinder.
1 - Set up for O.M. contect analysis (bunsen burner, crucibles, ring stand, ring clamp, tongs, etc.)
1 - Seed counter, digital, stop setting adjustment:
1 - Plastic bag sealer (hot iron), 220v.
- Seed packets
- Rolls of H.D. plastic bagging material, various widths.
- Misc. glassware: graduated cylinders, beakers, flasks, etc.
- Shipping containers for soil, foliar, and seed samples.
- Plastic storage jars, wide-mouth.

G. ADDITIONAL FIELD SUPPLIES AND EQUIPMENT

100,000 plain pollinating bags
25,000 red stripe pollinating bags
25,000 green stripe pollinating bags
10 folding pruning knives
20,000 wire tages assorted colors
20,000 plastic bags various sizes
10 picking bags
500 jute harvest bages
10 ctn color flagging
50,000 12" garden stakes
200,000 # 6 coin envelopes for seed
200,000 # 3 coin envelopes for seed
1 backpack manual level action spray rig w/cone & fan nozzles
1 boradcast fertilizer spreader (tractor driven PTO)
1 shallow bin dumping trailer (hydraulic)
1 ULV battery powered spray rig

III. ILLUSTRATIVE LIST OF NEEDED OFFICE SUPPLIES AND EQUIPMENT

A. IABNA OFFICE

2 - Micro-computers, IBM-compatible, desk-top, 512K byte RAM, dual 5 1/4" floppy drives, B/W monitors, standby power source/protection
2 - Epson LX1000 printers 220v
Assorted office furniture, equipment and supplies

B. KOLO OFFICE

2 - Micro-computers, IBM-compatible, desk-top, 512K byte RAM, dual 5 1/4" floppy drives, B/W monitors, standby power source/protection
2 - Epson LX1000 printers 220v
Assorted office furniture, equipment and supplies

C. INBAN HEAD OFFICE

2 - Micro-computers, IBM-compatible, desk-top, 512K byte RAM, dual 5 1/4" floppy drives, B/W monitors, standby power source/protection
2 - Epson LX1000 printers 220v
Assorted office furniture, equipment and supplies

D. CELLULE RECHERCHE VULGARISATION

2 - Micro-computers, IBM-compatible, desk-top, 512K byte RAM, dual 5 1/4" floppy drives, B/W monitors, standby power source/protection
2 - Epson LX1000 printers 220v
Assorted office furniture, equipment and supplies
1 - VHS video cassette player a camera, with 5 system color TV
2 - Slide projector, screen, and 20 carousels

E. DECOB

2 - Micro-computers, IBM-compatible, desk-top, 512K byte RAM, dual 5 1/4" floppy drives, B/W monitors, standby power source/protection
2 - Epson LX1000 printers 220v
Assorted office furniture, equipment and supplies
Miscellaneous field and survey equipment

IV. ILLUSTRATIVE LIST OF PROJECT VEHICLES

A. 6 - 4x4 double cab pick-up trucks

B. 5 - 4x4 vehicles, Land Cruiser type

C. 4 - sedans

D. 100 - off road motorcycles