# PN HAR OLI 48326

### NIGER IRRIGATION SUBSECTOR ASSESSMENT

### VOLUME ONE

MAIN REPORT

July, 1984 USAID, Niamey Glenn Anders, Irrigation Engineer Walter Firestone, Agronomist Michael Gould, Environmental Specialist Emile Malek, Public Health Specialist Emmy Simmons, Farming Systems Economist Malcolm Versel, Vegetable Marketing Teresa Ware, Institutional Analyst Tom Zalla, Team Leader

# NIGER IRRIGATION SUB-SECTOR ASSESSMENT

# Table of Contents

		Page		
	EXECUTIVE SUMMARY	i		
I.	INTRODUCTION	1		
II.	GOVERNMENT AND DONOR ACTIVITIES RELATED TO IRRIGATED AGRICULTURE	2		
Α.	Government of Niger Institutions 1. Ministry of Rural Development (MDR)	2 2		
	<ol> <li>Ministry of Hydrology and the Environment (MHE)</li></ol>	3		
В.	Research (MESR)	4 4		
III.	IRRIGATION SYSTEMS IN NIGER	5		
A. B.	Jointly Managed River Pumping Systems Jointly Managed Surface Dam Systems	6 6		
C.	Systems	7		
υ.	Systems	7		
IV. ENGINEERING ASPECTS OF IRRIGATED AGRICULTURE				
	IN NIGER	8		
Α.	Factors Influencing Development Costs	9		
	2. Design Standards	11		
	3. Competition	12		
	4. Risk and Uncertainty	12		
В.	Water Supply and Management Problems	13.		
C.	System Maintenance.	14		
D.	Irrigation	15		
v.	PRODUCTION TECHNOLOGIES AND AGRONOMIC	17		
-	CONSTRAINTS	17		
Α.	Cropping Systems and Cultural Practices	17 17		
	2 Surface Dam Systems	17		
	3. Ground Water Pumping Systems.	18		
	4. Micro Irrigation Systems	18		

١

В.	Agronomic Constraints on Increasing Yields Under Irrigation	. 19
VI.	ECONOMIC AND FARMING SYSTEME ASPECTS	. 21
A. B.	Costs and Returns to Irrigated Farming Farming Systems Constraints on Irrigated	. 21
		. 23
VII.	MARKETING ASPECTS OF IRRIGATED AGRICULTURE	. 26
A. B.	Marketing Systems	26 26 26 26 27
C. D.	Vegetables	27 27 28 28 29 29 29 29 29 30
VIII.	INSTITUTIONAL, SOCIAL AND POLICY ISSUES	31
A. B. C. D. E. F.	Cooperatives Extension and Training ONAHA. Research Management System and Tand Tenure. The Kole of the Privace Sector	31 32 33 34 35 35
IX. H	ENVIRONMENTAL AND PUBLIC HEALTH ISSUES	38
A. B. C. D. E.	Water Resources. Soils	38 39 30 39 40
X. 1	PROGRAM AND PROJECT POSSIBILITIES	41
A. B.	Improving Production Versus Expanding Irrigated Area	41 41
3	Address	41 42
C. 1	<ul> <li>Frogram Areas which USAID Might Address Along with Priority Problem Areas Under a Production Improvement Program</li></ul>	43 44 44 45

 $\mathcal{F}$ 

# NIGER IRRIGATION SUBSECTOR ASSESSMENT

# Table of Contents

# VOLUME TWO: ANNEXES

ANNEX	A:	DONUR ACTIVITIES RELATING TO IRRIGATED AGRICULTURE	A-1
ANNEX	B:	IRRIGATED PERIMETERS IN NIGER: EXISTING AND UNDER WAY	B-1
ANNEX	C:	AGRONOMIC ASPECTS OF IRRIGATED AGRICULTURE IN NIGER	C-1
ANNEX	D:	THE ECONUMICS OF IRRIGATED AGRICULTURE DEVELOPMENT	• 1
		AND PERFORMANCE IN NIGER	D-1
ANNEX	Ε:	VEGETABLE MARKETING IN NIGER	F_1
ANNEX	F:	INSTITUTIONAL AND SOCIAL ISSUES RELATED TO IRRIGATED	<b>C-</b> I
		AGRICULTURE IN NIGER	F-1
ANNEX	G:	ENVIRONMENTAL REVIEW OF IRRIGATION IN NIGER	G_1
ANNEX	Н:	PROGRAM AND PROJECT POSSIBILITIES	
ANNEX	I:	TERMS OF REFERENCE FOR VEGETARIE MARKETING STUDY	1-1
ANNEX	J:	IMPACT OF IRRIGATED AGRICULTURE ON PUBLIC HEALTH IN NIGER	1-1
		WITH SPECIAL REFERENCE TO SCHISTOSOMIASIS	.1_1
ANNEX	К:	ASSESSMENT OF THE ENGINEERING ASPECTS OF IRRIGATION IN NIGER	K-1

.

#### NIGER IRRIGATION SECTOR ASSESSMENT

#### Executive Summary

#### Background

Of over 9,000 hectares of irrigation schemes established in Niger since independence, only 5,500 hectares were actually in production in 1983. Existinirrigated area is falling out of production at the rate of 12% per year. Moreover, irrigated land still in production is producing well below its agronomic potential. This state of affairs is a source of concern to donors who see the development of irrigated agriculture in Niger as crucial to the country's ability to feed itself over the longer term. The purpose of this report is to identify the reasons for this substantial underachievement of potential and to suggest areas where USAID might most effectively focus its development assistance for this subsector.

Responsibility for irrigated agriculture in Niger is divided principally between the <u>Genie Rural</u>, the <u>Office National</u> <u>des Amenagements Hydro-Agricoles</u> (ONAHA) and the Ministry of Hydrology and the Environment (MHE). The <u>Genie</u> <u>Rural</u> is responsible for design and for supervising construction; ONAHA, for implementation, management and maintenance of irrigated perimeters; and the MHE for collecting and analyzing information on surface and groundwater.

The FED, FAC, IBRD, CCCE, KFW and Kuwait are the most active donors working in irrigation. At the present time, Niger has under construction or committed for donor financing over 5,500 hectares of new perimeters. Another 4,000 hectares are scheduled for rehabilitation. Donors generally provide training, credit and technical assistance for the perimeters which they finance.

#### Irrigation Systems

Niger has four predominant types of irrigation systems. Jointly managed river pumping systems are located on the flood plains and terraces of the Niger River. They generally produce a double crop of rice. These account for about half of all irrigated land.

Jointly managed surface dam systems are found in and near the Maggia Valley. They account for about 20% of Niger's developed irrigated area. Cotton and sorghum are the principal rainy season crops grown on these perimeters which essentially provide only supplemental irrigation. Less than 25% of the land produces anything during the dry season because of a lack of water in the reservoirs. Vegetables, wheat, millet and other crops dominate dry season cropping systems on these perimeters.

Niger is just completing development of its first medium-scale, jointly managed groundwater pumping system at Djiratawa, on the Goulbi Maradi. This system accounts for less than 2-1/2% of Niger's irrigated area, but being a tube-well system, it offers promise for developing vast shallow river valleys where surface reservoirs tend to silt up and experience very high rates of evaporation. Because of the more reliable water supply, dry season vegetables are more important on the groundwater pumping systems than on the other nonrice perimeters.

Individual managed micro-irrigation systems probably account for somewhere around 25% of Niger's total irrigated area at the present time. These are generally small, family-sized systems, ranging in size from a quarter hectare to two hectares. On these systems, farmers draw water from wells six meters deep or less, using various manual methods, and generally produce high valued vegetables--more often than not, onions.

Small scale irrigation is found in all four systems. Small scale systems tend to be 2-20 hectares in size, but their crucial identifying characteristic is their management system, not their size. Small scale systems tend to be initiated and managed by a group of farmers or individual households, with minimal or no assistance from external sources.

The cost of developing one hectare of medium scale irrigated perimeter in Niger is high, even by Sahelian standards, amounting to four to six million FCFA per hectare. Key factors accounting for the relatively high cost include difficult topography, unnecessarily high design standards, a lack of competition in bidding for construction contracts and political risks and uncertainty.

#### Water Supply and Management

Water supply and management appear to be a problem on virtually every perimeter. Reduced rainfall has lowered the flow of the river and reduced the inflow into the inland reservoirs. At the same time, heavy siltation has reduced the storage capacity of the reservoirs and greatly reduced their ability to provide adequate water for dry season irrigation. Unnecessarily long pumping periods, excessive application of water, poorly cleaned canals and poorly leveled fields all compound problems of water supply.

ONAHA is in the process of trying to make farmers take greater responsibility for maintaining irrigation systems. It is raising user fees for the services it provides, and at the same time, making farmers responsible for perimeter level maintenance under threat of removal from the perimeter. It is not known to the assessment team whether these sanctions have been applied in more than isolated instances.

#### Agronomic Aspects

In general cultural practices on irrigated perimeters are adequate by West African standards, though there is considerable room for improvement. Farmers generally plant improved varieties and apply close to recommended levels of fertilizers. Weeding, however, is not always up to standard. Except in the case of an outbreak, farmers do not apply insecticides to their rice. Cotton, on the other hand, receives seven applications everywhere but at Konni, where cultural practices are by far the poorest in the country.

Continuous cropping of rice is causing an increase in disease problems on the river pumping perimeters and depressing yields. Rotating rice with highyielding rainy season sorghum would break the breeding cycle of rice pests and diseases. Yields for rice range between 2.5-3.0 tons per hectare during rainy season and 3.0-3.5 tons per hectare during the dry season. Cotton and sorghum yields range between two and three tons per hectare everywhere but at Konni, where they average around one ton.

Cultural practices for vegetables were quite varied on both the microperimeters and the medium scale surface dam systems. Insects were a problem virtually everywhere and farmers often did not know where to get insecticides.

Principal vegetables grown under irrigation in Niger are onions, tomatoes, peppers and, to a much lesser extent, carrots, lettuce and cabbage. Onions are clearly predominant, with 1980 production estimated at 100,000 tons. Yields average around 30 tons per hectare.

The principal agronomic constraints on increasing yields of irrigated crops include heterogeneous soils that prevent plant water needs from being uniformly met; poor seed quality; lack of varieties that are resistant to cold in the case of rice, and diseases in the case of vegetables; unpredictable rains and flood levels leading to untimely planting that depresses rice yields; poor weeding practices; inappropriate fertilizer recommendations; nonuniform planting dates that lead to inappropriate applications of water on some of the crops; continuous monocropping on the rice perimeters; and lack of availability, and use of insecticides.

#### Economic Aspects

In spite of these problems, available evidence suggests that private returns per day of labor in irrigated farming exceed those of rainfed agriculture. Onions, improved sorghum and peanuts are consistently among the highest, and cotton and rice among the lowest. This partially explains the tendency of farmers to plant more sorghum than officially allowed on the cotton/sorghum perimeters. It also explains the tendency of rice farmers to give higher priority to rainfed crops in allocating labor.

During the beginning of the rains, farmers on all the perimeters face intense demands for labor for both dryland and irrigated crops. This problem is worse on the rice perimeters where, in addition to having to prepare the rice nursery just when wor<sup>1</sup> on rainfed crops gets intense, farmers must harvest the dry season rice crop. In such a situation most farmers give priority to the rainy season crops since they account for the bulk of the family food supply. Cultural practices on irrigated crops suffer as a result.

Farmers on irrigated perimeters face several problems that are increasing their financial risk as the GON tries to restructure its agricultural policy. The shift from tractor plowing by ONAHA to usen plowing by farmers seems to be causing delays in land preparation in some cases. Not enough teams of oxen are available to do the necessary work. Input supply is also a problem on some perimeters, both because of ineffective ordering by the cooperative, rationing by the <u>Centrale d'Approvisionement</u> (the public sector input supply agency), and the lack of credit. Without modern inputs, farmers have difficulty obtaining yields that are high enough to pay all of their expenses and still have a competitive return to their labor. Reduction in input subsidies that are now occurring, and the trend toward full cost pricing of ONAHA services, are putting additional financial pressure on farmers working on the medium scale irrigated perimeters.

### Marketing

The national supply/demand balance for cereals is such that any amounts of rice, sorghum, cowpeas or peanuts that the perimeters can produce over the next twenty years will have no trouble finding a national market. The national demand for fresh vegetables is growing at least as fast as the population of Niger's towns. Regional demand is growing even faster. Tomato and onion production have increased by an estimated 13-15% per year over the past ten years. Demand for onions from coastal countries is so strong that coastal merchants consistently come to Niger to pick up supplies. There is also a good demand for dried vegetables, but a lot less is known about this market.

Demand for vegetables, though strong, cannot absorb the glut of production that occurs during the principal vegetable production period of January to April. This problem will get much worse as three new perimeters emphasizing vegetables come into full production in 1984-85.

To deal with market gluts, farmers dry some of their surplus onions, peppers, tomatoes and okra, but more perishable crops sometimes rot in the field. There appears to be potential for better planning of planting so as to distribute production over a longer period of time. Available evidence suggests that markets for dried vegetables can also absorb larger quantities of produce, but a more careful study of vegetable markets in West African coastal countries is needed to confirm this impression. Annex I contains the terms of reference for such a study.

Farm level storage and preservation in Niger is fairly rudimentary and losses are high. Changes in harvesting, handling and drying procedures should be able to reduce these losses somewhat.

The team was not able to identify new high valued crops that present special opportunities for Niger, but several existing ones offer better potential than rice and cotton. Dry season peanuts are quite attractive, primarily because the value of the hay during that time of the year exceeds the value of the peanuts. High-yielding sorghum may do better than rice during the rainy season while helping to avoid continuous cultivation of rice and the increased problems with plant and human diseases which that causes. During the hot, dry season, onions and peppers sell for about twice their fresh vegetable equivalent price during the principal producing season. Finally, inform<sup>3+</sup>i; obtained by the team indicates that Niger's onions are sold into world is at Abidjan for an F.O.B. price, less transport costs from Niger, that is over twice what Niger's producers receive during the same period. Add to this the potential for further developing coastal markets for Niger's fresh onions and dried vegetables and there is reason for optimism. Hopefully, prices for irrigated crops and revenues from irrigated farming can be maintained at current levels, if not increased in real terms, over time.

#### Irrigation Cooperatives

In spite of a twenty-year program to build and strengthen cooperatives in Niger, they are still, in general, weak institutions subject to a substantial degree of government regulation. Cooperatives on the irrigated perimeters are among the strong ones, but even they often lack internal dynamism. Until recently, ONAHA was responsible for maintaining irrigated perimeters. Following the recommendations of the Zinder Conference, ONAHA has shifted this responsibility to the cooperatives. The GON is also trying to get cooperatives to take direct responsibility for acquiring inputs, managing credit and managing distribution of water. Formerly, UNCC and ONAHA agents provided substantial assistance with these tasks. In the future, the cooperatives will have to rely on themselves. At the present time, the lack of an effective training program to help cooperatives and farmers assume these responsibilities is frustrating this transition.

#### Extension

ONAHA's extension service is weak and lacks proper support. Agents are not well trained and most lack substantial experience in irrigated agriculture. The country lacks training specialization in irrigated farming; and a rapid transfer of personnel into and out of ONAHA from the MDR prevents the accumulation of practical experience. Training programs aimed directly at farmers may provide the only long-term solution to these problems.

Extension training models in use in Niger tend to be quite directive. Course content is usually quite theoretical with little give and take between trainer and trainee. Any training program aimed at farmers or extension agents should be careful to pay as much attention to the techniques of training as to the content.

The mediocre performance of irrigated agriculture in Niger is not entirely the fault of ONAHA. In a very real sense, ONAHA has not been given what it needs to fulfill its responsibilities. GON bugetary allocations for maintenance work, coupled with unpredictable shortfalls and delays in what is promised, create a situation in which planning and coordination are next to impossible. At the same time, the GON has been hesitant to raise user fees or to take action against farmers who fail to repay their debts to ONAHA. In such a situation, ONAHA has little choice but to continue to accumulate operating deficits. Yet by cutting contractual employees rather than civil servants in its efforts to reduce those deficits, ONAHA may be reducing, rather than increasing, its longterm effectiveness.

#### Research

Research in Niger does not effectively support extension programs on irrigated perimeters either. INRAN does not give high priority to problems of irrigated agriculture in its budgetary and personnel allocations. Communication links between research and extension, though better on some irrigated perimeters than in dryland agriculture, are not developed. INRAN's primary involvement with perimeter level research is via contracts with ONAHA or donors financing a particular project. Although this approach can produce excellent results, it needs to be based on a longer term institutional research program to be really effective. This is lacking at INRAN.

# Private Sector Involvement

The private sector supplies fertilizer, fuel, some insecticides, marketing and very limited other services to cooperatives and farmers on irrigated perimeters. The way the GON administers its input subsidies program discourages a more extensive private sector involvement in input supply. A preferential, subsidized rate schedule for cooperatives used by ONAHA to charge for its services discourages more private sector involvement in provideing services. Private sector suppliers who service what they seil do exist, and ONAHA obtains from them many of the materials it supplies to perimeters. Some farmers purchase pumps directly from these same suppliers, but most obtain pumps in Nigeria where costs are one-half to two-thirds those in Niger. Surprisingly, farmers seem to be developing their own capacity for maintaining and repairing such pumps. The one area where the private sector has not yet gotten involved is in providing extension services.

#### Environmental and Public Health Issues

Niger has adequate surface and groundwater to meet the needs of land already developed or under development for irrigation. Periodic shortages of water for irrigation result from the lack of adequate storage and the unfavorable location of some pumping stations following from the secular decline in river flow. Underground aquifers, though moderately productive, could probably not support very large tube wells, but it should be possible to utilize numerous lower capacity tube wells spaced so as to minimize interference with each other. Both surface and subsurface water quality is generally good.

Soils on irrigated perimeters are generally well drained and salinization and alkalization are not important problems. Erosion can be, however, and the coarser textured soils in the drainage basins of many of the surface dams give rise to heavy siltation of the reservoirs that greatly reduce the economic life of such investments. In such areas tube wells probably represent a more cost effective method for irrigating.

Urinary schistosomiasis appears to be prevalent near most permanent surface water sources in Niger. Average infestation rates in such areas range between 50% and 90% among children 5-14 years of age. Malaria is also a problem. Both diseases are aggrevated by poor design and poor maintenance of irrigated perimeters and reservoirs.

In order to effectively deal with the causes of water-borne diseases, Niger needs to establish a strong role for the Ministry of Health in the planning, design and administration of irrigation schemes. This could be in the form of an interministerial commission or authority, with both Ministry of Rural Development and Ministry of Health participation. This commission would review the design of new irrigation schemes and should have authority to establish critical water-use practices and enforce sanitary and victor control measures. The same commission could serve the function of integrating the implementation cuncerns of ONAHA with the engineering and design concerns of the Genie Rural.

Proper canal maintenance in the form of removing silt and aquatic vegetation, and providing mechanical barriers at the pump and canal heads to restrict the amount of vector carrying debris that enters the system can reduce the incidence of schistosomiasis. Proper location of pumping heads and sufficient grades on canals so as to avoid the accumulation of silt are system design factors that reduce the activity of the snail vectors and the incidence of the disease.

#### Programming Options

In looking at program and project possibilities, the Irrigation Subsector Assessment Team notes that the problems that confront the irrigation subsector in Niger are not really that different from the problems that constrain agricultural development in general. As a consequence, overcoming these constraints will require the same breadth of actions and programs.

The Irrigation Subsector Assessment team unanimously recommends that USAID concentrate its resources on improving the performance and output of irrigated land already developed rather than on expanding area under irrigation. At current levels of performance, most investments in new perimeters are not economic.

The critical problem areas which the team recommends for USAID focus include: selection of cropping systems, labor bottlenecks, perimeter maintenance, cultural practices and extension, credit for inputs, management of water, control of disease vectors and perimeter level applied research. The summary report outlines two broad approaches for doing this: (1) strengthening ONAHA and (2) a pilot program aimed at privatizing as many of ONAHA's functions as possible, in particular, extension. Both alternatives will require further study. The former, especially, will require close interaction with other donors to see how they view ONAHA's role and evolution over time. The latter has the advantage of being able to function independently of the structure of ONAHA while, at the same time, working closely with ONAHA and helping it to explore more effective ways of attaining objectives it has already established for itself. Annex H includes discussion of the pros and cons of a much wider array of program and project alternatives.

#### NIGER IRRIGATION SUB-SECTOR ASSESSMENT

#### I. INTRODUCTION

Acutely aware of the country's fragile climatic situation, the Government of Niger has placed high priority on developing its irrigated agriculture resources in order to guarantee its food supply. The Niger Agricultural Sector Assessment and the CDSS both note the potential importance of irrigation to Niger's agriculture. Land already developed for irrigation could account for over 10% of total crop production if properly used. However, the high cost of developing new perimeters (four to six million CFA francs/ha), and the fact that only about 5500 of 9000 hectares already developed for irrigation were under cultivation in 1983, has caused USAID Niger to take pause in its approach to the sub-sector.

To help it determine what, if any, should be its role with respect to irrigated agriculture in Niger, the Mission fielded an interdisciplinary team to conduct an assessment of the irrigation sub-sector. The general terms of reference for the assessment were as follows:

- 1. Review available literature and other donor activities relating to irrigated agriculture in Niger. Prepare a summary of activities currently underway and planned and identify areas requiring further study and action.
- 2. Evaluate the effectiveness of GON research and extension programs as these relate to irrigated agriculture and make recommendations for improvement.
- 3. Examine organization typologies for both large scale and small scale irrigated perimeters as well as irrigated gardens in Niger and identify constraints which impede their functioning.
- 4. Identify to what extent cropping patterns and lack of markets are limiting effective utilization of available irrigated land in Niger.
- 5. Assess the extent to which services now provided by ONAHA can be provided by the private sector and identify AID assistance that can facilitate such a transfer.
- Assess the technical and economic feasibility of promoting small scale irrigation development in Niger. Identify the crops in which the costs of irrigated perimeters, large and small, can be reduced.

- 7. Assess the impact of irrigated agriculture on public health and the environment,
- 8. Construct a working definition of small scale irrigation.

Each of the individual team members had specific terms of reference which outlined their responsibilities vis a vis the overall terms of reference. This included writing an independent report on their subject area. Each of these reports is attached as an annex to this document. This document provides a summary of the individual reports as they related to the general terms of reference. In addition, it oulines the pros and cons of some programming possibilities with respect to irrigated agriculture in Niger.

# II. GOVERNMENT AND DONOR ACTIVITIES RELATED TO IRRIGATED AGRICULTURE

#### II. A. Government of Niger Institutions

Principal GON activities related to irrigated agriculture are divided between three Ministries: Rural Development, Hydrology and Environment, and Higher Education and Research.

#### II. A.1 <u>Ministry of Rural Development (MDR)</u>

Within the MDR two departments, the Agriculture Service and the <u>Genie Rural</u>, and two parastatals, the <u>Union des</u> <u>Cooperatives et de Credit</u> (UNCC) and the <u>Office National des</u> <u>Amenagements Hydro-Agricoles</u> (ONAHA), have direct involvement with irrigated agriculture.

The <u>Genie Rural</u> has primary responsibility for the conception and design of irrigated perimeters and for supervising construction activities. It does not, in general, do the construction itself, but will carry out limited construction activites if requested to do so by a farmer or a local authority.

The Agriculture Service of the MDR is responsible for providing seed, plant protection and extension services to both dry land and irrigated agriculture areas. It is also responsible for micro irrigation systems and serves as the principal GON liaison with NGO's, many of which actively support construction of shallow wells for vegetable gardening. Normally, it is the Agricutlure Service that administers donor credit programs for small garden well construction such as those provided by the Dosso and Tahoua Productivity Projects. The Agriculture Service rather than the <u>Genie Rural</u> is responsible for supervising construction of these wells.

UNCC is responsible for cooperative organizations throughout Niger. It assists with the formation of cooperatives and, in practice, with their operation. On the irrigated perimeters most UNCC agents have been seconded to ONAHA so they are, in fact, ONAHA employees. However they continue to represent the cooperatives in their relations with UNCC. This includes the important functions of ordering inputs and preparing applications for animal traction loans as well as collecting repayments. The agents also assist with cereals marketing by the coops.

ONAHA's principle function has been to implement, manage and maintain irrigated perimeters in Niger. This includes providing extension services and supplying inputs to farmers in conjunction with UNCC. ONAHA also has responsibility for constructing perimeters for national and regional governments. Namarigoungou was its largest operation of this kind.

With the reforms proposed at the Einder Conference and adopted in full by the GON, OMAHA will progressively reduce its presence on the perimeters. Following a two year start-up period on new perimeters, during which OMAHA will organize and train farmers, ONAHA will be represented only by the perimeter chief who will serve as a resource person for the farmers in the perimeter.

#### II. A.2 <u>Ministry of Hydrology</u> and the Environment (MHE)

Within the MHE, the Department of Water Resources has responsibility for collecting and analysing information on surface and ground water resources in Niger. It maintains an inventory of all studies undertaken, wells dug and water analyses made. It is the first place to begin looking for information on water resources available anywhere in Niger.

The Office of Ground Water Resources (OFEDES) is a parastatal attached to the MHE. Its primary function is to dig wells on a fee-for-service basis. OFEDES drills almost all of the wells destined for household water use and a sizable percentage of deep wells for livestock and agriculture. Should AID become involved in tube-wells, OFEDES would probably be the executing agency.

#### II. A.3 Ministry of Higher Education and Research (MESR)

This Ministry houses both the <u>Ecole Superieure d'Agronomie</u> (ESA) at the University of Niamey and the <u>Institut National de</u> <u>Recherches Agronomiques du Niger</u> (INRAN). The University provides training in rural engineering and hydrology and carries out some applied research on irrigated agriculture.

INRAN is responsible for all agriculture research. It maintains stations at Kolo and Tarna and sub-stations at Tillabery, Losso, Belgou, Gaya, Agadez and elsewhere. INRAN carries out limited amounts of research related to irrigated agriculture at most of these sites. INRAN also has a few conventions or agreements with individual projects or perimeters to carry out applied research of special interest on a fee-forservice basis.

#### II. B. Donor Activities

At the present time, over 5500 hectares of new irrigated perimeter are either under construction or committed for financing by various donors. The major donors are the IBRD, KFW, the FED and Kuwait. An additional 4000 hectares are scheduled for rehabilitation under projects financed by the IBRD/CCCE/FIDA and the FED. In the area of small scale irrigation, the ADB will finance development of 1000 hectares of small scale perimeters (2-20 hectares) along the Niger and Komadougou river valleys. The FED sponsored MMM project and the Italian sponsored Keita Rural Development Project will finance similar activities, including about half of over 3500 permanent garden wells planned for Niger over the next 3-5 years. PVO's will account for another 700 or so garden wells.

Most donors which finance the construction and rehabilitation of irrigated perimeters also provide technical assistance to the government services and parastatals involved. The FED and FAC provide over a dozen technical assistants to the G.R. and ONAHA. GTZ finances one T.A. at the Genie Rural and the ADB will finance another five under the Small Scale Irrigation Project. Additional assistance for ONAHA is programmed under the IBRD/CCCE/KFW Rehabilitation Project and under Belgian bilateral aid. The Department of Water Resources receives assistance from FED, FAC and UNDP.

The remaining major areas in which donors are active include training for cooperative officials and farmers and providing revolving credit funds to cooperatives in the perimeters which the donors are financing. Both of these activities are in the planning stage.

Annex A provides a more comprehensive listing of donor activities relating to all aspects of irrigated agriculture in Niger.

#### • III. IRRIGATION SYSTEMS IN NIGER

The irrigation sub-sector assessment team identified four predominant types of irrigation in Niger, based on the way water for irrigation is collected, applied and managed. These include: jointly managed river pumping systems; jointly managed surface dam systems; jointly managed ground water pumping systems; and individual managed micro-irrigation systems. Within each of the first three types we can distinguish between medium and small scale systems, with the dividing line between medium and small being management system rather than irrigation technology.

Following a typology used by FAO (Strebelle, 1983) for ger, most of the perimeters now under the direction of ONAHA would be classed as medium scale systems. They require outside intervention for establishing the system, draw very large quantities of water, and require external or collective management for operating the system and managing the use of water.

Small scale systems, on the other hand, tend to be initiated by a group of farmers, a <u>Groupement Mutualiste des Producteurs</u> (GMP) or a Groupement Mutualiste Villageois (GMV)— and are seldom over 20 hectares in area. Small scale systems include, but are distinguished from, micro-irrigation systems which are undertaken by an individual farming unit. Micro-irrigation systems are generally 0.2-1.0 hectare in size but can range as high as two hectares. Thus the crucial distinction is the complexity of the management system rather than the type of irrigation technology used. The Irrigation Sector Assessment team has adopted this approach.

Outside of the Komadougou Valley there are relatively few operations between two and twenty hectares in Niger. In that valley, however, there are both surface dam/dike systems and pumping systems from surface water sources in the small scale range. These tend to be collective rather than individual operations. Little of what is being done by individuals exceeds, if the the micro-irrigation dimension. As irrigated agriculture in the force to see Niger develops, however, we can expect to see individual entrepreneurs increase the scale of their operations such that the technological continuum between micro and small scale will become more diffused. Again, the more useful operational distinction is between the scale of management rather than the scale of technology.

<sup>1/</sup> By world standards, there are no large perimeters in Niger.

<sup>2/</sup> The GMV is usually a village level cooperative association. The GMP is a sub-division thereof and includes only those farmers who have agreed to associate themselves for a particular production activity.

#### III. A. Jointly Managed River Pumping Systems

Most of these are located in <u>cuvettes</u><sup>1</sup> and on the terraces along the Niger River. The <u>cuvette</u> systems generally cover 100-400 hectares, the largest being a 1350 hectare perimeter at Namarigoungou. Without the protection of dikes, most of these lands would be inundated when the river rises to flood stage. The systems permit a near total control of water with the dikes controlling inflow during the flood season and pumps providing water during the low water season. Internal drainage systems must evacuate excess water by pumping when the level of the river exceeds the level of the drain. The soils are generally fine textured and very suitable for rice. Most of these systems produce a double crop of rice.

Terrace systems are located on the plains above the principal river valley. All are between 30 and 100 hectares but only two are functioning at the present time. The terraces are hardly ever flooded and, as a result, tend to have coarser textured soils that are more suitable for vegetables and sorghum than for rive. Because of their elevation relative to the river bed, terrace systems require larger pumps that must draw water from the river for both cultivating seasons. Consequently, operating costs are considerably higher than for <u>cuvette</u> systems. With the decline in the flow of the river, several of these perimeters no longer have good access to water and have been abandoned.

At the present time, terrace systems account for about 400 hectares of an estimated 5500 hectares of perimeters already developed along the Niger River. It is estimated that as much as 110,000 hectares of terraces could be developed should the Kandaji Dam eventually be constructed. Annex B, Table B-1, lists the various perimeters along with other key data concerning each one.

#### III. B. Jointly Managed Surface Dam Systems

The larger surface dam irrigation systems in Niger are found in and near the Maggia Valley. ONAHA is currently managing seven operating perimeters that range in size from 30-2600 hectares. Smaller ones (2-20 hectares) are found in the Komadougou Valley where <u>mares</u> and dead branches of the river are diked by local farmers in order to impound water for dry season cultivation. The Komadougou system appears to be similar in effect to the poulder system used on Lake Chad. The irrigation assessment team did not observe either system.

<sup>&</sup>lt;u>1</u>/ <u>Cuvettes</u> are depressions along the river and include the flood plains adjacent to the river.

The larger surface dam systems are used primarily for supplemental irrigation of rainy season crops. Limited areas are cropped during the dry season, depending on the amount of water remaining in the reservoir. Rainy season crops are divided roughly half between cotton and sorghum while dry season crops are more varied and include vegetables and a large area in fallow. The highest yields of irrigated sorghum and cotton are found in the Maggia Valley perimeters.

#### III. C. Jointly Managed Ground Water Pumping Systems

This type of system is limited to the Goulbi Maradi perimeter at Djiratawa. The Maradi perimeter will consist eventually of a series of 40 tube wells emptying into interlinked canals that distribute water by gravity to 500 hectares of crops. The wells range in depth from 16-24 meters. The attractiveness of this system is its divisibility and flexibility vis-a-vis perimeter design.

A companion pilot project at nearby Ruwana is exploring the economic feasibility of using a single tube well to irrigate suitable land on a single village basis. One well is sufficient for 7-10 hectares of crops. With this system, water is distributed from a central reservoir via six inch, gated aluminum pipes. The gates are placed every 70 centimeters or so on the pipe. When closed, the gates allow water to run up- what have the hill under pressure from the reservoir. This reduces leveling means requirements over the stationary canal systems. Because of the cost of pumping, this type of irrigation system is most suitable for crops that do not require much water. The Djiratawa and Ruwana perimeters are producing sorghum, cotton, peanuts and vegetables. Like the Maggia Valley perimeters, sorghum and cotton are planted in more or less equal shares during the rainy season. Peanuts and vegetables dominate dry season cropping systems.

Small jointly managed ground water pumping systems are also found along the Komadougou Valley where they are beginning to replace traditional, labor intensive pumping methods. Ten to fifteen farmers pool resources to purchase a motor pump sufficiently large to supplement residual moisture on 5-10 hectare wheat and green pepper fields that line the river. Apparently the use of such pumps is expanding rapidly in this area.

#### III. D. Individual Managed Micro-Irrigation Systems

Historically these systems have used relatively labor intensive techniques for pumping water from shallow wells two to six meters in depth or for impounding water from rivers and seasonal waterways. The systems are generally used to produce high valued garden products, though in the Air Mountains and the Komadougou-Yobé river valley, cereals are also important. With the well systems the density of wells varies between three and six per hectare. The wells are individually owned and the owner is generally the only one using water from a well. An individual farmer usually has more than one well.

When irrigating with the wells, farmers rotate between them in order to allow time for the reservoirs to recharge. Storage capacities in these small wells vary between one and three cubic meters of water. Recharge capacities vary even more. The number of wells generally varies inversely with recharge capacity.

Shallow wells are generally hand dug unlined structures ranging from one to two meters in diameter at the bottom. Depending on soil texture, unlined wells have to be redug every one to five years, most commonly, every year. In some areas, farmers are beginning to construct permanent cement-lined wells. In addition to longevity these have the advantage of being able to maintain a much larger reservoir and a larger recharge surface than unlined structures. Because of this, fewer wells can supply the water needs of a given area. There is an active demand for credit on commercial terms to construct such wells.

The team observed four different methods of drawing water from these wells. The simplest is a system where a farmer draws water using a rope and calabash. The farmer then either carries the water to a basin or spills it into a canal that carries the water to the basin being irrigated. With this system, one farmer can draw about one cubic meter of water per hour and about 5 m per day from a 4-5 meter well. The maximum depth for such a system is around seven meters. At deeper levels farmers are probably not able to move enough water to make this type of irrigation attractive.

The <u>shadouf</u> system, though widespread, appears to be less prevalent than the calabash system. With this system, a farmer can move greater amounts of water than with a calabash system and do so with more balanced effort. The maximum depth of a <u>shadouf</u> system is probably six meters and its water moving capacity is about 25-30% greater than the calabash method.

The <u>dallou</u> system, also observed on a limited basis by the team, is more prevalent in the Air Mountains. It involves drawing water with a pulley and animal power using a skin as a water container. From a depth of 4-5 meters the skin can be drawn and emptied twice per minute, releasing 3-4 m<sup>3</sup> of water per hour. This system is used for water depths of 4-12 meters.

The team also observed small motor pumps being used by individual farmers to draw water from shallow wells. These pumps vary in capacity from 8-13 m<sup>3</sup>/hour. They are most prevalent along the Nigerian border where they cost less than

two-thirds as much as in Niamey. Farmers use them for a water depth up to six meters. At prices prevailing in Nigeria, demand for these pumps is expanding rapidly. The team heard reports of pump owners providing custr services to vegetable farmers near Lake Chad for 30% of the harvest. Paybacks of one year or less are not uncommon in the Komadougou Valley. With time, these pumps will no doubt replace many of the existing labor intensive systems now so common on shallow wells.

At the present time Niger has an estimated 2000 permanent cement-lined wells. The area currently being irrigated by small wells, both traditional and permanent, is probably on the order of 3000 hectares.  $\pm 2$ 

#### IV. ENGINEERING ASPECTS OF IRRIGATED AGRICULTURE IN NIGER

#### - IV. Α. Factors Influencing Development Costs

Virtually all medium scale irrigation systems in Niger have been designed and constructed by one of a small group of expatriate contractors. Although the Genie Rural has ultimate responsibility for approving project design, in practice it is the donors who decide. In cases where the donor has no design makes key decisions which have a substantial impact on to ultimate project costs. Several factors in this process operate singetten der Timos to increase rather than reduce overall development costs.

#### IV. A.1 Topography

The topography of the Niger River is such that many of the sites suitable for new irrigation are long and narrow. A good portion of the broad basins that do exist have already been developed for irrigation. As good sites become more limited, key development costs per hectare will rise rapidly. Canals and dikes, in particular, begin representing a higher proportion of total system costs the more elongated is the To date, the cost of constructing one hectare of perimeter. new perimeter has been running in the 4-6 million CFA francs range. In the future, this cost can be expected to rise in real terms as these less desirable sites are brought into production.

Given the topography of much of the land remaining to be developed along the Niger river, it would seem that small,

<sup>1/</sup> Based on our field observations, the ratio of traditional to permanent wells must be at least ten to one. Assuming five improved wells per hectare versus eight unimproved wells, the 2000 permanent wells in existence suggest a total area of 2900 hectares.

single pump, 20 hectare perimeters  $\frac{1}{2}$  would be a sensible way to develop these marginal areas. In these areas the larger schemes lose much, if not all, of their pumping economies to higher construction costs. These smaller perimeters are more easily divided into independent operating units that can be more effectively managed by individual GMP. This should reduce problems with perimeter maintenance. It also reduces the need for leveling and allows farmers to create much of the hecessary infrastructure themselves. USAID may want to consider financing a pilot project along these lines.

As the number of good river bottom sites diminishes, more attention focuses on the proposed Kandadji Dam and the 110,000 hectares of terrace land that it will allow to be cultivated. The irrigation team wonders whether a series of small dams on the branches of the river, and even on the river itself, might not be a less costly, more sensible alternative to a single large dam. This matter merits further study.

Surface perimeters in the interior present other problems. The lack of ground cover over much of the drainage basin couses significant erosion. The resulting silt flowing into these structures causes, in turn, very high rates of sedimentation of the reservoir. This greatly shortens their useful life and reduces their storage capacity. As a result, area cultivated is reduced. The very flat valleys in which most of these dams are located greatly increase evaporation and further reduce water available for irrigation.

Tube wells may present a more economical technology for developing such areas. The Maradi project hopes to hold costs per hectare on Ruwana type perimeters to 2.5 million FCFA per hectare. Very large tube wells would not be appropriate because the aquifers are not very thick and have low to medium specific capacities. Numerous lower capacity wells spread so as to maximize production with minimal interference would, in most cases, be more efficient. This is another instance where a pilot project could provide some useful information for guiding irrigation policy in Niger. The experimental tube well perimeter at Ruwana, and in other areas planned by the Maradi project, bear close watching from USAID for this reason.

On perhaps a more selected basis, topographical relief can provide the context for some moderate perimeter establishment costs. The FAO/ADB Small Scale Irrigation project will emphasize developing small <u>cuvettes</u>, dry tributaries and flood plans on the Niger and Komadougou rivers that are not suitable for larger scale development. Because of substantial local involvement and the nature of the technology employed, the project expects to be able to develop 1000 hectares for 4.5 million CFA francs per hectare versus the 6.0 million currently budgeted by the Genie Rural for new projects.

1/ Of the type for nd near Bakel on the Senegal River.

#### IV. A.2 · Design Standards

A number of the irrigation systems observed by the team were clearly over-designed. Canals were lined with cement in areas where no lining was essential; dikes were constructed to protect against all but 100 year floods where it was probably appropriate to take greater risks; pumps were too large for water needs; and structures and equipment are unnecessarily complicated and expensive. All of these are essentially judgement calls however, so many engineers and economists would disagree quite strongly on where to draw the line.

In general, a good deal of the over-designing that one observes on some of the perimeters in Niger stems from a desire to reduce problems in system maintenance that have plagued Niger. In effect, engineers are substituting capital for management and labor resources. The alternative of reducing the need for both capital <u>and</u> management resources by designing systems that can be broken into smaller management units more easily handled by farmers does not get adequate attention. In this context, the GON's current struggle to find ways of shifting more of the perimeter responsibilities to farmers bodes well for containing perimeter establishment costs. However, it will not likely meet with much success until realistic user changes force farmers themselves to get involved in questions related to system design.

The <u>Genie Rural</u>, as the service that is ultimately responsible for approving perimeter designs, is quite agreeable to reducing design standards once peasants assume greater responsibility for maintenance. In the past it has been blamed for not taking adequate precautions against the types of problems which commonly arise in Niger. However, unless peasants engage themselves contrac .ally to provide the necessary support, the G.R. will continue to take a conservative stance on design standards. Peasants, on the other hand, will have no interest in design changes that will require greater work for them unless their user charges are reduced accordingly. Obviously if these are already zero, it will be difficult to get any help from them.

Not all needed changes in design will reduce costs. The faile failed with necessity of providing sufficient gates to allow measuring the factor of the amount of water used in a particular block and to facilitate to prove water management so as to reduce the incidence of waterborne diseases will add to costs, though perhaps not materially so. Lining canals reduces canal maintenance costs and, in the absence of alternative solutions to perimeter maintenance problems, does provide a less hospitable habitat for vectors of waterborne diseases. Thus, unless labor intensive alternatives for keeping canals free of vegetation and silt are accepted by farmers, changes in design that reduce construction costs may only serve to increase medical costs and/or lower farmer productivity by an equal or greater amount.

### IV. A.3 Competition

There are only three or four large contractors technically qualified for large irrigation works. They sub-contract to smaller Nigerien firms but are able to maintain an oligopolistic position by nature of cheir size and the size of the perimeters. Estimates offered in private conversations with donors and others closely involved in the contracting process indicate that costs could be reduced by 35-50% if there were greater competition.

The obvious solution to this problem was to create ONAHA. As a parastatal institution it would be in a position to force costs down through competition. Unfortunately, experience at Namarigoungou, which was done on force account by ONANA, suggests that inefficiencies within ONAHA make it as costly as private firms. As a result, the MDR recently restricted ONAHA to a maintenance only role. Part of ONAHA's problems stem from the fact that it is run more like a ministry service than the autonomous parastatal that it is.

There are alternatives to ONAHA carrying out construction activities itself, though these would need testing on a pilot basis before AID could feel confident they would work as expected. USAID could provide credit and technical assistance to small Nigerien contractors to enable them to take on larger jobs. Alternatively, scaling down designs will make it easier for existing firms to qualify for the contracts. Or, ONAHA might assume the role of general contractor and contract out most of the work to Nigerien sub-contractors similar to the way current contractors do. This might involve providing large earth moving equipment on lease or rental in order to reduce barriers to entry for the smaller firms.

#### IV. A.4 Risk and Uncertainty

The uncertainty of national budgeting and donor financing contributes to high costs since contractors must absorb the overhead of maintaining expensive technical personnel and equipment while awaiting project and contract approvals. Associated cost factors include the difficult transportation links to coastal supply points and the risks of political instability both within Niger and in countries through which supplies must pass.

<sup>&</sup>lt;u>1</u>/ Mali had a similar experience with an ONAHA type parastatal.

#### IV. B. . Water Supply and Management Problems

The sharply reduced rainfall that has become typical of Niger in recent years is creating water supply problems for both large and small systems. The major unanswered question is whether the shift is temporary or permanent. The answer has an important bearing on appropriate designs for new and rehabilitated perimeters. Indeed, a good deal of the work slated to be undertaken by the IBRD/CCCE/KFW Rehabilitation Project involves modification to existing systems to improve their access to water. Many perimeters are now much more distant from water sources than was ever considered possible when the perimeters were originally designed.

Problems with water availability are aggrevated by poor internal management of water on the perimeters, mostly at the farm level. These problems are partly interrelated with the problems of topography and design already discussed. They include such things as pump selection which is poorly adapted to the lifting head required; poor pump installation and maintenance; poorly leveled fields; friction losses occurring because of poorly cleaned canals; and, unnecessarily prolonged pumping periods because of staggered planting dates or the desire to observe official working hours instead of monitoring water use in the evenings and at night.

The absence of water measurement devices at a level sufficiently close to farmers to permit them to control water use does nothing to encourage efficient water use. However, rather than assume that the solution to this poblem lies in installing devices that will require monitoring by someone other than the farmers themselves, it would be useful to give some thought to identifying administrative and organizational solutions that can provide nearly the same results at a much lower cost.

More thought needs to be given to the choice of pumping systems and the interface between the technological and the social/institutional aspects of perimeters. On the institutional side, a series of smaller pumps might pose fewer management problems than one larger pump, even though the larger pump is more efficient. The smaller pump could be managed by a single GMP, even on a larger perimeter divided into several management units.

There is clearly a need for some applied research on pumping technology, particularly for matching pumping heads with soil and crop requirements on small perimeters; solar and wind technology for interior valleys; and animal powered water pumping systems for micro-perimeters as compared to small motor pumps. The prognosis for cheap solar pumping technology is not particularly encouraging at this time but where electricity is available, electric pumps have a cost advantage over diesel pumps.

#### IV. C. System Maintenance

At the present time ONAHA is trying to redefine the responsibilities of itself and farmers with respect to irrigated perimeters. The team has received conflicting information on what is occurring. According to the recommendation of the Zinder Conference, ONAHA will become a technical services organization providing pump maintenance and other services on a fee-forservice basis. This implies that farmers can contract with anyone for the services. Separate sources at ONAHA both confirmed and denied that farmers would be permitted to contract with private firms for pump repair services. Since the pumps are GON property, there was some question as to whether the government would want to ensure that they receive proper care by entrusting this function to ONAHA.

The crucial issue with respect to where farmers go for maintenance will revolve around how ONAHA sets user fees. At the present time its prices to cooperatives are lower than the prices it charges others who demand its services. Unless ONAHA's costs are considerably above private sector costs, there is little likelihood that the cooperatives would chose anyone other than ONAHA for the services it requires. Until ONAHA moves to full cost pricing for its services, the private sector will have a difficult time getting established in services markets except where ONAHA's inefficiences exceed its subsidies.

Perimeter level maintenance involves simpler solutions. In general, maintenance appears to be poor principally because farmers have no burning need to do the necessary work. In cases where irrigation rights are withdrawn when farmers do not provide labor for essential maintenance activities, perimeters appear to be much better maintained. An alternative would be for the cooperative to <u>hire</u> farmers willing to do the maintenance work and then add the cost to everyones <u>redevance</u>.

There are, of course, other causes of poor maintenance of canals. Weeds become a special problem during the labor crunch at the beginning of the rains when irrigation is less urgent and labor constraints are particularly acute. The dry season, however, appears to offer ample opportunity for canal reconstruction and maintenance should farmers have adequate incentive.

Under the IBRD Rehabilitation Project cooperatives will be required to enter into a maintenance contract with ONAHA before the project will begin rehabilitating a perimeter. These contracts will define the responsibilities of farmers and those of ONAHA with respect to maintenance of canals and pumps, among

<sup>1/</sup> An annual payment which farmers make to ONAHA to cover the cost of seed, fertilizer, fuel, pump maintenance and repair, etc. as well as a portion of the investment costs of the perimeter.

other things. It is hoped that this approach will resolve perimeter maintenance problems. It is not clear just how these contracts will differ from current contracts between ONAHA and the cooperatives that are providing inadequately for maintaining perimeters in a good state of repair.

#### IV. D. Feasibility of Promoting Small Scale Irrigation

The FAO/ADB Small Scale Irrigation Project paper estimates the cost of developing 1000 hectares of small perimeters along the Niger and Komadougou rivers at around 75% of the cost of new medium scale installations. The ability to enlist the help of beneficiaries in perimeter construction more than offsets the greater costs associated with undertaking a multitude of small dispersed projects.

The anticipated 2.5 million CFA per hectare cost of the single tube well system being tested at Ruwana is less than two thirds the cost of the medium scale system being developed at nearby Djiratawa. Variants on this theme could probably reduce installation and operating costs still further by substituting subterranean stationary pvc pipe for the movable but costly gated pipes.

The cost of developing one hectare with permanent shallow wells and a single portable motor pump for each five or six wells would probably come to less than 1.5 million FCFA. Moreover, most of this work can be done by village artisans.

These three examples suggest that small scale irrigation can indeed provide a cost effective alternative to medium scale systems. They are more likely to fall within the competence of smaller local firms to perform. Moreover, such systems present far fewer management problems that farmers themselves cannot handle.

The development of such systems does need to be selective, at least initially. There are numerous shallow, alluvial aquifers, and some deeper phreatic water tables that can only be developed with small scale systems that effectively mine the water over a much larger area than the area cultivated. On some of the less favorable riverine formations, smaller 20 hectare units may even be more cost effective than a single larger system; they can be apportioned one to a single GMP and, as a result, can elicit greater farmer participation in design and development. Higher yielding tube wells with submerged multi-stage pumps may be a technically feasible next step for larger systems. These alternatives all require further, more indepth investigation.

The major issue vis-a-vis small scale irrigation concern the ability to rely on such systems for a major expansion of the area under irrigation, and the proper role of public sector assistance in promoting that expansion. With respect to the former, the Small Scale Irrigation project and the perimeter at Ruwana in the Maradi project all point to the potential for major expansion of small scale systems.

Though not yet tried on a large scale, the demand for unsubsidized credit to install permanent, cement-lined, shallow wells on micro-perimeters appears to be guite substantial. Once these wells are put together into systems of five or six per hectare, using portable motor pumps to draw water, we can expect a major expansion of area cultivated. With it will come a declining cost of production that promises to make irrigated dry season peanuts, sorghum, and possibly, cowpeas and cotton profitable at import or export parity price levels, whatever the case may be. Such installations would need to remain dispersed, however, since they would have to mine water over a much larger area than the area cultivated to obtain sufficient water for irrigation. Some combination of a deeper tube well with a series of shallower wells might permit a more intensive level of development of available land, while still keeping per hectare costs well below current costs for medium scale perimeters.

The principal question regarding the shallow well option, as attractive as it appears from the point of view of cost and the potential for local level management, is the area over which such systems would be feasible. The very impressionistic and hurried field trip undertaken by the assessment team provides a very weak basis from which to make an informed judgement. Our individual impressions vary from "limited" to "immense", simply confirming our weak basis for judgement. Even in areas where topography and existing developments appear promising, it is likely that farmers have gravitated toward the more favorable spots. Wells sunk in adjacent areas might find deeper or less prolific water tables or other problems not immediately obvious to the casual observer. This is an area obviously requiring some indepth study.

Defining an appropriate role for government in this area also merits some serious thought. With the help of PVO's and small components of existing integrated rural development projects, farmers are probably producing up to the capacity of existing markets for vegetables. An effective credit program to finance construction of improved wells and acquisition of small pumps could provide for most of farmers' needs within the context of the present system. Unless the concept of assistance extends beyond systems which can only be economic by producing high value crops, the potential for substantial expansion, and therefore for constructive public sector involvement, will be limited. V. PRODUCTION TECHNOLOGIES AND AGRONOMIC CONSTRAINTS

# V. A. Cropping Systems and Cultural Practices

# V. A.1 Irrigated Rice Perimeters

As on most perimeters, rice farmers prepare their land by plowing with oxen. They plant improved seed from WARDA and most farmers apply recommended or higher levels of NPK and urea fertilizers. Except in the case of an outbreak, farmers do not apply insecticides to their rice. In the two perimeters visited by the team, there was evidence of increasing problems with bacterial and viral diseases due to the continuous cropping of rice. Actual yields obtained on all Miger valley rice perimeters average between 3.0 and 3.5 tons of paddy per hectare during the dry season and 2.5-3.0 tons per hectare during the rainy season. The most important factor explaining the lower rainy season yields appears to be cool dry weather during the critical flowering stage.

#### V. A.2 Surface Dam Systems

Although originally intended for double cropping, the surface dam systems usually have enough water to irrigate only about 25% of the available land during the dry season. Thus these systems are primarily providing supplementary irrigation for rainfed cotton and millet.

During the dry season farmers grow a wide array of vegetables and limited amounts of millet, wheat, maize, and cowpeas. Farmers also cultivate the inside of the reservoirs using residual soil moisture as the level of water is drawn down for irrigation of the perimeters.

Cultural practices in the surface dam perimeters vary. The Maggia Valley perimeters have the highest technical efficiency and yields and the Konni perimeter, the lowest. All the perimeters grow the same variety of cotton, a high yielding, high lint variety. Farmers in each one apply insecticides and fertilizer but the amounts are not uniform. Adjusting for the number of applications and the proportion of area actually treated, farmers in the Konni perimeter applied 28% of the recommended amount of insecticides and 18% of the recommended amounts of fertilizer. This compares with 100% for all but one of the Maggia valley perimeters for both insecticides and fertilizer. Not surprisingly, yields of seed cotton in the Maggia Valley perimeters averaged 2.2-3.0 tons per hectare versus 1.1 tons for Konni. Differences in sorghum yields were similar.

Cultural practices were noticeably petter in the Maggia valley than in Konni, as well. Weeds were better controlled, plants were more appropriately spaced and operations were performed more timely. Agents at Konni did not appear well informed about the irrigation needs of the crops being grown there. It appears that the small extension service at Konni is simply overwhelmed by the magnitude of the task it is being asked to perform.

#### V. A.3 Ground Water Pumping Systems

The Goulbi Maradi tube well perimeter divides its crop calendar into three seasons. During the rainy season, the entire area is planted half to sorghum and half to cotton as is done in the Maggia Valley. During the early dry season about 40% is planted to cool season vegetables. Then, during the hot dry season, another 40% is planted to peanuts and hot season vegetables. About 20% of the land is left fallow during the entire dry season. About 10% of the 1/3 hectare to be allocated to each farm family is reserved for a farm garden in which the farmer grows what he chooses.

Cultural practices on this perimeter were considerably better than at Konni. Farmers applied around 80% of the recommended levels of fertilizer to sorghum and cotton. At the same time, insects were less of a problem. Weeding and maintenance of canals are not what they should be but farmer practices are improving as the perimeter moves through its second year of operation. Yields are closer to those of the Maggi valley perimeters with improved sorghum averaging 2.1 tons per hectare and peanuts and cotton, two tons. Onion and tomato yields were quite good as well.

In the Ruwana perimeter, weeding and other problems in evidence also appeared to be related to farmers' inexperience with irrigated agriculture. Farmers are growing essentially the same crops as on the larger tube well perimeter. No yield data was available but results on this perimeter should approximate those at Djiratawa as farmers gain experience with the system.

#### V. A.4 Micro Irrigation Systems

Niger has a particularly diverse mixture of micro-irrigation systems, i.e. those two hectares or less in size. Most range between 0.2 and 0.4 hectares. Farmers with these systems usually grow vegetables for local markets though, in the Air Mountains, wheat and other cereals are also important. Onions are the mainstay of these systems. Tomatoes, peppers, squash and to a losser extent carrots, cabbage and lettuce are also important. A substantial portion of the more perishable vegetables are dried on the farm for sale when prices are more favorable.

Generally, irrigation water for the micro-irrigation systems is drawn from shallow wells by means of a <u>shadouf</u>, calabash (<u>puisette</u>) or <u>dallou</u>. In areas where shallow well irrigation has a longer history, farmers tend to use small earthen canals to distribute water to their plots. Elsewhere they simply carry it to the parcel. Obviously, irrigation capacity is much higher with the canal delivery system. •Cultural techniques on the micro-perimeters range from excellent to abysmal. Not surprisingly, the worst were observed in areas where shallow well irrigation is relatively recent. Generally, spacing was quite good. Most of the farmers observed by the team use at least some fertilizer and manure on their plots but few could express the amount in standard units. In some areas insects and nematodes were a serious problem. Farmers generally recognized the problem but dia not know where they could obtain insecticides and did not appear to understand the importance of crop rotation for controlling nematodes. Many farmers kept their own seed and, for some, seed sales are an important source of income.

ields on the micro-perimeters vary widely, of course, but 30 tons per hectare for onions and tomatoes are not unusual in the more established areas. Marketing vegetables during the flush season was a problem for all but the onion producers.

#### V. B. Agronomic Constraints on Increasing Vields Under Irrigation

Soil structure and heterogeneity are problems on some of the perimeters. Sandy soils require relatively large amounts of water to maintain a given level of soil moisture. Where soils are particularly heterogeneous, plant water needs are not uniformly met. Both of these problems contribute to the poor performance of the Konni perimeter.

Seed quality appears to be a problem on some of the rice perimeters as improved strains are degenerating due to continued use of the same variety. Lack of cold-tolerant varieties is especially critical for both the rainy season (during the flowering stage) and the dry season (during the establishmenstage) crops. Available varieties of vegetable seeds frequently offer no disease resistance and are intolerant to high soil temperatures. The general area of identifying crop varieties that are suited to the particular soil-weather-temperature conditions of the different perimeters merits much greater attention from INRAN than it receives at present.

Water availability leading to untimely planting is a prollem on both the river pumping and the surface dam systems. Farmers cannot plant their rice seedlings on the river pumping schemes until the river rises up to the pump intake. Thus delays in the arrival of the flood often delay transplanting. This, in turn, increases the age of the plants at transplanting which, if more than 20-30 days old, reduces tillering and depresses rice yields. Moreover, it delays the harvest of the rainy season crop and. as a consequence, the planting of the dry season crop, with similar consequences.

On the surface dam perimeters untimely planting sometimes results from the fact that planting cannot begin until the reservoir has captured enough water to ensure the survival of the crop. At the same time, the overall quantity of water is generally not sufficient to permit a full dry season crop. Only two of the six Maggia Valley perimeters grow any crops at all during the dry season. Poor weeding practices are another widespread problem. Farmers frequently begin weeding late and do not always keep the edges of fields and canals clean. As a result, mature seeds blow from untended portions of the fields into the irrigation canals and then are distributed to the fields under near ideal growing conditions. Weeding problems appear to be at least partly related to competition for labor with dryland crops.

The team noted wide variations in the opplication rates for fertilizer that do not appear to be related to yields. This no doubt arises partly from the fact that fertilizer is frequently poorly placed and applied indiscriminately or at the wrong times. Sometimes farmers use an inappropriate fertilizer simply because it is available in local markets. Other unidentified factors also clearly play a part. Overall, however, it would seem that fertilizer recommendations are not always appropriate for the particular crop and soil combinations found in specific perimeters.

Water management practices pose additional agronomic problems on many of the perimeters. Non-uniform planting dates result in the situation where some farmers need to irrigate when others need to dry their fields prior to harvest. This not only raises pumping costs but also depresses yields. In some cases, extension agents did not know the water requirements of the crops being grown. Usually this also resulted in overirrigation.

Continuous monocropping of rice is causing a buildup in soil diseases and insect pests. These are having an increasingly noticeable effect on rice yields. Rotating rice with other crops, such as a high yielding sorghum, would help break the breeding cycle for plant pests and diseases and reduce their virulence. This would provide a more immediate solution than breeding new varieties. At the same time, better weeding and more thorough and timely applications of pesticides would considerably improve vields of all crops.

These constraints point to the need for perimeter level applied research on cropping systems, fertilizer application and response, water management and pest control, among other things. Not only would this help identify more effective cropping technologies for each perimeter but it would provide a logical interface between farmers, extension agents and researchers that should lead to more effective research and extension elsewhere as well.

#### VI. ECONOMIC AND FARMING SYSTEMS ASPECTS

#### VI. A. Costs and Returns to Irrigated Farming

The kinds of irrigated cropping systems found in Niger are correlated with the technology/management systems previously described, but not perfectly so. A rice-rice rotation is commonly found on the jointly managed river pumping schemes. A cotton/sorghum-vegetable fallow system is found on both the jointly managed surface dam and ground water systems. The micro-perimeters include a wider range of systems but rainy season fallow or sorghum coupled with dry season vegetables appears to be the more typical system outside of the Air Mountains.

The inability of Niger to keep irrigated land in production does not appear to be due to low cash returns to farmer labor expended on irrigated crops. A somewhat summary analysis of the private costs and returns of producing the major crops grown under irrigation in Niger shows returns to family labor ranging from 700-800 FCFA per day for rice and cotton to around 1700 FCFA per day for irrigated sorghum and maize. Onions earn between 2500 and 3000 FCFA per day. These synthetic returns to labor compare with an average return to labor allocated to rainfed crops of somewhere between 500 and 700 FCFA per day.

When looking at the value of production in relation to the amount of cash inputs required to produce it, the picture becomes more complex. Farmers' financial risk appears to be lowest for rainfed crops, followed by irrigated onions, groundnuts and sorghum. It is highest for irrigated rice and cotton. These measures of risk explain farmers observed production priorities much better than returns to family labor. They may also provide some insight into why farmers have allowed certain perimeters to slip into disrepair.

Available data on the costs and returns of producing rice on the river pumping schemes in the Niger Valley are not in agreement. A recent ONAHA (1983) study calls into question data which show farmers earning more per man day from rice than from rainfed crops, arguing instead that returns are barely competitive with rainfed millet. According to the authors of the study, these low returns, plus the small .25 hectare parcel normally allocated to an individual family along the river, virtually force farmers to give higher priority to other sources of income. If true, this would explain some of the labor related problems which are constraining rice yields. The higher returns from sorghum than cotton in the cotton/sorghum-vegetable/fallow cropping systems have encouraged a continuing shift toward sorghum. Nonetheless, the government, through ONAHA and CFDT, resists this in order to satisfy the country's domestic cotton needs. Only by heavily subsidizing insecticides and maintaining a fairly strong control over crop rotation is it able to keep farmers from moving away from cotton production.

Problems with dry season water availability have greatly reduced the role of dry season vegetables in this crop rotation. Still, the value of dry season vegetables grown inside of the silted reservoirs is equal to about 70% of the market value of the irrigated cereals grown on the perimeters.

Dry season vegetables are much more important on the Goulbi-Maradi perimeter since the tube wells provide a more reliable and steady source of water. To reduce problems associated with marketing large volumes of vegetables, the perimeter divides the dry season into two distinct cropping periods, with part of the land reserved for each. Farmers grow groundnuts during the hot dry season when vegetables do not do well. They have obtained very good results primarily because the revenue from peanut hay exceeds that from the two ton yield of groundnuts; the harvest occurs at a time when forage is in particularly short supply. Moreover, the market for both is immense.

Returns to wheat and cowpeas at Konni and maize and cowpeas at Goulbi Maradi do not appear promising and do not confirm the synthetic returns to labor mentioned previously in this report. Yields were low for the two cereals and pests are a real problem for cowpeas.

No member of the team was able to obtain first hand cost and return information on the Air Mountain cropping system. Observers suggest it is highly productive and profitable for farmers. Using the <u>dallou</u> system to irrigate plots of .5 to one hectare, farmers in the Air Mountains produce wheat, millet, vegetables and potatoes, mostly for local and regional consumption. Although most available land is under production, observers seem to agree that production would increase if additional markets were available at prices near current levels.

The fallow sorghum-vegetable cropping system tends to be found mostly on micro-perimeters irrigated from shallow wells or from reservoirs created by farmers as along the Komadougou River. This is also the most common cropping system for flood recession agriculture.

<sup>&</sup>lt;u>1</u>/ The team does not consider flood recession agriculture to be irrigation since it does not involve active management of water.

• During the rainy season, the soils that grow the best vegetables are often too wet for anything but sorghum or fallow, though selected areas around many villages and around Niamey can be successfully double cropped. One large area near Galmi double crops onions.

Cash production costs with the individually managed microirrigation vegetable cropping systems are moderate. Traditional wells must be redug almost every year and farmers purchase fertilizer and hire labor for pumping water or helping with irrigation. Farmers purchase pesticides when these are available and, increasingly, small motor pumps, but neither item is widely available.

Apart from onions, the team was unable to obtain estimates of gross margins per hectare or per day of family labor for vegetables. Onions are clearly produced in the greatest volume, followed by tomatoes and then squash, sweet potatoes, okra and hot peppers. At 30 tons per hectare, onions yield a return to management and family labor of over 3000 FCFA per day. At yields of 50 tons per hectare, this return would almost double. This compares with 1000 FCFA per day or less for rice and rainfed crops other than sorghum. Perhaps this explains in part, why farmers continue to increase production of vegetubles even as prices decline and they complain of market gluts.

With the recent completion of two substantial perimeters devoted largely to vegetable production, Tillakeina and Galmi, and a third one at Goulbi Maradi where vegetables are very important, vegetable farming in Niger is entering a new phase. Production and marketing problems that will reduce returns are already surfacing. Pest control will have to take on increasing importance if farmers are to maintain yields.

#### VI. B. Farming Systems Constraints on Irrigated Production

In addition to the agronomic and engineering constraints already mentioned, the irrigation sector team identified several farming systems factors which constrain irrigated crop production in Niger. The most important appears to be intense competition for labor between dryland and irrigated crops during the rainy season. During this period farmers must prepare nurseries for the rainy season rice crop, harvest the dry season rice crop, and prepare and plant dryland fields. Subsequently, the weeding of dryland fields competes with planting and irrigating rice.

Because rice tends to be regarded as a cash crop, farmers are less able to call on traditional collective work arrangements that enable a farmer to mass large amounts of labor to overcome key labor bottlenecks. Irrigated crops tend to be viewed as strictly individual undertakings. For this reason, the same farmer who will lend labor for traditional crops, will work on another's rice field only if paid. Needless to say, the acute shortage of cash at the beginning of the rainy season prevents many farmers from hiring the labor needed for the timely performance of agricultural operations. Farmers appear to give higher priority to rainfed crops than to irrigated crops when demands for labor become particularly acute. This is at least partly related to the small size of irrigated parcels. This is another factor leading to late planting, poor weeding and untimely irrigation for rice--all of which depress yields. In the Maggia valley where dryland production potential is more limited, farmers give higher priority to irrigated crops in allocating labor. As a result, cultural practices are correspondingly better and irrigated crop yields are higher.

The labor constraint on perimeters is aggrevated by the need to reconstruct field dikes, bunds and channels destroyed during land preparation. This reconstruction work must be done at about the same time as land preparation and plainting of rainy season crops. If plot sizes were larger or water were more available during the dry season, some of this work could be avoided or done at a time when labor demands are less acute. Alternatively, it may be possible to use puddling techniques with oxen similar to those used in Asia so as to reduce the need for post-plowing reconstruction. This needs to be researched but it would have the added advantage of providing better water control.

The shift from tractor to oxen plowing seems to be causing delays in land preparation in some cases. ONAHA reports that not all perimeters have sufficient numbers of oxen teams to do the necessary plowing when needed. This arises from insufficient supplies of oxen as well as from inadequate care of those which are available, reducing the average effective area that one team can handle. The net effect is to further delay planting, putting production schedules and fertilizer and other investments more at risk.

Other factors are increasing the financial risk that farmers in irrigated perimeters face. Some of these are avoidable. For example, input supply is a problem in several areas. This problem has two separate causes: ineffective ordering and lack of credit. One knowledgeable source indicated that much of Konni I's problem with pests was due to a failure on the part of the cooperative to order the insecticides in sufficient time and in sufficient quantity to meet the needs of the crops.

Inputs are generally available on a cash basis and insecticides for cotton are free. Other inputs for cotton are still available on credit. But unless the cooperatives order the inputs on time and pay for those obtained on credit as required, they risk either getting their inputs late or being cut off from production credit and not getting them at all.

Except for most of the cotton perimeters, farmers on irrigated perimeters no longer receive production credit from

the CNCA because of very poor repayment rates on past loans. While government suspension of credit under these circumstances is certainly understandable, indeed desirable, farmers who do not have the means to pay cash do find themselves more exposed financially. Without fertilizer and insecticides, yields may fall below levels necessary to cover fixed costs plus provide a competitive return to farmers' labor.

Reductions in input subsidies now underway in Niger may add an additional element of financial risk for some farmers. Farmers along the river are more likely to be purchasing fertilizer and insecticides from the <u>Centrale d'Approvisionnement</u> rather than in the already unsubsidized private market which is more active along the border with Migeria. As the GOM reduces subsidies, costs will rise for these farmers. Available evidence indicates that nitrogen and phosphorous fertilizers will still be quite economic on irrigated rice even under full cost prices from present sources of supply. However, there can be no doubt that it will reduce overall returns to rice production and require a more efficient level of operation to meet all expenses.

Finally, the move toward fuller-cost pricing of services provided to farmers by ONAHA will increase the financial burden and risk of farmers still more. Some of this, such as charges for water, will be done in a context where an individual farmer has little control over waste and misuse by other farmers working in the perimeter. Thus the problem of good farmers subsidizing poor farmers will become increasingly evident and sensitive. The GON should begin now identifying procedures for helping farmers within the perimeters decide how to handle this problem.
VII. MARKETING ASPECTS OF IRRIGATED AGRICULTURE

#### VII. A. <u>Marketing Systems</u>

Most cereals and cotton grown on irrigated perimeters are marketed through one of three parastatals. At the present time, all these markets are officially controlled. Minimum producer prices are set by the government, and sales to nonofficial intermediaries within official marketing areas are illegal.

During the past year the government has begun to relax its control of cereals markets. Soon farmers will be allowed to sell on private markets any rice not required to repay perimeter operating charges and loans from the farmer's cooperative. The number of official sorghum and millet buying points has been reduced and outside these markets farmers may sell to anyone. Unfortunately, most of the sorghum sold from irrigated perimeters must be sold on official markets, as must cotton, peanuts and cowpeas since most perimeters contain official buying points for these crops.

Whereas most coreals produced on irrigated perimeters now pass through official channels, marketing of vegetable products has never been controlled by the government. At the wholesale level these are sold through itinerant bulkers and traders who purchase at the farm level, and through merchants and assemblers in village markets. In some cases farmers organize wholesale marketing themselves and rent trucks, obtain export documents and sell in coastal markets. Those close to retail markets may retail their produce directly to consumers.

#### VII. B. Demand for Irrigated Grains and Vegetables

#### VII. B.1 The National Demand for Cereals

Demand for cereals produced under irrigation faces promising growth prospects. Indeed, self-sufficiency in grain production has been the primary justification for developing irrigated agriculture in Niger. According to the recent Agriculture Sector Development Grant Proposal (USAID, 1984), Niger imports about 60,000 tons of rice and 100,000 tons of sorghum and millet in an average year. This deficit is expected to double by 1980.

Eliminating this deficit will require bringing into production an additional 60,000 hectares of double cropped irrigated cereals at current yield levels. This compares with a current anticipated expansion in irrigated cropping area of 1000 hectares per year over the 1980-1988 period. Thus demand will not constrain the marketing of irrigated cereals production.

# VII. B.2 The National Demand for Fresh Vegetables

The national demand for fresh vegetables is also growing quite strongly. Numerous observers note the tremendous increase in consumption of European type vegetables among Nigeriens over the past ten years. As much as 30% of veg table production is consumed on the farm by members of the producing household. High rates of growth in urban population and income coupled with declining real prices for fresh vegetables have provided further stimulus for vegetable consumption. Unfortunately, no reliable quantitative consumption data exist with which to document this evaluation. Available data on production of vegetables, though of questionable value, do, nonetheless, tend to support the reported accounts of rapid growth in national consumption of vegetables.

# VII. B.3 The Interregional Demand For Fresh Vegetables

Interregional demand for fresh vegetables, especially those consumed in relatively large quantities by African households, appears to be even stronger than national demand. Most of an estimated 13-15% annual growth in onion and tomato production since the early 1970's, for example, probably flows into export markets. Demand for onions from coastal countries is so strong that those merchants come to Niger to pick up supplies.

Demand, though strong, is not infinite. One cooperative which did engage in direct export of onions in order to increase its return when local markets were glutted, usually divided its shipments between Lagos and Malanville--in spite of the fact that prices were 20% higher in Lagos. It did this to avoid depressing prices and reducing overall returns. This suggests that Niger will have to give more attention to marketing guestions if it expects to continue expanding vegetable production as much as is currently planned.

#### VII. B.4 Demand for Dried Vegetables

For many years farmers in Niger have been drying tomatoes, onions, peppers and okra as a means of preserving surplus fresh vegetable production. According to farmers, rainy season prices for dried tomatoes and peppers are double those of equivalent fresh vegetable prices during the main vegetable growing season. No quantitative estimates of production or sales are available but the price data certainly suggest considerable room for expanding production of dried vegetables. In addition, there may be scope for further development of the markets for dried vegetables, especially as producers improve processing quality and expand their marketing radius to include more distant African countries.

Dried vegetables fit into traditional food consumption patterns for most African households quite well. The principle uncertainty at this time is the extent to which the dried vegetable market in these countries is already developed and, perhaps saturated with local production. Should the market for dried vegetable exports prove capable of substantial expansion, then USAID may want to take a closer look at simple solar powered vegetable dryers and ways of developing this market.

#### VII. C. Constraints on the Marketing of Vegetables

#### VII. C.1 The Timing of Production

The major marketing problems with fresh vegetables arise from the highly seasonal nature of vegetable production in Niger. During the latter part of the hot dry season and much of the rainy season, many vegetables will either not set fruit or they succumb to insect and disease problems that prevent economical production. At the same time, farmers are preoccupied with their rainy season crops. Moreover, many of the better lands for vegetable production are flooded over much of the rainy season. As a result of all these factors, most vegetables are virtually non-existent in local markets from June to November. For the same reasons, most farmers begin planting vegetables following the harvest of their rainv season cereals crops. This causes most of the country's fresh vegetable production to hit the market over a three month period between January and April. The resulting glut depresses prices. In the case of highly perishable products such as lettuce, farmers may even let part of the crop rot in the field.

In spite of the ecological and climatic constraints on extending the growing season for vegetables, it does appear that farmers could be doing more than they are. In one village near Madaoua, farmers deliberately delayed planting onions so their product would hit the market when prices were 20% higher than flush season prices. Near Galmi, some producers concentrate on onions and produce two crops per year. This necessarily implies less attention to rainy season cereal crops but these farmers find the tradeoffs worthwhile. Finally, producers around Niamey succeed in providing a more steady supply of vegetables to that market.

By getting an earlier start on seedbeds and phasing planting times over a longer period farmers should be able to push a larger share of their production into periods when market prices are above flush season prices. Unfortunately, we do not yet have a good enough idea of how vegetables fit into the overall farming system to be able to say definitively that the average farmer would increase his total income by making such adjustments. On the surface, it seems that he would.

#### · VII. C.2 Market Access

In some areas, such as the Maggia Valley and the Air Mountains, the lack of good farm to market roads and the distance from consuming centers discourage more intensive vegetable production. The absence of a substantial volume of consumer good imports from outside means that agricultural produce often must bear the full cost of round-trip transportation to regional markets.

Although improved farm to market roads would lower marketing costs and, as a result, probably raise prices received by producers, it is not at all clear that this would be a cost effective solution to the problem of market access. Oxen carts can move cereals and dried vegetables over very rough terraine quite cheaply. Before turning to improving farm to market roads to move fresh produce, it would seem wise to examine market prospects for dried vegetables as an alternative to better roads for moving fresh vegetables.

# VII. C.3 Storage and Preservation of Vegetables

Losses associated with farm level storage of vegetables can run quice high. Estimates for traditional onion varieties run as high as 30-40% over three to four months after harvest. This partly explains the rise in prices during the slack production season.

Storage losses appear to arise primarily from high ambiant temperatures during storage. They seem to be aggrevated by premature harvesting, rough or excessive handling when moving the produce into storage, and poor ventilation in storage areas. Some farmers have found techniques for reducing storage losses. These need to be identified and confirmed through research. There is also room for developing and selecting varieties with better storage characteristics under Nigerien conditions. INRAN has been conducting research on ventilation systems but apparently it has been unable to improve substantially on farm level performance thus far.

Most preservation of vegetables in Niger is via solar drying on straw mats or on the ground. This increases spoilage by preventing proper ventilation and prolonging the drying process. It also increases the introduction of foreign matter, a factor that can't help but reduce its value in the market. Whether consumers would be willing to pay for the improved quality resulting from more effective and more hygenic drying conditions needs to be explored in the vegetable marketing study outlined in Annex I.

#### VII. C.4 Entrepreneurial Capacity

The team's vegetable marketing specialist notes that vegetable merchants in Niger seem to lack the entrepreneurial desire or capacity to fully develop and exploit potential markets for vegetables in neighboring countries. He feels that they emphasize short term profits and are reluctant to take the kinds of risks necessary to develop vegetable markets and maximize long run profits. Many Nigeriens share this view.

While this hypothesis is certainly plausible, it may be premature to conclude that the marketing opportunities which appear to be viable, indeed are. In the very high interest rate environment of rural financial markets, it is difficult to justify long run investments of any sort on a private basis. Once the GON or donors identify investments in market development for vegetables that offer promise from a national economic point of view, they will need to focus on ways of reducing risk or otherwise increasing the private rate of return so that private returns on marketing vegetables equal private returns available from other investments.

#### VII. D. <u>New Markets and Products</u>

No obvious new products suggested themselves to the team as offering special potential for increasing the value-added that Niger realizes from its investments in irrigated agriculture. Several older ones, however, appear to be more promising than rice and cotton, two of the most widely grown crops on irrigated perimeters.

The team's farming systems economist found private returns to family labor applied to peanuts, cowpeas and sorghum to be considerably higher than returns to cotton and rice. Although there was not sufficient time to do an economic analysis, the high proportion of subsidized inputs available for cotton and rice suggests that their relative unattractiveness would not change in economic terms. Morever, Niger experiences substantial deficits of peanuts and sorghum while the export potential for cowpeas clearly exceeds any reasonable production potential the country can develop over the next ten years. Add to this the agronomic reasons for incorporating sorghum peanuts and cowpeas into irrigated crop rotations and you have a fairly compelling argument for giving more attention to growing these crops under irrigation, even on the rice perimeters. The major obstacles to such shifts are policies which give priority to self-sufficiency in cotton and rice production for political reasons. Pests are also a problem with irrigated cowpeas, making it difficult to realize their potential.

On the vegetable side, onions are clearly the most profitable option available. The only question is the absorptive capacity of this market outside of Niger. To address this question, we are recommending a study of vegetable imports and the seasonal availability of fresh and dried vegetables in coastal African countries. Dried tomatoes, peppers, onions and okra are four which are already established in African diets and therefore merit special attention. National markets alone will not support the kind of expansion in vegetable production envisioned by the GON.

High valued vegetable crops for export to European markets do not seem so promising. The recent failure of fairly well organized exporting operations in Niger and elsewhere in the Sahel, the high quality standards in those markets, and the intense competition from countries which are much closer and which have lower cost packaging industries all argue against success. There may be some potential for displacing such exports to Ivory Coast but this will also require a degree of marketing sophistication that has yet to demonstrate itself in Niger.

#### VIII. INSTITUTIONAL, SOCIAL AND POLICY ISSUES

Historically, institutions which play key roles in supporting and implementing irrigated agriculture in Niger have not placed high priority on involving farmers in planning and decision making. Most observers feel that this is one factor explaining the relatively poor performance of Niger's irrigation sub-sector to date. Partly in response to this presumption, the GON has embarked on a nationwide campaign to strengthen the cooperatives and make farmers more responsible for management and maintenance of irrigated perimeters.

# VIII. A. Cooperatives

Efforts to strengthen cooperatives in Niger are not new. The UNCC, the agency primarily concerned with cooperative development in Niger, has existed since shortly after independence. During the 1970's its role grew to include marketing of food grains and supplying farmers with inputs. It gave little attention to cooperative education over this period so UNCC agents had to assume much of the additional work and responsibility associated with these functions.

In 1984, Niger's cooperatives are still, by and large, weak institutions. The government defines their role and function and specifies rules and procedures. Cooperative membership is determined by place of dwelling rather than by group affinity or common interest, a legal requirement that undermines the social cohesiveness and group solidarity of the cooperatives. The cooperatives are not permitted to charge membership fees or to assess members for establishing an investment and working capital fund. In reality, cooperatives in Niger, with certain notable exceptions, have little internal dynamism of their own. In its own way the GON is still trying to correct these problems but skeptics abound as to its likely long term success without giving farmer groups more latitude in determining their own rules and procedures.

The Zinder Conference recommended several changes in the way the GON approaches cooperatives on irrigated perimeters. These included making the cooperatives themselves directly responsible for acquiring inputs, managing production and medium term credit, primary maintenance of irrigation infrastructure and managing the distribution of water. More significantly, the Conference recommended that the head of each perimeter, now an ONAHA employee, be employed directly by the cooperative. The Zinder Conference did not, however, try to define an appropriate role for government in regulating the legal structure and operating rules of cooperatives. Although the GON has publicly stated its full support of the Zinder recommendations and is trying to implement them on a selective basis, the lack of an effective training program for helping farmers to assume these responsibilities is one factor impairing the evolution of the desired changes.

#### VIII. B. Extension and Training

Niger's extension service is weak and lacks proper support. It is based on a top-down one-way communications model that has difficulty adopting its recommendations to regional variations in climate, soils and production practices. The extension approach to farmers is directive rather than participatory and the agents themselves tend to be poorly trained and ill prepared for the extensive responsibilities they are being asked to assume. This situation is particularly acute within the irrigation subsector where farmers are more interdependent and the performance of substantial investments is highly dependent on the quality of extension services available to farmers.

At the present time the training program at Kolo does not include a specialization in irrigated farming. Training in management is extremely weak, even though many agents working in irrigated perimeters are placed in managerial roles.

Correcting these deficiencies via training programs will be difficult unless the MDR stops the frequent movement of personnel into and out of the irrigation subsector. Although, officially, assignments are made on a five year renewable basis, many of the agents with whom the team spoke had been working in irrigation less than two years and looked forward to the day when they would move elsewhere. Most of the agents and their superiors see this mobility as central to their ability to advance within the ministry. While this mobility may facilitate personal advancement, it certainly does not facilitate accumulation of human capital ir the irrigation subsector. Creation of irrigated agriculture professionals at all levels, with appropriate incentives and advancement to encourage them to remain in the irrigation subsector, is urgently needed in Niger.

Training programs aimed directly at farmers may provide a longer term solution for improving cultural techniques and irrigation system management than training extension agents. Farmers, at least, are more or less permanently attached to the perimeters. The CPTs are beginning to teach farmers vegetable gardening during the dry season, and have an easier time finding trainees for this aspect of their training program. But, thus far, they have tended to draw trainees from all over an arrondissement. This prevents the accumulation of a critical mass of farmers in any one area that could support each other with respect to collective activities and management such as is needed in irrigated perimeters.

In some areas, the concept of the CPT is being modified to suit the needs of irrigated perimeters. But to provide useful training for farmers working in irrigated agriculture, the CPTs will need to change more than their recruiting program.

The question of training in Niger necessarily raises the issue of training models. Most training models employed in areas related to training of extension agents and farmers tend to be quite directive in manner, theoretical in content and to emphasize what the trainer has to offer to the trainee. There is little room for give and take along the lines of more participatory, practically oriented training models. Yet given the lack of experience of many teachers and ONAHA extension agents, everyone, including ONAHA, would benefit from increased feedback from farmers and from their own teaching trials on why certain recommended practices are, or are not, appropriate in a particular situation. Any training program aimed at either extension agents or farmers should pay as much attention to the techniques of training as to the content.

#### VIII. C. ONAHA

The poor performance of Niger's irrigated perimeters relative to their potential goes beyond the historical lack of farmer participation in decision making and the low level of training and lack of experience of extension agents and perimeter managers. In a very real sense, ONAHA has not been given the necessary means to fulfill its mandate.

The overriding problem is an inadequate budget for undertaking the necessary maintenance, coupled with unpredictable shortfalls or delays in its being able to obtain its budgetary allocations. At the same time the MDR has been very reluctant to raise user fees that would generate the necessary revenue from farmers to permit ONAHA to fulfill its maintenance responsibilities. Shifting responsibility for maintenance to farmers is one way of dealing with this problem without raising user fees directly. Still, ONAHA will not be able to plan its activities, program its resources, and then effectively execute its plan of action unless and until it can count on the government to provide promised budgetary allocations on a reliable and timely basis.

ONAHA's problems with its operating budget are compounded by the unwillingness of political authorities to support sanctions against farmers who refuse to pay for accumulated user fees and credit for inputs. In 1982, the payment rate for accumulated user fees and outstanding input loans dropped below 50%. The operating leases signed between farmers and ONAHA specifically provide for sanctions against non-payment of debts. Yet without the political will to enforce them, or the necessary budgetary supplements to cover the resulting shortfall, ONAHA has little choice but to accumulate larger operating deficits.

ONAHA is also confronted with an imbalance in its personnel--too many tractor drivers and not enough accountants, draftsmen, mechanics, etc. It is correcting this problem and is reducing its overall staff. Unfortunately, it is cutting contractual rather than civil service employees. Given the notorious lack of motivation of many of the latter, there is some doubt that ONAHA will emerge from its current reorganization plan being a more effective organization.

Other problems plague ONAHA, such as a lack of infrastructure necessary to fulfill its responsibilities, a division of responsibility for design and execution between itself and the <u>Genie Rural</u> that reduces its overall effectiveness, and an insufficient number of extension agents to carryout its program of action even if they were all well trained and effective. At the same time, the linkages with INRAN are little developed and its recommendations to farmers sometimes of questionable value. In short, ONAHA is trea ed and managed too much as a service of the MDR and not enough as the autonomous institution that it is. Unfortunately, the current management of ONAHA seems quite satisfied with this arrangement.

#### VIII. D. <u>Research</u>

Irrigation research in Niger is not very effective at supporting the extension program on irrigated perimeters. This arises both from the low priority given to irrigation in INRAN's research program and from the lack of effective communication linkages between research and extension and between research and farmers.

The INRAN researchers working solely on irrigated crops are those working on rice, fruit trees, sugar cane, and irrigation systems. The work on rice is highly dependent on WARDA and that on fruit trees and on irrigation systems is largely donor driven. INRAN has no one in training to continue work on irrigation systems when the GERDAT researcher departs.

INRAN's primary vehicle for carrying out research on irrigated agriculture is by contracting with ONAHA and particular projects to carry out research requested by the user. Although this approach is producing good results in select cases, such as at Djiratawa in Maradi, it is lamentable that INRAN does not have a more structured, longer term program of its own.

There is no doubt that INRAN needs more research staff, or at least a shift in the priorities of existing staff, if it is to become more effective in providing and testing new irrigated crop production technologies. Even more important is the need for INRAN to develop feedback loops between its research program and the farm application of research results. With such linkages, research institutions could more effectively disseminate research findings to farmers. More cooperation between research and development projects of the kind now occurring in the Goulbi Maradi perimeter is sorely needed.

#### VIII. E. Management System and Land Tenure

The lack of maintenance of canals on the irrigated perimeters may arise in part from the seasonal labor shortage. But it may also be due, in part, to a lack of legitimacy on the part of the management committee designated by cooperative members to manage various aspects of the irrigation system. If farmers sitting on this committee do not carry with them some traditional source of authority, farmers may not accept their decisions and rules.

Some sources suggest that the manner of allocating irrigation parcels and the usually small sized plot given to a single family may explain part of the lack of attention to irrigated crops by farmers. In such a brief encounter with villagers as was possible in a study of this kind, we found no evidence of dissatisfaction in the way parcels had been allocated. Some civil servants have parcels but as far as we could determine, most owned land within the perimeter before it was developed for irrigation. As far as the size of parcel goes, this seems to be almost entirely related to the political desire to distribute available irrigated land as widely as possible. It is difficult to see how a popular government could do much else, even recognizing the problem it poses for maximizing the effectiveness of investments in irrigation.

#### VIII. F. The Role of the Private Sector

The private sector is very active in perimeter design and construction, though contracts for larger jobs and more sophisticated services tend to go to European rather than Nigerien firms. A key issue is how to strengthen the competitive capacity of Nigerien entrepreneurs so that they might be able to assume a greater share of the design and general contracting work.

At the present time the large, usually foreign, contracting companies sub-contract with Nigerien businesses, jobbers and equipment suppliers to provide services and materials. Most of these sub-contractors appear to lack sufficient capital - and maybe the expertise - to make the kind of investment necessary for taking on the larger tasks. It would be useful to study this group more closely in order to identify key constraints on their growth and development. With such information it should be possible to develop a program that can help them make the transition from jobber to primary contractor.

As with other areas of Niger's agriculture, the way in which the GON administers its subsidies constrains the private sector from playing a more active role in supplying operating inputs to the irrigation sub-sector. Even with the GON decision to raise user fees to farmers, substantial direct and indirect subsidy elements still exist in such things as fertilizer, insecticides, equipment and pump servicing and repair. ONAHA is phasing out its highly subsidized tractor hire services in favor of farmer owned draft animals.

With some inputs, such as fertilizer and, to a lesser extent, tractor hire services, the private sector plays an important role in spite of the subsidies. With others, such as pump maintenance and repair, cooperatives rely much more on ONAHA. Indeed it was not clear to the irrigation sector assessment team whether the cooperatives were even permitted to engage private sector contractors for such support. We received conflicting information from different sources within ONAHA.

Numerous businesses in Niamey sell pumps, and service what they sell. ONAHA deals with many of these firms to acquire pumps and parts it needs for its operations. Cooperatives could do this as well. But until ONAHA fully charges for its services related to the pump, there is little incentive for farmers to deal directly with suppliers.

The private sector is already active in supplying pumps to individual farmers or groups of farmers. Some pumps are purchased from importers/distributors in Niamey but most appear to come from Nigeria where comparable pumps cost 50-65% as much as in Niger.

Farmers appear to be servicing many of these pumps themselves and doing quite well at it. The FAO/ADB Small Scale Irrigation Project and a CIDA project both envision providing training in pump maintenance and repair. In any case, ONAHA has never been involved in maintaining and repairing pumps outside of its perimeters.

<sup>&</sup>lt;u>1</u>/ We were not able to identify with certainty the reasons for such large differences. The total of customs and fiscal duties and other taxes levied on pumps imported legally into Niger add 40% to the CIF cost. Restrictive licensing of importers does not appear to be a cause, though standard commercial pricing practices in Niger may well be.

Cooperatives already purchase fuel directly from private merchants, many of whom deliver fertilizer at the same time. The CA is always available for other inputs but since the CNCA has stopped providing credit, farmers no longer have an incentive to buy from the CA unless its sale price is cheaper than the private market. For fertilizer it usually is not. For many types of animal traction and spraying equipment it is, since subsidies are paid directly to the CA rather than to importers or manufacturers.

In addition to supplying inputs, the private sector provides masons, well-diggers, mechanics, metal workers and even oxen drivers who provide invaluable services for the construction and maintenance of irrigation infrastructure. This informal system of hands-on technicians warrants further investigation and, possibly, assistance with skills development and business expansion.

The private sector is most active in the area of marketing. Currently it markets all the vegetables produced on irrigated perimeters and a substantial amount of the grain which is sold. Only for cotton is private sector involvement limited.

Niger can expect its private sector to continue to market vegetables and other products from irrigated perimeters. This includes interregional long distance trade. It cannot expect much private sector product or market development to occur in the magnitude needed without some catalyst from the public sector. Marketing studies, experiments with alternative storage and drying technologies, even perhaps, identification of marketing opportunities will be areas where the public sector will have to provide leadership. But once viable opportunities and markets are found, it is hard to believe that, as active as it is at the present time, the private sector will not respond to them. Donors or the GON may have to provide credit for the construction of drying facilities or technical assistance for quality control and market development. But individual cooperatives and merchants have a keen personal interest in evacuating their produce as effectively and at as high a price as possible. Long distance coastal trade already exists. It is a relatively small step to supplement this with marketing inputs that provide the kind of information needed to reduce risk and uncertainty and thereby improve the efficiency with which the private sector carries out its marketing functions.

In discussing the private sector's role in developing irrigated agriculture in Niger, there is a tendency to ignore farmers and farmer organizations. There is no reason why many of the services needed on irrigated perimeters cannot be provided by farmers themselves. This is especially true when one considers the amount of time it may take to identify and obtain the services of technicians living in towns. As the GON implements its recent policy of making irrigation systems autonomous and farmer groups more responsible for them, the technical burden on farmers will increase. To cope effectively with this shift of responsibilities, farmers will need help in developing the necessary skills.

The one service not provided by the private sector at the present time is that of extension. Yet one can conceive of several ways of privatizing extension. Many countries in Africa do this through crop authorities, the CFDT and its national successors being the most notable case in West Africa. However we are not aware of any instances where this has been seriously tried for food crops not tied to cash crops.

The recommendation of the Zinder Conference that the cooperatives employ extension agents directly is one of the more exciting proposals for extension reform to come along in a long time. Identifying, formulating and testing ways of doing this could form the core of USAID development project that would have regional applicability if successful. In a later section we present some ideas on how such a project might look.

#### IX. ENVIRONMENTAL AND PUBLIC HEALTH ISSUES

#### IX. A. <u>Water Resources</u>

Niger has adequate surface water supplies to meet the irrigation needs of land already developed or under development for irrigation. Periodic shortages of water result from insufficient storage and poor placement of pumping stations rather than from inadequate surface water supplies. Abnormally low flows in the Niger River have deprived some pumping stations of a water source while heavy siltation of inland reservoirs has greatly reduced their storage capacity. Provided the necessary infrastructure investment is made, planned irrigation development in the Niger River Valley and in the Ader Doutchi-Maggia region should not be constrained due to lack of water. Whether such investments in infrastructure will be economic is a question that needs to be approached on a case by case basis.

Ground water resources in Niger appear to be adequate, if not plentiful, and of reasonably good quality for irrigation. In some areas, such as the Air Mountains, the volume of ground water available may restrict the scale of agricultural development. Generally, however, the aquifers available to support irrigation projects are moderately productive. Very large tube wells will frequently not be appropriate since many of the aquifers are not thick and have low to medium specific capacities. A more efficient scheme would involve numerous lower capacity tube wells spaced so as to maximize production with minimal interference with each other. Any development of tube wells for irrigation will need to be evaluated carefully on a case by case basis.

#### IX. B. Soils

In general, Niger's soils are well drained and sub-surface drainage is not required. In some areas surface drainage is not particularly good, leading to isolated problems for crops other than rice but these are due more to poor water management and system maintenance than to the structure of the soils. Salinization and alkalization are not important problems though the presence of some soils with a naturally high sodium content and the hetergeneous nature of soils in general argues for site specific analyses of soil and water quality as a precautionary measure.

Erosion is more of a problem, especially on the poorly covered soils of the major north-south drainage basins. Rapid siltation of the principal surface dam reservoirs makes development and exploitation of surface water sources a problematic exercise. In such areas tube-wells probably represent a more cost effective method for irrigating valley bottom soils.

#### IX. C. Pesticides and Fertilizers

At the present time, the use of both fertilizers and pesticides in Niger is low. On irrigated perimeters where use of both is relatively high, very little water is returned as drainage to the river; most of it percolates into the ground water table. If fertilizer herbicide or pesticide use increases substantially, then ground water quality should be monitored.

#### IX. D. <u>Waterborne Diseases</u>

The snail intermediate hosts for urinary schistosomiasis are found throughout Niger. Urinary schistosomiasis is a major public health problem in communities located near surface water sources. Average infection rates vary between 10 and 50%, with children between 5-14 years of age having between 50 and 90% rates of infection in some riparian communities. Intestinal schistosomiasis is less well studied in Niger but its endemicity is certainly much lower than for urinary schistosomiasis.

On-site visits reveal the widespread existence of aquatic vegetation and host snails in irrigation canals along the river and in permanent inland reservoirs. These are less important problems on those surface dam perimeters where the reservoirs are dry for longperiods, helping to keep weed and snail populations in check. Throughout Niger, irrigation canals and reservoirs serve as bathing and washing centers so the potential for spread of the disease once introduced is quite high. Only the narrow cement lined canals fed from ground water sources at Djiratawa were free of aquatic vegetation and snails.

#### IX.E.Measures for Improving Public Health Aspects of Irrigation Projects

In order to ensure that public health issues receive the necessary consideration in the design and implementation of irrigation projects, the Government of Niger needs to establish a strong role for the Ministry of Health in the planning, design and administration of irrigation schemes and other water resource projects. ONAHA could serve as the nucleus or executing arm for an interministerial commission or irrigation authority that would have strong public health representation. This commission should review the design of new irrigation schemes and the operation of existing ones with the goal of incorporating a public health perspective. It could also serve the function of better integrating the implementation concerns of ONAHA with the engineering and design concerns of the Genie Rural. Such a commission should have authority to establish critical water-use practices, enforce sanitary and vector control measures and forbid agricultural practices known to encourage the transmission of disease. In this way, basic environmental sanitation and vector control measures could be built into each project from the outset. The commission should collaborate closely with OCCGE and the recently created Schistosomiasis Research Center in Yaounde and could call on other in-country and external experts as needed.

In existing perimeters proper maintenance of canals to control silt and aquatic vegetation would increase water velocity and reduce vector habitats. Mechanical barriers at the pump and canal heads would restrict the amount of snail carrying debris that enters the system. Eliminating seepage from canals would destroy breeding areas for snails and mosquito larve while application of a moluscicide would control snails in the canals. Periodic drying of the canals and/or fluctuation of water levels has also proved effective as a vector control measure. Finally, chemotherapeutic treatment of infected individuals and health education can reduce the role of the human agent in the transmission of waterborne diseases.

In new perimeters, the location of the pumping head and sufficient grades on canals can reduce the intake of vectors and the accumulation of silt in canals. Distribution systems can be designed so as to permit whole sectors to be isolated and dried as a vector control measure. Froper siting of new villages can reduce the exposure of human populations to deleterious environmental conditions. Finally, cropping systems, which rotate rice with other crops that demand less water, can effectively create soil water conditions that are not favorable for establishment of vector habitats.

The range of possible actions for dealing with waterborne diseases and disease vectors is obviously quite broad. Yet unless the public health perspective is brought to bear in the actual design and operation of irrigated perimeters, these and similar changes have little chance of receiving serious consideration by those in a position to do something about them.

#### X. PROGRAM AND PROJECT POSSIBILITIES

#### X. A. Improving Production Versus Expanding Irrigated Area

From the previous discussion it is clear that the problems which constrain irrigated agriculture in Niger are not really that dissimilar from the problems that constrain dryland agriculture and agricultural development in general: weak institutions; inadequate technologies, poor policies, and lack of coordination between government agencies. As a consequence, overcoming them will require the same breadth of actions and programs.

To focus these actions, the irrigation team recommends that USAID concentrate its efforts on making existing irrigation systems function more effectively rather than on expanding the area under irrigation. This should include efforts to minimize the public health dangers created by irrigation systems. Once USAID is able to identify, apply and demonstrate a successful approach for doing this, its application to other existing and newly established perimeters will have the effect of increasing the social effectiveness and the economic rate of return of a much larger level of investment than that made only by USAID.

The need to incorporate public health considerations into the design of new irrigation systems might provide one exception to this general strategic approach. At the present time other donors are more than willing to provide the funding necessary to expand the area under irrigation. USAID might want to consider providing the technical assistance and funding required to ensure that vector control and other public health issues receive appropriate consideration in the design of these systems. This assistance could center around creating and providing technical assistance to the interministerial commission or irrigation authority discussed previously. Preparation for it should include a rather comprehensive review of how public health issues are currently incorporated into irrigation system design by the Genie Rural and ONAHA.

#### X. B. Choosing Priorities

Within this general strategic approach, USAID needs to identify priority areas around which it wants to develop its programs. To dramatize the kinds of choices that must be made, we have divided the constraints discussed in the report into four groups.

#### X. B.1 Critical Problems Which USAID Should Address

The problems that require immediate attention include the following:

- a. poor selection of cropping systems
- b. labor bottlenecks
- c. poor perimeter maintenance

- d. ineffective extension
- e. lack of credit for inputs
- f. poor management of water
- g. inadequate control of waterborne diseases
- h. lack of perimeter level applied research

Some of these problems are interrelated; poor perimeter maintenance is at least partly due to labor bottlenecks and partly responsible for uncontrolled waterborne diseases. Some, such as the lack of credit, involve rather straightforward solutions. Others, such as ineffective extension, require further diagnosis of the reasons and identification of workable solutions. For example, there is a clear need to strengthen the tecnnical skills of the agents, increase the number of agents relative to the area cultivated, provide incentives for making a professional committment to irrigated agriculture, reduce turnover, and strengthen extension's links with research.

Some of the problems have multiple solutions, e.g. herbicides, credit for hiring labor, research on alternatives to transplanting rice and/or weeding with animal traction might each provide an appropriate solution to labor bottlenecks in a particular context. All of these problems, however, have in common the fact that they lead to subscantial underachievement of the potential of irrigated agriculture. Overcoming them will require a general production improvement program on one scale or another and better coordination between agencies concerned with various aspects of irrigated agriculture.

#### X. B.2 Problems Which USAID is Addressing in Existing Projects

Several USAID projects, while not specifically directed at irrigated agriculture, nonetheless are making improvements that can fairly easily be made to benefit irrigated agriculture. The APS project will make inputs available on a more timely basis by strengthening the input supply parastatal and providing revolving funds to cooperatives to cover working capital. It will strengthen cooperatives through training in cooperative management. The same project envisions major improvements in extension training.

The Agriculture Sector Development Grant is inducing a more flexible approach to output pricing that should benefit farmers on perimeters since they, almost by definition, must sell controlled commodities in official markets--although the extent to which this is actually happening is not clear. It should also increase the availability of inputs by changing the way the GON sets and applies input subsidies. The Niamey Department Project will provide a facility for designing and prototype testing of animal traction equipment. In addition, it is experimenting with some exciting approaches to farmer training in some of the CPT's in the department. Programming obviously involves choices and choice involves eliminating some options. Some program areas which would probably be excluded if USAID pursues production improvement on existing perimeters as its overall strategy would be the following:

- expanding the area under irrigation in a substantial way
- b. enabling ONAHA to develop a capacity to contract with local firms for perimeter construction work

٩

- establishing pilot small scale perimeters a la Bakel
- d. measuring and/or monitoring ground water resources
- e. testing technologies for exploiting ground water resources
- f. providing credit for constructing permanent wells and purchasing motor pumps
- g. strengthening the MDR and the <u>Genie Rural</u>, apart from that provided by creating an overall coordinating body such as an irrigation authority
- h. providing extension support for micro-perimeters
- i. reinforcing PVO's vis-a-vis vegetable gardening
- j. improving plant protection services on a broad scale
- k. strengthening INRAN to carry out research on:
  - i) pest and disease resistant crop varieties
  - ii) vegetable varieties with good
  - marketing and storage characteristics
  - iii) irrigation systems
- strengthening INRAN in the area of research methodology and experimental design

#### X. B.4 <u>Program Areas Which USAID Might Address Along With</u> <u>Priority Problem Areas Under a Production Improvement</u> <u>Program</u>

This includes program areas that could be incorporated into a production improvement project without greatly diverting management resources away from the primary project purpose. Much would depend on the particular form the production improvement project would take.

- a. limited pilot activities such as testing shallow well or tube well technologies for providing supplemental irrigation for a surface dam system
- providing market information for planning vegetable production
- c. processing and storage of vegetable crops

- d. creating small scale management units within larger perimeters
- e. restructuring ONAHA into a financially and administratively autonomous institution
- f. strengthenting the role of the Ministry of Health in the design and implementation of irrigation schemes

# X. C. Possible Project Alternatives

The two broad options which we propose for dealing with the critical problem areas which USAID should address center around strengthening ONAHA or finding alternatives, possibly private sector alternatives, that offer more promise for overcoming the priority constraints.

#### X. C.1 Strengthening ONAHA

The reasons for strengethening ONAHA include:

- ONAHA is responsible for ensuring that irrigation investments are productive.
- 2) The functions which ONAHA now performs will continue to have to be done by some agency for some time. Cooperatives will <u>net</u> be able to assume many of these functions in two years as the GON now hopes.
- 3) ONAHA has a logical organizational structure for housing the kinds of interventions which the team sees as important. It has one director general and one accountant. That would simplify the USAID project management task.
- ONAHA is a semi-autonomous agency, with a clear organizational mandate, already on its way to certain kinds of needed reforms.

Some likely problems in working with ONAHA include:

- <u>ONAHA's bureaucratic structure</u>. Altering this will not be easy. ONAHA has given little indication of wanting more administrative autonomy and it does not seize that which it already has.
- 2) Inadequate operating budget. ONAHA is still very dependent on the GON for its operating budget. As with other government and parastatal agencies, ONAHA's operating budget has continually been underfunded, delayed and underallocated and the prognosis is for more of the same.
- 3) <u>Poorly motivated workforce</u>. ONAHA civil servants would resist the kinds of changes necessary to develop a stable and motivated workforce--changes which, in the present context, suggest a gradual withdrawal of ONAHA personnel from the civil service--perhaps to a contractual basis for all personnel.
- 4) Many other donors are also dealing with organizational questions at ONAHA. This might prove frustrating if all can not agree on a common course of action.

- 5) USAID would have difficulty finding the kind of senior, highly competent, politically savvy individuals needed who were also fluent in French.
- 6) The <u>Genie Rural</u> rather than ONAHA is the logical locus for institutionalizing public health considerations in irrigation system design.

#### X. C.2 Privatizing Extension

As an alternative to strengthening ONAHA, or perhaps as a less direct approach to doing it, USAID might launch a pilot project aimed at doing many of the same things as with an ONAHA project, but trying to privatize as many of ONAHA's functions as possible. Such a project could begin on an experimental basis in a single perimeter, in collaboration with ONAHA but not as a part of a project to restructure ONAHA. It could be seen as the first step toward making cooperatives responsible for perimeter level extension, with ONAHA reserving the functions of technical assistance, training of trainers, and coordinating applied research in support of the cooperative employed extension agents. Such a project might include some or all of the following components:

- USAID providing individual GMP's with funding to 1) pay part of the salaries of extension agents who would be employed by, and contractually responsible to, the cooperatives. The salaries of the agents would be composed of two parts: a fixed amount paid by USAID equal to no more than one-half the current GON salary for new extension agents, plus a variable amount paid by the GMP equal to some percentage of the increase in production occurring after the agent begins working for the coop. The PID design team would work out the details of how this increase would be measured and documented, how both farmers and and agents can be protected from abuse, the percentage of the net value added from the increased production that the agent would earn, and how and when the cooperative would assume the full cost of the agent's compensation. This would presumably create an incentive for the extension agent to perform and for farmers to learn as quickly as they could.
- 2) A training component for the extension agents that would cover water management, cultural practices, cropping systems, etc. This could be done through a special component of the APS II project directed toward irrigated agriculture, coordinated by an extension agronomist attached to the perimeter. It could also be provided by a private training organization such as ORT, though USAID would have to pay for it.
- 3) Using an existing CPT at the edge of the perimeter to provide short-term training for extension agents, farmers and cooperative officers. The CPT could serve as a locus for applied research of importance to the perimeter. The training would be coordinated and

reinforced by the extension agronomist. Hopefully the CPT staff could become an integral part of project staff.

- 4) A USAID financed applied research program carried out in the perimeter itself under the direction of a USAID/ONAHA farming systems researcher working in collaboration with INRAN researchers. USAID would provide field resources, and where necessary, other expenses of INRAN researchers conducting trials on the perimeter. The farming systems economist and the extension agronomist would provide the necessary link between the researchers and the extension agents/farmers. However both would be employed by ONAHA, not INRAN.
- 5) Dividing a larger perimeter into management units small enough to be handled completely by a single GMP. Ideally each GMP would have its own extension agent but if the GMP were too small, more than one GMP would share the agent's salary and expenses. Each GMP would be responsible for control of its own water and could choose its own cropping system.
- 6) Credit for the purchase of essential inputs such as fertilizer and insecticides. It goes without saying that such a program should come with a solid dose of discipline with clear, absolute and timely sanctions for dealing with non-payers. The extension agents or the GNP might be given a percentage of loan repayments. This could be integrated with plans to provide cooperatives with a capital stock under the APS project.
- 7) Experimentation with improved animal traction equipment designs, in collaboration with the Niamey Department Project. The extension agronomist would provide the initiative for the interaction.
- 8) Pilot projects relating to supplemental irrigation from tube wells and improved drying and marketing of vegetables provided the project site were on a surface dam perimeter and technical and marketing studies confirmed the desirability of such activities. Vegetable drying and marketing could be done by a private firm under contract or by the cooperatives themselves.

The two technical assistants would have to have ample, short-term back-up in order to be able to deal with such a wide range of problems. But giving them full responsibility for program execution will greatly reduce the likelihood of coordination problems in program execution. ONAHA would be expected to provide a counterpart for each technical assistant. The long run goal of ONAHA to have only one agent per perimeter serving as a consultant for farmers would be maintained. Any other extension agents would be hired and paid by the GMP's and cooperatives, as they felt was necessary. The training provided to them by the project would, in effect, become the basis of their livelihood. They would, as a result, take much keener interest in it. This would provide a powerful stimulus to keep training relevant to the economic needs of farmers. Eventually it should become possible to charge for such training as extension becomes viewed more and more as a market determined income generating service.

The advantages of the second approach to dealing with the priority constraints are the greater control it will give over project size, design and execution. It would require very little coordination with other donors as a condition of project success. Rehabilitating ONAHA on the other hand, would be a mammoth project no matter how it were designed. It would raise complex coordination problems. Indeed, nothing says that the multiple donors involved with ONAHA would agree on the direction such restructuring should take. At the present time, ONAHA, and presumably the donors working with it, seem to believe that ONAHA will be able to retire to an advisory role on the perimeters after two year perimeter establishment program. We are not that optimistic.

Whatever approach is taken, the next step for USAID is to make a clear study of the problems of ONAHA and the programs now underway to reform it. With this information in hand, it can then begin informal discussion with other donors on what it sees as important changes that are needed to ensure that ONAHA comes reasonably close to realizing its full potential. At the same time, it can begin to identify a perimeter where a more modest project might take place. The one advantage of Konni is that yields are so low we know that the technology exists to double or triple them just by transfering what is being done elsewhere in Niger. This will provide some leeway for mounting an applied research program that can generate new applications of available technologies that offer to increase farm incomes. Obviously USAID should make a thorough socioaconomic study of whatever perimeter looks promising before committing itself to a single perimeter model activity.

These two options are but two of many identified by the team. Annex H includes a more complete discussion of the pros and cons of several other alternatives to which we attach lower priority.

- Africare; "Revised Tara Hydro-Agricultural Project"; Niamey, October 21, 1982.
- Arguillon, J.; "Potential Areas for the Development of Largescale Irrigation in the Upper Valley of the Niger"; paper presented at the International Seminar on Prospects for Irrigation in West Africa; Ibadan, Nigeria, 22-27 Oct., 1972.
- BGRM; "Atlas des Eaux Souterraines du Niger"; 1979.
- BGRM: "Cartes de Planification pour l'Exploitation des Eaux Souterraines de l'Afrique Sahelienne"; 1975.
- Bomans, E.; "Evaluation des Techniques Appliquées sur les Perimètres Rizicoles, volumes I et II"; ONAHA, Niamey, 1983.
- Bretagne, S.; "Retentissements clinique et biologiques de la schistosomose urinaire au Niger: A props d'une enquête réalisée dans deux villages des environs de Niamey"; These pour le doctorat en Médécine Diplôme d'Etat, Université Val de Marne, Faculté de Médecine de Creteil, 1984.
- Briend, Roger; "Rapport Technique, Hivernage 1983"; ONAHA, Direction Regionale de Tahoua, 1984.
- Caisse Centrale de Coopération Economique, Mission d'Evaluation; "Evaluation Economique de l'Aménagement de la Rive Gauche
  - du Fleuve Senegal", Rapport General et Annexes; Paris, 1982.
- Centre Sahélien de l'ICRISAT; "Rapport Annuel 1982"; ICRISAT/ Niamey, 1983.
- Chamorin, T.; "Bilharzioses au Niger"; Rapport 5ème Conférence Téchnique, OCCGE, 2, 609-610, 1965.
- Chamorin, T.; "Un Rapport sur l'Activité et les Résultats Obtenus par l'OMNES"; 4eme campagne, 1967.
- Chapelle, G., et al; "Etude du Dévéloppement de la Production Maraichère, Niger: I. L'offre et la Demande de Légumes"; Bureau pour le Dévéloppement de la Production Agricole, Paris, 1974.
- Claude, Marcel J.; "Principaux Systèmes d'Irrigation Existants au Niger"; source unknown, undated manuscript (1984?).
- Club du Sahel; "Dévéloppement des Cultures Irriguees au Niger, Propositions Pour un Second Programme 1980-1985; 1979.
- Coudert, J., L.B. Thrower and J. Henry; "Culture et Commercialisation des Oignons dans les Pays du Sahel et de l'Afrique de l'Quest: Leur Dévéloppement dans le Cadre des Petites Exploitations Maraichères"; Centre du Commerce International/ FAO, (ITC/DIP/22), Geneve, 1981.
- \_\_\_\_; "Actions Concrètes Recommandes en Rep. du Niger"; CCI/FAO, 1981.
- Cullen, M.A. and A. Waldstein; "Grain Markets in Niger"; USDA/ ERS/IED, Africa and Middle-East Branch, Washington, D.C., 1983.

Delarbre, Gilbert; "Diagnostic de l'ONAHA"; IDA/OSEM, 1983.

- Deschiens, R.; "Le problème sanitaire des bilharzioses dans les territoires de l'Union Française. Generalités et repartition géographique"; Bull. Soc. Path. Exot., 44:350-377, 1951.
- Eilerts, G.S. and Ingold, D.L.; "Shallow Well Construction"; Lutheran World Relief, New York, undated.
- Enger, W.; "Niger Agricultural Sector Assessment"; Volume I: Synthesis, USAID/Niger, 1979.

and M. Smale; "Implications of Foreign Assistance on Niger's Domestic Investment Capacity", Vol. II, part A of Niger Agricultural Sector Assessment; USAID/Niger, 1979.

- FAO; "Sixième Reunion du Sous-comite Quest et Centre Africain de Correlation des Sols pour l'Evaluation et la Mise en Valeur des Terres"; FAO, Rome, 6-12 fevrier 1984.
- FAO, Technical Cooporation Programme; "Development of the Water Resources of the Komadougou Yobé Basin, Niger-Nigerian Joint Commission on Cooperation, Report of the Project Formulation Mission"; Rome, 1981.
- Gaud, J.; "Les Bilharzioses en Afrique Occidentale et en Afrique Centrale"; Bull. Org. Mon. Santé, 13:209-258, 1955.
- Genie Rural; "Synthèse des Travaux de la 9ème Reunion Annuelle des Cadres du Genie Rural; Niamey, 20 janvier 1984.
- Gretillat, S.; "Enquêtes Malecologiques au Niger," Abstract; 3ème Congrès International de Parasitologie, Munich, vol. II, 818-819, 1974.
- Gretillat, S.; "Enquêtes Malacologiques au Niger (Contribution à l'étude de l'épidemiologie des trematodes dans la partie occidentale du Niger)"; Rapport Ecole des Assistants des Agents Techniques de l'Elevage de Niamey (Niger), 12 pp, 1974.
- Hoepffner, M.; "Les Bassins Versants de Tabelot, Etude Hydrologique (Campagne 1978); ORSTOM Mission au Niger, 1979.
- Horowitz, M.; "Niger: A Social and Institutional Profile", Institute for Development Anthropology; New York, 1983.
- IBRD et al.; "Aide-Memoire adressé au Gouvernement par la Banque, Mondial, la CCCE, et la KFW Concernant le Projet de Rehabilitation d'Amenagements Hydro-Agricoles"; Mimeo, 1984.
- INRAN: "Fiches Techniques Vulgarisation, Actualisation des Resultats de Recherches", 2ème edition; Niamey, 1983.

; "Fiches Techniques Vulgarisation, Fiches de Signalisation Variétales, Résultats de Recherches - Informations Techniques -Alternatives Technologiques"; INRAN, 1984.

- Ithaca International Limited; "An Evaluation of the Agricultral Technical Packages for the Republic of Niger, Main Report and Annex B: Volumes I et II; Ithaca, New York, December 1983.
- Jaujay, J.; "Coopération pour le Dévéloppement de l'Afrique, Bulletin de Liaison du Comité: Perimètres Irrigués"; Caisse Centrale de Cooperation Economique, 1983.

- Keller, J. e. al; "Project Review for Bakel Small Irrigated Perimeters"; USAID/Senegal Project No. 685-0208, WMS Report 9; Utah State University, Logan, 1982.
- Maina, Sanda; "Analyse Economique du Marketing du Riz au Niger"; ONAHA Division Mise en Valeur, Octobre 1983.
- Malek, E.A.; "Bilharziasis Control in Agricultural Pump Schemes Near Khartoum, Sudan and An Evaluation of Chemical and Mechanical Barriers"; Bull. World Health Organization, 27: 41-52, 1962.
- McEwen, F.L. and Stephonson, G.R.; "The Use and Significance of Pesticides in the Environment"; Wiley-Interscience, New York, 1979.
- McJunken, F.E.; "Engineering Measures for Control of Schistosomiasis"; Agency for International Development, Washington, D.C., 1970.
- McIntire, John; "Report on Millet Trials on Farmers Fields in 1982"; Economics Unit Report; ICRISAT, Niamey, 1983.
- Ministère du Dévéloppement Rural, Direction des Etudes et Programmations; "Insertion de la Riziculture Moderne Dans les Exploitations de la Zone de Namare Goungou, Complement d'Etude Socio-Economique sur l'Amenagement de Namare Goungou, Première Partie"; MDR, 1983.
- , "Section des Cultures Fruitières et Maraichères; "Evaluation 1983 at Objectif 1984 du Service"; Reunion des Cadres Agricoles, Fev. 1984.
- ; "Rapport Annuel d'Evaluation, Campagne Agricole, 1982/83"; MDR, 1983.
- \_\_\_\_\_, Direction des Services de l'Agriculture; "Rapport Annuel, Statistiques Année 1981"; Niamey, undated.
- \_\_\_\_; "Rapport Annuel, Tome II, Statistiques Année 1980"; Niamey, undated.

\_\_\_\_\_, Service Suivi et Evaluation des Projets; "Rendements Observés en Janvier 1984 pour la Culture de L'Oignon"; undated table.

- Ministère de la Sante Publique et des Affaires Sociales; "Rapport d'Activités"; Niamey, 1982.
- Moris, J., D. Thom, and R. Norman; "Prospects for Small-Scale Irrigation Development in the Sahel"; WMS II Project, AID/Washington (ST); draft version, November 1983.
- Norman, Ray; "Niger Itinerary: Water Management Synthesis II, West Africa Trip"; USAID/Niamey, 1983.
- OMVS; "Assessment of Environmental Effects of Proposed Developments in the Senegal River Basin"; 1980.
- ONAHA; "L'Office National des Aménagements Hydro-Agricoles"; 1982.

; "Projet Réhabilitation de Perimètres Irriguées, Financement IDA/CCCE/KFW Synthese ... la Mission d'Evaluation du Projet"; Niamey, 1984.

ORSTOM; "Le Niger à Kandadji"; 1980.

Poulin, Roger, David Gow and Edward Scott; "An Alternative Approach to the FEED Project"; Development Alternatives, Inc., Washington, D.C., 1984.

Prentice, A.M.; "Cotton, with Special Reference to Africa"; 1973.

- Projet Badeguichiri; "Projet Badeguichiri (Département de Tahoua)"; Reunion des Cadres Agricoles, Fevrier 1984.
- Projet de Dévéloppement Rural Maradi; "Reévaluation du Projet Maradi Tome 1, Bilan"; MDR, 1983.

Projet Fruitier Gaya; "Rendements Observés en Janvier, 1984 pour la Culture de l'Onion"; Mimeo, 1984.

; "Resultats des Essais de Comportement des Espices Leguminères Cultivées Durant la Saison Sêche 82-83"; Mimeo, 1984.

- Projet Maradi; "Evaluation Cultures Irriguées, Novembre 1982 a Janvier 1984"; undated table.
- Projet Oasis-Air; "Rapport d'Activites 1978"; Lutheran World Service (Niger), undated manuscript.
- Raoult, B.; "Projet Namari-Goungou, Rapport Final de l'Exécution Mise en Valeur Agricole, 1 - Agronome"; 1983.

Roux, J. and B. Sellin; "L'endemie Bilharzienne dans les Regions de Gotheye et de Tillabery (Rep. du Niger)"; OCCGE Doc. Tech. No. 5817, 1975.

- Sellin, B., F. Mouchet and E. Simonkovich; "Enquête Parasitologique et Malacologique sur les Schistosomes sur le Site du Futur Barrage de Kandadji (Republique du Niger)"; OCCGE, Centre de Recherches sur les meningites et les schistosomiases, Niamey, Rapport No. 9/82, 1982.
- Sellin, B. and J. Roux; "Enquête sur les Mollusques Vecteurs de Bilharzioses dans les Regions de Goteye et Tillabery (Niger)"; Mission ORSTOM auprès de l'OCUGE, Doc. Techn, OCCGE, No. 5819, 1975.
- Sellin, B. and B. Simonkovich; "Les Mollusques Hotes Intermédiaires de la Bilharziose Urinaire dans la Région de Kofouno (Rep. du Niger)"; Rapport d'enquête, Doc. Tech. OCCGE, No. 6155/76, 1976.
- Sellin, B., E. Simonkovich, L. Ovazza, E. Sellin, M. Desfontaine and J.L. Rey; "Valeur de l'examen macroscopique des urines et des bandelettes reactivés pour la détection de l'hematurie et de la proteinurie dans le diagnostic de masse de la schistosomiase urinaire, avant et après traitement"; Medecine Tropicale, 42: 521-526, 1982.
- Sellin, B., E. Simonkovich and J. Roux; "Etudes de la Repartition des Mollusques Hôtes Intermediaires des Schistosomes en Afrique de l'Quest"; Medicine Tropicale, 40: 31-39, 1980.

51

- Sellin, B., E. Simonkovich, E. Sellin, J.L. Rey and F. Mouchet; "Situation epidemiologique de la schistosomose à <u>schistosoma</u> <u>haematobium</u> dans la zone du perimetre irrigué rizicole de Liboré, Niger"; Presentation de la zone et resultats des enquêtes parasitologique chez l'homme; GCCGE, Centre de recherches sur les meningites et les schistosomiases, Rapport No. I/83, 1983.
- Service de L'Agriculture, Departement de Maradi; "Commentaire sur les Résultats de la Campagne Agricole 1983"; Reunion des Cadres Agricoles, Fevrier 1984.
- Service Mondial de l'Eglise; "Notes sur les Aspects Hydro-Geologiques des Activities 'Oasis de l'Air'"; Rapport Interne, 1975.
- SOGREAH; "Amenagement Hydro-Agricole de la Vallee du Goulbi de Maradi - Etudes Pedalogiques de Detail"; Service du Genie Rural, MDR, Niamey, July 1963.
- \_\_\_\_; "Etude Pédologique dans la Vallée du Dallol Bosso Etude de Reconnaissance"; SGR/MDR, 1963.
  - \_\_\_\_; "Aménagement Hydro-agricole de la Plaine de Birni N'Konni-Etude Agro-pedalogiques"; SGR/MDR, 1963.
- \_\_\_\_; "Etude Pédalogique dans la Vallée de la Maggia Etude de Reconnaissance"; SGR/MDR, Niamey, 1964.
  - \_\_; "Aménagement Hydro-Agricole de Terasses et Cuvettes dans la Vallee du Fleuve Niger, Perimetre de Namarigoungou", Annexes; Grenoble, undated.
- SOGREAH/BRGM; "Etude du Plan de Developpement de L'Utilisation des Ressources en Eau du Niger, Analyse le la Situation Actuelle"; 1981.
- SOGREAH/Louis Berger, S.A.R.L.; "Projet de Réhabilitation des Aménagements Hydro-Agricoles au Niger, lère Etape: Données de Base et Diagnostic, Annexes 1-8"; Faris, 1982.
- ; "lere Etape: Annexes 9 et 10"; Paris, 1982.
- ; 2ème Etape: Perimètres du Fleuve Niger, Avant Projet Detaillé, Pieces Ecrites Générales, la Mémoire"; Paris, 1983.
- \_\_\_\_; "Avenant No. 3, Etude Hydro-pedologique Préalable au Drainage"; Paris, 1983.
- \_\_\_\_\_; "Perimètres de l'Ader-Doutchi-Maggia, 2ème etape: Avant-Projet Sommaire et Etude de Préfactibilite"; Paris, 1982.
- Soil Science Society of America; "Pesticides and Their Effects on Soils and Water"; ASA Publication No. 8, 1966.
- Steinberg, D.I., Cynthia Clapp-Winceh and A.G. Turner; "Irrigation and AID's Experience: A Consideration Based on Evaluations"; USAID Program Evaluation Report No. 8, Washington, 1983.
- Tager-Kagan, P.; "Contribution à l'étude de l'épidemiologie des principales trematodoses des animaux domestiques dans la région du fleuve Niger"; Revue Elevage Medecine Veterinaire Pays Tropicales, 30: II-18, 1977.

- Tara Integrated Rural Development Project; "Cost/Benefit Analysis, Phase II Dry Season Rice Crop"; AID/Niamey, undated table.
- Toh, K.; "An Analysis of Niger's Interim Plan, 1984-85"; USAID/ Niger, March 1984.
- Union Nigerienne de Credit et Cooperation; "Elements Pour la Reunion de la Commission Consultative sur les Prix des Intrants Agricoles 1984"; Ministere du Developpement Rural, Niamey, 1984.
- ; "Projet Appui au Dévéloppement Agricole du Départment du Diffa, "Evaluation - Campagne 1983-1984"; Reunion Annuelle des Cadres de L'Agriculture, Fevrier, 1984.
- UNCC/CID<sub>E</sub>; "Projet d'Appui au Dévéloppement Agricole du Département de Duffa, Niger: Plan de Campagne Exercice du 1/4/84 au 31-3/34"; MDR/Agence Canadienne de Dévéloppement Internationale, Niamey, 1983.
- USAID; "Agriculture Sector Development Grant"; SAAD, Miamey, 1984.
- USAID; "Environmental Assessment Guidelines Manual"; 1974.
- USAID; "Environmental Design Considerations for Rural Development Projects"; 1980.
- USAID; "Environmental Guidelines for Irrigations"; 1981.
- USAID; "Water, Engineers, Development and Disease in the Tropics"; 1975.
- Van Laere, J.F.; "Aide-Memoire du Directeur de Perimètre et de L'Encadreur Rizicole"; ONAHA, Niamey, Mars 1982.
- \_\_\_\_; "Enquête de Marché Projet Tilla Kaina"; ONAHA, Niamey, 1982.
- VITA; "Environmentally Sound Small Scale Agricultural Projects"; 1979.
- Waldstein, A. and F. Masson; "Vegetable Marketing on the Mossi Plateau of Upper Volta"; AID (ST/MD/RI), Washington, 1983.
- Walton, W.C.; "Groundwater Resource Evaluation"; Mc-Graw-Hill, New York, 1970.
- Wright, C.A.; "A Note on the Distribution of <u>Bulinus Senegalensis</u>"; West African Medical Journal, 8: 142-148, 1959.
- Wright, W.H.; "Geographical Distribution of Schistosomes and Their Intermediate Hosts"; In: Epidemiology and Control of Schistosomiasis (bilharziosis); N. Ansari, editor, 1973.
- World Health Organization; "Snail Control in the Prevention of Bilharziasis"; WHO Monograph series No. 50, 1965.

# NIGER IRRIGATION SUBSECTOR ASSESSMENT

VOLUME TWO

ANNEXES

July, 1984 USAID, Niamey Glenn Anders, Irrigation Engineer Walter Firestone, Agronomist Michael Gould, Environmental Specialist Emile Malek, Public Health Specialist Emmy Simmons, Farming Systems Economist Malcolm Versel, Vegetable Marketing Teresa Ware, Institutional Analyst Tom Zalla, Team Leader

# NIGER IRRIGATION SUBSECTOR ASSESSMENT

# Table of Contents

# VOLUME TWO: ANNEXES

ANNEX	Α:	DONOR ACTIVITIES RELATING TO IRRIGATED AGRICHITURE	۸۱
ANNEX	B:	IRRIGATED PERIMETERS IN NIGER: EXISTING AND UNDER UNY	H-1
ANNEX	C :	AGRONOMIC ASPECTS OF INDICATED ACTIVITY AND UNDER WAY	B-1
ANNEX	D:	THE ECONOMICS OF IRRIGATED AGRICULTURE DEVELOPMENT	C-1
		AND PERFORMANCE IN NIGER	<b>.</b>
ANNEX	Ε:	VEGETABLE MARKETING IN NIGER	D-1
ANNEX	F:	INSTITUTIONAL AND SOCIAL ISSUES RELATED TO IRRIGATED	t-I
		AGRICULTURE IN NIGER	<b>-</b> 1
ANNEX	G:	ENVIRONMENTAL REVIEW OF IRRIGATION IN NIGER	1-1
ANNEY	ц.	PROCEAM AND BROATER DOCEAN ATTER	G-1
	···	TROUGRAIN AND PROJECT POSSIBILITIES	H <b>-</b> 1
ANNEX	1:	TERMS OF REFERENCE FOR VEGETABLE MARKETING STUDY	T_1
ANNEX	J:	IMPACT OF IRRIGATED AGRICULTURE ON PUBLIC HEALTH IN NICEP	1-1
		WITH SPECIAL REFERENCE TO SCULETOCOMMARKS	
	v.	ASSESSMENT OF THE REPORT OF SUBSIDISUMIASIS	J-1
ANNEX	N.	ASSESSMENT OF THE ENGINEERING ASPECTS OF IRRIGATION IN NIGER	K-1

1

# ANNEX A

# DONOR ACTIVITIES RELATING TO IRRIGATED AGRICULTURE IN NIGER

# Tom Zalla

	Table of Contents	
	• · · ·	Page
Α.	Construction and Rehabilitation of Perimeters	A-1
Β.	Ins Jution Development and Technical Assistance 1. ONAHA 2. Genie Rural 3. Other	A-3 A-3 A-3 A-4
c.	Seed Production for Irrigated Crops	A-4
D.	Training	A-4
Ε.	Cooperative Financing and Credit	A-5
F.	Garden Wells, Micro-Perimeters and Small Scale Irrigation	A-6
G.	Research	A-7
Н.	Studies 1. New Perimeters 2. Water Resources 3. Other	A-8 A-8 A-8 A-9

r (c

#### ANNEX A

### DONOR ACTIVITIES RELATING TO IRRIGATED AGRICULTURE IN NIGER

#### Tom Zalla

This annex summarizes available information on donor activites recently completed, underway or currently planned in eight different subject areas: construction and rehabilitation of irrigated perimeters; institution development and technical assistance; seed production for irrigated crops; training; cooperative financing and credit; garden wells and micro-perimeters; research; and studies and water resource assessments. The purpose of this annex is to bring to the attention of the reader the large amount of work on irrigated agriculture currently being undertaken in Niger. This list of activities, while not exhaustive, should be reasonably complete. Most of the data were obtained directly from the donors concerned.

# A. <u>Construction and Rehabilitation of Perimeters</u>

Over the next three years Niger will complete construction or rehabilitation of approximately 7,000 hectares of land on over 30 different perimeters. The largest part of this area will come from the perimeters of Namaregoungou and Konni II. The most important donor is the IBRD. The FED, CCCE, KFW and Kuwait provide important amounts of financing for perimeters as well. Table A-1 lists the perimeters and provides aggregate cost and other relevant data on each one.

The range of costs per hectare between the various projects is very large, with no obvious relationship between size of perimeter or date of completion. Specifications included in the cost figures vary from one project to another, the most extreme being the IBRD/CCCE/KFW Rehabilitation Project. It includes as much money for nonperimeter costs as for direct perimeter costs. In general, it appears that new perimeter construction costs are running between 4-6 million FCFA/hectare. Rehabilitation is costing between 2-3 million FCFA, or almost one-half as much. The <u>Genie Rural</u> is currently using six million FCFA per hectare as a planning figure for new construction.

In addition to the perimeters listed in Table A-1, the GON is currently seeking financing for the following perimeters for which preparatory studies are already complete:

Lotta		150	hectares
Goude 1		85	hectares
Koulou		500	hectares
Unakouanza		600	hectares
Goulbi Maradi	ΙI	500	hectares

		Cost (MII	lion CFA)	Estimated			
	Cultivated		Per	Year of	Source of a	Type of	Cropping
New Perimeters:	Area	Total	llectare	Completion	Financing 47	Perimeter	System
	1550	6100 <sup>b</sup> /	3.9	1484	162D/KFW	Cuvette	Nice
Kawat It	1100	4200	3.8	1084	Knustt	Surface Dam	Polyculture
	260	4200 e/	ט.נ רר	1004		Surface Dam	Polyculture
Galmi	260	2200~	1.1	1904			Polyculture
Yelewani	120	660	5.5	1984	BOAD	Cuverte	Rice
Goulb1-Marad1	500	2500	5.0	1985	IBRD/CCCE/FIDA	Tubewells	Polyculture
Tiagulrire Aval	250	1000	4.0	1985	P. R. China	Cuvette	Rice
Namardegeungou	250	1000	4.0	1985	FED	Cuvette	Rice
Kourani-Baria	750	5200	6.9	1987	JICA/ADB	Cuvette	Rice
Diaberi	400	2500.7	6.3	1986	FED	Cuvette	Rice
Dambou	400	n.ad/	n.a.	<b>a.a.</b>	BOAD	Cuvette	Forage/Dairy
Rehablilized Perimeters:					· .		
Tlllakelna	68	350	5.1	1983	FED	Terrace	Vegetables
Koutoukale	340	1200	3.5	1982	FED	Cuvette	Rice
Karma	123	250	20	1983	FED	Cuvette	Rice
Karalyourou	150	350	2.3	1985	FED	Cuvette	Rice
13 In Niger Valley	2335)	el		1987	IBRD/CCCE/KFW	Cuvette	Rice
5 to Manada Mallou (\$50)		11000=	3.4	1987	IRRD/CCCF/KHJ	Surface Dama	Sorghum/Cotton
Kourtere	20	305	n.a.	1985	Belgium	Cuvette	Rice

#### TABLE A-1: New and Rehabilitated Large Scale Irrigated Perimeters Recently Completed, Currently Under Development or Committed to Financing

a/ Excluding the FNI unless otherwise noted.

b/ Actual cost was 22.5 million DM and 15 million \$U.S. Converted at EM=100 CFA and \$U.S.=250 CFA, the average rate assumed to have prevailed during the disbursement period.

 $\frac{c}{-}$  Actual cost was 20.5 million DM. Converted at DM=105 CFA.

 $\frac{d}{d}$  Not available.

- Including approximately 5.5 million CFA for costs and contingencies related to training in cooperative management and other non-perimeter related costs,

Source: Donors; Claude (1983); Delarbre (1983); ONAMA (1984).

#### B. Institution Development and Technical Assistance

.

#### B.1 <u>ONAHA</u>

The FED finances four technical assistants who are permanently assigned to ONAHA: an agronomist working with the <u>Mise en Valeur</u> division; a rural engineer who is responsible for ONAHA's construction activities; a mechanic working with the infrastructure division; and an agricultural economist working on monitoring and evaluation.

FAC provides long-term technical assistance to ONAHA as well. The number and specializations of the TA's change over time, depending on the agency's perception of key problem areas. At the present time the FAC provides one expert to work within ONAHA itself as an advisor to the Director General of ONAHA and a mechanic and two agronomists to work in the context of specific projects. A fifth technician is assigned to ONAHA's Regional Office at Tahcua to supervise irrigated cotton perimeters in the Muggia Valley.

Projects now in the planning stage will provide additional technical assistance for ONAHA. The Belgians are planning to provide one person for ONAHA's evaluation unit and one agronomist to supervise production activities on the Saye perimeter--originally financed by the Belgians.

The IBRD/CCCE/KFW Perimeter Rehabilitation Project will provide technical assistance for a monitoring and evaluation unit to be attached directly to the Director General of ONAHA. It will also provide financing and technical assistance for a new management control unit. This will include CCCE financing for an expatriate chief accountant and an administrative and financial director. The regional directorates of ONAHA will receive technical assistance under this project.

KFW will provide assistance to ONAHA in the form of the transfer of equipment and personnel from Namaregoungou. In addition, it will provide financing for additional equipment needed to carry out activities under the Rehabilitation Project. That project will create regional brigades with responsibility for maintaining pumps on the perimeters.

#### B.2 <u>Genie</u> Rural

In addition to assistance provided directly to ONAHA, the FED is financing a technician working with the <u>Genie Rural</u> of the MDR. The technician will supervise construction activities at Namardegoungou and carry out studies for Diaberi. The <u>Genie Rural</u> also has two FAC engineers and one French volunteer assigned to its topography section. Another French volunteer supervises perimeter construction activities.

GTZ has provided an engineer to work with the Tahoua regional office of the <u>Genie Rural</u>. He is assisted by two German volunteers.

The Small Scale Irrigation Project being developed by FAO for ADB financing will provide management and operating expenses for establishing a Small Scale Irrigation Management Support Unit within the <u>Genie Rural</u> service of the MDR. That project will also finance building and infrastructure for two technical units to be established at Niamey and Diffa to supervise work being executed under this project. The project includes financing for five technical assistants to work on the project, one attached to the central unit at Niamey and two attached to each of the regional technical units.

#### B.3 Other

The Rehabilitation Project will provide technical assistance to strengthen operations and management of the Riz du Niger. The project donors are optimistic that with improved management and revised worketing policies, RINI will be able to greatly increase its throughput and improve the efficiency of its operations. This will, in turn, increase the price it can pay farmers for their rice and still remain competitive with imports.

#### C. <u>Seed Production for Irrigated Crops</u>

The Belgians are financing a 20-hectare rice seed farm at Kourtere costing 305 million CFA francs. Rehabilitation of the existing perimeter will begin in mid-1984. Belgium will provide a technical assistant to run the farm.

The Rehabilitation Project includes provision for rice seed production and multiplication on selected perimeters covered by that project. So does the Namaregoungou perimeter project.

Outside the Niger River Valley, CIDA will finance production of one ton of floating rice seed within the Diffa Productivity Project. GTZ is financing conversion of the research station at Indoudcu in the Air mountains into a seed improvement and multiplication center. The center will produce vegetable and cereal seeds for the irrigated crops common to that part of the country. CFDT produces seed cotton for the cotton perimeters.

#### D. Training

The FED has agreed to provide ONAHA with 350 million CFA francs to mount a training program aimed at coops on the perimeters which the FED has financed. The FED/ONAHA training program has already been defined and will emphasize cooperative management. The GON requested the FED to extend the training program to include the perimeters to be rehabilitated by the IBRD/CCCE/KFW Rehabilitation Project. The IBRD is agreeable, on the condition that the training program be fully integrated into its project. How er, the FED money is usable only for a pure training program. As a result, it does not appear that there will be a single training program to cover all perimeters.

The CCCE will finance preparation of a protocol accounting system to be used in the Rehabilitation Project training program, should two programs prove necessary. Moreover, the Rehabilitation Project training program will give more attention to extension and farmer training than will the FED program.

Under the Diffa Productivity Project, CIDA is financing a program to train peasants in pump maintenance and repair. Use of motor pumps has risen sharply in the Komadougou-Yobe Valley in recent years. The current number of pumps in use is somewhere around 350. This number is expected to double over the next 3-5 years. The FAO/ADB Small Scale Irrigation Project also plans to provide training in pump maintenance via a contract with a pump supplier in Niamey. Its training program will support small scale irrigation activities in both the Niger and the Komadougou Valleys.

# E. Cooperative Financing and Credit

In conjunction with the CCCE and the CNCA, Paris, the FED is considering providing a line of credit to the CNCA, Niger, to help it to regain a sound financial footing. If this project goes through, CNCA, Paris, will provide four technical assistants to help restructure Niger's CNCA. These technical assistants would be financed by the CCCE.

The FED has also decided to add an operating fund for cooperatives on the FED perimeters to its Perimeter Rehabilitation Project. An initial audit of the cooperatives' accounts will determine the legitimate debt of each cooperative towards the CNCA. The cooperative will then have to pay this debt before it will qualify for new credit.

While awaiting the restructuring of the CNCA, the BDRN will handle the FED financed revolving funds for the cooperatives. The coops may not make loans to farmers from this fund and coops must repay 100 percent of the outstanding principle and interest to maintain their access to the fund. The FED has maintained the right to block the credit account of a cooperative should it fail to meet all conditions of the line of credit. Interest payments on the line of credit will go into a separate investment account. With the agreement of the FED, the prefect and the departmental UNCC delegate, the coop can then decide how to invest the funds in the investment account.

The Rehabilitation Project will also provide revolving funds to finance input and output purchasing activities for cooperatives on its perimeters. Like the FED project, the IBRD is insisting t'at the GON complete the identification of outstanding debts of the cooperatives prior to initiating the project. Work begun in July, 1983, by the GON is proceeding slowly and will require the assistance of a private accounting firm. Once these individual farm debts are identified, an arbitration commission named by the GON will decide which are valid. The project will require full payment for those debts and nonrepayers will be expelled from the perimeters. Details for administering the project's credit fund await a satisfactory resolution of CNCA's administrative and financial problems or an acceptable alternative proposed by the GON.

In addition to providing operating funds to the cooperatives, the Rehabilitation Project will provide credit for animal traction equipment along the lines of the existing CCCE credit program. This credit program will include the FED financed perimeters of Tillakeina, Toula, Karma and Koutoukale. In addition, the CCCE, will expand its program to add financing (500 million CFA) for 1500 animal traction units to the program administered by the CNCA for the benefit of cooperatives on all irrigated perimeters; i.e., whether or not they are affected by the Rehabilitation Project. The Small Scale Irrigation Project wi'l provide credit for pumps, motocultures, oxen, animal traction equipment, spare parts and blacksmithing tools. The modalities for executing the project's credit program have not yet been defined.

 $C_{i}$
There is also a considerable amount of credit being made available for construction of shallow wells under the Dosso, Tahoua and some of the NGO projects. The proportion of total cost required to be repaid varies between 15-100 percent with 50-75 percent being a common range. Repayments are usually funneled into a revolving fund that finances additional wells. Most of these credit programs are administered through the Agriculture Service of the MDR since it has responsibility for vegetable gardening and garden well construction.

#### F. Garden Wells, Micro-Perimeters and Small Scale Irrigation

There is a great deal of localized activity promoting the installation of permanent garden wells and other types of micro-perimeters. The two largest well projects are included in the FED financed 3M Project and the Italian financed Keita Rural Development Project. Together they account for over 50 percent of the 3500-4000 permanent garden wells planned for construction at the present time. Table A-2 summarizes available data on garden wells. The data appear to be reasonably complete.

TABLE A-2: Garden Wells to be Constructed Under Current and Planned Rural Development Projects in Niger

Project	Department	Donor	Number of Wells Financed
Three M IRD Keita IRD Dosso Tahoua Productivity Agadez Agr. Devel. Bouza Valley Gardening Telemces Gardening Boboye Ccop-Kolbou Various projects Other PVO	Zinder Tahoua Dosso Tahoua Agadez Tahoua Gahoua Dosso Niger Niger	FED Italy IBRD/FAC GTZ GTZ LWR LWR Africare AFVP	1000 1000-1500 200 150 450 250ª/ 50 200ª/ 100ª/
		TOTAL	3600-4100

 $\underline{a}^{\prime}$  Estimated based on total project financing.

In addition to constructing wells, donors and PVO's are quite active in developing or rehabilitating micro and small scale perimeters in <u>mares</u>, <u>bas-fonds</u> and in branches of river basins. The largest project of this kind is the FAO/ADB Small Scale Irrigation Project. It will provide financing, credit and technical assistance for establishing or reestablishing 1000 hectares of jointly managed small scale perimeters (2-20 ha.) along the Niger (250 ha.) and Komadougou (700 ha.) river valleys and in selected areas in other parts of the country (50 ha.). About half of the land brought into production is expected to be planted in rice, sorghum, wheat and maize. The rest will go to garden products. The FAO/ADB project has an expected internal rate of return of 17

60

percent. The FAO is clearly staking out for itself the role of principle promoter of small scale irrigation in Niger.

CIDA is also considering a project for constructing small dams along the branches of the Komadougou. However, that project will probably not go ahead unless the ADB does not finance the FAO designed project. CIDA is providing other assistance to small perimeter development along the Komadougou through the Diffa Productivity Project. This includes providing mobile pumps for filling mares on the banks of the river to store water for subsequent dry season irrigation. It also includes extending canals for <u>cuvettes</u> and small perimeters which have fallen out of production because of the <u>declining</u> flow of the river.

The FED finances the development of small perimeters on <u>bas fonds</u> in Zinder Department. NGO's are also active in this domain, though their programs are generally quite localized, seldom including more than one small perimeter (2-15 hectares).

One of the more interesting experiments/developments pertaining to small perimeters is found in Maradi at Ruwana. The Maradi Productivity Project is testing a tube well/perimeter layout that may prove promising for village level installation at a cost of about 2.5 million CFA francs per hectare. The IBRD/CCCE/FIDA will finance five such perimeters on an experimental basis through the project. Each well can irrigate 7-10 hectares of land using special pipes with gates that permit water that is gravity fed from a reservoir to run uphill until it reaches an open gate. This reduces leveling requirements for establishing perimeters.

#### G. Research

The Ruwana micro-perimeter provides an example of applied research on irrigation systems. CIDA is financing 12 wells on the Komadougou in order to identify which water pumping techniques are most effective in the soils that prevail in the valley.

At Losso a FAC financed, GERDAT researcher has been experimenting with biogas power for driving water pumps and with aspersion, gated pipes and other gravity-fed irrigation systems. The FAC is financing the expansion of this research operation by providing 275 million CFA to rehabilitate 30 hectares. The station will concentrate on cultural systems for developing terrace irrigation along the Niger River.

In addition to its assistance at Losso, the FAC is financing construction, technical assistance and equipment for the Radio Isotope Laboratory at the University of Niamey. Under the project the University will launch a program of research on drip irrigation. Other research on irrigation techniques was carried out at Indoudou in Agadez Department as part of the German aid program in the Air mountains. This research ended about a year ago because the GON did not find the results interesting.

In addition to research on irrigation systems, several donors are financing agronomic and cropping systems research. WARDA provides a researcher to INRAN to work on rice fertilization. The FAC and CCCE support research on fruit crops through the Gaya Fruit Project. And many of the perimeters support applied research on cropping systems and fertilizer response as an ongoing project activity.

#### H. Studies

#### H.1 <u>New Perimeters</u>

Italy i financing a study of the Gabou/Bonfeba <u>cuvette</u> and is preparing an implementation plan. It is not committed to financing construction of the perimeter at this time. The <u>Genie Rural</u> estimates that the perimeter will cover a net area of 2300 hectares. The cost is not yet known.

The BOAD is financing preparatory studies for a 150 hectare perimeter at Dambou. This perimeter will be used for producing forage and feeds for an intensive milk production operation.

The FAC is providing 225 million CFA francs to prepare a comprehensive plan, a feasibility study and tender documents for establishing irrigated perimeters in the "Trois Cuvettes" area of the Niger River. Approximately 10,000 hectares of land are irrigable in this area. The CCCE has agreed to finance one of the three <u>cuvettes</u>. The cost is expected to come in somewhere around 5 million CFA francs per hectare.

#### H.2 Water Resources

FAC is providing 150 million CFA to study the utilization of <u>sub-terranian</u> water from the Tahoua valley and the <u>cuvette</u> of Agadez. Apparently this area includes tens of thousands of hectares of potentially irrigable land but the water resources are not yet quantified. This study is already underway. The results will be integrated into the FED project for the development of the Air mountain area of Niger.

FAC is providing 100 million CFA to the Ministry of Hydrology and Environment (MHE) to continue ongoing work on cartography of the Niger River; and another 100 million to continue a census of water resources throughout Niger. The census program includes putting on computer available information on Niger's water resources in order to increase the ease of access to available information.

The MHE is receiving assistance from the FED as well. The FED is financing a study of surface and subsurface water resources in the Komadougou-Yobe valley. The study is being carried out by FAO. FAO is also receiving support from a UNDP project that is studying ways of developing the four principle watersheds common to Niger and Nigeria: the Komadougou, Goulbi, Maradi, Maggia and El Fadama/Togway. The study is being undertaken within the structure of the Nigeria-Niger Joint Economic Commission. It's purpose is to devise a plan for apportioning the waters of these important river basins between the two countries. A second UNDP study, the Water Potential of the Niger Basin, provides assistance for planning and policy analysis relating to development of the Niger River Valley.

Finally, the FED is conducting studies of the <u>mares</u> of Zinder with a view toward identifying those with potential for development. At the present time

most of these <u>mares</u> are already dry (March) so it is not yet known whether their development will be technically feasible.

## H.3 Other

The FED financed a study of vegetable marketing in the Tillaberi/Niamey marketshed in conjunction with the rehabilitation of Tillakeina.

The CCCE is financing an audit of the debts of the cooperatives to be included in the IBRD/CCCE/KFW Rehabilitation Project. The IBRD has made the identification and resolution of outstanding cooperative debts a condition precedent for implementtation of the Rehabilitation Project. CCCE will finance an audit of ONAHA to update its accounts to September 30, 1983. The last audit covered the 1980/81 fiscal year.

10-1

Perimeter	Total	Area (hecta Cul	reg)	Number of	Date Placed in	Source of	Cropping	
Site	Cultivable	<u>R.S. 82</u>	<u>D.S. 83</u>	Participants	Service	Financing	System	Observations
iger River Covettes								
Namari Goungou	1550	587/	790	1243	- 1982	1 BRD/KFU	Rice	Incl. 218 be added to 1097
Toula	244	243	243	625	1975	FAC	Rice	11101. 250 Ha added 11 1904
Kokoman1	39(43)	-	-	137	1970	FAC	Rice	1880 rehab to restore 43 ha
Sona	152(145)	130	1:30	346	1970	FAC	Rice	IBRD rebab to add 15 by to r a man
Lossa	180(173)	141	121	403	1970	FAC	Rice	18RD rebab to add 32 ba to r a same
Koutoukale	341	311	300	720	1982	FED	Rice	Town relian to and 52 ha to 1.5. area
Karma	145	102		300	1983	FED	Rice	
Karegorou	136	99 10/	69	437	1964(1985)	FED	Rice	Being rababilited by RED to be send to the
Kourtére	10(20)	10	10	32	1973(1985)	(Beletun)	Rice	Belgians to rehab and add 10ha to a
Kirkissoye	94 (100)	85	93	308	1964	FAC/FNI	Rice	IBRD rebab to add 15 ba to r a anor
Saadla	115(105)	105	100	396	1973	Lybte/FNI	Rice	LIND to rebab
Saga	380 (380)	301	3.38	1081	1966	Formosa	Rice	1880 to rehab
Libore	230 (245)	151	204	700	1973	P.R.China	Rice	18k0 reliab to add 94ba to r e area
Ndounga 1	268(258)	176	212	770	1973	P.R.China	Rice	1880 reliab to add 87ba to r.s. area
Ndounga 11	275(272)	176	223	1076	1977	P.R.China	Rice	1880 reliab to add 96ba to r.s. area
Scherl	385(357)	284	315	1100	1979	P.R.China	Rice	Like reliab to add 73ba to r.s. area
Say	300	262	245	467	1981	Beletum	Rice	this reliables and 75hill to 1.5. area
fera	130(99)	73	73	360	1975	Africare	Rice	11000 rehab to add 26ba
Firgoun	240(108)	58	-	n/a	1983	Fut Fund	Rice	1980 reliab to add 200a
Daikena	101(108)	101	n/a <sup>c/</sup>	n/a	1964	n/a	Rico	LRPD reliab to add Jona to r.s. area
Yalewani	120				1985	ROAD	Rice	to be completed in 1085
Tlaguirire Amont	220	n/a	n/a	n/a	1978	REA	Forana	Current Status unknown
Tlaguirire Aval	250	-	-	-	1978(0.0)	FAC/PR O.IM	Rice	Not completed by RAC Chipp will some to the
Lanorde	100	n/a	n/a	ula	1968	FNI	Rice	Current status unknown
Konroni Barla	750			-	Planued	ADR C/	Rice	To be completed to 1007
Diaberi	400	-	-	1 <u>.</u>	Planned	FED	Rice	To be completed in 1987
Dombou	400	-	-		Planned	ROAD	Forthalm	To be completed in 1966, being designed
Namarde Goungou	250	-	-		.c.	FED	Rice	To be completed in 1985
Existing Perimeters	5015	3395=/	3466 4					

A N U E X B TABLE B\_1 : IBRIGATED PERIMETERS IN NIGER : EXISTING AND UNDERWAY; 1984

Underconst. or planned 2170

Source : Delarbre (1983) : ONAHA (29, 1984) ; Claude (c.1983) ; Annex A : Bensons (1983)

- a/ Detarbre (1983) reports 1117 hectares. Since Namarigoungou was just being brought into production the lower figure is probably correct.
- b/ Delarbre (1983) reports 34 for Karegouron and 227 for Say.
- c/ n/a = not available ; U.C. ~ under construction
- d/ Proposed

66

e/ Excluding those for which date is not available

TABLE 8-1 (continued)

Burdmutur	That al	Area	lumber 1	Number	Date	· · · · · ·		
<u>site</u>	Cultivable	<u>K.S. 82</u>	D.S. 83	Participants	Service	Financing	System	Observations
Niger River Terraces								1.1.1
THIJakaIna	68	-	64	n/a	. 1962(1983)	FAC/FED	Vegetables	FED rehab. in 1983
Sokoira er	42	-			1964	FAC/FNI	Polycult.	Abandonned
Gabagoura 17	30	n/a	n/a	n/a	1966	FAC	Vegetables	Sprinkler Irrigation, status unknown
Lossa 11	91	n/a	n/a	n/a	1975/76	FAC	Polycult.	INRAN Substation
Sona 11	71	n/a	n/a	n/a	1983	FAC	Polycult.	indan substation
Goudel	60	n/a	n/a	n/a	75/76	FAC	Rice	Current status unknown
Sub-total	362	117.1	64					
Maggia Valley Perimeters								
Ibohamane	750	590	-	600	1967	FAC	Sorg/Cot	IBRD to rebab.
GaTdan-Magag1	120(128)	120	55	270	1971	FAC .	Sorg/Cot.	IBRD rehab to add 8ba to r.s. area
Kore-Taboye	57	-	-	97	1966	FAC	Sorg/Cot.	Abandonned
Moulela	62(65)	62	10	124	1967	FAC	Sorg/Cot .	IBRD rehab to add 3ha to r.s. area
Kawara	52(50)	52	-	69	1968	FAC	Sorg/Cot.	1BRD to rehab.
Tounfafi	27	23	-	57	1968	FAC/FN1	Sorg/Cot .	1BRD rehab to add 4ha to r.s. area
Garadounme	75	X.	-	100	. 1968	FAC	Sorg/Cot.	Abandonned
Sab-total	1143	847						
Other Perimeters						1.1		
Kuani	1330	1986	5115	1.77%	1690			
Kourt I	1100	1200		1773	. 1980	Kuwalt	Polycult.	
Calmt	260			1.4	0.0.	Kawale	Polycult.	To be completed in 1984
Coulbi Maradi	500	210	-		0.6.	KFW	Polyculi.	To be completed in 1984
Luda-Dirfa	30	ala		0.91	0.5.	TBRD	Polycult.	To be completed in 1985. Tubewell system
Tame Diffi	17		11/L	aya	1070	n/a	n/a	Cuverte on Kamadougou
Cool Doval Asr Oltfa	120		11/4	n/a	1973	FED/CEAO	Polycult.	Cuverte on Kamadougou
centerios errostrostrotta	120		147.0	nya	. 1977	FN1/CEAO	Pelycult.	Cuvette on Kamadoagou
Subtotal	335/	1496	602					
or which:					4			
Existing	1977							
Under Const./ Planned	1380	1						
Total existing	9117	5738	4197					
Total Planned	3550							•

1/ Also reported as having been financed by FED (Claude, 1983, p.9)

5

## ANNEX C

# AGRONOMIC ASPECTS OF IRRIGATED AGRICULTURE IN NIGER

## Walter Firestone

## Table of Contents

		<u>Page</u>
Α.	Introduction	C-1
Β.	Soil Characteristics in Irrigated Areas and Related Water Management Issues 1. Niger River Valley 2. Birni N'Gauri/Dallol Bosso 3. Birni N'Konni/Maggia Valley 4. Goulbi Maradi	C-2 C-2 C-2 C-2 C-3
с.	Cropping Patterns, Predominant Production Technologies and Related Yields <ol> <li>Irrigated Rice Perimeters</li> <li>Surface Dam Systems <ol> <li>Birni N'Konni and the Maggia Valley Perimeters</li> <li>The Galmi Perimeter</li> </ol> </li> <li>Groundwater Pumping Systems <ol> <li>Micro Irrigation Systems</li> <li>Shadouf Irrigation</li> <li>Dallou System</li> <li>Small Motor Pump Systems</li> <li>Agronomic Practices and Problems on Micro Perimeters</li> </ol> </li> </ol>	C-3 C-6 C-6 C-11 C-11 C-13 C-14 C-15 C-16 C-16
D.	Agronomic Constraints on Increasing Yields Under Irrigation 1. Water Availability 2. Labor Availability 3. Land Availability 4. On-Farm Water Management Practices 5. Poor Seed Quality 6. Utilization of Improvement Inputs 7. Cropping Systems 8. Climatic Conditions	C-16 C-17 C-17 C-17 C-17 C-17 C-17 C-17 C-18
Ε.	Current Irrigated Agriculture Research Activities in Niger 1. Cotton 2. Lossa Irrigated Crops Research Substation a. Varietal Trials b. Techniques of Irrigation c. Rehabilitation of Experimental Soils	C-18 C-18 C-18 C-18 C-19 C-19
F.	Recommendations and Conclusions	C-19

•

63

#### ANNEX C

## AGRONOMIC ASPECTS OF IRRIGATED AGRICULTURE IN NIGER

#### Walter Firestone

#### A. Introduction

In March, 1984, the USAID Mission in Niamey, Niger, fielded an interdisciplinary team of experts to assess present activities within the irrigated agricultural subsector in Niger. The team was to make recommendations regarding the potential for further USAID involvement in the subsector. If warranted, the study might provide the basis for the formulation of a PID, eventually leading to active participation by the USAID Mission in some phase of irrigated agriculture within Niger.

As the team agronomist, my activities involved the gathering and review of pertinent agronomic and irrigation documents. Field trips included a day visit to the large, irrigated rice perimeter at Namari Goungou and a second more extensive trip to perimeters at Birni N'Gaoure, Galmi, Maradi, the Goulbi valley, Bouza and Birni N'Konni. We observed irrigation systems ranging from small gardens to fairly large perimeters. We saw both gravity flow surface dam systems and pumped groundwater systems. Other activities included meeting with officials from INRAN, ICRISAT, The Ministry of Rural Development - Agricultural Service, ONAHA, CDFT, The Lossa Research Canter (<u>Unité Experimentale des Cultures Irriquées</u>), GTZ (Plant Protection Center), various private voluntary organizations, UNCC, FAO and the FED.

My individual terms of reference were to:

1. Identify and analyze critical farming/irrigation systems, institutions and farmer training.

2. Interact with other team members and provide resource material as needed.

3. Prepare a draft report relating to various agronomic activities associated with irrigated agriculture in Niger.

4. In conjuction with other team members, make recommendations for effective USAID project interventions in the subsector. This should include details on the agronomy portion of PID design, including detailed studies on agronomic research and other requirements for small scale irrigation activities.

This report describes my findings.

#### B. <u>Soil Characteristics in Irrigated Areas and Related Water Manage-</u> ment Issues

#### B.1 Niger River Valley

This region has been influenced by the "Continental Terminal" sandstone. It has young soils with sandy-clay textures and ferruginous (lateritic) upper layers. The leached ferruginous soils have a sandy silty texture. The soils of the river bed and surrounding lowlands originated from the meandering of the Niger River where clay particles were the main deposits and silt particles are a minor fraction of the accumulated sediment. These areas are called cuvettes.

The soils in the depressions along the river are similar to the soils within the <u>cuvettes</u>. However the clay material is only 60 to 80 cm. thick, deposited on sandy soil containing gravel and conglomerate material. These hydromorphic soils have a temporary water table but they do not appear to have any problem with salinity or alkalinity.

Higher up and away from the traditional course of the river lie the terraces of the Niger River Valley. The medium terrace has very heterogenous soils. The substratum has been equally influenced by the Continental Terminal, colluvion and eolian materials (eroded young brown soils). At the junction of the major river bed and the medium terrace, there are brown hydromorphic and alkaline soils of granite origin with a heavy clay profile. These soils are not appreciated by the farmers. Generally they prefer the higher sandy soils for cultivating their dryland cereal crops.

The soils utilized for irrigated rice throughout the Niger River Valley between Niamey and Tillabery are mainly clay soils, which are ideal for rice culture. However, internal drainage of these soils is extemely slow, making water management more difficult. Since these soils have the ability to retain moisture, irrigations should not be too frequent, yet should provide adequate moisture for paddy rice culture.

#### B.2 Birni N'Gauri/Dallol Bosso

This region is composed of two major soil categories: regosols (soils which are not highly developed) and ferruginous soils which have evolved from soils of central Niger. The regosols are found on the denuded portions of the laterite plateau. The ferruginous soils developed on sandy surface deposits, as well as on the plateaus and slopes. Sandy soils of the Dallol Bosso region and other areas having similar soil textures, require adequate but short irrigations, especially during periods of high solar radiation.

#### B.3 Birni N'Konni - Maggia Valley

The plateau areas of the Maggia Valley are mineralized soils with Continental Terminal sandstone predominating. Eroded mineral soils have formed on limestone/calcareous outcroppings on the steep higher slopes. The chemical and physical properties of soils are dominated by a relatively high organic matter content (higher than 1%) and a high C/N ratio. They contain few mineral colloids. This causes a structural instability and increases soil erosion. On the gentle bank slopes, soils are young and have calcerous tendencies associated with brown and reddish-brown soils. These soils have the same physiochemical characteristics as those of the steeper slopes.

The depressions and alluvial plains of the lower Maggia contain soils that are generally rich in bases, absorb water well, have an average organic matter content for vertisols (1 - 3%) and a low organic content for hydromorphic soils (about 0.40\%). They also have a neutral pH, are fine textured and have well developed structure.

The soils located on the terrace areas and utilized by several irrigated perimeters have developed from alluvial formations and consist mainly of sandy clay and sandy silt textures. The clay and silt fractions in these soils predominate over the sand. The soils require normal irrigations, but the frequencies need not be too often, as they have a capacity to retain moisture.

The soils within the Birni N'Konni Plain are extremely heterogeneous and require careful water management. Moderate, but not too frequent irrigations, are generally adequate as these soils have fairly good moisture retention capabilities. Since cotton is grown on these soils, it is important that the soil drain itself without undue delay after irrigation. Cotton does not like wet feet so provision must be made for good surface drainage. There are areas within this region containing sandy loams which require close attention during periods of irrigation.

The soils of the Maggia Valley are of medium textures (silty sands, sandy loams and silty clays) with good internal drainage. The management of water on these soils is fairly easy. They sculd receive substantial, but not too frequent, irrigations.

## B.4 Goulbi and Maradi Valley

. Within the Goulbi-Maradi Valley there exists sand sedimented cretaceous slopes and leached ferruginous soils which are typical of Maradi. These are well drained soils with a very low C/N ratio. The surface texture is very poor in fine elements, but their rate increases down the soil profile. Fertility of these soils is very low. Exchange capacity is also low.

The lands found in Goulbi, Maradi, Tarka and Kaba flood plains are similar to those of Dallol Maroui. They are mostly composed of poorly drained young soil deposits on recent fine sandy alluvium deposits. These soils are generally associated with less leached ferruginous soils on old sandy alluvium deposits.

# C. Cropping Patterns, Predominant Production Technologies and Related Yields

## C.1 Irrigated Rice Perimeters

There are approximately 20 operational irrigated rice perimeters situated along the Niger River Valley at various locations between Niamey and Tillabery. These perimeters range in size from 10 to 1350 hectares; most involve total control of water and produce a double crop of rice. At present there is a total of about 8000 hectares of total water control systems under the direction of the National Office of Irrigation Development (ONAHA). The irrigation assessment team visited two perimeters along the Niger River. One, Namari Goungou, was recently completed with funds from the World Bank and KFW, and is the largest perimeter on the river. The perimeter has two pump stations, each containing four large submersible pumps. Three are operational and one is on standby, but the pumps are rotated daily. Main, secondary and tertiary canals are concrete lined to eliminate maintenance problems. The tertiary canals open into a long extended field ditch containing sufficient water to irrigate many farm parcels. Throughout the perimeter, there was a network of connecting surface drains.

The design of the Namari Goungou perimeter was overly sophisticated. It was clearly extremely expensive to construct. It would have been possible to utilize the heavy clay soils in the area to reduce construction costs.

Apart from poor maintenance of both the farm ditches and the drains, this perimeter was relatively well managed. Rice plant densities appeared to be generally good, but there were a few parcels where spacing was not properly done. The water levels within the paddies appeared to be adequate.

Namari Goungou receives pure  $M_1$  IR-15 seed from WARDA. Rice seed is multiplied on the perimeter and released to farmers as well as to UNCC for distribution to other perimeters.

Most perimeters along the river produce a double crop of rice. A double crop of rice requires approximately 12 months of intensive cultural practices. Farmers must be attentive so as to avoid an overlap between the two rice cycles and to minimize competition with traditional rain-fed staple food crops. Proper scheduling of work activities is made difficult by delays in the arrival of the flood and the presence of a cold period in January and February that constrains transplanting activities.

Ideally farmers should establish their dry season rice nurseries in mid-November for transplanting between mid-December and early January. Delays in the arrival of the flood in July causes a delay in transplanting and consequently in the harvest of the rainy season crop. This, in turn, often delays planting of the dry season crop to between mid-February and mid-March when the weather is more favorable for growth of the seedlings. During March through May the weather becomes hotter and conditions for flowering are good.

During May and June farmers plant their traditional millet crop on land situated outside the irrigated perimeters. At the end of May they begin harvesting the dry season rice crop. This corresponds with the arrival of the rains. At this time labor availability becomes particularly constraining. In addition to harvesting the dry season rice crop, farmers must prepare the rice nursery.

This is followed by preparation of fields for the second rice crop, weeding traditional cereal crops, planting the second rice crop during late July into August, and then weeding the second rice crop.

During the rainy season months of July through October the weather is hot and humid and good for rice. However, in November it turns cooler and drier, just as the rice plant is flowering. This is a factor depressing rainy season rice yields. Competition with dry land crops for labor for irrigation may also explain part of the drop in yields that occurs with the rainy season crop.

The recommended application rates for fertilizer on irrigated rice is 100 kilograms of 15-15-15 and 200 kilograms of urea. That comes to 107 kilos of nitrogen, 15 kilos of phosporous and 15 kilos of potassium. According to an ONAHA study (Bomans, 1983) only about 20% of all farmers use this rate. Sixty five percent used more than the recommended amount. Available data suggests that much higher levels of fertilizer are profitable for the farmer under certain circumstances. Curiously though, the largest group of farmers, 30%, were using a higher dose of fertilizer that according to research results, is actually associated with lower yields than the recommended dose. This points to the uncertainty and confusion surrounding farmer behavior in Niger and the need for more clearly focused, applied farming systems research on irrigated agriculture.

Except in the case of an outbreak, farmers do not apply pesticides to rice. They did apply Furodane to control an outbreak of white fly in 1982. Disease problems are more persistent. The continual double cropping of rice makes it difficult to control diseases once they occur. A yellow mottle and a bacterial blight both appeared in 1982 and have become major disease problems. There is no control except to obtain resistant varieties or to rotate rice with a high yielding sorghum or maize variety. The rotation breaks the breeding cycle for the disease, something that is virtually impossible in a monoculture system.

Yields on rice perimeters in the Niger Valley vary between 2 and 4.8 tons per harvest on a perimeter wide basis for the dry season crop and between 1 and 4.8 tons for the rainy season crop. The model range is betwen 3.0 - 3.5 tons per hectare during the dry season and 2.5 - 3.0 tons during the rainy season. The wide differences in perimeter wide yields suggest that there is considerable room for increasing production under presently available technologies.

In a recent report (Bowmans, 1983) notes the utilization of seedlings which are too old as a principle factor depressing average rice yields. Because of delays in harvesting the rainy season crop, farmers are frequently forced to wait until after the January/February cold period to set out their seedlings. Thus the seedlings are between 60-70 days old. The proper age of scedlings is 20-30 days. The plants begin developing secondary tillers after that age and later transplanting depresses the number of tillers which the plant develops in the field. This has a fairly direct and dramatic impact on yields unlecs planting density is increased accordingly.

Because of varied pressing commitments farmers have elsewhere, rice in a given block is usually planted at very different times. The resulting uneven stage of maturity of the crop increases water use by lengthening the period of time the perimeter needs water. Water is also wasted when irrigation activity falls off during the latter part of the day and farmers open tertiary gates and farm drains in order to keep the canals from overflowing. It is not clear why the head of the perimeter does not reduce the throttle on the pump.

Given cultural practices, degree of water application, fertilizer rates and plant protection activities, current average yields achieved on the various perimeters are realistic. It was noted earlier that lower rainy season yields are caused by climatic conditions. Nonetheless, overall yields and returns can be improved by increasing fertilizer rates, adhering to a tighter crop calendar and by eliminating the misuse of water.

## C.2 <u>Surface Dam Systems</u>

Over the years a number of surface dam gravity flow irrigation systems have been developed by various European donors. The eight such systems presently in existence are administered by ONAHA. Most of these schemes are located in the Maggia Valley and have been in operation for several years, some of them for at least 15 years. The two larger ones include Konni I which has just been completed and Konni II now nearing completion. A chird at Galmi will be fully operational for the first time during the dry season of 1984. Following is a listing of these schemes and their total irrigable land areas.

<u>Perimeter</u>	Hectar	res Available
Konni I Konni II Galmi Ibohamane Mouleila Kawara Tounfafi Guidan-Maggia		1,330 1,100 260 750 62 52 27 128
	TOTAL	3,709

Table C-1: Surface Dam Irrigation Schemes in Niger

Konni I and II and Galmi have the most modern irrigation systems. The five remaining perimeters are scheduled to be rehabilitated under the IBRD/CCCE/FIDA Rehabilitation Project. Water storage for all of these systems consists of a reservoir behind a large earthen dam, often situated in a contributary watershed adjacent to a wide alluvial valley.

These reservoirs and dams are located in regions that are sparsely vegetated. Rocky hills make up the perimeter of the main valleys and much of the runoff comes from this terrain. As a result, sedimentation has been a serious problem within the water storage basins. The perimeter at Ibohamane, one of the older schemes, has lost half of its storage capacity in just 15 years due to the buildup of sediment in the reservoir. The reservoir serving the Galmi perimeter is extremely wide and of minimal depth. Thus, evaporation losses are exceptionally high. If the annual decline in rainfall in this region continues the GON will have to begin exploring ground water resources as an alternative source of irrigation.

# C.2.a Birni N'Konni and the Maggia Valley Perimeters

The irrigation team spent a great deal of time at Konni I. It is a gravity flow system with a very advanced water conveyance system. Primary, secondary

and tertiary canals are lined with concrete. Metal gated water metering structures control water flow in both the secondary and tertiary canals. Turnouts to the field ditch consist of a permanent pipe located at the bottom of the canal and passing through the canal embankment. This system is well known for its suitability and effectiveness. The rate of flow outward is dependent on the water level in the tertiary canal only. If the farmer desires to cut off the flow of water into his area, he simply blocks the entrance to the pipe. Once water passes through the turnout it flows through a small temporary earthen canal from which the farmer draws water for his parcel.

The soils within the project area are extremely heterogeneous, consisting of medium texture to heavy clay soils with isolated pockets of sandy loams. The average parcel size is .75 ha., but a farmer can have several, depending upon the size of his family. There are 3,500 parcels of .75 ha. within this perimeter.

Like other ONAHA perimeters, Konni I has a cooperative which assures plowing by animal traction, distributes fertilizers and seed, and collects the cost of ag-inputs from the farmer at the harvest. If a farmer does not cooperate and misses three meetings, he loses his rights to his parcel. Each farmer is responsible for weeding the perimeter surrounding his parcel.

The cropping pattern at Konni I is similar to the other diversified irrigated perimeters in the Maggia Valley, as is indicated in Table C-2. Farmers cultivate cotton and sorghum during the rainy season, with some millet following sorghum to utilize the residual soil moisture. Usually farmers must irrigate cotton and sorghum to supplement available rainfall as necessary. Dry season cultivated area is reduced due to a shortage of available water within the reservoirs. The crops grown at this time are wheat, onions and niébé.

In spite of being a well-designed perimeter, Konni I was a disaster area as far as cultural practices are concerned when the irrigation team visited it during early March, 1984. The areas between the primary and tertiary canals were covered with weeds in seed. The seeds were blowing into the irrigation water and being carried to the growing fields. This compounded an already serious weed problem. The prolific sedgenut grass (<u>Cyperus rotundus</u>) is widespread throughout the cultivated fields of the perimeter. The farm ditches are full of weeds and are irregular in shape, all adding to an inefficient delivery of water to the parcels. The farm drains are in similar condition.

Plant pests were a problem throughout the entire Konni I perimeter. Plants were covered with thousands of black aphids, producing so much honeydew that the plants were slick with secretions. The poor state of affairs is confirmed by data in Table C-3 that compares use of pesticides on cotton at Konni I with the other Maggia Valley perimeters. Konni farmers applied pesticides only five times, as compared to seven applications recommended by CFDT.<sup>1</sup>

 $<sup>\</sup>frac{1}{CFDT}$  recommends two applications of Peprothian followed by five applications of Decis, using the ULV method. The rate of application is three liters per hectare per application.

Table C-2:	Area Cultivated in Maggia Valley Perimeters	During	the	1983
	Rainy Season, By Crop	-		
	(Hectares)			

			CRÚP		
Perimeter	Sorghum	Cotton	Millet	Others	Total
Konni I	569	523	53		1,145
Ibohamane	313	298			611
Guidan-Maggia	59	64	5		128
Mouleila	23	31	9		63
Kawara	23	23	5	2	53
Tounfafi	4	12	8		24
Totals	991	951	80	2	2,024

Source: Briend (1984). Not all the tables in this report are consistent with each other. Total cultivated area is summed from other tables containing crop specific data; i.e., Table: 59, 51 and 511. This differs from area reported by Briend in his Table 51.

•

Perimeter	Total Area <u>Planted</u>	First	Percent of Second	Area Plant Third	<u>ed Actuaily</u> <u>Fourth</u>	/ Treated, Fifth	By Treatm Sixth	ent <u>Seventh</u>	Total Number of Treatments
Konni I	523	88	72	22	10	6	0	0	5
Ibohamane	298	100	100	100	100	100	100	92	7
Guidan Maggia	64	100	100	100	100	100	0	0	5
Mouleila	31	100	100	100	100	100	100	100	7
Kawara	23	100	100	100	100	100	100	0	6
Tounfafi	12	100	100	100	100	100	100	100	7
Totals	951								

## Table C-3: Number of Pesticide Treatments Applied to Cotton and the Percentage of Coverage For Six Maggia Valley Perimeters, 1983 Rainy Season

Source: Briend (1984), Table 59.

7

•

In addition, Konni farmers applied the pesticides to an increasingly smaller proportion of the area planted to cotton with each subsequent application. It is not surprising that pests are a major problem in the perimeter.

Konni also has the lowest use of fertilizer of all the Maggia Valley perimeters. Using 150 kilograms of 15-15-15 per hectare and 50 kilos of urea, the recommended levels of each, as a basis of comparison, Konni parcels received only 20% of recommended levels of 15-15-15 and only 11% of recommended levels of urea. This compares with essentially 100% of recommended levels for all the other perimeters except Guidan Maggia, where farmers used about 50% as much as was recommended (Briend, 1984).

Konni had other problems, too. Cotton was still being harvested in March, whereas the last picking ought to be completed in late December. However, there was not much left to harvest, as many flowers did not develop and many cotton-seed bolls did not open. Spacing of the cotton plants in the row were over a meter apart, as compared to the recommended spacing of 40 cm. Finally, extension agents did not appear well-informed about the irrigation needs of the crops being grown there.

The impact of all these deficiencies in cultural practices is reflected in Table C-4, which details average cotton yields obtained during the 1983-84 season on the various perimeters. Yields at Konni were less than one-half as much as yields on any of the other perimeters. All perimeters grow the same cotton variety, L 299-10, a variety that yields well and has a lint content of 40%.

#### Table C-4: Cotton Yields in Maggia Valley Perimeters, 1983-84 (Tons/Hectare)

Perimeter	<u>Yields/Ha.</u>
Konni I Ibahamana	1.072 (not complete
Guidan-Maggia	3.00
Mouleila	2.80
Kawara	2.563
Tounfafi	2.242

Source: CFDT, Niamey.

Konni I is a capital intensive project and it is not being utilized to its utmost capacity. Financially, it is a liability. Management, technical staff and, above all, the farmer himself need considerable help in the form of on-farm training in proper cultural practices and planting methods, maintenance of the irrigation system and proper water management techniques. A project the size of Konni I should be entirely operational for both seasons, with full use of its land resources; otherwise, it is not a viable entity. However, given the shortage of water, it would be better to fallow the entire perimeter during the dry season in order to concentrate on cleaning the system, controlling weeds, reducing plant diseases and insects and conserving soil fertility. A fallow season would also allow the reservoir to accumulate water for the rainy season crop.<sup>1</sup> Under present state of operations, this perimeter is deteriorating very rapidly and this could very well set an example for things to come when Konni II becomes operational.

Elsewhere in the Maggia Valley farmers working on the irrigated perimeters appear to be hard-working and very knowledgeable individuals. They are totally familiar with their environment and physical resources, both land and water. Their cultural practices are timely, and they use ag-inputs and plant protection services as recommended. Their cotton yields reflect their cultural practices, and are good when compared to other areas in Africa.

#### C.2.b The Galmi Perimeter

This recently completed perimeter contains 245 hectares in diversified crops consisting of onions, sorghum, maize, cowpeas and potatoes. This is the first season the area is being cropped under irrigation. Water for the perimeter is received from a nearby storage dam containing seven million  $m.^3$  of water.

There are seven kilometers of main canals, which are concrete-lined, and which contain a system of drops and gated structures. Water is repased from the secondary, concrete-lined canals into a tertiary clay-lined canal which supplies water to the farm ditches via metal siphons approximately three centimeters in diameter.

There are 831 people with parcels in the Galmi perimeter. Prior to the development of the perimeter, the area was a traditional onion producing zone. The plan is to grow a double crop each year, fully utilizing the perimeter during the dry season, provided there is sufficient water in the dam. The growing period for onions in this area is 40 days in nursery and 120 days in the field to maturity. Traditional onion production in the area was 15-20 tons per hectare prior to the perimeter. Under controlled irrigation, onion yields are expected to reach 45-50 tons per hectare.

The siphons that deliver water into the farm ditch are 30-40 cm. above the ground level. As a result, the discharge is causing the impact area in the field to erode heavily. This problem can be solved by extending the siphon to provide a horizontal discharge into the farm ditch.

#### C.3 <u>Groundwater Pumping</u> Systems

The largest irrigated perimeter utilizing groundwater for irrigation is found at Djiratawa in the Goulbi Maradi Valley. This perimeter was started in

<sup>&</sup>lt;u>1</u>/Prentice (1973) reported that on the Gezira scheme in Sudan, where water is scarcer than land, the notably high proportion of fallows in the rotation benefits cotton yields. It allows better control of pests and diseases because of the long gap between cotton crops, and affords the opportunity to control pre-cotton weeds which would otherwise waste large quantities of water through evapo-transpiration.

The crop calendar on the perimeter is divided into three seasons: the rainy season, the cool dry season and the hot dry season. As in the Maggia Valley perimeters, the entire area is planted half in sorghum and half in cotton during the rainy season. About 40% is planted to cool season vegetables and another 40% is planted to peanuts and hot season vegetables. The two dry season crops overlap so it is not possible to get three crops. About 20% of the land remains fallow over the dry season.

In the 1982/83 dry season, farmers planted almost 100 hectares of peanuts and vegetables. During the cool vegetable growing season farmers applied an average of 36 kilos of urea and 110 kilos of 15-15-15 per hectare against a recommended 50 and 200 kilos respectively. During the hot dry season, they applied an average of 152 kilos of 15-15-15 versus the recommended level of 200.

In the 1983 rainy season, farmers planted 100 hectares in sorghum and 90 hectares in cotton. Sorghum received an average of 79 kilos of 15-15-15 and 80 kilos of urea per hectare as opposed to recommended levels of 100 kilograms of each. Cotton received 166 kilos of 15-15-15 and 44 kilos of urea in contrast to recommended levels of 200 and 50 kilos respectively. Yields obtained on the 1982/83 crops are summarized in Table C-5.

Table C-5:	Average Yields for Dry Season and Rainy Season
	Crops in the Goulbi Maradi Perimeter, 1982/83
	(tons per hectare)

Crop	Hectares Planted	Average Yields
Tomato	28	38.7
Peppers	14	7.5
Unions	3	50.4
Other Garden	6	n.a.
Peanuts	46	2.0
Sorghum	100	2.1 (1.6) <sup>a</sup>
Cotton	90	2.0

()D

 $\underline{a}^{/}$ Traditional varieties. The higher figure is for improved varieties.

.

During the dry season of 1983/84 the area under cultivation continued to expand as more of the perimeter became operational. Tomato production grew to 57 hectares, peppers to 22 and other vegetable crops accounted for another 20 hectares of land. Peanuts were planted on about 100 hectares. No yields were available at the time of the team's visit to the perimeter in March.

Farmers in the perimeter have their own millet fields outside of it. In the early stages of the perimeter's growth, millet competed with the irrigated crops for labor, to the detriment of the irrigated crops. This situation has recently turned more favorable for the irrigated crops as farmers realize their greater potential in the face of uncertain rainfall. Nontheless, maintenance of canals and weeding are still problems on the perimeter. As at Konni, sedgenut grass (<u>Cyperus rotundus</u>) was a problem throughout the perimeter. There were also numerous weeds in seed along the irrigation canals.

Adjacent to the Djiratawa perimeter at Ruwana, the Maradi project is financing an experimental irrigation system that shows promise as a village-level management unit. The system consists of a single tube well emptying into 50m.<sup>3</sup> reservoir which then feeds water by gravity to a 6.5 hectare area surrounding the well. The system utilizes gated aluminum pipes 6" in diameter connected to the base of the reservoir. The gated pipes allow water to flow uphill under pressure from the reservoir and consequently, reduce the need for leveling. The perimeter is divided into 18 equal pie-shaped parcels, each one assigned to an individual farmer. The farmers work together on irrigation activities but maintain individual responsibility for their respective parcels.

It is still too early to judge the results of this experiment but the concept is interesting. Slight modifications in design and cropping system would eliminate the need for the costly gated pipes and could extend the area irrigated by 50% or more. As farmers on the perimeter gain more experience with irrigated agriculture, weeding and other cultural problems now in evidence should improve. The size and the divisibility of the investment create the potential for expanding area under irrigation at about one-half of the current cost of medium scale perimeters. Given the easier management possible with smaller perimeters USAID will want to monitor closely the evolution of this experiment.

## C.4 Micro-Irrigation Systems

There are several types of micro-irrigation systems in Niger. North of Agadez in the Air Mountains, farmers produce a variety of vegetables practically all year long using the <u>dallou</u> system of irrigation. This system utilizes animal power to draw water from shallow wells to irrigate small gardens.

In the southern third of the country, from Birni N'Gauri extending to and around the Maradi region, traditional well gardening is practiced during the dry season only, from September through April. Water for the gardens is obtaired from the dallols occurring in the region, or other locations where the water table is high, using <u>puisette</u> or calabash, <u>shadouf</u>, <u>dallou</u> and mechanized methods for drawing water from shallow wells.

41

#### C.4.a Puisette, or Calabash Systems

The team visited a small, irrigated garden at Boboye-Kolbou, about 30 kilometers north of Birni N'Gaoure. This small venture, operated entirely by women, is supported by Africare. Africare finances construction of cement-lined wells and fencing of the garden to protect against animals.

A small number of women have been growing onions in this village for over 30 years. This year, with the help of Africare, they have diversified their cropping patterns and have greatly expanded the area under cultivation and the number of participants. In addition to onions, they have planted tomatoes, peppers, cabage, maize and squash. They are also shifting away from their traditional onion variety toward the <u>violet de Galmi</u> for the export market.

The site at Kolbou contained 8.5 hectares of which 3.5 hectares were in mango and guava trees and the remaining five hectares were devoted entirely to vegetable growing. Each woman worked a plot of 360 square meters and shared water from one of 38 wells covering the five hectares. Much of the produce was sold to local villages. Surplus crops were dried for sale at a later date.

The plots are usually fertilized with manure and 15-15-15 prior to planting. The women do not know the application rate. They receive technical assistance from the Agriculture Service of the MDR, which has a young agent assigned to the perimeter.

Water to irrigate the vegetable plots is drawn by hand via a rope attached to a calabash. The water is then carried to the plot and emptied onto the plants. This year the women have tried two other methods to irrigate their plots: sprinkler cans, which do not erode the ground, and earthen canals to distribute water to their plots. The women were pleased with the canal system, claiming that it used water more efficiently, saved time and increased yields. The soils in this area are very sandy, usually to a depth of 2-3 meters. Irrigations are conducted frequently throughout the day, especially during the hot dry season.

The land in the gardens at Kolbou is not being utilized properly. Much land is wasted and cultural techniques are not good. The onion crop was doing well, but the other crops were in poor condition. However, at the time of our visit it was nearing the end of the season and the plants were beyond their prime.

Improvement is needed in areas of this type. This would encompass better cultural practices, a uniform and timely utilization of improved inputs, an orderly layout of garden plots and a more efficient water distribution system in order to eliminate the time-consuming task of carrying water from the well by hand.

The team also visited a small-holder garden area at Shindigui, near Bouza, where Lutheran World Relief has been providing assistance. Since LWR constructed and gave to village women 10 cement-lined wells, 4.5 to 8 meters deep, the number of participants has grown from 19 to 135. The area farmed has expanded in size from the original 4.5 ha. to a current area of 11.5 ha. All the land resources in the area are now fully utilized, being served by 33 cement-lined wells.

The cement wells provide side-wall stability below the water table, thereby increasing storage volume and reducing the number of wells required to irrigate a given area of land. The wells are centrally located so they can be utilized by four farmers. Each farmer draws water using a rope and calabash, and dumps the water into a bed of millet stalks at the head of a canal. The millet stalks prevent erosion. The water then flows into a system of small soil channels and is diverted into basins as needed, usually by children. Many of the farmers in this area have dug a traditional second well within their individual plots. The farmers stated that they need a second well to compensate for a slower recharge rate during the hot dry season, the primary onion and vegetable growing period. Farmers usually draw water twice a day, waiting for the wells to recharge between drawing times. Plots are irrigated twice a week at the beginning of the season and twice per day during the peak season.

The entire area of the Shindigui perimeter is well managed by the farmers. Land is utilized to its maximum capacity and weeds are not seen, as in other areas. A UNCC agent provides technical assistance as needed. He visits the area early in the season, measures farm plots and issues a specific fertilizer package. Usually it is a 15-15-15 (total amount is unknown) and is free,<sup>1</sup> financed from a 400,000 FCFA revolving fund replenished each year via a 1,000 FCFA per member contribution. Farmers obtain yields of 15-20 tons per hectare for tomatoes and 24-32 tons for onions.

The farmers at Shindigui have been experiencing marketing problems. Next season they plan to begin growing garlic on a limited scale and to shift away from tomatoes and onions.

In the Goulbi Valley outside Maradi, the team visited several small irrigated systems using <u>shadouf</u>, <u>dallou</u> and small motor pumps to irrigate. All three systems experienced similar agronomic and marketing problems.

#### C.4.b <u>Shadouf Irrigation</u> Systems

The <u>shadouf</u> is a traditional water-lifting device that consists of a long pole attached to an axle with a calabash attached to a long rope at one end and a weight at the other. Water is lifted and deposited into a distribution canal which carries the water to the plot to be irrigated. This system requires one man to lift the water and another, usually a child, to irrigate the plots. This system can draw water from approximately six meters. One <u>shadouf</u> can irrigate 0.2 to 0.25 hectares, depending on the size of the reservoir and the depth of the well.

## C.4.c Dallou System for Irrigation

Under this system, water is lifted by oxen from wells that are 4-6 meters deep. The water is lifted in a leather bag containing approximately 20 liters of water. The bag empties into a sloping metal through which drains into a concrete reservoir. It takes approximately 30 seconds to draw 20 liters of water. At the base of the reservoir an open metal pice releases water into an irrigation channel. One individual then distributes the water to the plots.

 $\frac{1}{N}$ ext season 1984, the fertilizer will be sold at the rate of 25 CFA per kg.

ゆり

#### C.4.d Small Motor Pump Systems

I observed only one small scale motor pumping operation on my field trip. The farmer owning the pump in question had paid 250,000 CFA for it in Nigeria. He did not know the rate of discharge nor the horsepower of the unit. When operating, the pump discharged a steady stream of water about 7.5 cm. in diameter. As compared to the <u>dallou</u> system, this method of pumping water was clearly superior as far as the time required to irrigate a given sized parcel. However, the farmer is a considerable distance from a repair shop and parts supplier, so unless he has enough cash on hand to travel long distances when the pump breaks down, he risks losing his crop. This particular farmer was quite adept at repairing his own pump and had the entire pump broken down for cleaning earlier in the day when other team members stopped to interview him. By the time we arrived, the pump was operating again.

#### C.4.e Agronomic Practices and Problems

The agronomic problems witnessed within the various micro irrigation systems around Maradi were similar, perhaps because they shared the same river valley and marketing area. All the farmers used 15-15-15 and organic matter to fertilize their gardens, but none knew the amounts. Most irrigated once every two or three days at the beginning of the dry season, progressing to twice per day for lettuce and onions as the weather becomes hotter and the subsoil dryer. The farmers provided their own onion and lettuce seed, the dominant crops in the area, and purchased tomato and pepper seeds.

The soils in the area were of a sandy loam texture that is prone to disease and insect problems when vegetables are grown. Inspection of carrots revealed heavy nematode infestation. The only economic control of nematodes in this situation would be to cultivate a catch crop of groundnuts or cereals in rotation with vegetables. From this point of view, the common practice of planting the dryer of these soils in sorghum during the rainy season should definitely be encouraged.

#### D. Agronomic Constraints on Increasing Yields Under Irrigation

Irrigated agriculture in Niger faces several agronomic constraints. These affect primarily production in the rice/rice and the grain/vegetable production systems.

#### D.1 Water Availability

There are periods (May through July) when the Niger River is too low to supply sufficient water to the intake structures of the pump stations for the rice perimeters. This situation delays the planting of both the rainy season crop (which is normally planted in July) and the subsequent dry season crop, with a depressing effect on yields. In regard to the Maggia Valley schemes it appears that overall water quantity, as opposed to the timing of water availability, is the primary factor limiting agricultural production. Rainfall largely determines how much water from the reservoirs will be needed for supplementary irrigation. What remains in storage then determines how much land can be irrigated during the following dry season. The dry season, therefore, is the period when the critical water management/distribution issues arise.

#### D.2 Labor Availability

During the months of June to August, several agricultural operations overlap. During this period farmers harvest their first rice crop, weed their traditional millet crop and plant the second crop of rice. At this time available family labor is not sufficient to meet the large demand for labor. In addition, many farmers do not have the financial resources to hire labor. As a result, farmers increase plant spacings, let some cultural practices slip and eliminate others. All these factors depress yields.

#### D.3 Land Availability

To date, the most desirable and readily accessible land for irrigation from surface water sources has mostly been exploited. The projected Kadaji Dam project would yield an additional 140,000 hectares of river terraces for irrigation. These soils are predominately sandy and are considered marginal for irrigated agriculture.

There are other areas in the north and southeastern regions of Niger with soils more suitable for irrigation. Water for irrigating these new areas can be obtained from the existing dallols occurring in the regions and where the water table is high. However, many of these areas are isolated, with little existing infrastructure. Obtaining the capital necessary to develop them would pose a significant problem.

## D.4 <u>On-Farm Water Management Practices</u>

Water management practices are poor throughout the different irrigation schemes, causing needless waste of a scarce resource. Efficient irrigation demands well-timed, disciplined and coordinated work--three attributes which at the present are not forthcoming on irrigated perimeters within Niger.

#### D.5 Poor Seed Quality

Rice varieties introduced some years ago are no longer pure. IR-15 will reach that state shortly. Many other seeds planted under irrigated conditions have a low yield potential. At the present time only CFDT, the cotton organization, conducts an intensive varietal testing program and releases new varieties regularly.

#### D.6 Utilization of Improved Inputs

Fertilizer is applied indiscriminately to various irrigated crops. The is an inefficient practice. On-farm testing of different rates of fertilizer applications for different crops on various soil textures, utilizing different cultural practices and irrigation conditions is needed. A similar testing program for the use of pesticides for various crops under irrigation is also imperative. Present plant protection activities are ineffective.

## D.7 <u>Cropping Systems/Monoculture</u>

Continuous cropping of rice is causing a buildup of soil diseases and insect pests that are reducing yields and that are difficult to eliminate. For two major diseases first appearing in 1982, bacterial blight and gellow monthe, there is no direct control other than developing resistant varieties. Rotation of rice with a high yielding sorghum variety would break the monoculture cycle and reduce the virulence of these diseases.

#### D.8 Climatic Conditions

In January and February it is too cold to plant rice. If farmers are not able to plant in December, they must wait until March. This usually means transplanting rice plants that are too old for maximum production.

# E. Current Irrigated Agriculture Research Activities in Niger

#### E.1 Cotton

The <u>Compagnie Francaise</u> Pour le <u>Developpement</u> <u>des Fibres Textiles</u> (CFDT), a private French firm involved in the development of the cotton industry in Niger, conducts research on irrigated cotton. The basic cotton seed is obtained from research stations located in Chad, Mali, Cameroon and the Ivory Coast. All are under the direction of the <u>Institut</u> <u>de</u> <u>Recherches</u> <u>du</u> <u>Coton</u> <u>et</u> <u>des</u> <u>Textiles</u> <u>Exotiques</u> in France. Promising cotton seed strains are sent from these stations via the main office of IRCT in Montpellier. CFDI, Niger, then field tests them under Nigerien climatic conditions, utilizing irrigation.

CFDT conducts its cotton seed field trials at three locations in Niger: Djiratawa, Konni I, and Lossa. The field trials receive the same cultural practices, fertilizers and pesticides recommended to farmers. All experimental trials are conducted during the rainy season and receive supplemental irrigation when needed. These field trials are repeated for two years before accepting a new variety for multiplication and distribution. New varieties may last from three to five years before being replaced by a new one.

#### E.2 Lossa Irrigated Crops Research Substation

The Lossa station began operating in 1977 under DGRST of France with the purpose of conducting research on irrigated terrace agriculture. In 1981, GERDAT took over the station from DGRST. Reportedly, it will pass to CNAHA in the near future.

The Lossa perimeter is irrigated by electric pump from the Niger River. The station covers 24 hectares divided into one hectare parcels. The experiment station operates 16 parcels and the remaining eight are worked by four pilot farmers with two hectares each. At present the substation realizes two crops per year.

The substation operates three research programs: introduction of new varieties, alternative irrigation techniques and rehabilitation of experimental soils.

#### E.2.a Varietal Trials

The station tests sorghum, wheat, maize, groundnut, cowpeas and cotton varieties. It has obtained experimental yields of three tons per hectare for wheat, six tons for sorghum, four tons for maize, 3.7 tons for groundnuts in the shell and four tons for cotton. Cowpea yields were not available, but cowpeas

46

From an operations point of view, irrigated agriculture in Niger is constrained by several factors: poor cultural practices (plant spacing, weeding), inefficient utilization of fertilizers, use of low potential seed varieties, poor pest control practices, improper maintenance of irrigation systems, inefficient water management practices, the lack of viable crop packages and the weakness of institutions responsible for developing and transferring new technologies and cultural practice information to farmers. To deal with these problems, the following programs are recommended:

1. Develop an applied/adaptive farming systems research and development program for irrigated agriculture. This should include selection and field testing of new high-yielding, disease-resistant varieties of major economic crops and vegetables. It should provide for on-farm applied research on different cropping patterns, including intercropping, which are of actual or potential importance for limited resource farmers. This program should also provide an adequate source of viable seed with periodic releases of new material to replace varieties that have deteriorated.

2. Implement a program of fertilizer trials within the various irrigated areas in the country that incorporates soil, plant density and water application variables for important crops. These trials should be designed so as to provide farmers with area, crop, soil and water specific recommendations for maximum economical production.

3. Implement a plant protection program oriented toward irrigated agriculture. This should include a program for continuously screening existing and new insecticides for their effectiveness in controlling plant pests. It should also provide information on pesticide preparation and use for specific crops as well as the most effective methods of application. Efforts aimed at the direct control of pests should be supplemented with breeding and selection programs aimed at identifying crop varieties that are resistant to important diseases.

4. Provide farm level training of farmers in cultural practices, use of insecticides, fertilizer application, irrigation techniques and water management. USAID should consider supporting a modified Benor (training and visit) approach to extension training. This system utilizes progressive farmers to communicate one simple agricultural message at a time to neighboring farmers. This program would be most effective if integrated with the applied farming systems research component recommended previously.

5. Develop ONAHA into a financially and administratively autonomous institution with an interest in making profits. Assist ONAHA to strengthen the technical skills of its extension agents through a serious in-service training program; increase the number of skilled ONAHA agents per perimeter; provide management training to ONAHA perimeter directors.

Many other donors are actively providing assistance o irrigated agriculture in Niger. Some finance programs are already underway which relate to the above recommended actions. USAID will need to explore more fully what the programs intend to do and what, if any, additional support it might provide. With so much needing to be done, full integration of donor and host government programs relating to irrigated agriculture is essential.

# ANNEX D

## THE ECONOMICS OF IRRIGATED AGRICULTURAL DEVELOPMENT AND PERFORMANCE IN NIGER

## Emmy Simmons

## Table of Contents

		Page
Α.	Introduction	D-1
8.	Direct Costs and Returns to Irrigated Cropping Systems 1. The Rice-Rice System 2. The Sorghum/Cotton-Fallow/Vegetable System 3. The Air Mountain System 4. The Vegetable-Vegetable System	D-9 D-9 D-10 D-12 D-13
C.	Farm Level Constraints on Irrigated Production 1. Factors Increasing Costs of Production 2. Factors Depressing the Volume of Production 3. Factors Related to Financial Burden and Risk	D-14 D-15 D-20 D-22
D.	Sectorial Choices: The Government's Options for Irrigated Agriculture 1. Expanding Irrigated Surface 2. More Efficient Use of Water Already Controlled	D-23 D-24 D-25
Ε.	Conclusions and Recommendations	D-26
Anne	ex D-1: Some Notes on the Applied Research Unit	
	in <u>Projet Maradi</u>	D-30

46

#### ANNEX D

#### THE ECONOMICS OF IRRIGATED AGRICULTURE DEVELOPMENT AND PERFORMANCE IN NIGER

#### Emmy Simmons

#### A. Introduction

The full exploitation of land already developed for irrigated crop production in Niger could under present input-output relationships, produce about 50,000 tons of grain, 3,500 tons of cotton, 2,600 tons of potatoes, 85,000 tons of onions, and 60,000 tons of other vegetables annually. Valued at 1984 prices, this implies a potential contribution of over 16.6 billion FCFA to GDP, by comparison to an estimated 146 billion FCFA contribution from rainfed crop production. This irrigated production would involve nearly 11,000 hectares (70 percent cropped twice) by comparison to an estimated five million hectares in rainfed crops. Tables D-1 and D-2 present the bases for these estimations.

Actual production levels on irrigated hectares are, however, considerably lower than anticipated. Production performance in the 1982 and 1983 seasons and present levels of perimeter utilization indicate that Niger will realize only 26,000 tons of grain, 2,100 tons of cotton, 2,600 tons of potatoes, 73,000 tons of onions, and 46,000 tons of other vegetables from about 8,000 irrigated hectares. This implies an addition of just under 11 billion FCFA to GDP, or a realization of only two-thirds the potential (Table D-3). It also implies underutilization of established processing capacity for paddy and cotton.

Between 1965 and the present, Niger has directed investments of about 35 billion FCFA to the development of water control structures, primarily for the purposes of increasing grain and cotton production on about 9,000 hectares. Farmers on their own initiative annually invest an estimated 16 million FCFA in structures to irrigate 3,000-4,000 hectares. Many of these structures last for only one dry season production cycle. While one can assume that farmers' privately-owned structures are all used to capacity in most years, the same is not true of those which are constructed and managed under government auspices. At present, only about 5,500 hectares of the 9,000 hectares which have been developed by GNAHA<sup>2</sup> or its predecessor agencies are in productive use.

:

 $<sup>\</sup>frac{1}{"}$ Perimeter" is used here to indicate an irrigation system designed by professional engineers with some degree of centralized water control.

<sup>&</sup>lt;u>2</u>/ONAHA is the readily pronounceable acronym for the <u>Office National d'Amenage</u> <u>ments Hydro-Agricoles</u>. A parastatal organization, it is charged with management of most perimeters.

	Total H	lectares								
Type of Perimeter	Season	Season	Grain	<u>Cotton</u>	Unions	n ('000 MI) Vegetables	Potatoes			
Niger River <u>cuvettes</u> , ONAHA-managed	5,635	5,635	45.1	<b></b> '						
Niger River terraces, ONAHA-managed	362	362	1.4			10.9				
"Interior" ONAHA-managed perimeters <sup>a</sup>	1,840	1,015	2.0	2.0	20.0	10.0				
Maggia Valley, barrages, ONAHA-managed	1,143	0	1.5	1,5						
Goulbi-Dallol, indivi- dual, and small coop enterprises	(3,000) <sup>b</sup>	3,000	(1.8)		60.0 <sup>-</sup>	30.0				
Air gardens	530	260	1.1				2.6			
Komadengou River perimeters <sup>c</sup>	500	500	1.1		5.0	10.1				
TOTALS	10,010	10,772	52.2	3.5	85.0	61.0	· 2.6			
Value of Production (million FCFA) <sup>d</sup>	16,	620	5,220	420	3,400	7.320	260			

## Table D-1: Summary of Potential Irrigated Production from Already Developed Areas

Sources: Areas are largely from Annex I, Table I-1, supplemented by personal communication from Ralph Royer on the Air, and the FAO feasibility study for Komadougou development. Yields are from the 1982 SOGREAH/Berger report and Rover.

 $\frac{a}{\ln c}$  Includes Konni I, Galmi and 250 hectares of Goulbi Maradi perimeters.  $\frac{b}{\ln c}$  Not truly irrigated, as no supplemental water is applied to cover rainfall deficits. Not, therefore, included , in totals.

c/This information is decidedly vague. The CLLSS assessment noted 500 ha. developed, but no further detail was

d/given. d/Prices reflect farm level prices, estimated as follows: 100 FCFA/kg. grain; 120 FCFA/kg. cotton; 40 FCFA/kg. onions; 120 FCFA/kg. all other vegetables; 100 FCFA/kg. potatoes.

Sorghum and millet are officially sold at 80 FCFA/kg. (the official paddy price is only 90 FCFA/kg.), but open market paddy prices (which should account for most of sales) are generally higher. No value has been added for by-products, which is likely to be a significant omission.

Crop	Hectares ('000)	Yield (kg/ha)	Output ('000_MT)	Price Per Kg.	Total Value (Million FCFA)
Millet	3,000	400	1,200	75	90,000
Cowpeas	944	180	170	100	17,000
Sorghum	717	600	430	75	32,250
Groundnuts	140	610	. 85	70	5,950
Cotton	6	425	3	120	360
Maize	12	780	9	20	180
TOTALS	4,819				145,740

Table D-2: Summary of Potential Rainfed Crop Production in Niger

91

٠

Sources: Hectares reported for 1980 by the Ministry of Rural Development (found in the ONAHA Report for 1982); yield levels for all but cowpeas and sorghum, same sources; cowpeas and sorghum are from Ithaca International (1983); values are from Ithaca International price estimates. No byproduct values are included. Again, this is possibly a serious omission.

	Total H	lectares		•			
Type of Perimeter	Rainy Season	Dry Season	Grain	<u>Actual</u> Cotton	Production Onions	(.'000 MT) Vegetables	Potatoes
Niger River <u>cuvettes</u> , ONAHA-managed	3,395	3,466	21.4				
Niger River terraces, ONAHA-managed		64				0.3	
"Interior" ONAHA-managed perimeters"	1,600	700	1.0	.9	7.6	6.2 <sup>b</sup>	
Maggia Valley, barrages, ONAHA-managed	847	65	0.9	1.2		1.3	
Goulbi-Dallol, indivi- dual, small coop enterprises	(3,000) <sup>c</sup>	3,000	(1.8) <sup>c</sup>		60.0	30.0	
hir garding	530	260	1.1	•			2.6
Komadougou River perimeters	500	500	1.1	·	2.0	3.1	
TOTALS	.872	8,055	25.5	2.1	6 <u>8</u> .8	40.9	2.6
Value of Production (million FCFA)	10,	754	2,550	25 <b>2</b>	2,784	4,908	260

## Table D-3: Estimated Actual Irrigated Production on Utilized Area, 1982 and 1983

Sources: Reports from ONAHA on Tahoua Department and Niger River production, Royer for Air, Projet Maradi Report. (mimeo), 1984.

All footnotes from Table 1 apply.

9'L

 $\underline{a}$ /Includes 16C hectares for Galmi coming into production in 1983.

 $\underline{b}$ /Includes 93 tons of dry season groundnuts grown in the Goulbi Maradi (Djiratawa) perimeter.

 $\underline{C'}$ Again, not true irrigation, so has not been included in totals.

Farmers' major cash expenses in irrigated agriculture vary according to crop, as is indicated in Table D-4. They range from a few thousand FCFA per hectare for a vegetable production enterprise which manually lifts water from a series of wells, to as much as 140,000 FCFA per hectare for pump-irrigated dry season rice production in the ONAHA-managed perimeters in the Niger River valley. By contrast, farmers' cash costs for producing rainfed grain are estimated to be less than 10,000 FCFA per hectare per season.

Farmers' most significant single operating expense on all types of systems is labor. In irrigated systems, labor use is a function of both water application technology and crop. Gross margins per day of labor invested in irrigated agriculture, assuming projected yield levels, range from an estimated 800 FCFA per day for irrigated cotton to 1,650-1,750 FCFA per day for irrigated sorghum and maize. Onions appear to earn its producer between 2,500 and 3,000 FCFA per day.

Of the irrigated crops, rice has the lowest ratio of the value of production to the amount of cash inputs. Irrigated onions and groundnuts have the highest. Looking at this ratio for all crops--both irrigated and rainfed--one can estimate that farmers' financial risk is lowest for rainfed crops grown under traditional production conditions (no fertilizer, no animal traction), relatively low for irrigated onions, groundnuts and sorghum, and relatively high for irrigated rice and cotton. This risk assessment helps to explain farmers' priorities in production.

	Cash Co	ctc	Labor Days (bouse-	<u>Total Ou</u>	itput (kg)	Value o (FCFA	f Output /kg)	Total	Gross Ma	argin
<u>Crop/System</u>	Item	FCFA	hold)	Product	Product	Product	Product	Value	Hectare	Day
RAINFED										
Millet; traditional hoe technique	Seed Tools Marketing	750 2,300 175	80	430	3,400	75	1	35,650	32,425	405
Cowpeas; grown as intercrop with millet	Seed Tools Marketing	2,400 2,300 750	21	180	700	100	35	42,500	37,050	1,748
Sorghum; tradi- tional	Seed Tools Marketing	1,125 2,300 250	106	650	5,200	75	1	53,950	50,275	474
Groundnuts; tra- ditional	Seed Tools Marketing	2,400 2,300 3,500	103	635	1,900	70	35	110,950	102,750	998
IPPICATED							ų. 1			
							•			
Sorghum; furrow irrigation; gravity system	Seed Fertilizer Plowing Interest ONAHA Transport	2,000 7,000 6,000 600 10,000 12,500	94	2,500	5,000	75	1	192,500	154,400	1,643
Cotton; furrow irrigation; gravity system	Seed Fertilizer Plowing Interest ONAHA	11,500 15,000 1,100 10,000	326 <sup>a</sup>	2,500		120		300,000	262,400	805

### Table D-4: Costs and Returns for Rainfed and Irrigated Crops, Per Hectare, By Season

D-6

<sup>&</sup>lt;u>a</u>/In Maradi in 1983 rainy season, only 258 days were actually used for cotton production, although yields were also lower than assumed by SOGREAH/Berger and costs were higher. Using Maradi figures, the gross margin per labor day would be 709 FCFA. The SOGREAH/Berger analysis suggests an alternative method of calculation based on hiring 124 days of labor for weeding and harvest. At an additional cost of 43,000 FCFA per season, this method results in a return to <u>family</u> labor and management of 1,086 FCFA.

Crop/System	Cash Cos Ttem	ts FCFA	Labor Days (house- hold)	<u>Total Ou</u> Product	itput (kg) By- Product	Value of (FCFA) Product	f Output /kg) By- Product	Total Value	Gross M Per Hectare	argin
Groundnuts; furrow irriga- tion; gravity system	Seed and other costs estimated to be same as f irrigated sorghum	or	196	2,027	5,400	70	35	330,890	292,790	<u>1,494</u>
Cowpeas; furrow irrigation; gravity system	Seed and other costs estimated to be same as f irrigated sorghum	or	196	1,000	3,800	100	35	233,000	194,900	994
Onions; individual or small coop- managed; manual lift <sup>D</sup>	Seed Fertilizer Well Marketing Wage labor	80,000 9,500 2,000 246,000 90,000	326	30,000	?	50	?	1,500,000	1,072,500	3,290
Onions; basin, gravity system, ONAHA-managed	Seed Fertilizer Interest Plowing ONAHA	80,000 9,500 700 10,000 10,000	326	30,000	?	30	?	900,000	789,800	2,423

# Table D-4: Costs and Returns for Rainfed and Irrigated Crops, Per Hectare, By Season (Continued)

.

جب

<sup>&</sup>lt;u>b</u>/Assumes that individual/coop delivers onions in sacks to wholesalers. Costs are: materials, labor for sacking, transport from field and are estimated to equal 615 FCFA/sack of 75 kg.

Crop/System	Cash Cost <u>Item</u>	s FCFA	Labor Days (house- hold)	<u>Total Ou</u> Product	tput (kg) By- Product	Value of (FCFA/ Product	Output kg) By- Product	Total Value	Gross Man Per Hectare	rgin Day
Rice; ONAHA- managed peri- meter; pump; basin irrigation; dry season	Seed Fertilizer Spraying Wage labor Plowing Thresher Transport ONAHA Interest	4,500 16,000 300 40,000 14,000 20,000 9,300 32,000 1,500	283	3,500	2,400	95	10	356,500	218,900	773
Rice; ONAHA- managed peri- meter; pump; basin irrigation; rainy season	Same as dry season		246	3,000	2,400	95	10	309,000	171,400	696
Maize; furrow 1,726 irrigation; ONAHA perimeter	Seed Fertilizer Plowing Interest ONAHA Threshing Transport	3,000 9,250 7,500 1,100 10,000 9,000 5,000	87	2,000	5,000	· 85	5	195,000	150,150	

8-D

# Table D-4: Costs and Returns for Rainfed and Irrigated Crops, Per Hectare, By Season (Continued)

Sources: Rainfed data are taken from Ithaca International, Type I, traditional farms (1983). Irrigated input/output data are mostly taken from SOGREAH/Berger (Annex 9, 1982) with the exception of the groundnuts data, which was taken as far as possible from Maradi reports. Rice yields and prices were also revised to be more consistent with Bowman's (1982) results and current market prices.

.

-----

## B. <u>Direct Costs and Returns to Irrigated Cropping Systems</u>

There are three types of grain-based cropping systems currently practiced in Niger:

- -- In the ONAHA-managed perimeters in the Niger River Valley, a rainy season crop of transplanted rice is followed by another during the dry season.
- -- The crop rotation most common in all ONAHA-managed perimeters away from the Niger River involves a rainy season crop of sorghum and cotton followed by a dry season fallow or a set of mixed grain and vegetable crops.
- -- In the Air Mountains, individuals using bullock power lift well water to their fields to grow a rainy season crop of millet or potatoes, followed by a dry season crop of vegetables or wheat.

Jointly managed irrigation systems tend to emphasize cereal, legumes and cotton production. Individually managed irrigated fields tend to concentrate on vegetables during both seasons. The onion-onion rotation of the Galmi area is the most extensive example of this latter system, but small gardens around most villages and the city of Niamey also fall into this category.

To understand the major factors affecting the productivity of each of these cropping systems it is useful to consider them in more detail.

#### B.1 The Rice-Rice System

Of the four major grains produced under irrigation, rice involves both the highest costs and the highest returns per hectare. In 1982, the SOGREAH/Berger (1982) study team estimated that average cash production costs paid by the farmer each season were in the range of 130,000 to 140,000 FCFA per hectare. In addition, the Government of Niger provided subsidized goods and services worth 75,700 FCFA per hectare per season. Gross returns at the farmer level, assuming that the farmer sold all grain production (estimated at 3.5 tons of paddy in the rainy season and 4.5 tons in the dry season) as well as all rice straw (2.4 tons each season), were estimated to be 844,000 FCFA per hectare. This assumed that the farmer sold part of this paddy (1,500 kg. per hectare) to the Government at the controlled price of 80 FCFA per kilo and all the rest at the open market price of 120 FCFA/kilo. Revenues and costs at these levels would imply a return to labor and management provided by the farmer and his family of around 1,000 FCFA per day.<sup>1</sup>

In fact, however, yields are not as high as this, and costs may be significantly greater. The Suivi-Evaluation Unit of ONAHA (ONAHA, 1983) and a study team from the Ministries of Rural Development and Plan sampled rice farmers

 $<sup>\</sup>frac{1}{P}$ resent price levels of about 90--95 FCFA/kilo for paddy on both official and open markets would result in daily returns between 900 and 1,000 FCFA.
during the 1982 rainy season. They both found average yields of only 3.3 tons per hectare<sup>1</sup> and cash costs of over 200,000 FCFA per hectare. Both studies evaluated all production at the 1982 official price of 30 FCFA per kilo and found net revenues to be about 50,000 to 60,000 FCFA. On this basis, farmers on three of the perimeters sampled actually realized negative net returns to rice production, and farmers on two other perimeters received net revenues of less than 5,000 FCFA per hectare. Only on three other perimeters were farmers estimated to have cleared over 100,000 FCFA per hectare. Assuming that each farmer on these perimeters hired half the labor to produce this rice crop and provided the rest from family sources,<sup>2</sup> the average return per day for each family worker would have been only 400 to 500 FCFA per day, barely competitive with rainfed millet.

Given in addition that each farmer only controls 0.26 hectares of irrigated rice production in the Niger River perimeters, the Suivi-Evaluation Unit concludes that farmers must have other sources of income to survive. Their estimated revenue levels indicate that farmers participating in thic kind of production enterprise are likely to realize only 2,300 FCFA per month from their efforts. The Suivi-Evaluation analysts suggest--and interviews with farmers in Namarigoungou confirmed--that rain-fed crop production, livestock-raising, trade, and employment of family members elsewhere are considerably more important sources of income than is rice production. This is an important conclusion to bear in mind when constraints to increasing rice production and interventions for releasing them are discussed later.

# B.2 The Sorghum/Cotton--Fallow Vegetable System

In the mid to late 1960's, GON constructed seven surface dams in the Maggia Valley. These dams were intended to provide supplementary irrigation for cotton and sorghum during the rainy season, as well as substantial irrigation for a dry season vegetable crop. Three factors have prevented full realization of this objective in the Maggia:

1. Several of the dams were breached with heavy rains in 1978, reducing the water-holding capacity of the reservoirs;

2. Siltation has occurred much faster than expected, further reducing the capacity of the reservoirs and increasing overflow after a hard rain; and

3. Below normal rains in the Maggia during many of the past several years have often prevented the reservoirs from filling.

 $\left( \right)$ 

Hy comparison to an overall average yield of 2.7 tons per hectare reported for the 1982 rainy season in all Niger River Valley perimeters (p. 37)

<sup>&</sup>lt;u>2</u>/Which seems reasonable based on the amounts of expenditure (presumably cash) reported. It is probably worth checking more closely into the methodology used for these surveys before widely extrapolating the results.

During the rainy season five of the dams provided supplementary irrigation.

The relative allocation of land to cotton and sorghum has also changed within these systems. In the five Maggia Valley surface dam systems operating in 1983, farmers planted a little more than half of the total area to sorghum. They also put a few hectares into maize and millet. This compares with the intended proportion of two-thirds cotton, one-third sorghum.

The half sorghum-half cotton allocation has been approved by ONAHA, as it makes a sensible rotation in terms of pest control and soil fertility. Further increases in sorghum at the expense of cotton are frowned upon, however, as cotton is a national priority. Moreover, the GON feels that farmers need the cash income generated by cotton in order to pay for irrigation and input charges associated with irrigated sorghum production--sorghum being largely consumed by the producing households.

The apparent tendency of farmers to alter the cropping mix slightly in favor of sorghum is understandable. Rain-fed crop production in the Maggia has been very poor. At the same time, returns to labor in irrigated sorghum production are considerably higher than for cotton or rain-fed grains. The gross margin analysis of sorghum production at fairly high, but realistic yield levels (2.5 tons per hectare) reported in Table D-4 indicates an average return per day per family labor of about 1,650 FCFA. This compares to a return of just over 800 FCFA per day of family labor expended in irrigated cotton production (and, notably, harvest). Moreover, the Government of Niger incurs significantly higher subsidies per hectare of irrigated cotton than it does with sorghum. According to SOGREAH/Berger (1982), these amount to about 153,000 FCFA per hectare of cotton grown (over half of which goes for pesticides and spraying) as compared to 55,000 FCFA for sorghum.

Given the problems with reservoir capacity in all the Maggia Valley dam perimeters, the only dry season production which takes place is recessional (<u>decru</u>) cultivation of vegetables and grains in the reservoir floor as the water level drops. SOGREAH/Berger estimates the value of this production to be over 70 percent of that realized from irrigated production. From the farmers' point of view, this is obviously important as a source of income and food, but it is not irrigation <u>per se</u>. The Maggia surface dam systems can all thus be characterized as using a sorghum/cotton-fallow cropping system.

Both Konni and the Goulbi Maradi perimeters utilize a rainy season rotation of cotton and sorghum, though they are not technically located in the Maggia Valley. Neither perimeter has yet attained anything like its planned capacity and both are still in the trial-and-error stage as far as cropping systems go. To date, sorghum yields at Konni are averaging 1.1 tons per hectare as compared to well over two tons per hectare in four of the five Maggia Valley schemes; yields of 1.1 tons of seed cotton per hectare in Konni compare to nothing less than 2.5 tons in all five Maggia-barrage systems. Results at Maradi for the 1983 season were midway between 1.9 tons of sorghum and 2.0 tons of cotton per hectare.

Both the Goulbi Maradi and Konni perimeters envision the eventual establishment of a dry season grain, grain lequme, or vegetable crop after the sorghum and cotton harvest. Since Maradi is pump-based, and the water supply seems fairly reliable, a current cropping intensity of 146 should not be too difficult to maintain as the system expands. The perimeter's Applied Research Unit has found that groundnuts do extremely well in the hot dry season (which is not good for vegetables), producing, under experimental conditions, as much as four tons of groundnuts in the shell and seven tons of green hay at-a time when forage prices are very high. Actual yields in the 1982/83 season were two tons of groundnuts and 5.4 tons of hay; these provided a respectable return of nearly 1,600 FCFA per day of labor invested in production. Thus, vegetables would follow sorghum and groundnuts would follow cotton in the rotation.

The managers of Kunni perimeters I and II have not yet found the dry season cropping system which will match their water resources (likely to vary from year to year according to the rainfall and accumulated storage in the reservoirs) with their market. While no hard figures are yet available for Kunni I, experience accumulated during the 1983/84 dry season suggests that the emphasis which has been placed on wheat production in this season was misplaced. Reported yields are lower than anticipated and the market for unmilled wheat is not as good as projected. Still on trial in the fields are cowpeas and maize. But, as the agronomist on the team noted, pest damage is very likely to reduce cowpea yields substantially.

Trials on the Goulbi Maradi perimeter also indicate that cowpeas are not likely to turn out to be the most effective dry season crops, nor is maize, which proved to be a particularly heavy water user. Moreover, currently-available varieties do not respond well to fertilizer. Yields per unit of input were, in fact, low enough to convince Maradi project management to drop maize as a recommended crop.

### B.3 The Air Mountain System

Detailed information on costs and returns for this system were not available. Qualitative reports, however, indicate that the system is highly productive and profitable. A family is said to be able to subsist on the produce and income from 0.5 to one hectare of irrigated land. The Air farmers' <u>dallou</u> system of lifting water from wells is also said to be sufficiently effective to have been recommended for use elsewhere in Niger. The Canadians sponsored a small project in northern Niamey Department a few years ago and there were scattered efforts by CFDT some years back to encourage individuals in the Goulbi Maradi area to grow irrigated cotton using the <u>dallou</u> system of irrigation. There has also been a suggestion that the Air farmers could specialize in seed potato production for the rest of the Niger provided transport, storage and marketing problems could be solved. However, it is unlikely that the rest of the farming system practiced in the Air can be transferred either whole or in part to other irrigated areas in Niger. Weather and soil conditions make the wheat, millet and potato production situation there unique.

 $<sup>\</sup>frac{1}{T}$  There are reports that funding was stopped after one year of activity, but they could not be confirmed. It would be interesting to know the reasons for the cessation of funding if, indeed, they are true.

### B.4 The Vegetable-Vegetable System

There are several variants on the vegetable-vegetable system. The most common is the fallow-vegetable rotation, with perhaps the next most common being the sorghum-vegetable rotation. The heavier <u>fadama</u> soils, which are well-suited to dry-season, irrigated-vegetable cultivation, are often too wet during the rains to support anything but weeds or sorghum. Nevertheless, there are garden areas around many villages and the city of Niamey which can be--and are--successfully double-cropped with vegetables on a small scale. There is one large area near Galmi which is well-suited to an onion-onion rotation. This latter system appears to have been in operation using manual methods of water-lifting and irrigation for several decades at least. Recently, much of the area was incorporated into the ONAHA-managed perimeter at Galmi, using water supplied from a newly-constructed reservoir.

Under the traditional vegetable-vegetable production systems, farmers purchase few inputs. The major cash expense appears to be the seasonal construction and maintenance of an irrigation well, estimated to cost about 2,000 FCFA per season. Five or more such wells are needed for each hectare cultivated, depending on the water level and recharge rate per well. Farmers often hire additional labor as needed for vegetable production. Women appear more likely to use unpaid family members as additional hands on their fields. Labor can be a significant expense, as manual water-lifting is very time-consuming, requiring as many as 600 labor-days to grow a hectare of onions, for example. As market awareness has grown among vegetable producers, and as Lutheran World Relief, Africare and others have demonstrated cement-lined permanent wells, many growers have begun to add other purchased inputs to their dry season vegetable production operations<sup>1</sup>. Fertilizer, improved seeds, permanent wells, pesticides and small gasoline pumps seem to be the inputs most frequently added--roughly in that sequence.

<u>Shadouf</u> and <u>dallou</u> methods of lifting water for vegetable production seem to be common in the Maradi area. However, they have not spontaneously spread to other areas, such as south of Madaoua, where production is just as intense during the dry season and manual water-lifting involves great expense.

Onions are apparently the vegetable crop produced in the greatest volume, followed by tomatoes, large squash, sweet potatoes, okra and hot peppers. Sweet green peppers and other vegetables seem to have more limited markets, although the Komadougou Valley producers are said to specialize successfully in dried green peppers for the Nigerian market.

Onions appear to have the best export potential of all vegetables at this time. They have an elastic market, a large demand, are relatively indestructible in transport and are amenable, when necessary, to on-farm processing in order to increase shelf life. Fresh tomatoes face a more limited market, higher

 $<sup>\</sup>frac{1}{No}$  information was obtained on wet season vegetable production, altrough Galmi onion producers probably use similar inputs in both seasons.

spoilage rates in transport and are more prone to diseases than onions. However, the dried tomato market in Niger is good enough to induce producers to produce a surplus of fresh tomatoes for drying and later sale at a substantial profit. The other vegetables have more limited local markets which seem to glut easily.

It remains to be seen whether the Galmi perimeter managed by ONAHA will, when fully operational, increase yields per hectare sufficiently over "traditional" systems to make this a profitable enterprise. Galmi red onions are apparently capable of yielding 50 tons per hectare under good production conditions (which the perimeter should provide), although it is currently estimated that normal yields are around 30 tons. At 50 tons, gross margins per hectare would rise to nearly 2 million FCFA and returns per day for management and labor would go from the 3,300 FCFA estimated to be realized at 30-ton yields to 5,800 FCFA. Moreover, it seems quite clear on the basis of anecdotal evidence that onion growers can generate enough profits in one season to generate savings for investing in more inputs and infrastructure for the next. Farmers spoke of adding more land, permanent wells and general enterprise expansion.

A grain/vegetable-vegetable rotation is envisioned for the terrace perimeters along the Niger River, with the emphasis apparently on the vegetables. Since terrace perimeters represent the major development opportunity for irrigated agriculture along the River (projected, post-Kandadji, at around 110,000 hectares compared to less than 30,000 for further cuvette development), it will be useful to closely monitor results on the Tillakeina perimeter. This ONAHA-managed perimeter has just been rehabilitated (new pumps, new canals, new layout) after having gone out of business a few years back. It is presently experiencing its first dry-season vegetable cycle under the new system. While harvests are not yet complete, both production and marketing problems have already surfaced. Pests, for example, reduced okra yields to 100 kilos per hectare, unlikely to pay the <u>redevance</u><sup>1</sup>, much less a profit. Other vegetables were finding the Niamey markets overcrowded with the output of in vidual producers who have gradually established themselves on the river banks on the outskirts of the Niamey. Since these small garden owners seem to be moving from a hand-watering technology to the use of small pumps, it can be assumed that they have found profit levels sufficient to try to retain their markets. Proximity to Niamey gives them an advantage over producers on the terraces further along the River.

# C. Farm-Level Constraints on Irrigated Production

Many factors prevent Nigerian farmers from attaining projected levels of output on presently irrigated land. These are well laid out in publications from those organizations most concerned with irrigation development (such as ONAHA and <u>Projet Maradi</u>). They are also readily confirmed in interviews with farmers and project managers all over the country. Trying to prioritize these

 $<sup>\</sup>frac{1}{The}$  fee determined by ONAHA and the cooperative to be the producer's share of production costs incurred by the perimeter as a whole.

D-15

constraints according to their relative impact on production, however, is not easy, since the constraints vary by crop and in their effect on farmers in different types of irrigation systems. For purposes of discussion, we have classified the more commonly-identified constraints according to whether they:

- 1. Increase costs of production, both per hectare and per unit of output;
- 2. Decrease the volume of production; or,
- 3. Shift more costs and risk from the state to farmers.

#### C.1 Factors Increasing Costs of Production

Those factors which increase farmers' costs of production are:

- 1. Poor design of the water delivery mechanism;
- 2. Inefficient water-lifting and application mechanisms;
- 3. Inefficient application of fertilizer;
- 4. Pest attacks necessitating frequent spraying of pesticides; and,
- 5. Very small plot sizes combined with tractor or animal plowing services which necessitate reconstruction of water control earthworks each season.

As a group, these constraints are important disincentives to irrigated crop production because there is little an individual farmer can do to relieve them, especially given the organizational structure of most irrigation systems in Niger. All he can do is pay.

The first factor is primarily relevant to the ONAHA-managed perimeters where poor design has reduced the economic life of the perimeters. In general, <u>Genie Rural</u> engineers or outside consultants, using minimal soil and water information, have tended to design "optimal" water delivery systems of a scale large enough to warrant substantial donor financing. These perimeters, developed in Niger over the last 20 years, were expected to be in productive use for 40 to 50 years. Yet almost all of the perimeters which are to be rehabilitated under the IBRD/CCCE/KEW Rehabilitation Project are less than 15 years old. The complete abandonment of some perimeters (Sakoira) and the poor production records of others provide additional evidence of the inadequacies of system design.

New perimeters, such as Namarigoungou, have supposedly been designed so as to "learn from experience." Unfortunately, the innovations seem to address only narrow technical lessons: (1) minimizing system maintenance, which has been a recurrent problem, by installing more costly cement structures in more places; and, (2) rectifying basic design errors evident in other perimeters (electric instead of diesel pumps, drainage systems, simpler water-control structures). Adequate attention is still not being directed to the problem of soil heterogeneity as World Bank specialists noted. Moreover, even with the benefit of past experience and more time to undertake the necessary technical studies, several areas included in the system at the planning stages had to be eliminated later. Only 1,650 of the planned 3,000 hectares proved to be irrigable. This generates higher costs per hectare actually cultivated and, consequently, higher costs for farmers. Furthermore, it seems as though few, if any, organizational lessons have been learned. It is our observation that technical system designs will need further adjustment to reflect farmers' economic interests and management capacities if future production is to meet anticipated levels for the projected life of the infrastructure. As has already been noted, returns per farmer in the rice-rice systems associated with the Niger River Valley perimeters are low and the costs which they are expected to cover from their production--but over which they have no control--are relatively high. Given the design changes being made, it appears as though ONAHA's solution to management difficulties--such as farmers not contributing adequate free labor for system maintenance--is to substitute capital for labor. It is not at all clear that farmers themselves would have chosen this particular alternative if allowed to choose, and if user changes accurately reflected the cost of the various alternatives.

Inefficient water-lifting and application mechanisms increase the cost of water both per hectare and per unit of output. Such inefficiencies appear to be common to all types of irrigated cropping systems, though they stem from different causes. Some are mechanical in origin, having to do with poor pump maintenance, poor location of pumps vis-a-vis water supplies, unlined canals in areas of sandy soils, poor levelling of fields, etc. Moreover, the inability of CNAHA perimeter managers and farmers to estimate crop water requirements and to measure the amount actually applied leads to excessive water applications and, consequently, excessive pumping costs.

The inefficient application of fertilizer is perhaps the factor which most affects the per unit cost of output. Farmers frequently apply amounts too small to have a discernable effect on output, or apply fertilizer at inappropriate times, when the growth impact is limited or nil. Farmers also tend to apply fertilizers which are available on the market, rather than those which are most useful for the plant. This occurs in border areas where simple superphosphate is applied because it is readily obtainable in Nigeria--even though nitrogen would provide a more cost-effective source of plant nutrients.

The Suivi-Evaluation Unit of GNAHA reports an interesting set of observations on fertilizer application in the rice-rice systems along the Niger River. A sample of farmers revealed that only 18 percent applied the amount of fertilizer recommended, that is, 100 kg. of 15-15-15 and 200 kg. of urea. The modal number of farmers (30 percent) applied more, 200 kg. of each. However, this greater application of fertilizer produced nearly 900 kg. less rice per hectare as compared to the levels attained by farmers using the recommended amount. The same yield-depressing effect of the 200 kg. NPK/200 kg. urea rate was noted in research plots elsewhere. Furthermore, a number of very high yields were noted on fields of farmers using less than the recommended amount of fertilizer. Thus, it may be too early to conclude that the recommended dose is the most cost-efficient amount. Alternatively, other unidentified factors are influencing yields.

 $<sup>\</sup>frac{1}{I}$  In the Niger River Valley, poor pump location has necessitated installation of relay pumping stations to move water from the river to the perimeter.

Pest attacks which necessitate frequent use of pesticides are another costincreasing factor. Breeding of varieties with better disease resistance may be the most cost-effective way of reducing such costs. However, better weeding and more thorough and timely applications of pesticides would increase their effectiveness, while the numbers of applications required for effective control. The team agronomist emphasizes the importance of crop-rotation systems for controlling plant pests.

Certain spraying technologies may further reduce pest control costs per unit of output. Tests by the Applied Research Unit in <u>Projet Maradi</u>, for example, showed both a cost-reducing and yield-increasing effect from experimental use of the electrostatic sprayer on cowpeas. It used fewer batteries than the ULY normally uses and resulted in a yield difference of 200 kilos across the varieties of cowpeas included in the test. Unfortunately, this technology is not yet widely available.

Reconstruction of dikes, bunds and channels destroyed in the plowing operation may not add significant cash costs to the production of rice, sorghum and cotton, but it must demand additional labor at a particularly busy time of the year for most farmers. Planting of rainfed crops and preparation of rainy season irrigated fields both start with the first rains. According to labor data in Table D-5, the household labor supply is stretched to its limits at this time. This implies higher-than-average opportunity costs for labor expended on fields at this time.

	Total Labor	<u> </u>						
Month /Tack		Kainy Season					Dry Season	
FIOREN/TASK	Required	minet	cowpeas	Sorgnum	"Uther"	Irr. Rice	Irr. Rice	
MAY Soil preparation/nursery	14.3					1.0		
Bird-scaring						1.8	 2 E	
Harvest							10.0	
JUNE	81.8							
Soil preparation Plowing		32.4	3.2	2.4	1.6	0.6 hired		
Seeding		10.8	10.8	0.8	3.6			
Threshing							15.5	
JULY	153.2			• •				
Veeding		122 0	 9 1	0.8				
Fertilization				0.0	2.1	1 5		
Cleaning canals/drains						0.4		
Transplanting						12.0		
AUGUST	52.4	07 0	<u> </u>					
Weeding Irrigating		27.0	8.1	4.0	2.1	7.5		
Cleaning canals/drains					1.2	2.0		
Fungicide application						0.1		
SEPTEMBER	35.1							
Weeding				2.0		2.5		
Irrigation Closuing consistent					1.2	2.0		
llarvest		10.8	16.2			0.4		
OCTOBER	33.1							
Irrigation					1.2	2.0		
Cleaning canals/drains						0.4		
Harvest		10.8		4.6				
паткествд		2.7	10.8	U.b				

# Table D-5: Hypothetical Household Labor Requirements for Rice-Producing Farmers in the Niger River Valley<sup>a</sup> (Person-Days of Labor)

15

D-18

<sup>&</sup>lt;u>a</u>/The hypothetical household is that of the Type I household in the Ithaca International (1983) report. The farm produces 2.7 hectares of millet/cowpeas, 0.2 hectares of sorghum, 0.1 hectares of other dryland crops and 0.25 hectares of irrigated rice.

	Total Labor	<u> </u>						
Month/Task		Rainy Season					Dry Season	
Honen/Task	<u>Required</u>	millet	cowpeas	Sorghum	<u>"Other"</u>	Irr. Rice	Irr. Rice	
NOVEMBER	17.3							
Bird-scaring	17:5					0 5		
Harvest						2.5		
Nursery establishment					3.0	10.0		
							1.8	
DECEMBER	16.3							
Threshing						15 5		
Soil preparation						13.5		
Plowing							U./ hinod	
141114.01/							ntrea	
JANUARY	13.9							
Iransplanting		<b></b>					12 0	
Fertilizing							1 5	
cleaning canals/drains							0.4	
FERDIADY	10.0						0.1	
Weeding	10.0							
Cleaning canals/drains							7.5	
Irrigation							0.4	
Fungicide application							2.0	
rangrerae apprication			~~				0.1	
MARCH	4 0							
Weeding	4.5							
Cleaning canals/drains							2.5	
Irrigation							0.4	
5						÷= *=	2.0	
APRIL	2.4							
Irrigation						•	0.0	
Cleaning canals/drains							2.0	
- ·						<b>** =</b>	0.4	

# Table D-5: Hypothetical Household Labor Requirements (Continued)

Required annual total 434.2 or a monthly average of 36 days/month; peak of 153 days/month Available from family sources 480.0 or a monthly average of 40 days/month; peak of 60 days/month

D-19

Monthly breakdown is based upon subjective allocation of tasks and labor times noted in Ithaca Interna-tional (1983) and SOGREAH/Berger (1982). McIntire's data for Niamey Department roughly confirms the subjective allocation of rainfed cropping schedule by months. For reasons of simplicity, both rainy and dry season rice here are assumed to require the same number of days, although SOGREAH/Berger (and Table D-4, above) note the probability of spending more days on dry season rice. Source:

#### D-20

# C.2 Factors Depressing the Volume of Production

Farmers' total volume of output is affected by:

- 1. untimely planting or transplanting;
- untimely water application;
- 3. poor weeding and pest control practices; and
- use of poorly adapted or unviable varieties.

The first of two factors are often related in practice, especially in the grain-based systems using surface water sources tied to the arrival of the rains. In the Niger River perimeters, rice is often said to be transplanted "too late," (that is, late July) with the result that seedlings are too old, tillering is reduced, yields suffer and the planting of the dry season crop is delayed--with similar output-reducing effects. There are two apparent reasons for this untimely rainy season transplanting. First, when the river flood arrives later than normal (as has been the case in the past two years) transplanting must be delayed until there is enough water in the river to sustain the crop. Secondly, farmers must plant and weed their main millet crop during this same period of time. Even a summary look at the probable monthly labor requirements in Table D-5 indicates that most households would find their labor resources stretched thinly during this period. Interviews with farmers in Namarigoungou confirmed this labor bottleneck in July/August. Moreover, many farmers find it hard to hire labor in order to do a timely transplanting operation because it requires substantial amounts of cash at a time when cash resources are low.

All of these constraining elements lead to a prolonged period of transplanting in the rice perimeters with the result that some plots will be near maturity while others are still in the grain development stage. According to water distribution figures, water is pumped to the fields even when 95 percent of the grain is nearly ready for harvest and should be drying out. It appears that farmers continue to apply water at this time simply because it is there, even though it is likely to reduce rather than increase yields at this stage of growth.

The negative effects of untimely planting and watering in the Maggia Valley surface dam perimeters are just as real, but stem from somewhat different causes. Because none of the dams is capable of holding water throughout the dry season, planting cannot start until the reservoir has captured enough water to support germination. Irrigation can, of course, only continue if there is replenishment of the reservoir during the season as well. In 1983, crops in both Konni<sup>1</sup> and Tounfafi perimeters were reported to have suffered from low availability of water in the reservoirs at critical periods<sup>2</sup>.

 $<sup>\</sup>frac{1}{Konni}$  is not in the Maggia, but it has a similar system of water supply and delivery.

<sup>&</sup>lt;u>2</u>/Cotton yields on the Tounfafi perimeter averaged 200 kilograms less than on the othe Maggia Valley perimeters, and those at Konni averaged over 1,000 kilograms less.

Untimely land preparation also contributes to planting delays in both ricerice and other grain-based systems. Most perimeters now use animal traction on an organized, but decentralized, basis to prepare land for planting. In principle, each perimeter should have one pair of oxen to plow every five irrigated hectares. In practice, oxen plowing has often been less productive than expected (three to five days/hectare, depending on the soil) with the result that some perimeters do not have enough animal traction units to do the job when necessary. Moreover, health services necessary to keep the animals working steadily are not always adequate. Whether the resulting plowing and planting delays have had significant yield-reducing effects by comparison to other factors already noted is not known.

Evidence on the yield-reducing effects of poor weeding and pest control practices is largely site-specific, but some illustrations suggest the magnitude of the potential negative impact. ICRISAT (1983), for example, found that delays in the weeding of rainfed millet reduce potential yields by nine kilos per day of delay. Given the relatively low millet yields, even a week's delay in weeding could mean a possible loss of 15 percent of total potential output<sup>2</sup>. The dramatic decline in yields due to ineffective pest control (which, to be fair, may or not have been due in this instance to poor practices) is illustrated by the 100 kg./hectare yields for okra obtained in the Tillakeina perimeter in the 1983/84 dry season<sup>3</sup>. Reasons for poor weeding and pest control practices obviously vary, but seem most often to involve competing labor demands at the farm-household level, lack of pesticides and overall poor crop management.

Poorly adapted varieties or unviable seeds are other apparent causes of low yields. Varieties with poor pest resistance and intolerance to high soil temperatures have perhaps the most serious yield consequences for vegetable crops. But the lack of cold-tolerant varieties of rice for dry season production and the degeneration in seed quality associated with continued use of the same rice variety appear to have greater negative effects on overall yields of rice.

The low potential of available maize varieties led the Maradi project management to exclude maize from the perimeters' crop rotation until more responsive varieties are available. It is likely that the Galmi perimeter managers will come to a similar conclusion when the results of its maize and cowpea trials are compared to those from onions. An ONAHA report for Tahoua

- $\frac{2}{\ln}$  Moulela and Konni observers indicated that the first weeding of irrigated fields was often delayed a month or more.
- $\frac{3}{\text{Expected yields for irrigated okra are in the range of four tons per hectare (<u>Projet Fruitier Gaya</u>, 1984).$

<sup>&</sup>lt;u>1</u>/Conversion from tractor plowing services began in 1982 under a Caisse Centrale project. Some perimeters do not yet, however, have the targeted number of animal traction units in place. ONAHA reports that demand is still greater than supply.

(Briend, 1984) suggests that millet not be planted in the Maggia perimeters since even with irrigation and fertilizer, yields will not exceed 1.5-2.0 tons per hectare.

Varietal tests of sorghum conducted by INRAN/ICRISAT is the Konni perimeter during the 1983 rainy season indicate that the generally recommended improved variety (L 30) may not be as well adapted to irrigated production conditions as 1/2 MSB (Briend, 1984). Test yields of the latter variety were over two tons greater than those realized with L 30. Such tests are not conclusive, of course, but demonstrate well the need for--and potential returns to--the identification of varieties suited to the particular soil-water-temperature conditions in different perimeters.

### C.3 Factors Related To Financial Burden and Risk

In all the perimeters managed by ONAHA, there has been a continuous reallocation of financial responsibility from the state to the farmers in the form of higher user fees and reduced subsidies. This trend is likely to continue or even be intensified with the perimeter rehabilitation and <u>Societe de Developpe-</u> <u>ment</u> programs. This redistribution is occuring both directly and indirectly. The net effect is to shift a substantial part of the financial risk of irrigated farming to farmers, with a consequent negative impact on production levels.

The first major shift involves discontinuing ONAHA tractorized land preparation services in favor of farmer-owned animal traction units. Rather than ONAHA continuing to provide services worth 29,200 FCFA per Electare per season while charging farmers only 11,000 FCFA, the CNCA now provides farmers with credit to purchase animal traction units. Each comperative should have one animal traction unit for every five hectares of invigated land (that is, one plowing unit for every 20 plotholders in rice-rice systems), but ONAHA reports more demand for traction units than it can supply. Anecdotal evidence indicates that the slowness of the animal traction plowing services is putting farmers' production schedules and other investments more at risk than before, though further factual analysis is required. Moreover, details on the repayment rates for this program need to be examined in order to assess the count of financial burden that farmers have actually assumed in this program.

The recent abandonment of the credit program for fertilizer shifted an additional financial burden/risk from the state to the farm. While UNCC/ONAHA still provide subsidized fertilizer supplies to cooperatives, access to these supplies in the last couple of seasons has been on a cash-only basis in most perimeters. As many observers feel that farmers apply fertilizer at the level they can afford, rather than at the levels recommended (borne out by field observations of ONAHA's Suivi-Evalution Unit), the lack of credit may have a significant affect on use of fertilizer and crop yields. The lack of complementary fertilizer may also raise the risk of realizing less-than-expected returns to the inputs of water or labor.

A third shift is already in the works--both at the operational level in ONAHA and at the level of national discourse on the principles of the <u>Societe de</u> <u>Developpement</u> following the Zinder Seminar. It will involve the gradual assumption by the farmers (through cooperatives) of the Losts of central perimeter

management and agricultural extension services. While farmers in CNAHA perimeters are already paying some of these costs in their <u>redevances</u>, SOGREAH/Berger (1982) estimated that approximately 46,000 FCFA worth of services per hectare irrigated were not being covered in 1982. At the same time, the Government of Niger intends to move toward open-market pricing of inputs, ridding itself of the financial burden associated with input subsidies amounting to 14,000 FCFA per hectare of irrigated rice.

In principle, all these changes should have the effect of making the farmers more efficient users of expensive resources by bringing financial and economic returns more into line. However, many water delivery systems in perimeters are designed in such a way that only centralized monitoring of water use is possible. No monitoring or measuring structures at sector or plot levels are in place to encourage farmers to be more water efficient. Thus, the problem of good farmers subsidizing poor farmers is likely to become a more important issue at the perimeter level.

In addition, there are likely to be some second thoughts on the part of the government with regard to the cropping systems followed in the Maggia and Konni perimeters. Farmers in these perimeters have the greatest personal financial interest in producing relatively more sorghum than cotton, and only high current subsidies and perimeter-level supervision make cotton as attractive as it is. Withdrawal of both subsidies and regulation would imply the need for CFDT to pay considerably higher seed cotton prices to farmers in order to maintain the present level of production.

# D. <u>Sectoral Choices: The Government's Options for Irrigates Agriculture</u>

Building on this fairly lengthy description of irrigated production systems and constraints to increased productivity of irrigated agriculture in Niger. we can briefly look at some of the sector level choices which the Government of Niger is facing. Obviously, those options in which the government's and farmers' interests are most congruent have the greatest chance of sustaining irrigated crop production and, therefore, the greatest probability of generating the expected flow of benefits over time.

On no perimeter to date has production proved sustainable over time without substantial subsidies or additional investments in structures or equipment. This failure has been attributed to many factors, including:

- -- Institutional difficulties on the part of UNAHA, UNCC, RINI and the farmer cooperatives; lack of training, inadequate accounting at the cooperative levels and inadequate staffing (IBRD, et al., 1984).
- Insufficient data about surface and groundwater availability; underestimation of potential siltation rates in the watersheds behind the Maggia barrages; the unprofitability of rice production when yields fall below 2.5 tons per hectare; and failure of technical systems due to inadequate repair facilities, e.g., for the pumps at Sakoira (SOGREAH/Berger, 1982).

Our own observations confirmed the importance of many of these factors and identified several more: lack of knowledge about crop water requirements; insuf-

ficient information about soil conditions and how to deal with them through water management and soil improvement measures at the perimeter level; very thin management staff on very complex, centrally-managed systems; real labor shortages at the farm household level; and, on ONAHA-managed perimeters in particular, virtually no physical or organizational mechanisms for encouraging individual farmers to use water efficiently--while there are plenty of incentives for free-riding<sup>1</sup>.

These are all factors--and there are certainly others--which the Government of Niger should consider before taking the next step in developing irrigated agriculture.

D.1 Expanding Irrigated Surface

Expanding the area under irrigation seems to be the broad option currently most consistent with Government priorities for increasing national food production. Six interventions could assist the Government of Niger to achieve this objective:

1. Construction of the Kandadji Dam or other water storage structures in the Niger River Valley;

- 2. further terrace development along the Niger River;
- 3. further cuvette development along the Niger River;
- 4. investing in market-expanding infrastructure which will encourage more rapid private expansion of irrigated area: road construction in selected areas, market information for irrigated crops, and agroprocessing facilities;
- provision of credit for inputs which substitute for peak season labor;
   e.g., small pumps for private irrigation systems, more animal traction; and
- 6. exploring possibilities for establishing tubewell perimeters in the Maggia Valley, the Dallol Bosso or other areas with significant subsurface water supplies.

Each of these potential interventions would relieve certain production constraints at the farm level while generating others. Better storage of water in the upstream portion of the Niger River, for example, would permit advancing the rainy season planting calendar for rice and might reduce the competition with millet for labor. On the other hand, if the dam is financed with user fees, the level of financial risk borne by farmers would increase. This might reduce current returns still further.

V/1

 $<sup>\</sup>frac{1}{The}$  one exception to this may be the strong local political leadership associated with the perimeter in Ibohamane.

Most of these potential interventions could be designed in such a way that farmers would have about the same level of control over their irrigated crop production activites as they do now (which is fairly minimal ir most cases). Or, they could be designed so that farmers' control over water and complementary resources would be enhanced. Terraces and <u>cuvettes</u> along the Niger River, for example, could be developed for operation in smaller management units, with less centralized pumping and water distribution systems. Farmers might also provide more financial and in-kind contributions for both construction and maintenance activities. This would relieve the Government's recurrent cost constraint somewhat, as well. But because terraces seem best suited to vegetable production, the marketing constraint may severely limit profitability and would have to be given careful consideration.

# D.2 More Efficient Use of Water Already Controlled

The second broad option in the irrigation sector which is open to the Government is to foster more efficient use of the water already controlled. This approach is being promoted by the World Bank, the Caisse Centrale, and the KFW as part of the proposed 11 billion FCFA Perimeter Rehabilitation Project. Other activities that would improve the operating efficiency of existing irrigated lands include:

1. A program of perimeter-specific and crop-specific fertilizer trials to determine cost-effective application levels under differing soil and water conditions;

2. institutional reform at ONAHA and perhaps at UNCC, to reduce their cost of providing goods and services and to facilitate assumption of these costs by farmers;

3. emphasis on pest control measures; e.g., short-term control through spraying interventions and longer term control through varietal selection for pest/disease resistance;

4. varietal selection and seed multiplication to provide continuously improved crop varieties for various soil-water conditions;

5. a series of measures to reduce water costs, such as more research on crop water requirements; developing extension messages and training curricula on crop water needs, examining possibilities for substituting pumps for labor in individually-managed irrigated areas;

6. a serious effort to address the issue of labor bottlenecks on the rice perimeters by means other than exhortation. This could include such things as exploring possibilities for broadcast seeding into flooded fields, use of herbicides, providing cash credit for hiring labor, or modifying the rainfed crop production systems (perhaps further expansion of donkey traction);

 $\binom{3}{2}$ 

 $<sup>\</sup>frac{1}{The}$  team did not visit the INRAN/GERDAT substation at Lossa, the principle site of crop/water research in Niger. Discussions with persons close to operations at Lossa suggest that the substation is understaffed.

7. developing varieties and storage/processing methods which can costeffectively reduce postharvest losses, particularly for perishable crops; and

8. measures which would slow the rate of infrastructural deterioration, largely in the realm of training--for farmers on canal maintenance techniques, and for pump operators on pump maintenance--but perhaps also in selective rein-forcement of infrastructure (more cement canal linings, for example, in sandy areas).

### E. Conclusions and Recommendations

Irrigated agriculture in Niger is remarkably productive, given its relatively short history. Construction and management costs are not excessively high by West African standards. While average costs are likely to rise as more difficult sites are developed and less accessible water sources are tapped, design changes could greatly temper that rise. Reported yields for irrigated crops are high relative to those achieved in perimeters elsewhere in the region. The <u>Office du Niger</u> in Mali, for example, rarely records average yields in excess of 1.5 to 2.5 tons of paddy per hectare, while in Niger average production in the range of 2.5 to 3.5 tons is common. Normal onion yields of 30 tons per hectare obtained by Galmi and Madaoua producers are good by any standard.

Furthermore, there appears to have been a substantial amount of private initiative in irrigation in Niger during the last decade or so. This reflects an increasing awareness that the long-term solution to the effects of recurrent droughts may well be in fuller exploitation of surface and groundwater resources. Even farmers regularly using irrigation for crop production, however, still consider their rainfed crops--millet, sorghum, cowpeas--to be their principal agricultural activities, with livestock an important complementary enterprise. This situation is likely to continue for some time for two reasons: first, the area of land presently under irrigation is small and likely to remain limited until storage capacity on the Niger River is significantly increased or tubewell technology is developed to tap underground sources; and, second, the government has adopted a policy of allocating each family (with two active workers) only 0.25 hectares in rice-rice and grain-vegetable systems and up to 0.75 hectares in supplementary irrigation systems (such as those in the Maggia Valley). Neither of these levels of irrigated farming are sufficient to support a family of five members, even at very high levels of productivity.

From a national perspective, expansion of grain-based irrigation systems has been promoted as an attractive option for food self-sufficiency. From a farmers' perspective, however, expansion of such irrigation has provided only a little additional family food security but a significantly greater financial risk. Individual farmers' investments in irrigation have reflected their own perspectives. They have concentrated on irrigating high-value cash crops where the financial reward is commensurate with the financial risks and the opportunity cost of labor.

The Government of Niger has supported its view of irrigation by channeling more than 35 billion FCFA into the establishment of irrigated perimeters primarily for the purpose of producing grain. Farmers have been induced to devote considerable effort to irrigated grain production by the subsidized provision of

 $\Pi_{\mathcal{A}}$ 

water, management services and other inputs and the promise of a fairly reliable level of output. The single crop on which farmers' and national interests converge is irrigated sorghum. It seems to have the potential to provide both increased amounts of food and a relatively high value of output per unit of input.

Capital for further expansion of irrigation infrastructure does not seem to be a significantly constraining factor at the national level, although financing requirements for the proposed Kandadji Dam may test this assertion. Capital at the farmers' level, however, may be constraining further expansion of private sector irrigation activities. More capital in the hands of farmers would probably encourage investments in cement-lined wells and in small gasoline pumps, both of which would allow the same amount of labor to farm a greater area.

A more important restriction on increased productivity of both national and private systems, however, appears to be that of skills--that is, people with a knowledge of water management techniques which will enable them to make more cost-efficient use of this limited resource. This includes a knowledge of agronomic techniques suited to the intensive modes of production which irrigation requires. It also includes the general administrative skills needed to facilitate joint management of a common resource and, in some cases, a set of common water delivery facilities. Thus, investments in human capital to do the research, training and extension needed to realize the full potential of existing financial investments in structures may be a more productive use of funds than additional direct investment in infrastructure itself.

Such investment in skills development would be quite complementary to the other types of sectoral investments which are necessary to realize the full potential of irrigated agriculture in Niger; i.e., (1) the provision of inputs for production (fertilizers, tools--both for cultivation and system mainte-nance--pesticides, herbicides, certified seeds); (2) the establishment of support infrastructure (research facilities on perimeters, storage buildings, cooperative buildings, training centers, vehicles); or (3) the expansion of roads, market information and agro-processing facilities.

In sum, it is recommended here that AID adopt <u>increased productivity of</u> <u>resources used in irrigated agriculture</u> as its sectoral objective and seek to achieve this objective by:

- 1. Supporting measures to reduce operating costs, such as:
  - -- Training farmers and ONAHA managers alike in techniques which will allow them to manage water more efficiently;
  - -- testing modifications of present systems which can give farmers and ONAHA managers the additional information about crop water requirements and about water use which they will need to apply the techniques;
  - -- re`earch on cost-effective levels of inputs under different soil and water conditions;

- -- development of lower-tech means of system maintenance; and
- -- developing realistic means of handing over operating functions to farmers (probably through training and some provision of equip-ment);
- 2. Focussing on ways to reduce labor bottlenecks, particularly in the Niger River Valley, by means such as:
  - -- Finding less labor-intensive ways to plant the rainy season rice crop than transplanting; or
  - -- testing a cash loan program to permit farmers to hire labor on a timely basis (for either rainfed or irrigated tasks in July and August); or
  - -- testing an alternative crop for rainy season irrigation which has lower labor requirements without sacrificing overall yields (sorghum seems an obvious candidate); or
  - -- mounting a general farming-systems research effort focussed on farmers whose cropping systems include both rainfed and irrigated crops; and
- 3. <u>Providing farmers with more choices</u> that allow them to reduce their risk and to develop a sustainable farming system which includes irrigated crop production as an important, if not principal, component. Such assistance could involve:
  - -- Development of irrigated crop varieties which would reduce production problems and provide marketable products;
  - -- testing and extension of techniques which would lower farmers' input costs per unit of output (probably largely through agronomic means but perhaps also in the storage areas),
  - -- credit; and
  - -- feeder roads and market information.

Transformation of these recommendations into AID projects would be fairly straightforward. The major initial choices would depend on Mission personnel and management preferences. The final shape would depend on Government of Miger institutional interests and absorptive capacity.

Cofinancing the Rehabilitation Project with the World Bank, <u>Caisse Centrale</u> and KFW, for example, would enable AID to offer assistance in the area of cooperative management training. The GON has requested the FED to expand its training program to cover the rehabilitated perimeters, but funding restrictions appear to prevent it from doing so in a way satisfactory to the other donors. AID would need to explore what the other donors see as an appropriate training intervention.

Institutional financing of ONAHA might be another mechanism to permit AID to target assistance toward the gaps which are likely to emerge in the multidonor rehabilitation program. Presently, the rehabilitation program seems to be geared to very selective strengthening of ONAHA, though details on its content are still evolving. It would seem to be worthwhile for AID to consider assisting ONAHA to contract with INRAN for a program of irrigation-related research to take place on perimeters. The Applied Research Unit in the Maradi project<sup>1</sup> provides an excellent example of the potential for this activity. An Applied Research effort at Konni is sorely needed, as is a farming systems research effort along the Niger River. This latter might be made to fit with ongoing Purdue research, but one wonders whether that would be wise given the very different orientation and the expertise that make up that team.

On the other hand, AID might wish to define one particular problem around which it could design a whole project or provide one particular bit of support infrastructure. Developing and testing groundwater-based perimeters as the "next generation" of irrigation projects in the Maggia and Tarka Valleys is an example. This would eliminate the need for so much close coordination of what already promises to be a very complex undertaking. However, such an approach may have the disadvantage of seeming peripheral to the main thrust of the Government's irrigation interests.

 $<sup>\</sup>frac{1}{See}$  Annex A for a brief description of the project's research program to date and likely future priorities.

### Annex D-1

# Some Notes on the Applied Research Unit in the Maradi Project

The Applied Research Unit has recently established a Pilot Farm in the Djiratawa Perimeter. It is set up similar to other plots in the perimeter and covers about ten hectares. It is used principally to test techniques and varieties for use by farmers in the rest of the perimeter (now covering around 250 hectares and involving almost 700 farmers).

Much of the work has been varietal testing, but varietal trials have been combined with trials on methods of seeding and seeding density, date of planting and quantity and timing of water application.

Following are notes taken from a summary volume prepared by the project for 1983:

### Rainy Season Cotton Trials

L 299-10 was tested for performance in 1981.

Five varieties were screened in 1982; six more in 1983.

Different levels of irrigation were tried in 1982/83.

Two herbicides (Zoriadex and Roundup) were tested in 1982.

### <u>Millet</u>

Two varieties were performance tested in the 1983 rainy season.

A combined trial on irrigation and seeding density  $(0.8 \text{ m} \times 0.8 \text{ m})$  was done, but the year was not reported.

#### Sorghum

Two varieties were tested for performance in the hot dry season, L 30 in 1982 and Tanout in 1983.

Rainy season trials involved: Ratooning, five variety trials in 1981, variety x date of planting, variety both with and without irrigation, and tests of performance x soil type using six local varieties and one from Kano.

### <u>Maize</u>

P3Kolo was tested for performance in all seasons.

A test of urea on P3Kolo was carried out in the cold season, 1980/81.

There were other tests of varieties x soil.

### Groundnuts

Five varieties were tested for performance against 55-437 as a check.

In the hot dry season, tests were held on:

Variety x irrigation variety x seeding density, and performance with different arrangements of furrows in the plots (?cngitudinal and transversal)

· .

· .

### Cowpeas

Miscellaneous variety performance tests.

#### Wheat

Only in the dry cold season:

Varieties x different size <u>planches</u>, varieties on rice soils, methods of seeding, date of planting, and density of planting.

### Rice, Flooded

In 1982 rainy season only, three varieties x three methods of seeding (dry, broadcast of pregerminated seed and transplanting).

### Vegetables

Tomatoes--spacing, varieties, onions--method of planting (on the flat in beds, on ridges), and others, but no details noted.

# Other Themes Explored or Still on the Agenda

- 1. Volumes of water needed for principal cultures. Water delivery to fields (each 1,600  $m^2$ ) is by siphon so fairly precise measurement for each plot, each crop was possible.
- 2. Land preparation methods. Three methods were tested against animal traction plowing as check: subsoiling with a tractor-drawn harrow; plowing with a tractor; plowing plus subsoiling with a tractor.
- 3. Rotation tests. Maize after sorghum, using land preparation methods tested above and two other methods of seeding the maize (1) direct, without further land preparation on top of old sorghum ridges; (2) after replowing and furrowing with animal traction.
- 4. Organic enrichment of soil, using cowpeas as a green manure and waste material from the brewery, as well as straw.
- 5. Fruit trees.
- 6. Manufacture of compost.

# Major Findings Which Have Been Used on Perimeters

- 1. Furrows which are parallel to the canals are the most efficient in terms of water use. They can be more easily levelled by hand and soil differences can be most easily compensated for.
- 2. Maize in the cold dry season after sorghum doesn't pay.
- 3. Groundnuts in the hot dry season are very promising--and recommended.
- 4. Millet, or at least varieties currently available for testing, is not promising as an irrigated crop. There are problems with the planting dates and with birds. The denser planting rate and CIVT and P3Kolo gave good yields but not high enough (defined as three to four tons per hectare).

.

M. Ogier, the present Director of the Applied Research Unit, suggested the following seven themes as priority areas for future research:

- 1. Improving methods of land preparation,
- 2. improving rates of mineral fertilization,
- 3. improving organic matter content of soil,
- 4. improving water economy (example: reducing tomato crop water usage from 11,000 m<sup>3</sup> to 9,000 m<sup>3</sup> by stopping watering sooner),
- 5. variety testing, particularly on sorghum and maize. One objective involves combining varieties and time of planting changes to reduce pest infestation on sorghum,
- 6. adaptation of cropping systems to different types of soils (example has been putting millet on sandy spots in higher areas), and
- 7. control of plant parasites, perhaps through cropping system (example is removing hot peppers from cropping system for a while in order to control aphids).

Annex E

# VEGETABLE MARKETING IN NIGER

An Assessment and Overview

ЬУ

Malcolm A. Versel Consultant

Post-Harvest Institute for Perishables University of Idaho

in conjunction with

Niger Irrigated Agriculture Sub-Sector Assessment Team General Development Office USAID/Niamey

March 7 - April 14, 1984

# ANNEX E

•

# VEGETABLE MARKETING IN NIGER

# Malcolm A. Versel

# Table of Contents

		Page
Α.	Introduction	E-1
Β.	Rationale for Irrigated Agriculture in Niger 1. The Role of Irrigated Production in Supplying Food Needs 2. Irrigated Crops as Revenue Producers	E-1 E-1 E-2
C.	Systems Employed for Marketing Output 1. Producer Sales in Official Markets 2. Producer Sales to Intermediate Traders 3. Producer Sales Directly to Consumers	E-3 E-3 E-4 E-5
D.	Market Prospects for Major Irrigated Crops Within Niger <ol> <li>Market Demand</li> <li>Constraints on Internal Marketing of Vegetables         <ol> <li>The Timing of Production</li> <li>Market Access</li> <li>Storage and Preservation of Produce</li> <li>Entrepreneurial Capacity</li> <li>Three Special Cases                 <ol> <li>Air Mountain Potatoes</li> <li>Vegetable Production for the Petit Marche of Niamey</li> <li>The Galmi Onion Trade</li> </ol> </li> </ol> </li> </ol>	E-5 E-8 E-8 E-8 E-9 E-10 E-10 E-10 E-10 E-11
Ε.	Marketing Prospects Within Neighboring Countries	E-11
F.	Summary and Conclusions	E-13.

12

#### ANNEX E

### VEGETABLE MARKETING IN NIGER

#### Malcolm A. Versel

### A. Introduction

This report constitutes the vegetable marketing component of the Niger Irrigated Agriculture Sub-Sector Assessment. The amount of time available for collecting the information on which this marketing survey is based was limited, especially for acquiring primary data. Because of the time constraint, the approach taken in this report is: (a) to identify those areas of concern to the marketing of vegetable crops in Niger; (b) to provide as complete a perspective of those issues as possible, and (c) to indicate areas requiring further study.

The role of marketing in any irrigated production scheme cannot be too strongly emphasized. In the absence of established and viable marketing channels, farmers have little incentive to produce beyond their own needs. Although producing at self-sustaining levels is not in itself an unworthy objective, it becomes impractical when farmers must cover costs of production in addition to meeting their food requirements. Income for market sales provide cash for purchasing production inputs, meeting social and governmental obligations, and acquiring goods and services unavailable at the farm level.

Irrigated farming in Niger, even at the most rudimentary technological level, involves some degree of investment. Obtaining water typically involves digging a well or acquiring a pump. In addition, farmers need seeds, soil enrichers, fencing, cultivating and irrigation equipment, etc. In spite of these sometimes costly investments, increasing numbers of farmers are getting involved in some form of irrigated agriculture.

# B. <u>Rationale for Irrigated Agriculture in Niger</u>

The individual producer seemingly has two objectives in producing irrigated crops: providing food for the household and generating income.

# B.1 <u>The Role of Irrigated Production In Supplying Food Needs</u>

Irrigated crops, according to the information gathered during our visits to the field, are viewed by producers as supplemental to traditional rain-fed crops. The rain-fed crops, primarily grain crops, are considered to be the principal source of food for the household. Because of this, farmers often give highest priority to rain-fed crops when allocating family labor<sup>1</sup>. This some-

124

 $<sup>\</sup>frac{1}{1}$  Inran also gives highest priority to rainfed crops. Only a small proportion of its research program is devoted to research on problems of irrigated crop production.

times delays preparation and planting of rainy-season irrigated crops and reduces their yields accordingly.

Irrigation facilitates production of fruits and vegetables and provides producers and their families with varie and more nutritionally complete diets to the extent that they consume their production.

In very rough terms we estimate that producing households consume as much as 30% percent of their production of most wegetable crops. This estimate should be considered as an upper limit for on-farm consumption of vegetable crops, subject to more detailed investigation.

The percentage of on-farm vegetable consemption will vary according to the area planted, yields, the number of people in the producer's household and the type of crop. Onions, for example, are frequently used in sauces as a condiment and hold up well under storage. Thus, farmers probably consume a higher percentage of onions than, say, squash, which they consume less frequently and in smaller amounts. Other crops which farmers consume relatively more of include okra, hot peppers and tomatoes, all of which may be stored in dried form, and lettuce and carrots, which are regularly taken from the garden for immediate consumption. Cabbages, melons and eggplants, on the other hand, appear to be produced principally for market.

With respect to on-farm consumption of grains, one study (Keita, 1983) estimated that producers consumed about 40 percent of harvested rice production. Another study (Cullen and Waldstein, 1983) indicates that 88 percent of the 1981 grain harvest (all grains) for Dosso department was stored for household consumption. These studies demonstrate considerable variation in how much grain is consumed by producing households.

Part of this difference may arise from the fact that 1981 was not a good crop year, but part of it also probably reflects a tendency to sell a greater proportion of the irrigated grain crop, given its supplemental role in the farming system.

### B.2 Irrigated Crops as Revenue Producers

Most farmers probably produce vegetables more for their revenue-generating potential than for meeting household food needs. In contrast to the market for traditional cereals, the market for vegetables has been unrestricted. This, coupled with favorable prices in recent years, has encouraged many farmers to begin growing vegetables.

Vegetable production was initiated in t . Niamey area about 19551 to supply the expatriate community with "European"-type vegetables. Since then the number of people consuming vegetables, especially Nigeriens, has increased manyfold. This has arisen partly from the increase in urban population and partly from changes in dietary preferences. At the same time, numerous small holder producers have begun growing vegetables. Indeed, farmers' response to the market opportunities presented by vegetable production has been so strong that since 1978 market gluts regularly occur during peak production periods.

<sup>1/</sup>Personal communication, Mr. Cissa Mamador, MDR.

Conditions of over-supply have created problems for producers. Prior to the occurrence of redundant stocks on the market, revenue from the sale of vegetables was sufficient to offset investment costs, input purchases, and other costs associated with growing and marketing vegetables and still leave substantial profits. In recent years, however, even though overall sales of vegetables have increased, producers' profit margins have declined as production has outstripped demand. For example, taking seasonal variations into consideration, prices for onions have remained at similar levels for about seven years. Given the unavailability of processing and preservation facilities, large quantities of fresh, highly perishable produce are left to spoil in the fields. Still, the possibility of acquiring immediate cash through sales of fresh produce continues to serve as a strong production incentive for most producers.

The remainder of this report will examine several possible solutions to these and other associated problems.

### C. Systems Employed for Marketing Output

Three marketing channels are available to farmers cultivating under irrigation: (1) for cereals, official sales at guaranteed prices to government agencies or their agents; (2) for all commodities, sales to intermediaries, and (3) sales directly to consumers.

### C.1 Producer Sales in Official Markets

Three agencies offer producers of designated crops the option of selling their produce at controlled prices: OPVN, which has responsibility for purchasing and maintaining stocks of grains including sorghum, millet, rice and corn; SONARA, which oversees the marketing of cowpeas and groundnuts; and CFDT, which manages cotton marketing under contract with the Nigerien government.

Each crop covered by these agencies has a controlled producer price and a prescribed method of marketing and payment. Except during the past two years, official producer prices have generally been below current market prices. When market prices are unfavorable, the official price serves as a floor price.

In most instances, the producer must be a member of a cooperative in order to sell to one of these agencies. Producers deliver their produce to the assembly point designated for their cooperative. Typically, this point is in their own or a nearby village, so the distance from field to delivery point is minimal. After the produce is cleaned, inspected and weighed, the producer is given written confirmation of the delivery and receives a partial or total cash payment, depending on the particular crop in question, for the value of the delivery.

This system is subject to many external influences. In particular, market prices both in Niger and Nigeria affect the amount of a given product which producers offer to the purchasing agency. Sometimes, a producer may elect to bypass the officially established marketing channel entirely and sell his produce to an alternative, and in some circumstances, illegal buyer.

This marketing approach does not currently extend to vegetable production. And while not suggesting that it should, thought should be given to extracting the positive elements from this approach and applying them to private sector vegetable marketing activities. These positive elements would include the organized delivery/transportation systems, the establishment of producer/consumer networks, and, if economically feasible, the establishment of guaranteed minimum (floor) prices to producers.

# C.2 <u>Producer Sales to Intermediate Traders</u>

The primary intermediaries for this channel are small Hausa merchants who traverse the countryside exchanging goods for money, or vice versa. This trade is the present-day manifestation of a generations-old tradition of commerce among the Hausa people<sup>1</sup>.

The manner in which the trades take place is also relatively well-established. Typically, a trader is familiar with a particular product from a particular area. He knows how each crop performed during the previous growing season and he is generally aware of the evolution of prices. He makes a circuit of villages by animal-drawn cart or truck, depending on the scale of his business. In each village he contacts producers and encourages them to sell their produce to him. There is some limited negotiation which takes place, but prices are gen.rally established for a particular zone and the trades usually take place within a certain, well-defined price range. The merchant bears the cost of all materials including packing and wrapping, transportation, labor costs, etc. Cash payment is made on the spot to the farmer. The trader continues to purchase produce until his capital is exhausted or the cart/truck is full. He then heads for market.

Intermediate traders have limited impact on prices. In many instances, they are price-takers rather than price-setters. Part of the reason for this is that they operate in a relatively competitive environment on a comparatively small scale. Because they have limited capital and cash flow, they are not able to accumulate large stocks of produce. If these traders could hold on to stocks, their enterprise would most likely be more profitable because they could wait for prices to rise before selling.

A variant of this trading pattern finds the farmer delivering his own produce to the trader, already wrapped or bundled. The farmer, of course, expects a higher price for the additional labor which he expended collecting and delivering the produce. This practice is generally used by those farmers living relatively close to concentrations of established merchants.

The advantage to the farmer of entering into a trading arrangement with an intermediary is he receives payment immediately in cash and incurs no additional labor for marketing. This is especially suitable for farmers who have little or no marketing expertise.

<sup>&</sup>lt;u>1</u>/One can find traders from other ethnic groups (Yoruba, Tamachek) conducting transactions throughout Niger. However, it is the Hausas who have the reputation of being formidable traders.

Many crops are handled in this manner. The principal ones are dried peppers and tomatoes, onions, squash and sweet potatoes. Grain crops are also collected by traders, although the practice is somewhat more common in Nigeria where the legislation covering grain trading is less restrictive than in Niger. Intermediate traders seem to prefer those crops which are better-suited for travel and storage. This reduces the likelihood of having a large quantity of produce spoil in transport as he moves from market to market.

It is difficult to estimate the exact percentage of vegetable production which is marketed through the producer-middleman network, but it probably amounts to between one-half and three-quarters of all producer sales of fresh and dried produce. The remainder is sold directly to the consumer by the producer or by a cooperative association of producers.

### C.3 <u>Producer Sales Directly to Consumers</u>

The number of producers who sell directly to consumers is limited. It is limited because of: (1) locational factors such as distance from markets; (2) poor market information; and (3) the lack of the kind of entrepreneurial predisposition necessary to succeed in the marketplace. Producers who try to sell directly to consumers place themselves in direct competition with experienced traders who have specialized knowledge of the market. For small quantities of produce, the additional margin and the corresponding imputed wage earned by selling directly may not provide the producer with adequate compensation for his time. In such instances the producer does better by selling to an intermediary.

Most direct sales to consumers are made by individual producers who offer their produce for sale at weekly or daily markets, depending on location. Prices are negotiated with each purchaser and are influenced by the selling prices of other vendors. The producer's net profit is what remains after he deducts the cost of packaging, transportation, market fees, losses due to spoilage and incidental costs. Some cooperatives of producers also sell their produce in common directly to consumers and divide the net profit according to the amount of produce which each producer presented for sale.

The crops which are most frequently sold directly to consumers by producers include fresh tomatoes, peppers, cabbage, lettuce and an assortment of other comparatively perishable products which must be sold soon after they are taken from the fields. More durable produce including onions, squash, okra and hot peppers are less frequently offered for sa'e directly to consumers by producers. Direct sales are most common where producers have perishable produce and live close to markets.

#### D. Market Prospects for Major Irrigated Crops Within Niger

#### D.1 Market Demand

Cereals produced under irrigation face promising growth prospects. At the present time, Niger imports around 60,000 tons of rice and 100,000 tons of sorghum, mostly from Nigeria through unofficial channels. This figure will more than double by 1990. Given current yield levels, Niger could absorb the produc-

tion of an additional 60,000 hectares of double-cropped cereals.<sup>1</sup>

At the present time, the country is adding only about 1,000 hectares of irrigated cropland per year. At the same time, dryland cereals production, which has been increasing about in line with population growth, will grow more slowly in the future since the major part of the reallocation of land from peanuts to cereals has already occurred, and increased area under cultivation rather than increased yields have provided the bulk of past growth in cereals production.

Vegetables also face promising demand prospects in Niger. Many consumers who now purchase fresh vegetables such as lettuce, carrots and other salad ingredients, have acquired the taste for them only in recent years. Demand has grown in response to high rates of urbanization, growth in urban incomes and exposure to the products in markets as well as in the news media. As demand has increased, supply has increased even faster, creating an abundance in markets that depresses prices and leads to still greater consumption increases. Production continues to expand into new areas and, according to farmers and merchants, areas which had no vegetables a few years ago now find a wide variety of produce in local markets. Thus, in a very real sense, the supply of vegetables is creating its own demand in Niger. As population, urbanization, incomes and vegetable production continue to grow, we can expect a continuing shift in consumer tastes and continued good growth in demand for fresh and dried vegetables.

Quantitative estimates of vegetable consumption in Niger are not yet available. Available production estimates are very poor and contain such anomalies that one wonders whether they bear any relationship to reality whatsoever. In addition, newly typed tables of historical data are seldom proofread, so even if the data were once reasonably good, this is probably no longer true. Bearing this in mind, Table E-1 summarizes available production data on the more important vegetable crops.

<sup>1/</sup>This is not to say that production of cereals represents the most valuable use of Niger's irrigated agriculture resources. Some, like sorghum, appear to offer good potential. Others, such as maize appear more marginal. Rice production could be economical if maintenance and cultural practice problems now plaguing irrigated perimeters were solved.

	-		<u>C</u>	<u>R 0</u>	<u>P</u>				
	<u>    Onions    </u>		Pepp	Peppers		Okra <sup>·</sup>		Tomatoes	
Year	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.	
1980	3,200	107,800	400	250	1,100	600	n.a.	n.a <sup>2</sup>	
1979	3,400	104,300	400	200	1,300	700	1,100	5,600	
1978	2,900	78,400	40 <del>0</del>	200	2,100	1,000	1,300	9,600	
1977	2,000	62,700	100	60	500	0 C	900	7,200	
1976	2,800	79,400	500	300	1,700	700	900	13,300	
1975	2,600	70,800	500	200	2,800	900	900	12,000	
1974	2,600	44,100	300	200	2,600	1,300	900	4,600	
1973	1,700	29,000	400	200	3,000	1,600	1,600	4,100	
1972	<sup>-</sup> 1,500	20,300	400	200	2,700	700	400	2,500	
1971	2,100	36,000	900	600	3,600	1,100	300	2,700	

# Table E-1: Area Under Cultivation and Total Production for Selected Vegetable Crops, 1971-1980, Republic of Niger<sup>1</sup>

Source: Service de Statistiques Agricole, Ministere de Developpement Rural.

 $\frac{1}{A}$ rea in hectares, production in tons. It appears that these data do not uniformly include all departments. When a department does not report on production, it is sometimes excluded from the totals.

2/Not available

Only onion production shows a clear trend, expanding at somewhere around 13% per year since 1971. Over a somewhat longer period, the 1962-64 average to the 1979-80 average, production has grown at around 10.5% per year. Tomatoes show some evidence of about a 15% annual growth rate, but the data do not seem to be internally consistent. Peppers and okra show virtually no growth at all, essentially failing to keep up even with population growth--a highly unlikely event. Overall, these data lend support to the general conclusion of reasonably good growth in consumption of vegetables in Niger, though the accounts of farmers and merchants provide a more solid basis for this conclusion. These growth rates are also broadly consistent with estimates made in a 1974 study (Chappelle, et al., 1974) which projected a 12-16% increase in consumption of vegetables between 1970 and 1980.

In spite of the continuing growth in demand for vegetables, farmers in many of the production areas visited raised the problem of insufficient market capacity. Producers were experiencing difficulty selling their vegetables when the market was already gorged with similar products from other producers. Interestingly, they seemed to respond slowly and somewhat ineffectively to changing market conditions. This suggests that farmers continue to find the returns from vegetable production to be interesting, even as prices are falling.

# D.2 <u>Constraints on Internal Marketing of Vegetable Crops</u>

# D.2.a <u>The Timing of Production</u>

Most vegetable producers pay little attention to what other producers are growing. There is a tendency for many of them to plant the same vegetables at about the same time, causing a glut in markets at harvest time. The highly perishable character of most vegetables coupled with the hot weather that prevails during March and April when many vegetables are harvested leads to a great amount of spoilage, both on the farm and in the marketplace when the produce cannot be sold quickly. In some areas, entire fields go to seed or are left to rot.

Partly the problem of seasonal gluts stems from the nature of the weather cycle in Niger. Many vegetables will not flower during the very hot season. During the rainy season, the high humidity and temperatures provide an excellent breeding ground for diseases. Moreover, farmers are preoccupied with rainfed cereal crops at this time and tend to view vegetable production as a sideline that they take up only when the dryland crops are harvested. Finally, many of the best dryland vegetable-producing soils are flooded until after the end of the rains, preventing farmers from moving more quickly even if they wanted to do so.

Because of these factors, from May, when the last of the cool-dry season production is sold, to November when a few scattered vegetables begin appearing on the market, there is virtually no domestically grown fresh produce available in Niger's markets. As a result, a substantial amount of domestic demand goes unmet at this time of year.

Within the context of Niger's environmental, ecological and climatic constraints on year-round vegetable production, farmers could adjust their production schedules so as to extend the growing season more than they do. However, they will need improved sources of market information and more reliable markets so they can safely reduce their dependence on their own cereal production. Where these conditions exist, some farmers are beginning to produce two vegetable crops in succession--onion producers near Galmi being one example.

Improved sources of market information need to be accompanied by increased extension efforts to inform farmers about marketing problems and educate them on how to respond more effectively to anticipated changes in aggregate supply. This would include research on planting dates and extension on staggering planting dates to take advantage of expected market demand at time of maturity.

### D.2.b Market Access

Rugged transportation conditions throughout much of Niger cause substantial bruising and damage to vegetables during transport. This accelerates spoilage and, along with distance to available markets, influences the kinds of vegetables which producers in a given area can effectively market.

If market access is difficult and market capacity is relatively small, farmers usually do better by emphasizing more durable vegetables such as squash, biennial onions, garlic, thick-skinned potatoes or vegetables which may be dried (tomatoes, peppers, okra). Of course, legumes such as cowpeas, pigeon peas,

groundnuts or lentils may also be grown. These crops tend to store relatively well, are less susceptible to damage during transport, and are readily marketable since demand for them is good.

#### D.2.c Presentation and Storage of Produce

Except for the onion variety violet de Galmi, most varieties of vegetables which farmers use do not store well in Niger's hot climate. This is partly due to the fact that vegetable storage is usually done in buidings which were designed for other purposes. Onions, for example, are stored in huts originally built for grain storage. These huts are poorly adapted to onion storage because they are insufficiently ventilated and allow bruised and injured onions to collect moisture and begin to spoil. Losses of 40 to 50 percent occur within three to four months of picking under such circumstances. This is one reason market prices rise from about 4,000 CFA per sack at the harvest to as much as 20,000 CFA during the rainy season.

This situation can be corrected. The <u>violet de Galmi</u> which most farmers use is a biannual variety which can be kept for up to eight months without significant storage losses if the onion is harvested at maturity. The mature onion should be stored in a dark but well-ventilated room which is relatively dry. This reduces storage losses considerably. If stocks could be stored over longer periods of time, farmers could better control market gluts, avoid sharp price fluctuations and maintain a more steady supply of onions to the consumer over the year.<sup>2</sup>

Preserving vegetables is not a major activity in Niger except in isolated areas such as the Komadougou Valley. What preservation is done is very rudimen-tary and of low quality.

The principal method currently used for preserving vegetables in Niger is open-air, solar drying. This method is used for drying tomatoes, peppers, okra and onions. Tomatoes and peppers are slit in half across their widest part, okra is sectioned, and onions are peeled layer by layer. The vegetables are then spread on straw mats or directly on the ground, and left to dry for a week or so in the sun. The area where the vegetables are dried is usually protected by a fence to keep away goats, sheep, cattle and chickens, but this provides no protection against smaller animals and insects. The drying is requently done under windy conditions so dirt and sand get mixed with the vegetables.

The use of low-cost screened racks or solar driers would be a qualitative improvement over the vegetable-drying techniques now used and would facilitate

<sup>&</sup>lt;sup>1</sup>/For a more complete discussion of onion storage problems, see "Culture et <u>Commercialisation des Ognions dans les Pays du Sahel et l'Afrique de l'Ouest:</u> <u>Leur Developpement dans le Cadre des Petites Exploitations Maraicheres</u>", by J. Coudert, L. B. Thrower and J. Henry, ITC/DIP/22, CCI/FAO, 6 Avr 1981.

<sup>2/</sup>Presently, many onion growers harvest the onion before it is fully mature, with the result that the moist "heart" of the onion often rots and takes the rest of the onion with it.

quicker and more hygienic drying. Presumably, consumers would prefer cleaner vegetables as long as prices did not get too far out of line with vegetables dried in the traditional way. Dried produce does not, however, appear to be differentiated by quality at this time.

Onion leaves are also dried and stored. The fresh cut leaves are slightly pounded in a mortar, rolled into fist-sized balls and dried in the open air. These onion leaf balls are used as condiments in a variety of African sauces. They are very easily stored in sacks and widely purchased by consumers throughout the year.

Nigeriens currently practice no traditional salting or brine storage, nor is any canning done by traditional growers. In Maradi, an entrepreneur has begun canning an assortment of fruit jams and other preserves on a small scale. If this effort is successful, it might be possible to duplicate it in other towns or for other products, including vegetables.

# D.2.d Entrepreneurial Capacity

One of the major constraints to assuring a regular supply of fresh and dried produce in markets throughout Niger is the lack of an entrepreneurial spirit on the part of private entrepreneurs. Many of the merchants who deal in vegetables have relatively limited capital, tend to specialize in one or a few products, and maintain a regular trading circuit. Their primary objectives seem to be quick turnover and maximum short-term profits. They take few risks and give little attention to planning and growth. If vegetable markets are to be expanded in Niger, the country's entrepreneurs will need to take greater risks. This includes testing and developing markets. It will also require a relatively solid basis of support from a well-capitalized commercial sector and better information on supplies and prices within Niger and in regional markets.

### D.2.e Three Special Cases

1) <u>Air Mountain Potatoes</u>. At present, most potatoes sold in southern Niger are imported, usually from Nigeria. This occurs even though substantial quantities of potatoes are being produced under irrigation in the Air Mountains, north of Agadez. Apparently, two influences are limiting the "importing" of Air Mountain potatoes into southern Niger. First, the distance of nearly 1,000 kilometers makes transport costly. Second, the potato trade between Nigeria and Niger is well-established and merchants appear to be reluctant to explore alternative sources of supply; that is, they are avoiding taking chances. The result is that relatively small amounts of Air potatoes are brought south, and those only on an occasional basis. Better information on prices and quantities needs to be made available to merchants.

2) <u>Vegetable Production for the Petit Marche of Niamey</u>. The <u>Petit Marche</u> is the center of the vegetable trade in the city of Niamey. This square-block area in the center of town supplies both Europeans and Africans with a diverse selection of vegetables provided by grower/vendors and by intermediary traders. The former grow their produce in gardens scattered throughout the city along the banks of the Niger River. The latter collect their offerings in Say and other towns as far away as Galmi, and bring them to Niamey. There is an active demand
for vegetables year-round in this market. However, each year, around the end of April, the supply of fresh vegetables in Niamey is interrupted, primarily for climatic reasons.

The grower/vendors who operate in the Niamey market have been producing vegetables for years. They have a relatively sophisticated cropping calendar, schedule their planting with respect to expected market demand at time of maturity, and report earning a fair recompense for their labor. Their experience in adjusting their planting schedule to correspond to market demand over time should be studied and applicable findings should be passed onto farmers in other vegetable production zones of Niger.

3) <u>Galmi Onion Trade</u>. The Galmi onion trade consists of a corps of merchants who send collectors out to neighboring villages or receive onions directly from growers who transport them into town themselves. The merchants place the onions in large burlap sacks, tie "breathing caps" made of braided palm strips on top of the sack, then wait for trucks from Abidjan, Lome, Accra, Cotoncu and Lagos to arrive. The onions are sold at a fixed price per sack throughout the town. The merchants must pay for collection, transportation, labor for sacking and sewing the caps into the sacks, and for the caps themselves. They perform no selection or other processing function. Their profit ranges from about 250 to 750 CFA per 75 kilogram sack.

### E. <u>Marketing Prospects Within Neighboring Countries</u>

The countries to the south and west of Niger, particularly the coastal countries, present strong potential markets for Nigerien produce. These countries have large numbers of urban consumers. With urban populations growing throughout Africa, dietary preferences are changing and vegetable consumption can be expected to grow accordingly. Thus, vegetable demand can be expected to grow at least as fast as the rate of urbanization in coastal countries.

The Galmi onion trade offers the greatest potential for exports of Nigerien vegetables. It has already established a reputation in several neighboring countries and appears to have good potential for replacing onions currently being imported into Lagos and Abidjan from Europe. Niger should be able to deliver onions to those cities at prices below those for onions coming from Spain and South Africa. There also appears to be some potential for developing exports to other areas of Africa, and even to parts of Europe where especially strong-flavored, long-keeping onions of the Galmi variety are in considerable demand. Nigerien producers could possibly replace other produce, such as lettuce or tomatoes, which is presently air-shipped from Europe to other African countries. For example, the flights from France which stop in Niamey carry Spanish and South American produce from Marseilles for delivery to Abidjan. If local producers could provide similar quality produce in attractive containers at a more favorable price, Nigerien produce may be able to replace these ex-African imports. This needs to be investigated in greater detail.

<sup>&</sup>lt;u>1</u>/An unconfirmed report claims that onions purchased in Galmi, shipped to Abidjan by truck, sacked in standard-sized sacks and delivered to the port are sold for 130 FCFA per kilogram. This is at least 40 FCFA per kilogram more than the lowest season producer price plus handling and transport to Abidjan.

Developing interregional African trade in vegetables is not without its risks. The distance from southern Niger, where most vegetables production takes place, to the coast is between one and two thousand kilometers, depending on points of origin and destination. Conditions of travel can cause substantial damage to susceptible produce through bruising, poor handling, harsh road conditions, etc. Improved packaging and protection of produce would be required to maintain quality standards for the higher-priced produce markets.

Customs policies and occasional political perturbations in neighboring countries often disrupt otherwise orderly trade routes. Fluctuations in exchange rates sometimes present arriers to profitable trade. If Niger becomes dependent on vegetable exports, such disruptions could cause considerable economic loss. Producers would need to formulate contingency plans for shipping by way of alternate routes should the need arise.

To minimize competition with producers in the importing country, Nigerien growers should differentiate their products by emphasizing and protecting the strong qualities of their products. Uncontrolled sale of Galmi onion seeds by Nigerien growers, for example, may compromise their long-run, competitive position vis-a-vis growers in other areas, as the variety becomes more widely available outside of Galmi.

To the extent that quality is a concern of targeted consumers, some changes may need to be made in the way in which Nigerien produce is presented on the market. Onions, for example, are purchased in recycled burlap sacks which may contain various sizes of ungraded onions. Greater standardization and selection according to size will be essential for developing international commerce.

Crops other than onions may also have considerable potential for export to African markets. Dried vegetables such as tomatoes, okra, peppers and onion balls store very well, are not susceptible to bruising during transport, bring relatively high prices in the market, and are widely used by Africans in their daily food regimes. Consumer demand for garlic is also relatively high among Africans as well as Europeans. Garlic is agronomically close to onions and would grow well in onion-producing areas.<sup>1</sup> Furthermore, garlic is already grown in the Air Mountains. Increased trade in garlic might have the complementary effect of stimulating potato trade from the Air region to the south.

Niger produces most of these products across a wide area of the country. To promote and develop exports of Nigerien products, merchants would have to identify markets, establish assembly points and shipping depots, contact importers and arrange regular shipments. It is not clear whether Nigerien merchants have the entrepreneurial skills and market discipline necessary to develop export markets. If they do, the question arises as to why they have not done more to develop these markets on their own. The reasons may be economic and, thus, merchants may need additional incentives to encourage entry into the export

135

 $<sup>\</sup>frac{1}{Personal}$  communication, Mr. Walter Firestone, Team Agonomist.

trade. USAID needs to acquire a more thorough understanding of the commercial circumstances facing Nigerien merchants before embarking on an export promotion program.

It does not seem prudent to consider markets outside of Africa at this time. Several enterprises in other African countries which have depended on exporting to Europe, notably BUD/Senegal, have gone bankrupt. SONIPRIM, a parastatal in Niger responsible for vegetable exports, also went bankrupt. Sharp competition and price fluctuations make the European vegetable market quite volatile. It is unlikely that Nigerien producers could compete effectively with Spanish, Argentinian, Brazilian and Israeli growers on European markets. By way of illustration, tomatoes were being sold in wholesale markets in Paris in January, 1984, for 60 CFA per kilogram, a price lower than tomatoes produced and sold locally in Niamey.

SONIPRIM has recently been reconstituted as a private venture. It is currently exporting green beans to Europe. The beans are selected according to size and quality by the growers, packed into six kilogram cartons which say "Produce of Niger," and air-shipped to Europe. SONIPRIM has secured contracts with European importers for 600 tons of green beans. If this operation is successful, it may be replicated for other vegetable crops. However, without the kind of close supervision provided by SONIPRIM, it is unlikely that the European export market will prove viable on a large scale.

# F. Summary and Conclusions

The individual producer has two objectives in producing irrigated crops, (1) to provide food for the household, and (2) to provide a source of revenue. Producers who grow irrigated crops benefit from more nutritionally balanced and varied diets. Farmers tend to regard irrigated crops as supplemental to traditional rain-fed crops. This leads to delays in planting which reduce yields of certain irrigated crops.

On-farm consumption of vegetables varies according to the quantity and type of vegetable produced and the number of people in the household. Other factors, such as market demand, market price, and availability of other foods to the household may also affect how much food the grower keeps for personal use. Onfarm consumption of produce from irrigated fields is estimated at not greater than 30 percent for any vegetable crop.

Irrigated crops also are grown as a source of revenue. A greater proportion of irrigated grain crops are sold as compared to rain-fed cereals. Vegetable production is largely oriented towards the market. Profit margins have been declining in recent years.

As production of vegetables is expanding, markets are becoming saturated, particularly during peak periods. Insufficient processing and preservation alternatives exist. As a result, large quantities of perishable produce spoil either in the marketplace or in the fields.

126

<sup>&</sup>lt;u>1</u>/Personal communication from Mr. Greppi, FED agronomist working with the Tilakeina vegetable cooperative.

Farmers use three separate channels to dispose of their irrigated production. They may sell cereals at controlled prices to government marketing agencies. Producers may sell both grains and vegetables to professional marketing intermediaries. Producers also may sell produce directly to consumers in local markets.

In the official system, governmental agencies organize transportation and delivery networks between producer and consumers, and producers benefit from guaranteed prices. These advantages might be adapted to vegetable marketing circumstances, but there is not at present a marketing agency for vegetables.

Some private-sector traders collect produce directly from producers at the village level. Growers negotiate a price with the trader and receive immediate cash for any produce sold. This marketing channel is widely used by the farmers.

Between one-half and three-quarters of all produce sales take place through intermediate traders. These traders are usually small-scale operators who have little impact on prices. They possess limited amounts of capital, are unable to accumulate and hold large stocks, and are oriented towards short-term profit taking. In this system, the traders assume the risk of marketing the produce.

Few producers sell directly to consumers. Poor market access, lack of information on current market needs and prices and entrepreneurial ability all limit the number of producers who find it advantageous to sell directly to consumers. Moreover, competition is high and producers must directly assume the costs and risks of marketing.

Although demand for vegetables is good and growing, poor market information contributes to poor production decisions. Farmers' marketing strategies are inflexible and do not identify alternative market outlets. As a result, market gluts arise periodically during the growing season.

Only a small percentage of vegetable producers schedule planting with an eye on market supplies at harvest time. These producers seem to be concentrated in Niamey. Increased extension education might help farmers develop and operate better production schedules.

Nigerien producers have limited choices for storing or preserving vegetables. Current storage techniques utilize buildings that were not designed for storage of vegetables. Preservation is limited to open-air drying. This typically results in a low-quality product which has accumulations of dust, insects and other debris. Improved, low-cost hygienic drying techniques would increase the quality of dried vegetables offered for sale. We do not yet know the extent to which this kind of quality is a consumer concern.

With respect to export markets for Nigerien produce, the countries to the south and west of Niger, particularly the coastal regions, present strong market potential. These countries have large numbers of urban consumers which typi-cally consume a higher proportion of vegetables than the nonurban population. As population increases, vegetable demand should continue to expand. The large urban centers along the coast are expected to remain viable markets for many years to come.

Onion trade seems to offer the greatest export potential for Nigerien growers. The Galmi onion variety has favorable flavor and storage characteristics and seems to be well-accepted in a number of African markets. Other crop selections with export potential include garlic, sweet potatoes and dried vegetables such as comatoes, okra and peppers. These crops benefit from broad-based consumer demand and frequent use in traditional African food preparations.

Nigerien producers may be able to substitute for vegetable imports from outside Africa if they can supply produce of equal quality at cheaper prices. Freight costs from Niger would certainly be lower than those of European suppliers. However, numerous failures of businesses involved in exports of high quality and highly perishable produce dictates careful study of the extent to which Nigerien producers and traders can satisfy this market before any action is taken.

Technologically sophisticated food processing facilities do not seem appropriate for Niger's vegetable industry at the present stage of development. Before advanced technologies are introduced, extension programs have to be strengthened, cultural practices need to be improved and production should be more carefully planned. More trained personnel and research to identify crop varieties which can withstand the country's climatic stress are also needed.

Because of the limited vegetable marketing opportunities currently available to growers, it is recommended that vegetable production be balanced by grain crop production on irrigated lands. Limiting the supply of vegetables can help stabilize prices. The income from the higher valued vegetables can then be used to cover costs of irrigation for all irrigated crops.

Niger has the capacity for producing high-quality, high-value vegetable crops. However, techniques used by Nigerien growers need to be perfected, both in terms of the nature and quality of their inputs and the post-harvest processing of their vegetables. This can only be done with an increased training and extension effort.

## ANNEX F

#### INSTITUTIONAL AND SOCIAL ISSUES RELATED TO IRRIGATED AGRICULTURE IN NIGER

#### Theresa Ware

# Table of Contents

Α.	Int 1. 2.	roduction and Recommendations Background Recommendations	F-1 F-1 F-1		
Β.	Niga 1.	er's Institutional Structure GON Services for Irrigated Agriculture a. UNCC and Cooperatives b. Extension and Farmer Training: The Agriculture Service c. INRAN and Irrigation Research d. ONAHA	F-3 F-4 F-6 F-7 F-8		
	2.	Coordination Mechanisms Between Research, Extension and Training	F-9		
	3.	The Private Sector	F-11		
c.	Farmers and Irrigation 1. Organization within the Perimeter 2. Labor Competition and Management 3. Incentives for Farmer Participation 4. Land Tenure and Distribution 5. Equipment Repair and Maintenance				
D.	Micro-Irrigation				
ε.	Conclusions				

Page

#### ANNEX F

#### INSTITUTIONAL AND SOCIAL ISSUES RELATED TO IRRIGATED AGRICULTURE IN NIGER

#### Theresa Ware

#### A. Introduction and Recommendations

#### A.1 Background

The purpose of this report is to highlight some of the institutional and social issues related to irrigated agiculture in Niger. The focus is farmer groups, including cooperatives, technical services support from the government and the institutional structure within which irrigated crop production takes place.

Interviews were conducted in Niamey, Tillabery, Namaregoungou, Sakoira, Birni N'Goure, Kolbou, Maradi, Djiratawa, Ruwana, Bouza Sumarana, Chindigui and Konni I between March 8-26 with various levels of civil servants and farmers. The results support the thesis set forth by Thomson (1982) and reiterated in the USAID/Niger SIP (1983) that the Government of Niger is organized along highly centralized lines of bureaucratic authority. Despite a number of rhetorical changes, notably the recommendations of the national seminar at Zinder in 1982, Niger's basic institutional structure remains a highly centralized, directive, statist system. The rhetoric on increased mass participation from the bottom up reveals a contradiction in terms.

The nature of the government's structure is important here. Farmers are being called upon to assume full responsibility for managing irrigated crop production. Yet, so far, they have been excluded from the process of the transfer of technical information and the benefits of ongoing research.

This report attempts to address some of the problems confronting both the farmer and those institutions with responsbilities for the delivery of services to farmers.

#### A.2 Recommendations

A.2.a USAID/Niger should assess its institutional capacity to effectively monitor an irrigation activity which may very well overlap with ongoing APS activities. This raises the question of the most effective utilization of USAID management resources.

A.2.b At least some farmers in cooperatives should be provided with perimeter level technical training.

1. A minimum three-month survey of organizational structures at the farmer level should precede development of the training program. This survey should determine the roles, functions and daily tasks to be performed by farmers in the management of perimeters. It should be conducted by two people skilled in organizational management rather than by cooperative specialists. They should examine every task which will have to be performed with full knowledge of what farmers are currently capable of doing. Cooperative specialists will not necessarily know how to provide this type of organizational management information. This survey should include an examination of the incentive structure, the authority/decision-making structure, perceived rewards and benefits for participation and other factors which will be part of the organizational structure in which farmers will operate.

2. Someone skilled in developing training modules and in conducting training activities should have responsibility for designing the farmer training program. Peace Corps trainers represent a possibility. There are also two people who have experience in conducting training in the Sahel within a participatory framework: Lee Jennings and Pirrett Countryman. Both are based in the Washington, D. C., area and have excellent French. Both have considerable experience in training in French-speaking countries.

3. USAID should discuss with FED/ONAHA their proposal for the development of human resources in the cooperatives along the Niger River and in Tahoua region. That project includes an interesting component for teaching by video and audi-visual methods. That may be of interest to the APS project. It may prove possible to revise and/or expand the design more along the lines of a participatory rather than directive model.

A.2.c ONAHA mid-level infrastructure and mise en valeur technicians need shortterm perimeter level training in water management techniques. These should be designed and implemented as intensive--maximum two months per session--"handson" workshops.

A.2.d USAID should examine the AID-funded Water Management Synthesis II<sup>1</sup> project's "hands-on"" experimentation in participatory irrigation management designed by Cornell University. Cornell is one of the three WMS II participating universities. Its approach may have relevance for a training program designed for farmer cooperatives.

A.2.e USAID should also examine the WMS II Colorado State University Diagnostic Needs Survey to determine its relevance for use in a training design for midlevel ONAHA technicians. If the diagnostic survey is relevant from a technical. point of view, USAID should consider the possibility for using funds from the Sahel Regional Program for upgrading the French language capability of appropriate WMS II personnel.

<sup>1/</sup>The WMS II project, funded and assisted by AID/W through the Consortium for Internation1 Development, involves three universities: Utah State, Colorado State and Cornell. It provides services for improving the design and operation of existing and future irrigation projects. It also provides guidance to USAID for selecting and implementing development options and investment strategies.

A.2.f USAID should provide INRAN with researchers having an orientation toward irrigated crop research in order to alleviate short-term staffing problems. The long-range needs of INRAN in this area should receive equal attention.

A.2.g INRAN needs to conduct more farm-level research on perimeters. It needs to establish a feedback loop between farmers on the perimeters and the research stations.

A.2.h The MDR should develop an effective methodology for incorporating water management and other irrigation techniques into its extension program. Possibilities for doing this should be explored with the APS consultant, Vicki Shoen, now completing a three-month study of the country's extension service. The Mission needs to identify both short-range and long-range needs for a reorientation of the extension service.

A.2.i The Mission should identify at least two people trained and experienced in extension methodology to conduct short-term training workshops (maximum of two months) for extension agents. This should also be explored with Vicki Schoen.

A.2.j Skilled trainers should begin conducting Lossa-like workshops at frequent intervals in order to begin to break down communications barriers between farmers and line agencies responsible for delivering services to irrigated perimeters. These workshops should be conducted in a nondirective framework for the benefit of both high-level and mid level civil servants. Given the absence of nondirective communication inside the bureaucracy, it would be advisable to place a trainer in the Agriculture Service of the MDR two years prior to the beginning of the workshop in order to lay the groundwork for the workshops and to coordinate their execution.

#### B. Niger's Institutional Structure

One of the core characteristics of the Weberian Model of bureaucracy-of which the Niger government is an example--is predictability of roles, functions and outcomes. The highly centralized and directive structure assures order, maintains control and the retention, as well as the consolidation, of power by the regime. Behavioral outcomes are, by and large, predictable. However, shifting increasingly toward greater mass participation from the bottom up through decentralized organizational structures implies some loss of control. Actionable outcomes of a vitalized and informed rural population can neither be predicted nor totally controlled. Therein lies the contradiction.

The desirability of mass participation is official policy. In reality, however, participation has most frequently meant little more than mobilizing farmers for specific tasks; e.g., purchasing crops and collecting loan installments or user charges. There is a vast difference between mass participation in order to mobilize people for specific tasks and mass participation to empower people to increase their own control over their lives. There is no indication, based on the nature of mass participation to date in Niger, that the latter is what the State has in mind. It seems quite unlikely that a government concerned with maintaining order and remaining in power is going to thace in any meaningful sense the bureaucratic reorientation required to make mass participation from the bottom up a reality.

NW

The <u>Société de Developpement</u> stresses the need to "change peasant mentalities and motivations." The objective of the <u>Société</u> is to elicit the voluntary and active participation of the population in national development. The Societies are to provide the population with the possibility for managing its own affairs and for assuming responsibility for local level implementation of development activities. Just how this will be brought about is not yet clear.

Before discussing local level participation at a more meaningful level, we need to provide the setting for irrigation development in Niger.

#### B.1 GON Services for Irrigated Agriculture

The GON regards irrigated agriculture as critical for protecting itself against poor rainfall and drought. By expanding irrigated production, it hopes to increase the nation's production of staple cereals such as rice and sorghum, vegetable crops, cotton and fodder for livestock. Realizing this policy at bureaucratic levels of execution involves a number of agencies and institutions.

Prior to 1978 the <u>Union Nigerienne de Credit et de Cooperation</u> (UNCC) had primary responsibility for irrigation development in Niger. Under the authority of the Ministry of Rural Development, UNCC planned and monitored irrigation development through its technical, extension and marketing divisions.

In December, 1979, the <u>Office</u> <u>National des Amenagements</u> <u>Hydro-Agricole</u> (ONAHA) was created to assume responsibility for irrigation activities. ONAHA is a parastatal under the authority of the Ministry of Rural Development charged with essentially two responsibilities:

- -- To assure the development of hydro-agricultural infrastructure on behalf of the GON, and
- -- To assure the management and maintenance of this infrastructure by providing training and extension services to farmers in liaison with the UNCC.

On the irrigated perimeters UNCC shares with ONAHA the responsibility for organizing farmers into cooperatives for purchasing inputs and marketing cereals and other commodities.

The <u>Institut National de Recherches</u> <u>Agronomiques</u> <u>du Niger</u> (INRAN) is responsible for research on irrigated crops through its hydro-agricultural divisions located in Maradi, Kolo and Tillabery.

The role of <u>Eaux et Forets</u> in irrigated agriculture was not examined for this report.

#### B.1.a UNCC and Cooperatives

The UNCC, created in 1962 as an instrument of rural development, was established to provide administrative support to a network of small farmer groups which were successors to the colonial precooperatives. After 1965 these groups, already called cooperatives, were converted into voluntary membership groups to be locally managed. In fact, however, they continued to be controlled by delegates appointed by the UNCC director in Niamey.

 $\frac{1}{\sqrt{2}}$ 

During the 1970's the UNCC role broadened to include the marketing of food grains and other cash crops. Its role as a major supplier of agricultural equipment grew significantly during this period and so did its staff of accountants. Nonetheless, UNCC has continued to have difficulty in providing the timely delivery of agricultural inputs to farmers. There is also a problem with availability of improved seeds.

The one activity which did not grow, but rather became increasingly less significant during this period, was cooperative education. It has been stated that this lessening of the importance of cooperative education was due to the adoption by UNCC leadership of a new cooperative statute<sup>1</sup> which provided greater autonomy to small farmer cooperatives.

The cooperatives are supposed to play a major role in the development of the <u>Société de Developpement</u>. As currently constituted, however, cooperatives are more form (they have an elected body of officials) than substance. They remain the virtual creation of the State, subject to ever-changing decrees and regulations which govern their role and function and which determine the boundaries of their decision-making authority. The decrees and regulations passed in May, 1979, retain centralized UNCC control over the cooperatives. They specify the exact content of their rules and establish a standard set of procedures, such as the use of UNCC accounting forms, which the cooperatives are required to follow. Cooperatives in Niger are still very weak structures with little internal dynamic of their own to generate and sustain self-actualization.

Given the nature of cooperatives in Niger, several recommendations concerning irrigation management emerged from the <u>Seminaire National Sur la</u> <u>Strategie d'Intervention en Milieu Rural</u> held in Zinder in November, 1982. The one recommendation of particular relevance here is the one which called for the transfer of a number of functions on irrigation schemes to the cooperatives in an "immediate" timeframe:

- les operations ci-dessous soient immediatement et réellement transferées aux organismes paysans aprés sensibilisation et concertation;
- gestion des intrants agricoles (engrais, semences, gaz-uil, etc.)...;
- orvertures et gestion de la ligne de credit devant financer les charges de culture et autres activités liées à l'exploitation, sauf pour les cooperatives disposant d'un fonds de roulement propre;

 $u_{l,l}$ 

- les operations culturales autres que le labour;
- la gestion du tour d'eau;
- l'entretien primaire de l'infrastructure;
- le calcul et le recouvrement des redevances;

<u>l</u>/<u>Ordnance</u> 78-19, October 12, 1978.

- la commercialisation de leur recolte;
- que chaque cooperative crée un fonds de solidarité cooperative pour la prise en charge de l'exoneration a accorder par l'assemblée generale en cas de necessaires recolte liée a une calamité (Zinder, 1982).

Another recommendation urges ONAHA to "accelerate the process of selfmanagement of the cultivation of irrigation schemes." It was also recommended that the <u>chef du perimetre</u> on each scheme, who is now an CNAHA employee, should instead be employed by the cooperative itself and thereby made responsible to farmers rather than to the bureaucracy.

A host of problems emerge from these recommendations, the most critical of which is the lack of an effective learning/teaching model in this country to prepare farmers to assume the responsibilities outlined in the recommendations. Neither ONAHA nor the agencies providing supporting services (UNCC, INRAN, Agriculture Extension) has the capability to set in motion and sustain over time the required learning process. Even if each service did possess the resources needed to develop such a capability, the structure of the bureaucracy provides little incentive to cooperate and to coordinate programs and services so that limited resources con be used more effectively. Technical ministries and agencies continue to concrol their staffs vertically.

## B.1.b Extension and Farmer Training: The Agriculture Service

This control of starrs in a vertical manner is very evident in the Agriculture Service. Extension in Niger is the responsibility of the agriculture service of the Ministry of Rural Development. In a nutshell, it is a very topdown, hierarchical and one-way communications model with little feedback and adaptation to regional variations in climate, soil or production practices.

The "fiches techniques" developed by INRAN are passed on to the agriculture service as "givens" and then disseminated by <u>agents</u> techniques (who do not necessaril, understand what they are to disseminate) to farmer participants in the farmer training centers (the CPTs and CFJA). The full responsibility for dissemination of the "themes techniques" in these packages rests on the backs of these farmer participants who have been simply told what to do and then turned loose at the end of the training period with no follow-up support. The extension system is very theme-oriented and techniques are communicated in a directive "teaching" environment rather than in a participatory learning environment.

At this point in time, the agriculture service does not have a viable extension service. At the national level there is currently no one filling the position of head of extension. Agents are too few--one for every forty villages--and poorly motivated. They have no official means of transportation and no control over resources which could be accessible to them, such as vehicles for field trips. These vehicles may be commandeered at whim by a superior. There is also little relationship between what extension agents have been taught and the tasks they are asked to carry out.

CNAHA is aware of this lack of extension to the farmer in an environment calling for increased participation and responsibility for management of resources on perimeter parcels. As a result, it has developed a proposal to train cooperative members in improved irrigation techniques at the perimeter level. This proposal is under consideration by the FED.

USAID, under the Agriculture Production Support project, has commissioned a three-month study of the extension system in Niger. The study, which is almost completed, points out the need for an extension methodology in Niger (Schoen, 1984). What is sorely missing, in addition to adequate and appropriately trained staff and an extension methodology, is a capability for training people who have the responsibility for training farmers. There is also the need for an effective learning model as the framework within which both extension staff and farmers can begin to acquire improved skills and new knowledge in a participatory learning environment.

## B.1.c INRAN and Irrigation Research

The staffing and training problems which plague the Agriculture Service are equally present at INRAN. INRAN was created in 1975 to orient agronomic and botanical research more toward food production than had been the case under its French dominated predecessor, IRAT. INRAN is considered an autonomous research agency under the authority of the Ministry of Higher Education and Research. It has the dual task of developing improved varieties and providing foundation seed stocks for the agricultural service. The most critical constraints to carrying out these two mandates are the lack of enough appropriately trained staff and the lack of an effective mechanism by which small farmers can be involved in the research process, either in terms of information exchange at the technical level or in terms of actual on-farm trials.

In addition to these two constraints, line agency links to the agriculture service and to ONAHA are virtually nonexistent in the everyday working sense of performance-oriented linkages (there is a liaison <u>cellule</u> responsible for dissemination of the "fiche technique." INRAN's relationship or linkages with the agriculture service are such that ongoing efforts in new varieties research are not effectively communicated to agricultural agents, much less to the farmer. Farm-level concerns, such as comparative yield results between traditional (broadcast) and other methods of direct seeding and transplanting of rice cm perimeters in the Niger River Valley, do not get addressed because there are no workable links forged between ONAHA, INRAN and the farmer. A part of the problem here is that research rewards at INRAN continue to be more oriented towards rain-fed agricultural crops than toward irrigated agriculture.

INRAN has designed a proposal for irrigation research to be carried out on the Lossa perimeter. The proposal, presented at the March 12-21, 1984, INRAN Conference in Maradi, focusses specifically on water use; however, there is no description of who will conduct this research or how ONAHA, the Agriculture Services or the farmer will be involved.

Given evolving policy of the GON on irrigation as a means of increasing food production in the country, the nation's research institute should be in the process of developing a capability for the effective dissemination and sharing of research information on irrigated crops. Of equal importance, INRAN should be developing feedback loops for monitoring the farm application of research findings.

INRAN has a long-range need for researchers trained not only in the relevant technical areas specific to irrigation, but also in how to disseminate

1dk

their findings in an effective manner. In the short term, it needs intensive training courses in both technical areas and in the training of trainers for technical areas. These should be conducted at the field level by outside technical assistants.

USAID/Niger is aware of INRAN's technical staffing problems as well as its lack of an organizational mechanism to conduct on-farm research. It has addressed this in the NDD project by contracting a technical assistant to work with INRAN through a counterpart. The NDD contract expired last January and INRAN has not been able to replace this person. The bodies are simply not yet available. One of the ways in which INRAN's staffing problems could be addressed in the short run would be for USAID to fund directly an irrigated crops agronomist to work under the auspices of ONAHA in a way similar to what it has done with the NDD.

#### B.1.d ONAHA

On ONAHA-managed perimeters we found a lack of appropriate training for ONAHA technicians and a lack of experience on irrigated perimeters. Senior and mid-level technical staff consist of civil servants detached primarily from the Ministry of Rural Development and line agencies for specific periods of time, generally for two-year assignments.

ONAHA currently has no authority or veto over who is assigned or reassigned to its technical staff. Persons are moved according to overall staff needs of the MDR, in both irrigated and dryland subsectors. Thus, civil servants who become knowledgeable on perimeters could be reassigned to the dryland agricultural subsector after a period of two to five years. ONAHA senior staff view this assignment system as very positive and part of how one moves up in the MDR. These frequent reassignments do not, however, facilitate continuity of production activities on the perimeters. Assignment to ONAHA does carry with it certain benefits, such as supplemental pay, because the tasks to be performed are considered by the MDR to be more demanding than those in the dryland subsector.

By and large, mid-level staff are trained at Kolo. Unfortunately, Kolo has no specific core curriculum in irrigation or water management, though there is general introductory material within the <u>Genie Rural</u> infrastructure framework. Training at Kolo tends to take place in a directive manner. Kolo graduates are generally employed by the government, and in the case of ONAHA, are detailed from the MDR to ONAHA.

ONAHA's technical staff breaks down into the following categories:

(a) Senior Level/Infrastructure

Ingenieur de l'equipment rural Ingenieur de travail rural Technicien superieur hydro et equipment rural

 $\int \int$ 

 $<sup>\</sup>frac{1}{The}$  MDR will soon put into effect a new ruling which will assign civil servants to ONAHA for five years instead of the current two years.

(b) <u>Senior Level/Mise en Valeur</u>

Ingenieur agronome Ingenieur de techniques agricoles

(c) <u>Mid-Level Infrastructure</u>

Technicien du genie rural Conducteur des travaux Agent technique du genie rural

(d) <u>Mid-Level/Mise en Valeur</u>

Agent technique de l'agriculture Moniteur de l'agriculture

The <u>encadreurs agricoles</u> are the lowest level employees, and to date have been mostly contract employees. According to ONAHA officials, it is this level which is currently being cut back. ONAHA will eventually be completely staffed by civil servants.

The ONAHA technicians which we found on the perimeters were young and inexperienced. Some were just out of Kolo and others recently moved from the dryland sector to their first perimeter. All needed training in water management and techniques for effectively communicating with farmers. The director of the Konni I perimeter stated that his biggest worry was getting farmers to follow the ONAHA calendar. Again, the tone and basic attitude is directive rather than participatory.

Training is clearly a critical need on the perimeters. Yet unless the movement of civil servants in and out of the irrigation subsector is reduced, it will be difficult to avoid a constant decapitalization of the investment in human resources necessary to build a staff trained specifically for irrigation development. In effect, the only human resources cadre which is permanent on the perimeters are the farmers. Consequently, they should be principle focus for training programs. An investment in training farmers will be in keeping with the Zinder recommendations and has potential for long-term payoff provided a number of technical and research issues are simultaneously addressed.

# B.2 Coordination Mechanisms Between Research, Extension and Training

The organizational problem of coordinating limited resources to meet farmer needs will not automatically be solved through long-term or short-term development of a staff capability in irrigated crop research and extension. The problem of forging real organizational links between INRAN, ONAHA and the MDR extension service should be addressed through what Korten and Uphoff refer to as "bureaucratic reorientation," or the process by which vertical and one-way communications begin to move in horizontal and two-way directions. This reorientation is by no means a quick or simple task. It will require breaking down barriers between groups of people who have been trained, more precisely socialized, to communicate in a vertical manner.

What is needed are coordinating mechanisms. The exact forms these mechanisms will take can only be determined following closer descriptive analyses of

110

each participating institution (this would include the cooperatives) from an organizational point of A. Such an analysis should include the nature of its bureaucracy, its performance criteria, recruitment and tenuring policies, promotion and upward mobility, incentive structures, mandated authority and the responsibility and limits thereof, mechanisms for carrying out line responsibilities (internal and external) and client-constituent accountability. The analysis should also identify possible points for promoting effective coordination with other institutions charged with execution responsibilities under irrigated agriculture.

The Mission has some experience in attempting to build coordinating mechanisms to mesh the implementing acitvities of different agencies under its NDD project. In addition, the Lossa I and II workshops brought civil servants of various line agencies together over several days to identify problems and work through collaborative solutions. These seminars received positive recognition from other major donors. One problem noted at the Lossa seminars was an unconscious resistance to working in a nondirective environment. The participants tended to wait for guidance rather than move on their own in a problem-solving framework. This process of changing organizational personalities is a very slow one with tangible results being obtained only over a long period of time.

Irrigation schemes in other parts of the world are faced with the same coordinating problem. In Thailand, the Royal Irrigation Department, a virtually autonomous body within the Ministry of Agriculture, is responsible for building dams and constructing main canals in irrigation systems. To achieve project purposes in the case of Lam Nam OON, the project called for coordinating mechanisms that would bring together, in a manner unusual for Thailand, the Royal Irrigation Department and other elements of the Ministry of Agriculture with other ministries. Coordination and cooperation were particularly difficult in this case because the rewards of the irrigation department lay in construction, not in fostering farmer organization or coordination.

In Pakistan, the Federal Agriculture Department established a water management cell to help coordinate the project. It also created on-farm water management directorates in provincial agricultural departments.

In Korea, an irrigation project was managed by the Agricultural Development Corporation branch of the Ministry of Agriculture and Fisheries. There was very close coordination through the county government at the lowest level, as well as at the apex. This coordination included infrastructure, research and extension services (AID, 1983).

The point being stressed here is the need for an organizational mechanism capable of facilitating the coordination of activities and services to be delivered to farmers. This enables limited resources to be used more effectively for irrigated crop production. Attention must be paid to the design or creation of a coordinating mechanism which does not stifle whatever capacity line agencies may have to perform their jobs. Thus, the mechanism snould do more than facilitate and execute. It should also have a "training for organization" component.

Having isolated critical training issues and problems in AID irrigation development projects in the developing world, the final report on <u>AID's Experi</u>ence in Irrigation makes the following observation:

If training is proposed, it will probably be training for the organization's staff, primarily in building better infrastructure and secondarily, for better management of the entity itself. Only then, if ever, is consideration given to training for farmers, and it is most likely to be in the agronomic aspects.

Training for organization is rare.

#### B.3 The Private Sector

We cannot assume that the private sector is capable of servicing and repairing equipment. Informed decisions by USAID about a possible role for the private sector in irrigated agriculture will be possible after USAID completes its analysis study of the private sector.

#### C. Farmers and Irrigation

#### C.1 Organization Within the Perimeter

Farmers on the irrigated perimeters are currently organized into <u>Groupement</u> <u>Mutualiste Progressive</u> (GMP). The GMP is the smallest unit on the perimeter. Farmers are represented by a president, treasurer and a secretary-general. The government is represented by one <u>encadreur</u>. This group of four is called a <u>Comite de Gestion</u> for the perimeter. It is at this level that basic tasks are assigned and scheduling for water distribution is determined. As outlined carlier, farmers through their <u>Comite de Gestion</u> of the Cooperative will be expected to assume full responsibility for the following:

1) Technical Aspects:

- a) Monitor the quality of clearing and plowing
- 5) Determine all other tasks judged necessary for correct clearing and plowing
- 2) <u>Water Management</u>. Determine a calendar of water distribution and monitor the established program of distribution
- 3) <u>Maintenance of Infrastructure</u>:
  - a) Clearing weeds and debris from all canals
  - b) Monitoring for needed repairs
- 4) Management and Administration:
  - a) Management of agricultural inputs: distribution of inputs, monitoring applications and ordering and managing the stock
  - b) Establishing an accounting system and stewardship of funds
  - c) Marketing

Clearly, a great deal of training will be required to prepare farmers to assume these responsibilities. At this point in time there is not much evidence that farmers on large perimeters are assuming much responsibility. We observed, for example, at Konni I the presence of weeds and debris in the tertiary and field canals which seriously reduce the efficiency of water delivery. The lack of maintenance of canals is one of the key problems on the Konni perimeter and the <u>Comité de Gestion</u> did not seem to have the authority necessary to get farmers onto their canals for cleaning.

The relationship between farmers and this <u>Comité de Gestion</u> needs close examination. It is assumed that the farmers sitting on the <u>Comité</u> represent the sentiments of farmers making up the cell groups. They may not. UNCC needs to pay attention to assure that appointed farmers represent traditional authority so that they may enjoy the esteem and confidence of the community. There should be a mapping of traditional authority structures onto this "modern" <u>Comité</u> idea. As a general rule, they will then command the necessary respect and farmers will accept their decisions and rules.

#### C.2 Labor Competition and Management

Despite some responses by farmers that they have experienced no serious problems of labor shortages betwich dryland and irrigated cultivation, particularly in June-July for rice cultivation, the problem does exist. During this period, farmers must harves: and thresh rice from the dry season planting, prepare the rice nurseries for the rainy season and assume the planting tasks on traditional rain-fed fields. There is a labor constraint during this period which manifests itself on the irrigated parcels.

Labor which can be mobilized collectively for traditional fields cannot be commanded on irrigated plots. The key ingredient in determining whether labor will or will not be available for working on irrigated fields is cash. A head of household or village notable can command through traditional expressions of community-oriented service the collective labor of members of the community. The consensus of the community is that the labor provided will have a collective benefit--if individual crop yields are low, there is always the security of the collective granaries. There is no such attitude concerning the production from irrigated cultivation. These crops are perceived as strictly individual undertakings, the proceeds of which will not be collectivized. The same farmer who will lend extra labor for traditional cultivation tasks will only lend labor on irrigated fields if he is paid.

Farmers at Namaregoungou who use day laborers stated that they pay 500 FCFA per day plus two meals for critical tasks such as transplanting of rice seedlings. If there is no money to pay for this labor, the work is delayed because preference goes to the traditional fields.

The question of whether or not farmers would devote more time to their irrigated parcels if they had larger parcels has been raised and needs further examination. The question is raised because it seems to have possibilities for a net gain in cereals for the farmer and for the government. The possibility of such a change in production practices would have tremendous impact on the social attitudes of farmers concerning the use of labor. Keep in mind, however, that some perimeters such as Namaregoungou cannot expand the amount of surface an individual farmer has without eliminating other farmers from the perimeter.

The lack of maintenance of canals on the perimeters may arise in part from the seasonal labor shortage. It also could be due, in part, to a lack of legitimacy on the part of the Comité de Gestion. If farmers do not accept the

 $\sqrt{2}$ 

authority emanating from the <u>Comité</u>, they will ignore calls for tasks to be performed. At Konni I we were informed that farmers are given three warnings by the <u>Comité</u> if they refuse or forget to show up for assistance with specific tasks. The fourth time they are removed from the perimeter. How enforceable this will be remains to be seen.

#### C.3 Incentives for Farmer Participation

On the full water control perimeters we found a fairly high level of farmer participation because: (1) increasingly low crop yields of millet and sorghum on traditional rain-fed fields tend to make food requirements a high priority; and (2) generating income, in part to purchase grains, is a high priority. Farmers expressed satisfaction with perimeter parcels because it increased security against bad rainfall years and drought. Poor rainfall in the northern zone of the Niger River basin has increased demands of farmers on the right bank for parcels on the Namaregoungou perimeter.

The question of payment for water was raised at Konni I where farmers already pay a <u>redevance</u> of 12,375 FCFA per .75 hectares to help defray ONAHA administrative costs and costs of the infrastructure. This year farmers will be asked to pay an additional 5 FCFA per cubic meter of water used on their parcel. We heard no negative responses concerning this upcoming payment. A number of farmers stated that it is only fair that after five years they should be asked to pay something for use of water.

#### C.4 Land Tenure and Distribution

Law 60-28 of May, 1960, and August, 1962, decree 69-149 of October, 1969, and additional regulations from 1968 to 1972 set the basic conditions for the management of irrigated perimeters. They stipulate that land improved for irrigation belongs to the State, but is to be allocated among family units. Individual contracts for farmers have been drawn up to provide them with security of land tenure. Allocation of parcel size seems to vary from perimeter to perimeter. At Konni, distribution is based on size of family, with each parcel being 0.75 hectares. Families with a larger number of active workers have the possibility of obtaining additional parcels. At Namaregoungou parcel size was as small as .20 hectares per family, with no possibility for obtaining additional parcels.

The extent to which there is dissatisfaction with the way in which land has been distributed on the perimeters was not discernible during site visits. We were particularly concerned with finding out how women felt at Konni I about land redistribution. We had been informed by a GON official in Niamey that women at Konni I were "not very happy at having lost their traditional fields" when the government appropriated the land for irrigated development. Several women at Konni I who cultivated the land before the government developed the scheme responded that the land belonged primarily to the villagers at Terrassa Gouni and Gadandougo Mongou before it was developed for irrigation. After the census was completed and the villagers were informed of what would take place concerning the land, each person who had traditional fields received a .75 hectare parcel. All persons who had some rights to the land before were eligible for parcels. According to the director of Konni I perimeter, this includes some civil servants. One of the farmers interviewed, a former soldier, pointed out that there are some heads of household who have between 3 and 4 hectares. T. Keita (1982) has also pointed out that eligibility for parcels of land developed for irrigation is open to farmers who had land before the development. She uses the example of women in the Saye perimeter who are entitled to parcels if they held land prior to the development of the perimeter.

#### C.5 Equipment Repair and Maintenance

Repair and maintenance of primary irrigation infrastructure, according to an ONAHA field official, will remain the responsibility of ONAHA even after farmers have assumed responsibility for all other maintenance tasks and functions. On the other hand, the team leader for this assessment was told by the Director of the Niamey Regional Office of ONAHA that farmers would be responsible for hiring services to repair the pumps. This is a matter which needs further clarification in specific detail, going from the simplest infrastructure maintenance tasks to the most complex in order to lay out exactly what tasks have to be performed, by whom, with what tools and at what cost.

#### D. Micro-Irrigation

Although official policy does not call for placing emphasis on micro-irrigation projects, these systems cover 3,000-5,000 hectares of land and include irrigated gardens and orchards constructed and managed by farmers under their own initiative. A common characteristic of these micro systems — their reliance on <u>low</u> energy and highly-adapted technology in water and infrastructure. Farmers cultivate another 20,000 hectares using flood recession techniques, but we do not consider this to constitute irrigation since it does not really include management of water as much as management of land.

Given the Club/CILSS call for increased food self-sufficiency in the Sahel and the need for governments to mobilize their efforts in this area, I feel that the USALD focus should be on supporting the government's capability to respond to its citizen/farmers when the demand for support to irrigated cultivation increases. This will require the strengthening of a number of government institutions.

I would, however, be in favor of infrastructure support to micro systems only if concomitant attention is focused on the agronomic needs and marketing constraints of these systems.

#### E. Conclusions

Our field observations and analysis of other donor activity in the irrigation subsector suggest that there is greater need for improving the performance of what already exists rather than for expanding the area under cultivation.

Farmers cultivating on the full water control gravity-flow systems such as the Namaregoungou and the Konni I perimeters, those using groundwater systems such as at Djiratawa and Ruwana, those using the shallow well system as at Chindigui and Sumarana share a set of common problems:

 Lack of agronomic support in the form of farm-level research through extension in cropping techniques;

- lack of adequate technical information; and

- lack of any clearly perceived need to vitalize existing cooperative structures beyond their mandated functions.

Bureaucratic agencies or institutions such as the Agriculture Service, ONAHA and INRAN also share a set of common problems:

- They are understaffed at appropriate technical levels;
- existing staff is not appropriately or adequately trained;
- there is no effective learning model in the country by which new information, techniques and knowledge can be disseminated, assimilated, reacted to and refined;
- research has no real link to what is happening on the farm; and
- there are no coordinating mechanisms to facilitate linkages among services and between the services and the farmers.

- ∦4 √ン

# ANNEX G

# ENVIRONMENTAL REVIEW OF IRRIGATION IN NIGER

# Michael Gould

# Table of Contents

:

155

		Page		
Α.	Introduction			
Β.	Water Resources 1. Surface Water Quantity 2. Groundwater Quantity 3. Water Quality 4. Water Resources Summary	G-1 G-1 G-4 G-5 G-10		
C.	Soils 1. Waterlogging and Drainage 2. Salinization 3. Alkalization 4. Soil Erosion 5. Soil Summary	G-10 G-10 G-11 G-11 G-11 G-11		
D.	Public Health 1. Irrigation-Related Diseases 2. Fertilizers 3. Pesticides	G-12 G-12 G-13 G-13		

#### ANNEX G

#### ENVIRONMENTAL REVIEW OF IRRIGATION IN NIGER

#### Michael Gould

#### A. Introduction

USAID/Niamey has initiated a review of the irrigation sector in Niger. An important component of this review is the assessment of the impact of irrigation projects on the environment. This technical annex describes, specific to Niger, these environmental impacts. Since time constraints do not permit a comprehensive, in-depth assessment, only major issues are identified. Impacts on the socio-economic environment are addressed elsewhere.

This annex organizes the impacts on the environment into three major groups: water resources, soils and public health. The reader should be aware that there are numerous interrelationships between the three groups. For example, water is a primary input to irrigation. It is applied to the soil and the resulting runoff and percolation returns a portion of the water to surface and groundwater sources. The quantity and quality of the water has been affected by the soil and other agricultural factors (agricultural chemicals, physical design, etc.). The resulting changes in water quantity and quality directly impact on public health when the same water supply is used for human consumption.

#### B. Water Resources

#### B.1 Surface Water Quantity

The quantity of available water directly affects irrigation efficiency and feasibility. The best reference concerning the quantity of water available for irrigation in Niger is <u>Etude du Plan de Developpement de l'Utilisation des Ressources en Eau du Niger</u> (SOGREAH/BGRM, 1981). The water balance estimates for surface waters made by that study indicate that the present situation is satisfactory. The city of Niamey has experienced some shortages during particularly dry periods (for example, June 1974) but the ten-day low flow during a ten-year recurring drought year should be sufficient to provide water to Niamey and to existing perimeters. Shortages are the result of insufficient storage and the placement of pumping stations.

The other major use of surface water is in the Ader Doutchi-Maggia area. Sufficient water is available for current needs, but the storage capacity of the existing reservoirs has been severely reduced due to siltation. If surface water storage infrastructure could be rehabilitated and additional storage provided, then land already dedicated to irrigation could be made more productive and additional land put under cultivation.

Surface water is also seasonally available in the Dallols (Bosso and Maouri) and in the Goulbis (Gabi and Maradi) near Maradi. This resource is not significantly used due to the need for investment in storage. There has been some discussion of the development of Lake Madarounfa. However, a decision was made to concentrate on groundwater development in the Maradi area. In the Air region some use is made of small catchments to provide water for garden irrigation. Table G-1 has been taken from the SOGREAH/BRGM study. It summarizes the total volume of surface water resources in Niger.

To plan irrigation projects, one also needs to understand the dynamic nature of the resource; for example, the minimum flow of water available under dry year conditions. The SOGREAH/BRGM study also examined that factor and concluded that planned irrigation development in the Niger Valley and the Ader Doutchi-Maggia region would not be constrained due to a lack of water. (This assumes that infrastructure investments for storage, canals, pumping stations, etc. will be made.)

#### B.2 Groundwater Quantity

Many major cities (Dosso, Tahou: Maradi, Agadez, Zinder and Diffa) depend on groundwater for water supply. With the exception of Agadez, these cities experience water shortages due to inadequate pumping capacity during periods when water table levels are low. The best general sources of information on groundwater are the two BRGM studies, <u>Cartes de Planification pour l'Exploitation des Eaux Souterraines de l'Afrique Sahelienne</u> and <u>Atlas des Eaux Souter-</u> raines du Niger.

The three most important aquifers are the Quaternary Alluvium, Continental Terminal and the Continental Intercalaire. Other minor water sources are found in Precambrian bedrock, sedimentary formations of the Cretaceous Jurassic periods, and various epochs of the Tertiary period (Paleocene--Pliocene). Fortunately, areas under consideration for agricultural development are located near the major aquifers.

Major quaternary alluvial deposits are located at Dallols Bosso and Macuri, in the Tarka and Maggia valleys, in the Air mountains, and in the southeastern corner of Niger, near Lake Chad. The Continental Terminal underlays most of the southern portion of Niger. It is near the surface and therefore exploitable in the region extending southwest of Tahoua to the Niger River. It underlies the Maggia and Tarka valleys. The Continental Intercalaire underlies the Continental Terminal and emerges in the region east of the Continental Terminal. It extends to the east as far as Zinder, but remains south of Agadez. Characteristics of these three formations are described in Table G-2.

21 \

		Volume des	ressources		
		moyennes annuelles en			
Nom de la zone	Nom des fleuves, koris, etc.	eau superficielle (M.m.			
		des bassins	utilisabla		
Fleuve Niger et affluents rive droite	Niger à Niamey (31 500 M.m3) Affluents voltaïques (1 440 M.m3) Affluents béninois (3 200 M.m3) Niger à Gaya (35 300 M.m3)	35 200	35 200		
Affluents rive gauche du Niger		négligeable	-		
Les Dallols	Dallel Bosso (4 à 5 M.m3) Dallol Maouri (4 à 5 M.m3)	10	10		
Ader Doutchi- Maggia	Zourourou Badeguicheri Maggia	67 37 <u>55</u> 159	101 37 <u>118</u> 256		
Goulbis Gabi et Maradi	Goulbi Gabi Goulbi Maradi	226	226		
Zinder et Koramas		13	13		
Lac Tchad et Komadougou Yobé	Komadougou Yobé entrant au Niger (apport au lac Tchad : 200 M.m3)	555	555		
Zone nord du lac Tchad		négligeable	-		
AIr	Ensemble des écoulements à l'aval Ensemble des écoulements avec une utilisation sur tout le bassin	250	420		
Grands ergs	defination ser toot ie bassin	0	420		
Djado		négligeable	-		
Fotal des ressour	ces sans le fleuve Niger	1 210	1 480		
Fotal des ressour	ces avec le fleuve Niger	36 400	36 700		

# TABLE G-1: Surface Water Resource

G-3

	Quat. Alluvium	<u>Cont. Term</u>	<u>Cont. Intercalaire</u>
Thickness (meters)	10 - 30	30 - 75	25 <b>-</b> 40
Depth from surface (meters)	3 - 15	1 - 40	2 - 10
Specific Capacity*	20 - 40	1 - 10	5 - 15
Typical Capacity**	3 - 5	2 - 15	1 - 10
Transmissivity***	-	0.1 - 1	5 - 10
*Cubic meters per hour per	r meter of drawdowr	· ·	-

## Table G-2: Typical Aquifer Characteristics

\*Cubic meters per hour per meter of drawdown \*\*Well discharge (liters per second) \*\*\*In 10<sup>-3</sup> square meters per second

The SOGREAH/BRGM study generally considers all three major aquifers reliable sources of good quality water for water supply. In some areas, such as the Air mountains, the volume available may restrict the scale of agricultural development. The Continental Intercalaire and Terminal aquifers are also noted as occasional sources of artesian water (water flowing to ground surface, due to being under pressure in a confined aquifer). The feasibility of using groundwater for agricultural development should be determined on a case-by-case basis because aquifer characteristics will change, depending on the location.

#### B.3 Water Quality

There is relatively little water quality information available. Table G-3 presents a typical water analysis for the Niger River. The water is low in dissolved solids (salinity). Other data have indicated that the conductivity varies between 26-52 micromhos/cm. This suggests a dissolved solids concentration between 20 and 40 mg/liter. The water has a relatively low sodium content and can be described as a calcium bicarbonate-predominate water. This reflects the geochemical environment of the upstream basin. The water is in contact with weathered Precambrian and Cambrian bedrock and sandstone formations. These geological environments generally produce water of low mineral content.

/\/ .`7

Table G-3: Typical Water Analysis

Niger River LE HIGER A KAMDADJI

Concentration on mo/1 , Balanco Ioniquo

-

.

I DATE I PICELEVELENTE	1 +CO.11	(00) =		HS (mé	/1)	1	CATIO	) 11 <u>6 (mé</u> /	)	1 BILANCE	
••••••••••••••••••••••••••••••••••••••			<u> </u>	DC -		1 0a +	1 <u> </u>	· ]( +	lla +	inions	Cations
י ו י?−1−₽0	0,331	f 	i 0,0;	1 0,20	ro, o <b>1</b>	0,13	0,12	1 0,05	0,13	0,58	1 0,73
l II !11-280	1 0,4/21	<b></b>	1 0,01	l I 0,12		I 0,13	<sup>1</sup> 0,13	1 0,04	0,17	l 1 1 0,57	1 1 0,47 1
III 5 -3-80	1 1 0,42 1	<b>**</b>	l 0,02	1 0,02	l 	I I <sup>0</sup> ,12	   0,13	I 0,08 1	0,18	0,48	1 0,51 1
! IV ! 25-:-80	1 0,52 1 0,52		I I 0,03	1 0,13	0,01	l 1 0,12	I I 0,15	1 0,03	0,22	0,09	1 1 1 1 1 57
V 1 20-6-80 1	1 0,77 <sup>1</sup>	•••	0,07	0,11	0,01	1 1 <sup>0</sup> ,20	0,23	0,13	0,35	0,93	I 0,91 I
! VI   1−10-81	1 0 <b>,</b> 31			0,02		1 1 0,15	1 1 0,08	l () <sub>1</sub> 05	.,11	0,36	1 0,39 1
VII 31231	1 1 1 0,39 <sup>-</sup> 1 1			0,03	-	( 15	1 0,11	t t 0,0′ t t 1	0,13	0 <b>,</b> .;2	1 1 0,:3 1

- Valour mile ou inférieure à 0,01 mé/l

 $\langle \rho_0$ 

.

ភ្ ភ

The groundwater of the major aquifers of Niger has similar characteristics, though subsurface waters around Diffa, Birma and Dallol Maouri can have some salt. The BRGM information on general water quality information contained in the annex of the SOGREAH/BRGM study is summarized in Table G-4, below:

## Table G-4: Aquifer Water Quality

	Quaternary <u>Alluvium</u>	Continental Terminal	Continental <u>Intercalaire</u>
Classification	C1 - S1	C2 - S1	C1 - S1/C2 - S2
Total dissolved solids	130 mg/1	300 mg/1	150 mg/1

BRGM used the irrigation water suitability diagram developed by the USDA. It is based on the relationship observed between sodium content and conductivity to indicate suitability of water relative to crops. The diagram is presented here as Figure 1, and the interpretation in French is shown as Table G-5.

The general conclusion at this point is that water quality is not a constraint to irrigation development. No information on boron, arsenic, heavy metals or trace substances was obtained. Based on the general characteristics of this type of water, it would be surprising to encounter a major problem involving these substances.

110

#### FIGURE 1: IRRIGATION SUITABILITY DIAGRAM

G-7

The U.S. Salinity Laboratory staff (1954) has proposed the use of the sodium adsorption ratio (SAR) for studying the suitability of groundwaters for irrigation purposes. It is defined by

$$SAR = \frac{Na^{-1}}{V(Ca - Mg)/2}$$

where all concentrations are expressed in epm.

A soil high in exchangeable sodium is very undesirable for agriculture because it can become deflocculated and tends to have a relatively impermeable crust. This condition is promoted by waters of high SAR and is reversed by waters containing a high proportion of calcium and magnesium (Hem. 1959). Soil amendments such as gypsum or lime may correct the situation.

A diagram for evaluation of irrigation waters on the basis of SAR suggested by the U.S. Salinity Laboratory Staff (1954) is given in Fig. 7.10.



Fig. 7.10 Diagram for use in studying suitability of groundwater for irrigation purposes. (After U.S. Dept. of Agr. Handbook 60, 1954.)

6-8

TABLE G-5: Irrigation Water Quality Classification

CLASSIFICATION DES EAUX PAR DEGRES D'APTITUDE A L'IRRIGATION

Degrá	Qualité	Classes	
1	Excellents	C1-51	Sau utilisable sans danger pour l'irrigation de la plupart des cultures, sur la plupart des sols.
2	Bonne	02-51 02-52	En général, eau pouvant être utilisée sans contrôle particulier pour l'irrigation de plantes moyennement tolérantes au sel, sur sols ayant une bonne perméabilité. Principaus problèmes, dus aux plantes trop sen- sibles au sodium st aux sols à forte capacité d'échange d'ions (sols argileux).
3	Admissible .	C3-51 C3-52 C2-53	En général, eau convenant à l'irrigation de cul- tures tolérantes au sel, sur des sols bien drai- nés. L'évolution de la salinité doit espendant être contrôlée. Principour problèmes dus aux plantes trop sensi- bles au sodium et aux sols à faible perméabilité.
ц,	Médiocre	(4-51 (4-52 (3-53	En général, eau fortament minéralisée pouvant convenir à l'irrigation de certaines espèces bien tolérantes au sel et sur des sols bien drainés et lessivés.
5	Mauvaise	C3-54 C4-53 C4-54	Eau ne convences généralement pas à l'irrigation mais pouvent être utilisés sous certaines condi- tions : sols très pertéables, bon lessivage, plantes tolérant très bien le sel.

Les valeurs données sont celles des "Cartes de planification pour l'exploitation des eaux souterraines de l'Afrique sanélienne" Rapport ERGM 1975.

16)

#### B.4 Water Resources Summary

Information indicates that water resources, both in terms of quantity and quality, are potentially available to support increased agricultural development. In the Maggia, Tarka and Niger river valleys, surface water appears to be the most economical source. However, one should also consider the operational problems and loss of storage capacity already experienced in reservoirs in the Maggia due to siltation. The problem is severe. When all factors are  $c_{a}$ -sidered, groundwater exploitation may actually be the more economical. In the Niger River Valley where storage is not required, surface water is indicated. Construction of low head dams may be used to augment storage during the dry season.

The aquifers available to support irrigation projects are moderately productive. Very large tube wells are not indicated because the aquifers are not very thick and have low to medium specific capacities. A more efficient scheme would involve numerous lower capacity tube wells spaced so as to maximize production with minimal interference.

Another factor which may make groundwater exploitation more attractive than surface water use is the ability to temporarily "mine" the groundwater resource during drought periods. If carefully managed, water can be provided during the dry periods and the aquifer will be drawn down on the short run. Recharge will replen is most of the water. If the drought has not extended over many years, water demand can be reduced during the relatively wet years, and the "loan" repaid. Careful management and well monitoring are required if the resource is to be used efficiently in this mode.

Any tube well development to support irrigation will need to be carefully considered. Although the resource is available in the areas where irrigation is planned, it will need to be evaluated on a case-by-case basis.

The water quality of the surface water and the groundwater is good and is not  $\tau$  constraint to irrigation development.

#### C. Soils

Irrigation affects soils. The most serious potential problems related to irrigation are waterlogging, salinization and alkalization.

#### C.1 <u>Waterlogging</u> and Drainage

Waterlogging occurs when water saturates the plant root zone. This may be caused by natural events (floods) or may result from poor natural drainage. The pores between soil particles become saturated with water, reducing oxygen transfer to the plant. The upper layers of the soil may become devoid of oxygen (anaerobic) if substantial organic matter is present.

Waterlogging related to poor drainage does not seem to be a problem in Niger. In general, Niger's soils are well-drained. This has been confirmed by Mr. Zylstra from the International Institute for Land Reclamation and Improvement of Wageningen, Holland, here recently on mission for FED. Subsurface drains are not normally required. Surface drainage for the medium to large irrigation projects is provided in order to remove excess water from precipita-tion.

#### C.2 Salinization

Salinization is related to pc r drainage and high water tables. If the upper soil layers become saturated due to poor drainage and/or capillary rise from a high water table, evaporation may cause salts to concentrate at the soil surface. The severity of the problem is directly proportional to the initial salinity of the irrigation water. In brief, the three most important factors which result in salinization are:

```
High water table
High water salinity
Poor drainage
```

The soils of Niger generally are well-drained. The salinity of both the groundwater and surface water is low in most instances. The water table is only observed to be relatively high in the Quaternary Alluvial formations. Even in the areas of high water tables, salinization has not been observed as a significant problem. This is because the water salinity is usually low and capillary rise is reduced in sandy soil as compared to loamy clays. Although it is not generally a problem, salinization potential should nonetheless be considered at each site because soils are heterogeneous.

#### C.3 Alkalization

Alkalization is caused by excessive sodium (more correctly, an elevated sodium/calcium plus magnesium ratio) concentrations in the soil. Sodium ions cause clay particles to deflocculate, rendering the soil impermeable. Yery high bicarbonate or carbonate concentrations can cause the same effect by precipitating calcium and magnesium ions, which increases the relative concentration of sodium.

The waters of Niger are generally low in sodium, as well as other constituents. Therefore, the probability of problems with alkalization is low. It has been reported that some soils have a naturally high sodium content. Because of this, each site should be evaluated.

#### C.4 Soil Erosion

Erosion can potentially occur wherever the natural environment has been disturbed. The construction and operation of irrigation perimeters may cause soil erosion problems of both short and long term types. The mitigative measure is to utilize construction and operation methods which minimize situations conducive to erosion.

#### C.5 Soil Summary

The potential for soil-related environmental problems is low. The soils are generally well-drained and low in sodium content. The surface and groundwater are low in salinity and sodium; therefore, the probability of salinization or alkalization is low. The soils are heterogeneous and some isolated soil

165

problems have occurred. Therefore, any agricultural development project, particularly irrigation, should determine the characteristics of the soil and water at each location.

#### D. Public Health

Irrigation alters the hydraulic regime. Many diseases are water related; therfore, irrigation activities can potentially change the public health situation.

Another public health issue is related to the use of agricultural chemicals (pesticides, herbicides and fertilizers). Pesticides can cause water quality problems due to entrophication, and public health problems due to methemoglobinemia. Methemoglobinemia affects infants and is related to ingestion of water high in nitrates.

#### D.1 Irrigation-Related Diseases

Irrigation increases the available aquatic habitat. The areas covered with water are usually quiescent and provide good habitats for mosquitoes and snails. Therefore, it is expected that malaria morbidity will increase with irrigation. This is usually observed during the dry season in areas which normally would not have standing water. Adequate public health control measures should be put in place if malaria is to be suppressed. Another mitigative measure is to design canals to minimize standing water.

Schistosomiasis is a parasitic disease which depends on the existence of a snail (typically of the <u>Bulinus</u> genus) to serve as a host during part of its life-cycle. The <u>Bulinus</u> snail is an aquatic type which prefers quiescent waters. If the snail is present in the area, irrigation activities will usually cause its population to increase and the incidence of schistosomiasis will tend to increase if the disease is also initially present. The snails prefer habitats which are shallow, high in organic content, with moderate light penetration and which contain aquatic vegetation.

Effective countermeasures to reduce snail population are:

- Molluscicides
- Special canal physical designs (high velocity designs)
- jucation (don't urinate or bathe in the water)
- Canal linings
- Canal weed cleaning
- Reduce access by using fences

All of these measures can be effective if schistosomiasis is present.

The primary question, specific to this assessment of irrrigation in Niger, is whether schistosomiasis is a potential (or actual) problem in the irrigated areas. An expert on schistosomiasis (Dr. Emile Malek) is scheduled to visit Niger during May 1984 to make an assessment. He is much better qualified to address this issue.

16

#### D.2 Fertilizers

Fertilizers can contaminate surface waters if applied in excess and then the drainage water is returned to the watercourse. Fertilizers can also contaminate the groundwater with nitrates (either directly or as an oxidation product of urea or ammonia), if applied in excess and the physical situation is appropriate.

The team agronomist has indicated that fertilizer use is limited both in terms of extent and dosage; also, very little water is returned as drainage to the river, most of it percolates to the groundwater table. Therefore, the probability of problems, present or future, with entrophication and high groundwater nitrate is low. If fertilizer use is substantially increased, then proper application practices should be employed and groundwater quality monitored.

#### D.3 Pesticides

Modern agriculture requires the control of insects, weeds and disease. Agricultural chemicals are one of the options available to suppress pests. Unfortunately, these products can have very negative impacts on the environment if used improperly. As irrigated agriculture becomes more widespread in Niger, the probability of deleterious side effects will increase.

Proper use of pesticides requires specialized training in their storage, transport and application. Extension training must be provided to farmers and measures taken to ensure compliance. In Niger, the <u>Service de la Protection des</u> <u>Vegetaux</u> provides some of this assistance. Training is also provided by ONAHA. Any future irrigation activity should demonstrate that proper instruction will be provided to the farmers and that supervision is effective.

The present situation in Niger indicates that pesticide use is relatively low. These chemicals are costly and farmers can only purchase what is necessary. Pesticides in use are malathion, parathion, endosulfan, DDT and hexachlorocyclohexane (HCH or Lindane). These are all insecticides. No significant use of herbicides is reported. DDT and HCH are chlorinated hydrocarbons and can be expected to persist in the environment. Therefore, the concern of their use is related to food chain (bioaccumulation) effects and worker safety. Endosulfan is a sulfur-containing chlorinated hydrocarbon. It also persists in the environment but does not bioaccumulate through the food chain. It is of moderate toxicity.

Malathion is an organophosphate which is very toxic to insects but of low toxicity to mammals. It is superior to parathion, which is highly toxic to mammals as well. Therefore, malathion is much safer with respect to worker safety.

In brief, pesticide use in Niger is relatively low. As use increases, extension education must focus on proper management of pesticides. Fortunately, there are economic as well as environmental reasons to use pesticides efficiently with minimum waste.

# ANNEX H

# PROGRAM AND PROJECT POSSIBILITIES

# Emmy Simmons

# Table of Contents

			Page			
Α.	Five-Year Multipurpose Project					
	2. 3.	Project with ONAHA Arguments Against Implementation Considerations	H-2 H-3 H-3			
Β.	Two 1. 2. 3.	to Three Year Pilot Activities Arguments in Favor of Pilot Activities Arguments Against Implementation Considerations	H-4 H-4 H-5 H-5			
C.	Sing 1.	gle-Purpose Project Research a. Arguments in Favor of a Research Project	H-5 H-6 H-6			
	2.	<ul> <li>b. Arguments Against a Research Activity</li> <li>Water Management</li> <li>a. Arguments in Favor</li> <li>b. Arguments Against</li> </ul>	H-6 H-7 H-7			
	3. 4.	Animal Traction Use A Research-Extension-Training Project	H-8 H-8 H-8			
D.	Sing 1.	gle Perimeter Model Activity The Konni Option a. Arguments in Favor b. Arguments Against	H-8 H-9 H-9 H-9			
	2. 3.	The Sakoira Option The "Ideal Problem Perimeter"	H-10 H-10			
Ε.	Dowr 1. 2. 3. 4.	nstream Linkages Marketing/Processing of Irrigated Crops Monitoring Groundwater Resources Health Problems Access Roads	H-10 H-11 H-11 H-11 H-12			
F.	Doir	ng Nothing	H-12			

 $\sqrt{e^2}$ 

#### ANNEX H

#### PROGRAM AND PROJECT POSSIBILITIES

#### Emmy Simmons

USAID/Niamey requested this analytical review of the irrigated agricultural situation in order to:

- provide the basis for the <u>formulation of a Mission irrigation stra-</u> tegy;
- 2. explore the <u>feasibility of a USAID-funded intervention</u> (through articulation and analysis of several possible options); and
- 3. identify <u>information and personnel needs</u> for further development of the selected options.

In this section, we draw on the review and analyses presented in earlier sections of this report and focus on the articulation and analysis of several possible options for program and project intervention. The organization of this section follows that suggested in the team's collective scope of work:

- A. five-year multipurpose project,
- B. two to three year pilot activities,
- C. single-purpose project,
- D. single perimeter model activity,
- E. downstream linkages, and
- F. do nothing.

This discussion addresses information needs for developing the ideas presented into fundable projects.

#### A. Five-Year Multipurpose Project

There are five government institutions with which AID could work on solving various sets of irrigation-related problems: ONAHA, the Ministry of Rural Development, <u>Genie Rural</u>, the department-level administration and the Ministry of Higher Education. In addition, AID could work with a PVO on a multifaceted program of irrigated agricultural development.

The team recommends ONAHA for three reasons:

- 1) ONAHA is charged with making sure that irrigation systems are productive. This is coincident with our view of where the greatest problems in the sector lie.
- 2) Even though the GON sees a reduced role for ONAHA, the functions which ONAHA now performs will have to be done by some agency for some time. The farmers' cooperatives will, in our view, be unable to perform them in the next two or three years.
3) Given its structure, ONAHA seems a logical organization to house and counterpart the different kinds of technical assistance which we feel will be needed to pursue different project purposes.

ONAHA is now under the Ministry of Rural Development and, although the team feels that it would be useful to nudge ONAHA into a more autonomous position, the Ministry of Rural Development is likely to retain its overseeing role. But in order to focus on irrigation problems in the depth we feel is needed, it seems wiser to work with the smaller (ONAHA), rather than the more diffuse (MDR), organization.

<u>Genie Rural</u> is now charged with designing and supervising construction of irrigated perimeters. It is likely to continue to play an important role in these domains in years to come. There are problems with system design which do affect the productivity and sustainability of the systems and which could perhaps be addressed by working closely with <u>Genie Rural</u>. It is the team's view, however, that institution-building within <u>Genie Rural</u> would be a fairly narrow kind of intervention. In particular, it would miss the linking of solutions in both engineering and agronomic spheres, something which can be done by working with ONAHA.

Focussing on irrigation development in a Department (Niamey, for example), might be a good way to address the problem of helping farmers to manage both rainfed and irrigated farming enterprises more productively. But the Government of Niger views irrigation more from the national perspective. Working at the Department level is likely to result in a fragmented and frustrating entry into the sector as a whole.

The Ministry of Higher Education offers some good possibilities for working on research under INRAN. However, lower level agricultural training falls under the MDR and the Ministry of Higher Education does not seem to orfer positive leadership in linking these two things. Research and training efforts could be launched just as--if not more--effectively through other interventions discussed below.

PVO's at this point do not offer a lot of scope as they seem to be pretty well booked up for the size of their staff already. AID's experiences with Tara and Africare are relevant, and Mission personnel already understand the problems better than we do. But it is our impression that, unless a very small in evention is all that is envisioned by AID, PVO's are neither interested in, nor capable of, expanding their activities in this area.

## A.1 Arguments in Favor of A Multifaceted Project with ONAHA

- a. ONAHA is a <u>semi-autonomous agency</u> with a clear organizational mandate, already on its way to certain kinds of needed reforms (such as reductions in personnel). It is likely to be endowed with certain needed capital support from the IBRD/CCCE/KFW Rehabilitation Project.
- b. ONAHA has several technical divisions, each with clearly defined areas of focus. This would permit several different types of complementary project efforts (training, research, pilot perimeter redesign, for example) to get underway at the same time. It has only one Director-

 $g_{ij}$ 

General and one accounting section. This would simplify AID's project management tasks considerably, especially as the accounting section is also due to get technical assistance under the Rehabilitation Project.

- c. Two policy-related factors:
  - It would be nice to be near the center of action/information as the Kandaji Dam (or some smaller alternatives) comes closer to being an absolute must for further expansion of river-based irrigation.
  - 2) A single pot of money identified as ONAHA's for a few years might give the Mission a good (if not major) role in the dialogue visa-vis the larger policy questions (on <u>redevances</u>, crop prices, farmer responsibilities) which are going to be debated in the irrigation sector. These issues will be important in rainfed agricultural development as well.
- c. Although thoroughgoing reform of this particular organization is not high on the World Bank's list of priority parastatals to reform, it is generally agreed that ONAHA needs more reform.

#### A.2 Arguments Against

- a. The <u>current thinking on the future role of ONAHA</u> is extremely fuzzy. The talk is of "withering away" along with UNCC. But conversations with farmers and with perimeter managers about their futures did not engender a great deal of confidence that this would or could happen in the near future.
- b. <u>ONAHA personnel seem to like being part of the MDR</u> with minimal longterm responsibilities for sector development and performance and maximal opportunity to advance their careers by moving in and out of ONAHA. However, continual personnel changes increase costs and necessitate constant training and retraining of staff. It also reduces the staff's commitment to building up ONAHA's reputation for reliable service.
- c. <u>Other donors</u> are tinkering at the edges with the organizational questions of ONAHA. This might prove difficult to live with.
- d. AID would have a very difficult time finding the right kind of dynamic technical assistance for such a project; i.e., staff which are senior, organizationally astute, technically excellent, and fluent in French.

#### A.3 Implementation Considerations

Assuming that the Mission weighs these factors and provisionally decides that the advantages outweigh the disadvantages, it would then have to decide, more or less at the same time:

a. Which specific purposes could be pursued in an instituion-building project. Some suggestions are:

- perimeter maintenance and management training for farmers,
- irrigated crop research on several perimeters, perhaps in collaboration with INRAN,
- tubewell exploration, perhaps in collaboration with <u>Genie Rural</u> or OFEDES,
- seed production, especially vegetables, perhaps in Kourtere or along lines established in AID's seed multiplication efforts with small contract growers,
- b. how to fit within the multidonor Rehabilitation Project, and
- c. actual mechanisms for accomplishing its objectives (technical assistance in ONAHA itself vs. technical assistance in the organizations with which ONAHA is contracting.

The Mission should make a solid commitment to this option before taking the next logical step--doing a thorough institutional analysis of ONAHA and informally exploring the possibilities for a gradual change to the kind of autonomous agency we think is probably most likely to work in the long run. If the Mission were unable to make this commitment, it would probably be wisest to back into organizational discussions at ONAHA while pursuing the possibilities of projects along other lines as described below.

B. Two to Three Year Pilot Activities

Several potentially exciting pilot opportunities have presented themselves:

- 1. Trying rainy season sorghum on a rice perimeter,
- 2. designing and testing <u>animal traction equipment</u> which could be used for perimeter construction and maintenance,
- 3. development of a <u>farmer-constructed terrace or cuvette perimeter</u> along the Niger River with small pumps (i.e., transferring the Bakel model to Niger),
- 4. a <u>cash credit program</u>--in the rice perimeters to facilitate labor hiring at the bottleneck period; everywhere for the purchase of undefined inputs from undefined sources; on selected perimeters, for specified purposes (e.g., well and pump improvement), and
- 5. a pilot effort aimed at <u>developing tubewell technology</u> as a replacement for surface dams in the Maggia Valley.

One could do a bundle of pilot projects (say, through the MDR) or one could pick them up one at a time, perhaps linking them with another ongoing effort or contractor.

- B.1 Arguments in Favor of Pilot Activities
  - a. These would all be ways of getting one's feet wet without taking the plunge, although the tubewell project could be close to immersion.

- b. The animal traction component in particular would be nicely related to the FE/ED effort being tacked on to the NDD project.
- c. The farmer-constructed perimeter experiment could build on AID's positive experiences elsewhere in the Sahel. It would demonstrate a management alternative to the large-scale classic design still being actively followed in Niger. An additional point in favor of this particular pilot project is that it was suggested by ONAHA.
- d. The tubewell pilot project would probably take longer than three years but, again, it would provide a demonstration for what is presently a "technology gap" in Niger.
- e. The cash credit pilot program would address what is clearly a critical problem and would be relatively light to administer.

## B.2 Arguments Against

- a. A package of pilot projects like these would imply horrendous coordination problems with the Government. Several ministries and departmental entities would be involved.
- b. Given the attention that the Government is devoting to centrallyorganized perimeters, they may see pilot projects as being unnecessary or simply too small to bother with. Support might be thin.
- c. Such pilot projects would require recruitment of several creative people. These are always hard to find (on the other hand, Hausa or Zarma speaking ability might be more important than French and might be easier to learn).
- d. The projects might fail. They might demonstrate what not to do. Then AID would be back to where it started and not have anything but "lessons learned" to show.

#### **B.3** Implementation Considerations

Developing these pilot ideas to an intermediate step might be most effectively done by calling on in-country expertise. Have the Purdue team check out the possibility of a rainy-season sorghum cycle on the irrigated perimeters. Cajole Tara into trying it out with advice from ICRISAT. As the Rehabilitation Project gets its groundwater study in the Maggia underway, arrange to have the Mission engineer work with them in a couple of areas to get a better handle on the data. Entice some people from the Bakel Project here on an exchange basis; some of your NDD staff could visit there. The forthcoming FE/ED consultant will also be a logical choice.

## C. Single-Purpose Project

The "Example Options" paper prepared by the Mission suggests three types of single-purpose projects and we have added a fourth:

- 1. Research
- 2. Water management

- 3. Animal traction use
- 4. The research-extension-training link

Each of these project possibilities is discussed separately.

## C.1 Research

There is little doubt that one could develop a useful research project focussing on irrigated grains and horticultural crops. It could be funded <u>directly with INRAN</u> or it culd be <u>financed through ONAHA</u>. If it were funded with INRAN, technical assistance would be provided to work in the technical divisions of INRAN as regular staff. Such a project would probably have to involve some long-term training of Nigeriens as INRAN would be unlikely to want a program staffed only with expatriates for very long. Moreover, it is important that irrigation research become more institutionalized in INRAN than it is now. If a research activity were to be funded through ONAHA, INRAN could still execute the field-level research, but ONAHA would be able to contribute more strongly to the definition of the research problems. ONAHA would then be willing to give better perimeter level support; e.g., providing <u>aide-encadreurs</u> for data recording, pest observations, water monitoring, etc.

A third option, that ONAHA develop its own research staff and conduct its own studies, is not recommended for further consideration. It is contrary to the direction in which ONAHA personnel numbers are moving and is not likely to be as professionally sustained as it would be if INRAN were involved.

#### C.1.a Arguments in Favor of A Research Project

- 1) AID is already involved in cereals research. It could simply expand ongoing efforts with INRAN to get quickly on the ground.
- Perimeter level research would generate the knowledge base which is absolutely essential to boosting agricultural productivity on <u>all</u> irrigated fields.
- AID has a comparative advantage in finding researchers who are well qualified.
- A research project could be easily scaled to match AID's funding availabilities.
- 5) It would fill a real gap in the Rehabilitation Project.

#### C.1.b Arguments Against

- 1) Oh, no, not more studies!
- Research is probably peripheral, in the Government's view of irrigation development, to other things This might well put AID on a back bench in crucial irrigation-related falogue.
- 3) Research always takes time. Results may not be terribly exciting for a few years. The Maradi Project's Applied Research Unit, Lowever, has quite nicely demonstrated the short-term payoffs that could come from

such a unit. Perhaps the desperate need for some viable crop recommendations such as at Konni, would also help here.

4) Research efforts would require a substantial amount of technical assistance in the short term. Given that the pool of Nigeriens who can go into research in the next few years is limited, this may put pressure on training programs with equal or greater priority (such as for rainfed cereals research).

## C.2 Water Management

"Water management" per se is a fairly broad topic and more likely to be the outcome of several projects rather than a goal attained in one. However, it is possible to think of a single project dealing with water management in some particular way. For example, one could quite readily formulate a useful project in Niger on training in water management and another on on-farm systems for water management.

Such a training project could involve several components, such as:

- a. Development of a water management curriculum to be added as a specialization in Kolo; training of trainers in this curriculum.
- b. Development and testing of training materials to be used at the cooperative level for farmer training.
- c. A more in-depth course for farmers attending maraichage CPT's.

An on-farm systems for water management project could involve:

- a. A testing program for measuring devices which can be used by farmers to monitor their water use.
- b. A training program for farmers/cooperatives in water management techniques.
- c. An experimental research program with INRAN on water economy and crop water requirements.
- d. An ONAHA-wide monitoring and on-the-job-training program for ONAHA personnel in on-farm water use.

# C.2.a Arguments in Favor of a Project Focussed on Water Management

- 1) Water management is a fundamental problem on all perimeters, both jointly and individually managed.
- 2) AID has a ready contractor in Water Management Synthesis II.
- AID could be the first Africa project sponsor associated with the newly-formed International Institute of Water Management in Sri Lanka.

#### C.2.b Arguments Against

- 1) Until sufficient irrigated crop research is done on perimeters, training courses will be full of generalities and may not improve the situation all that much.
- Organizationally, trying to address "water management" could get very diffuse, unless organizational linkages were carefully established in the design phase.
- 3) Still, the obvious counterparts are likely to be scattered.

#### C.3 Animal Traction Use

A pilot animal traction effort has already been discussed above. As the subject of a project on its own, it is likely to remain fairly small unless, when the Caisse gets around to evaluating its animal traction project next year, it finds a need for some activity we have not considered. Some possible activities might include: forage crop development, feeding rations for traction animals, modified yoke and other equipment design to better fit the irrigation situation.

## C.4 <u>A Research-Extension-Training Project</u>

Several on the team have suggested that AID could usefully focus on the "research-extension-training" link in irrigation. This implies, perhaps, focussed efforts in each of the areas, coordinated by an overall liaison effort. One could envision this involving ONAHA, UNCC, INRAN, and perhaps Kolo as well as a cooperative on perimeters. This approach would have all the advantages and disadvantages of the individual efforts already noted (treating "water management" more or less as extension). In addition, it will have considerable organizational complexity at a time when UNCC is supposed to be disappearing.

Given the relatively limited knowledge base vis a vis applied research in irrigated agriculture, AID should be leery of moving too quickly toward an integrated program. A planned series of single-purpose projects, focussing initially on applied research, second on training, and last on extension reorganization and management would probably be a wise initial approach. After all that is underway, one could talk about liaison in more concrete terms. By that time, maybe the UNCC's future will have been worked out.

#### D. Single-Perimeter Model Activity

The <u>Konni</u> perimeter is perhaps the best example of a possibility along these lines. Others have been suggested as well: rehabilitation of <u>Sakoira</u>, a terrace perimeter just north of Tillabery which has been out of business since 1978; <u>Firgoun</u>, which AID has previously supported through the Entente Fund; and there still might be some <u>unfunded perimeters in the Rehabilitation Project</u> package.

In addition, one could define a type of "ideal problem perimeter" that one might wish to take on in order to maximize lessons learned---and then look around to see if one exists. A rice-rice perimeter on the point of collapse due to a centralized system of diesel pumping, perhaps scheduled for rehabilitation but

 $1/r_{j}$ 

not yet funded, preferably with fairly heterogeneous soils and sociable farmers might be such a choice.

## D.1 The Konni Option

Take it over and make it work.

## D.1.a Arguments in Favor

- Konni is easy to get to, evacuate produce from, and visit for supervisory purposes. Smuggled inputs from Nigeria should be available.
- 2) the physical layout does not, at first glance, look too bad. As a gravity system, recurrent costs should be low.
- 3) The sunk cost is already quite heavy, so marginal new investments should yield good rates of return.
- 4) The farmers in the perimeters who are from the villages to the north side of the irrigated area are reportedly very interested in making a go of farming in the perimeter.
- 5) As an experimental site, it offers many advantages: very heterogeneous soils, population, and crops.
- 6) The Government of Niger, which is paying the interest on the loan from Kuwait used to construct the infrastructure, is very interested in getting some help on making the perimeter viable.
- 7) It would provide AID with a very rapid startup in irrigation.
- 8) It would, given GON interest and the visibility of the effort, definitely give AID a major seat at the irrigation policy dialogue.

## D.1.b Arguments Against

- No feasibility study is in hand. There is some question about the long-term capacity of the dams to provide enough water and to deliver it through a very long canal system with excessive loss.
- 2) Many of the people assigned parcels in Konni I are not strictly farmers. They are, rather, traders and townspeople. There is some evidence that this has caused social conflicts and perhaps the less-than-impressive production record.
- 3) To date, there has been a bad crop choice for the perimeter. But there is little information upon which to quickly prescribe a better one. The time required to do the basic investigation needed will put additional pressure on AID in a highly visible situation.
- 4) The perimeters are understaffed, especially with agricultural skills.

- 5) A certain amount of additional infrastructure is still needed. This may require a substantial capital investment (e.g., for access roads to a couple of villages which were apparently cut off during construction of the perimeter).
- 6) Konni is very close to Nigeria. Labor costs will be high. It will also be very difficult for the Government to control the sale of produce from the perimeters should it wish to do so.
- 7) It is high risk--politically and operationally.

## D.2 The Sakoira Option

This is not recommended. The original perimeter was an outright gift for which the villagers took little responsibility. The level of perimeter utilization was never very high. The original pumping station and probably the perimeter are now too far away from the riverbank to be rehabilitated. Any activity in Sakoira would have to start from scratch as far as physical development goes. In addition, an extremely passive attitude on the part of the people would present a major obstacle.

#### D.3 The "Ideal Problem Perimeter"

Whether such a perimeter exists is not known. However, finding an "ideal problem perimeter" such as described above would offer:

- a. A good chance for demonstration of alternatives.
- b. A responsible way to get major experience in irrigation.
- c. A seat at the table in the policy dialogue.

These would have to be weighed against the possibility of failure, the difficulties of multidonor coordination, and the difficulties of interacting with ONAHA on a one-perimeter basis.

If AID feels that the Government will continue to pressure it to take on Konni (and AID does not feel up to it), it might be worthwhile to hire two people for six weeks each to visit it and other perimeters already known. This would mean digging over some of the SOGREAH/Berger ground, but it is probably the only way to get a comprehensive handle on the options from a management point of view. The two people, armed with a blanket <u>Ordre de Mission</u>, a car and six weeks' time, should be an irrigation engineer and a "manager" with substantial agricultural knowledge who can speak in project terms. They could be asked to report on problems in each perimeter, who is planning to do what about them, and to suggest what AID could specifically accomplish by taking a more active interest in each one.

#### E. Downstream Linkages

Four possible downstream linkages present themselves as potentially viable options for program involvement:

- 1) Marketing and Processing Irrigated Crops
- 2) Monitoring Groundwater Resources
- 3) Health Problems
- 4) Access Roads

#### E.1 <u>Marketing/Processing of Irrigated Crops</u>

The activities that suggest themselves in this area include identifying and developing export markets for onions and dried vegetables, improved solar drying technology, and grading onions and dried vegetables for export. AID should be careful in this area, however, lest its involvement imply direct public sector entry into marketing which, at this time, can only be negative.

Agroprocessing development probably has the most unknowns about it. However, it seems to promise significant returns if it will assist current private irrigators to expand production levels and permit more entrants. Vegetable processing from individual producers (or cooperatives) would promote the greatest income effect and avert what looks like a strong possibility of a devastating market glut in some vegetable products in the fairly near future. AID could finance the technicians to do the marketing and feasibility studies, fund a pilot project on solar drying techniques in Niger, and then provide project financing to cooperatives which demonstrate an interest in exploiting available markets. This might be the area where it would be worth calling in a high-priced business expert through the Private Enterprise Bureau (PRE) and getting some commercial-level advice--someone from the World Trade Institute or from a private corporation like Hanover Foods (which has worked with small-scale producers in Latin America to produce broccoli which is then frozen for the Norther American market). Onion is obviously the crop to begin with in Niger.

If AID finances weekly cereal price reporting under the ADSG as planned, it might be possible to add two or three vegetables to the list of prices reported.

#### E.2 Monitoring Groundwater Resources

This project would interest the <u>Direction des Ressources en Eaux</u> of the Ministry of Hydrology and Environment. It now has in place over 60 piozometers for monitoring groundwater levels. It is seeking financing for establishing baseline data and obtaining measurements in May and January of each year. More need to be added. Recent experience with the establishment of over 4,000 wells in Niger has revealed that the Atlas of Subterranean Waters contains many errors. Groundwater resource monitoring would need to be carefully linked with the groundwater studies proposed under the Rehabilitation Project and with FAO/UNDP, FAC, and FED studies currently underway in various parts of the country.

#### E.3 <u>Health Problems</u>

Preliminary indications suggest that irrigated agriculture does not present great health problems in Niger. This question will be examined more clearly by a subsequent team.

## E.4 Access Roads

Access roads in the Maggia and Dallol Bosso could be a real opportunity, especially if complemented by a strong PVO effort in the direction of cementlined wells and horticultural extension in the same area. Public works construction of these roads, using PL 480 red sorghum, might also be an option to explore. Maggia Valley interviews indicated that dry season migration to Nigeria has been cut back and people are hurting for dry season jobs. As long as rainfalls are not terrific and there are not substantial food surpluses, the PL 480 sorghum couldn't hurt. Simply paying people for labor might also be acceptable, trying for the most labor-intensive means of construction as possible.

## F. Doing Nothing

This option has little to recommend it. Irrigation is obviously important in Niger and there are problems to be solved.

As close as one would want to come to doing nothing is mounting a cour of small studies (a la Ray Norman and perhaps one farming systems research eff. t in the Niger River Valley, say, with Purdue participation or overseeing) and modifying follow-on phases of current projects to more explicitly address some aspect of irrigation. The NDD Project, for example, could develop a dry season fadama curriculum to use in the proposed mobile CPT's, or modify the FE/ED component to include animal traction equipment for irrigated agriculture. AID could also address some of the Kolo curriculum concerns regarding irrigated agriculture via the APS project without greatly increasing the weight of the project.

## ANNEX I

## TERMS OF REFERENCE FOR NIGER VEGETABLE MARKETING STUDY

The scope of work for this study included development of the terms of reference for a more detailed study of the feasibility of vegetable and highvalue crop production, processing, storage and marketing in potential irrigated perimeters. At the present time, however, given the magnitude of expansion in vegetable production envisioned by the GON, the marketing issue is clearly of paramount concern. Niger's own market for processed vegetables, apart from dried vegetables, is quite limited. Even if it were not, the high cost of canning and packaging materials in Niger and the high cost of transport would almost certainly render domestic canning and canned export operations highly uneconomic.

The real long-term comparative advantage of Niger with respect to vegetable production lies in developing and expanding fresh onion and dried vegetable markets. Niger already has an indigenous drying technology and established markets for these products that provide a solid foundation for development. Before moving in the direction of new products, markets for these more traditional exports should be more completely explored. For this reason, this annex provides the terms of reference for a more narrowly focussed vegetable marketing study than that indicated in the scope of work. Once the information from this proposed study is available, the mission will be in a better position to define more narrowly the production, storage and processing issues related to those crops that require further study.

#### 1. Production

Production of vegetables in Niger, especially onions, has proved to be quite profitable for Niger's farmers. Production of onions and tomatoes has grown at 12-15% over the past ten years and this level of expansion can probably continue without special measures. However, Niger is now in the process of greatly expanding the amount of irrigated area devoted to dry season vegetable production. Available evidence suggests that unless Niger finds new markets, the planned expansion of area under production may cause serious problems for marketing the increased output.

Demand for fresh onions and for dried onions, tomatoes, okra and peppers in the coastal countries of Africa is good relative to current levels of production in Niger. However, the current depth of these markets is not known. The extent of market acceptance of dried vegetables in coastal markets remains a major question mark. So does the possibility for expanding existing markets by better timing of the production and distribution of fresh and dried vegetables or by exporting to countries outside of Africa from coastal ports.

Dried vegetable products fit very well into traditional African consumption patterns, but we do not know the extent to which national production in these countries is able to satisfy demand. We also have no idea of the extent to

which improved drying techniques and better quality products might command a price premium for, or expand consumption of, Nigerier-produced dried vegetables.

With recent advances in aceptic packaging, it may be possible for Niger to overcome hardships imposed on more traditional forms of processing vegetables by long land transportation networks and a poorly developed domestic packaging and canning industry. While the prognosis for economic exports of tomato juice, tomato paste and other non-dried products aimed at African markets is not good, it nonetheless merits a closer look before concluding such exports cannot be competitive in African coastal markets.

## 2. Objective

To assess the potential for marketing fresh and dried vegetables of various quality and to identify current demand for mass-consumed, processed vegetable products in regional markets in the coastal countries of West and Central Africa.

## 3. Approach

The study will need to assess the supply and demand for fresh and dried vegetables over the course of a typical year, including seasonal availabilities, or the lack thereof, in coastal African countries. It should also assess, though with somewhat lower priority, existing market demand for tomato paste, tomato juice and other mass-consumed, processed vegetable products. The study should limit itself to onions, tomatoes, peppers, garlic, okra and other vegetables which could be grown under irrigation in Niger.

This study will require a review of available data on vegetable prices, marketing and trade by a marketing researcher familiar with vegetable production in Niger. It should begin with a brief review of available literature on vegetable marketing in West Africa, followed by a ten-day field trip to interview merchants and traders located along the entire southern border of Niger. It will require visits to major markets in coastal countries for discussions with transporters, wholesalers, retailers and consumers to get some idea of the current sources of supply, seasonal variation, price elasticity of demand, market acceptance for specific dried vegetables and the potential for the further development of dried vegetable markets. Ideally, the marketing researcher would be able to visit Ministry of Agriculture officials knowledgeable about vegetable production and marketing in their respective countries. From them he/she could obtain available quantitative data on production and marketing of the vegetables concerned, information on current government plans for national production and marketing programs related to them, and their perspective for potential Nigerien sales in their country.

To the extent that the market for a particular vegetable appears promising, the study should identify import requirements and restrictions and local distribution networks into which Nigerien exports might be integrated. It should focus on large cities in CFA zone countries, Nigeria and other countries with a hard currency. These would include Abidjan, Lome, Cotonou, Lagos, Ibadan, Douala and Libreville.

 $\delta^{\mathcal{V}}$ 

Because of the likelihood that an outsider asking questions might arouse suspicions, the USAID Mission or Niger Embassy in each country should inform national governments of the objectives of the study and should, where necessary, obtain the necessary clearances prior to the arrival in that country of the market researchers.

- 4. Specific Outputs and Terms of Reference
  - a. The market researcher will visit major exporting points in southern Niger and obtain the following information:
    - 1. Origin of foreign buyers and destination of final sales to the extent known to Nigerien market intermediaries.
    - Seasonal price fluctuations for wholesale quantities of fresh onions and dried tomatoes, peppers, onions, onion by-products, okra and other products which are exported in substantial amounts.
    - 3. Some estimate of quantities which are exported, broken down by month, to the extent possible.
    - 4. Important qualitative factors which buyers take into consideration in negotiating sale prices. Provide an indication of the impact of such factors on the final sale price.
    - 5. Any information traders might have on the relative importance of Nigerien products in meeting market demand in the destination countries.
  - b. The market researcher will visit major regional markets in Abidjan, Lome, Cotonou, Lagos, Ibadan, Douala and Libreville and gather the following information:
    - a. Identify the specific fresh and dried vegetable products found in each regional market that can potentially be supplied by Niger and note the common origin of each. This list should include at least fresh and dried onions, peppers, okra and garlic and dried tomatoes and tomato powder and should include products that are sly seasonally available, as well as those which are found in the market at the time of the survey.
    - b. Gather or develop seasonal price and sales estimates for each roduct.
    - c. Assess the potential for further development of dried vegetable markets in these countries, especially during those periods when fresh products are scarce in local markets.
    - d. Identify those factors which consumers consider to be important determinants of the quality of dried vegetables and the value they attach to those characteristics.

٠,

),

- e. Estimate the total amount of onion imports into each country, noting country of origin, season of activity and CIF prices paid.
- f. Where the market potential for Nigerien exports seems promising, identify import requirements, restrictions and taxes and marketing networks in which Nigerien exports could trade.
- g. In each country visited, assess the existing demand for processed vegetable products such as tomato paste, tomato juice and other mass-consumed vegetables and vegetable products.

## 5. Period of Service

The contractor shall spend three weeks in Niger reviewing available literature, carrying out the Niger portion of field work and making final preparations for visits to coastal countries. He/she is authorized to spend up to ten working days in each country visited, to the extent warranted by the information being gathered. Following completion of the country visits, the contractor will return to Niamey for two weeks to prepare the final report and discuss the results with USAID.

## 6. Reports

The contractor will prepare a report of his findings for each country visited to be included as an annex to a synthesis report. The synthesis report will include a five-page executive summary. All reports must be submitted to USAID for review four days prior to departure in order to leave time for necessary discussion and revision. The contractor will submit five copies of the synthesis report and two copies of the country annexes in final form prior to departure from Niger.

## ANNEX J

## IMPACT OF IRRIGATED AGRICULTURE ON PUBLIC HEALTH IN NIGER WITH SPECIAL REFERENCE TO SCHISTOSOMIASIS

## Emile A. Malek

## Table of Contents

		Page
Α.	Schistosomiasis As a Public Health Problem	J-1
Β.	Control of Schistosomiasis 1. Environmental Sanitation 2. Prevention of Contact with Invested Water 3. Chemotherapeutic Treatment of Infected Individuals 4. Control of the Snail Hosts	J-2 J-2 J-2 J-3 ·J-3
С.	Schistosomiasis and Its Snail Hosts in Niger 1. Prevalence of the Disease 2. The Snail Intermediate Hosts 3. Control of Schistosomiasis in Niger	J-4 J-4 J-5 J-6
D.	Examination of Some Irrigation Schemes and Water Sources in Niger 1. Irrigation Schemes a. Libore b. Tillabery c. Konni I d. Galmi e. Kawara f. Djiratawa g. Ibohamane 2. Other Freshwater Bodies a. Reservoir at Tera b. Lake Madarounfa c. Dogondutchi d. Dosso	J-6 J-7 J-7 J-8 J-8 J-9 J-9 J-9 J-9 J-9 J-9 J-9 J-9 J-9
E.	Summary and Recommendations 1. Establishment of a Central Authority 2. Collaboration 3. Improving Existing Irrigation Schemes 4. New Irrigation Schemes 5. Cropping Systems	J-10 J-10 J-11 J-11 J-12 J-13

, (s. 1

#### ANNEX J

## IMPACT OF IRRIGATED AGRICULTURE ON PUBLIC HEALTH IN NIGER WITH SPECIAL REFERENCE TO SCHISTOSOMIASIS

## Emile A. Malek

#### A. Schistosomiasis As A Public Health Problem

Schistosomiasis (or bilharziasis) is one of the most important public health problems of the tropics and subtropics. As a cause of morbicity, it is probably outranked only by tuberculosis and malaria. Conservative estimates place the number of infected individuals in the world at 200 million.

The life cycle of the parasites, called schistosomes, involves an intermediate host, a snail, in which a part of the life cycle is completed. Such snails are common in many freshwater bodies, natural and man-made. Eggs of the parasites leave the human body with the excreta, urine or feces, depending on the kind of schistosome. The eggs of the parasites hatch in the water and the larva that comes out infects a particular kind of snail, which differs according to the type of the schistosome, whether urinary or intestinal. Development of the larvae inside the snail takes place in about a month, and the new larvae which come out of the snail every day, swim in the water. If they encounter the human body, they mature and produce eggs which can be retained in all the organs of the body and which leave the body with the excreta.

Schistosomiasis is a chronic, insidious disease. Its symptoms are frequently masked by those of other conditions. Eggs have been found in almost all the tissues of the body. Damage is cumulative and, unless the initial exposure is unusually severe, symptoms of the disease emerge slowly. The intensity of infection is extremely variable. In most endemic areas, cases are diagnosed only incidentally when the individual seeks medical attention for some other complaint. Consequently, many cases go unrecognized and the disease is rarely established as a cause of death. In the urinary form of the disease, hematuria (blood in the urine) is usually an obvious symptom, and is not considered serious by many young children who experience it.

Urinary schistosomiasis is now regarded as a pathologic and chronic disease which has many clinical manifestations in the genital and urinary tract. For example, thickening and dilation of the ureters, the kidneys, and the urinary bladder are among the complications. Also, cancer of the bladder is now associated with urinary schistosomiasis in many endemic areas of Africa and the Middle East. Because of its chronic nature, schistosomiasis saps the energy of the individual, reduces his resistance, renders him prone to attack by other infections and lowers his productivity. These deleterious effects are difficult to evaluate, but, as a whole, they represent a social and economic burden of great importance. It results in a reduction in the capacity of the infected person to contribute to the local and national economy. For this reason, schistosomiasis tends to hampe, an economy to a greater extent than do the mcre highly publicized and greatly feared diseases. Due to the fact that precautions are not usually taken nor control measures instituted during the early phases, most soil and water-resource development projects in endemic areas cause the spread of schistosomiasis.

In rare instances, however, careful planning in the initial stages of schemes, coupled with suitable agricultural methods and strict water management during the operational phase, have reduced the extent of the snail habitats and lowered the prevalence of the disease. The snails that serve as the intermediate hosts for schistosomiasis are most apt to thrive in irrigation schemes and drainage systems that have been poorly designed, constructed and maintained. Therefore, in all endemic areas of schistosomiasis special attention must be given to designing, constructing and maintaining systems which provide for complete control of the water, and easy and efficient maintenance. Improper water management and primitive methods of water use in irrigation schemes located in schistosomiasis areas inevitably produce conditions that encourage snails. Fortunately, practical and effective methods for improving these conditions and for reducing the transmission of schistosomiasis have been found in some areas.

#### B. Control of Schistosomiasis

With our present knowledge, the objective for the control of schistosomialis is the reduction of transmission to a low level so that the disease ceases to be a problem of public health significance. Eradication is not possible except in a very few cases, such as small islands where the disease is endemic. There are several approaches for control and each is intended to break the life cycle of the parasite at some point.

#### B.1 Environmental Sanitation

The practice of strict measures to prevent water pollution would prevent the infection of the snail intermediate hosts. However, in most villages where schistosomiasis is endemic, facilities for the disposal of human excrete are completely absent or inadequate. Even when latrines are provided, they are frequently not used. Defecation and urination often take place near prigation canals and other bodies of water. These environmental conditions are responsible for the transmission of schistosomiases and other filth-borne diseases. It is believed that the ultimate solution for the control of these diseases must be based on improved sanitation, including the provision and use of adequate water supplies and facilities for the disposal of human excrete. However, the development and acceptance of effective environmental sanitation depends on many cultural factors which lie outside the fields of preventive medicine and public health. Although it may take several generations for these habits to change, health education is of some help.

## B.2 Prevention of Contact with Infested Water

In supplying irrigation water to arid areas, primary consideration is given to providing adequate quantities of water which is of satisfactory quality for crops. Often little thought is given during the planning and construction of an irrigation scheme to the fact that canals not only serve as a source of water for crops, but also for bathing and for domestic uses. It has been repeatedly recommended that safe washing and bathing facilities be provided. In a few areas, such as Venezuela and St. Lucia where they have been built and accepted by the people, these facilities have considerably reduced exposure. However, though farmers' exposure in irrigated areas can sometimes be reduced, it is difficult to eliminate. This is especially true of areas where small, hand-cultivated holdings are primarily devoted to subsistence farming.

## B.3 <u>Chemotherapeutic Treatment of Infected Individuals</u>

Chemotherapeutic treatment, especially of the young age groups which are intensely infected, would stop the supply of eggs in the excreta to the snails' habitats. Fortunately at present there are recently discovered effective drugs for all species of the schistosomes. Metrifonate (Bilarcil) is a cheap drug which is effective against urinary schistosomiasis. Praziquantel (Biltricide) and Oltipraz are effective against urinary and intestinal schistosomiasis, and have little or no side effects. There is a general agreement at present that chemotherapy, combined with some other measures, is a useful way to control schistosomiasis.

#### B.4 <u>Control of the Snail Hosts</u>

The two general methods available for control of the snail intermediate hosts are elimination of snail habitats through engineering design and modification of the ecology and through the use of molluscicides to kill the snails. Since snail habitats vary considerably from one endemic area to another, each should be considered separately when it comes to the choice of the best methods to be utilized.

Engineering and ecological control of the snail hosts involve changing the ecology of the water in which they live so that it no longer offers a suitable habitat for the snails. Public health engineers, with the aid of biologists, have developed methods for modifying snail habitats in natural and man-made endemic foci of transmission of the disease. For irrigation schemes there are suitable measures for modifying snail habitats in reservoirs and in irrigation canals and drains. Advantages of modifying the snail habitat include the use of local labor and materials; under certain conditions increased agricultural production through utilization of wasteland, improved irrigation and improved agricultural methods; control of filth-borne and arthropod-transmitted diseases such as malaria and filariasis; and reduction of the area in which it is necessary to use molluscicides on residual snail colonies.

Chemical control of snails involves the use of certain chemical combounds which have been found to be lethal to the snails in the laboratory and under field conditions. Although there are a number of synthetic chemical molluscicides which are effective against snails, there is only one at present which is available on the market--Bayluscide (riclosamide) which is produced by Bayer in Germany.<sup>1</sup>/ The molluscicide has to be applied twice or three times a year in habitats with flowing water, because the snails that usually escape, or are introduced later, can repopulate a habitat within a few months. This has led to the trial of various types of "focal control," where attempts are made to confine the control effort to limited areas where the snails are abundant, and

 $<sup>\</sup>frac{1}{Y}$ urimin, produced in Japan, and Frescon, manufactured by Shell in England, are no longer available on the market.

where transmission of the disease is taking place. Focal control should considerably reduce the cost of the control operation.

With regard to snail control, the development of molluscicides of plant origin and the biological control of snails are now being investigated. A number of natural plants which are found in several endemic areas possess molluscicidal properties. Extracts from these plants should be cheaper than synthetic chemical molluscicides, and their use will save foreign currency. There are also a number of enemies, predators and competitors of the snails which serve as intermediate hosts of the schistosomes. Among these predators and competitors are other snails. Studies are being carried out to find out if snails of nonmedical or veterinary importance can be used under field conditions to reduce or eliminate snails of medical importance.

## C. Schistosomiasis and Its Snail Hosts in Niger

## C.1 Prevalence of the Disease

Gaud (1955) noted prevalence rates for urinary schistosomiasir of 40% and 60% in Zinder and adjacent areas and a rate of 33% at Tanout. Dr :hiens (1951) stated that there are foci of infection in Dori, Zinder, Tillabery, Niamey, Fada N'Gourma, Dosso, Birni N'Konni and in N'Guigmi. The latter is an important focus in the litoral zone of Lake Chad. Chamorin (1965) found eggs of <u>Schistosoma hamatobium</u> causing urinary schistosomiasis in 45% of 13,857 urine examinations made in 1964 in the Tillabery Cercle; 68% of the persons infected were school children from 6 to 12 years of age. In the Magaria Cercle, 21% of 1,008 urine samples were found to be positive and at Tessaoua, the proportion was 25% of 1,174 individuals. Of 1,420 urine samples taken from nomad people, 11% were positive. In 1966, the same author found 50% of 10,107 samples at Say, 9% of 6,276 samples at Ouallam, 18% of 3,612 samples at Magaria, and 11% of 3,920 steples at Matameye to be positive. In 1967, he found 7% of 7,532 at Ouallam, 28% of 9,664 at Gaya, 46% of 3,040 at N'Guigmi and 14% of 3,700 at Diffa were also positive.

During the 1970's and 1980's, other prevalence data were obtained by investigators at O.C.C.G.E. (Organization <u>de Coordination et de Cooperation pour la</u> <u>Lutte Contre les Grandes Endemies</u>). Near Tillabery, Roux and Sellin (1975) found 59% of 170 children (5 to 19 years of age) at Sakoyra to be infected; 55% of 102 children (5 to 14 years of age) at Namari goungou; 36% of 118 children (5 to 19 years of age) and 31% of 140 individuals of all ages at Sarakoire; 20% of 65 children (5 to 19 years of age) and 14% of 151 of all ages at Diomana; 80% of 116 children (5 to 19 years of age) and 65% of 94 individuals of all ages at In Ates. Prevalence rates between 1% and 91% were found at the following villages in the Gotheye area: Zaria Koira, Kakassi, Ziguida, Llakoire, Bandio, Safatane, Leleye and Kossogo.

Sellin et al. (1983) conducted a survey at Libore irrigation scheme and recorded the following infection rates: 89% of 217 children (10 to 14 years of age) and 62% of 1,766 individuals of all ages at villages close to the rice fields (Kouldu-koura, Tiendifarou, Tonko Bangou and Mallele). Villages between 1.5 and 5 km. from the rice fields (Bangoubanda, Libore, Zarma Koroze) had 79% of children (10 to 14 years of age) and 57% of 1,228 individuals of all ages who were infected. Villages at more than 5 km. from the rice fields (Sorey, Garbal,

\9<sup>1</sup>/

Gonzare, Kogourou) showed infection rates of 46% of 127 children (10 to 14 years of age) and 23% of 966 individuals of all ages. These same authors (1982) conducted a survey for prevalence of the disease at the site of the projected Kandadji dam and found children 4 to 17 years of age in 15 villages to be 24% to 94% infected. Similar results were found by Assane and Rey (1982) at N'Dounga, Drayna and Bantoure near Niamey and by Hamissou and Mouchet (1982) at Bangaria.

Bretagne (1984) conducted a survey for schistosomiasis in the village of Niezegoure, a village situated close to a rice irrigation scheme near Niamey. He found high prevalences in all age groups, especially among children. Boys 5 to 14 years of age were all infected (28 out of 28; 100%), as were 36 out of 41 girls in the same age group. There were 13 infected out of 23 individuals over 40 years of age. The overall infection rate in the village was 77%. It is of interest to note that in this village the infection with schistosomiasis was very intense (500 eggs per 10 ml. of urine on average). In the same study Bretagne found a village far from the rice perimeter and all other water bodies almost free of the infection (6 infected of 170 examined and all six cases admitted they had travelled to the Niger River).

The annual report of the Ministry of Public Health and Social Affairs does not include detailed information about urinary schistosomiasis. The 1982 report notes that 12,950 cases were diagnosed in hospitals. As in 1981, about half of these cases (6,057) were from Niamey. Other localities include the Departments of Agadez (860); Diffa (703); Dosso (1,226); Maradi (1,610); Tahoua (1,510) and Zinder (984).

For 1982 through 1984, examination of the laboratory records at the clinic of Soudan Interior Mittion (SIM) at Galmi showed the presence of urinary schistosomiasis in that part of the country as well. These were cases which came to the clinic for other ailments and not for schistosomiasis. There was also a high prevalence of malaria.

No estimates have been made of the total number of individuals infected with urinary schistosomiasis in Niger. However, Dr. Alpha Cisse (personal communication) puts that number at about 300,000 individuals. I think that this is probably an underestimation.

There are no reports in the literature about the endemicity of intestinal schistosomiasis in Niger. The snail intermediate host, <u>Biomphalaria pfeifferi</u> was found once, infected with cercariae<sup>1</sup> (Gretillat, 1974). The investigators at 0.C.C.G.E. found <u>B. pfeifferi</u> in the area of Gaya. They have also just found infection with <u>Schistosoma mansoni</u> by examination of the feces of individuals in the Gaya region. It is of interest to note that there are a few irrigated schemes in that region.

### C.2 The Snail Intermediate Hosts

<u>Bulinus (Physopsis) globosus, Bulinus (Physosis) jousseaumei and Bulinus (Bulinus) truncatus rohlfsi are effective transmitters of urinary schistosomiasis. These snail intermediate hosts have been reported in different parts of</u>

 $\partial \rho_{\prime}$ 

 $\frac{1}{T}$  The larva of the parasite as they come out of the snail.

Niger. B. (Ph.) globosus was reported from east of Maradi, Yatawa, Takieta and Tapoa (Wright, W. H., 1973; Sellin and Mouchet, personal communication). B. (Ph.) jousseaumei was found in Gotheye and Torodi (Sellin, personal communication; Tager-Kagan, 1977; Sellin et al., 1980). The latter species is probably synonymous with B. (Ph.) globosus. Bulinus truncatus rohlfsi was reported from Zinder, Valley du fleuve, Kokoro, Dogondoutchi, Gaya, Balleyara, In Ates, Tillabery, Gotheye, Timia, Bangario, Say, Tahoua and Filingue (Gretillat, 1974; Sellin et al., 1976; 1980; Mouchet, personal communication).

Bulinus (Bulinus) senegalensis is also an intermediate host for urinary bilharziasis, but is restricted to temporary water bodies, especially ponds which may have water for a few months every year. It has been found at Gungass, Vallee du fleuve, Dosso, Filingue area, east of Dogondoutchi, Tahoua area, Galmi, Madaoua, Maradi, Aguie, Takieta and Zinder. (Wright, C.A., 1959; Mouchet, personal communication). A closely related species, <u>Bulinus forskalii</u>, is not an intermediate host for urinary schistosomiasis, but is often confused with it. It has been found in Lake Chad, Zinder, Vallee du fleuve, Kokoro, Tillabery, Gotheye, Torodi, and Say (Wright, W.H., 1973; Gretillat, 1974; Sellin et al., 1980, 1982).

Other snail surveys were also conducted in Niger. In the area of Kofouno, Sellin and Simonkovich (1976) reported <u>Bulinus truncatus rohlfsi</u> in ponds at Anzou and Terme and <u>Bulinus senegalensis at Kofouno and Zibane</u>. In the area of Gotheye and Tillabery, Sellin and Roux (1975) found <u>Bulinus truncatus rohlfsi</u> at Bendiou, Ziguida, Zara Koyra, Dargol, Tillabery, Sakoira, Namarigoungou, Famale and In Ates, and <u>Bulinus jousseaumei</u> at Zara Koira, Leley, Illokoyre Leno, Safartane, Kosogho, Sakoira, Namarigoungou, Famale and Diomana.

A snail survey was also conducted by Sellin et al. (1982) at the site of the future Kandadji dam, where they found <u>Bulinus truncatus rohlfsi</u> at Koutcugou, Yassane, Firgoun, Ayorou, Sanguile, Ayorou Goungou Koyre and Famale and <u>Eulinus globosus</u> at the same places except at Ayorou.

Although no cases of intestinal schistosomiasis due to <u>Schistosoma mansoni</u> have been reported, its snail intermediate host, <u>Biomphalaria pfeifferi</u> has been reported by Gretillat (1974) and Tager-Kagan (1977). Dr. F. Mouchet of O.C.C.G.E. recently found <u>Biomphalaria pfeifferi</u> at four sites in the region of Gaya in the Dallol Foga: Sabon Birni, Bengou, Kowara and Bara (Mouchet, personal communication).

## C.3 Control of Schistosomiasis in Niger

At present, no national program exists for the control of schistosomiasis in Niger. There is no awareness of the magnitude of the disease of the country.

#### D. Examination of Some Irrigation Schemes and Water Sources in Niger

#### **D.1** Irrigation Schemes

The consultant made field trips to several irrigated perimeters in Niger. The relevant findings are noted below.

1

#### D.1.a Libore

This is a 250-hectare rice irrigation scheme using water pumped from the Niger River. The primary and secondary canals are lined with concrete, while the tertiary are earthen canals.

Aquatic Vegetation: In the secondary and tertiary canals there is a heavy growth of water lilies, Nymphaea spp. and Ceratophyllum sp. The water lilies are anchored in a thick layer of mud on the bottom. There is also mud on the concrete sides of the canals.

<u>Snails</u>: In the secondary and tertiary canals the following species were found in abundance, in association with the aquatic vegetation.

- Bulinus (Physopsis) globosus
- Bulinus (Bulinus) truncatus rohlfsi
- <u>Bulinus (Bulinus)</u> forskalii

The first two species are recognized intermediate hosts of urinary schistosomiasis. The snails collected were, however, found negative for the schistosoma when they were examined in the laboratory.

<u>Human-water contact</u>: At the time of the visit, women were washing clothes and children were bathing and swimming in the secondary canals, very near to where the snails were collected.

Other observations: Seepage was very noticeable from rice fields to neighboring land producing swamp areas suitable for snail and mosquito larvae breeding. There are one or two villages near the irrigation scheme and other villages at a distance. The researchers at O.C.C.G.E found high prevalence rates of urinary schistosomiasis among the population in the villages near the scheme, especially among children.

D.1.b <u>Tillabery</u>

This is mainly an irrigated rice scheme, similar to the one at Libore. The water is pumped from the Niger River and the primary and secondary canals are lined with concrete, while the tertiary are earthen canals.

Aquatic vegetation: The aquatic vegetation is scarce in the secondary and tertiary canals, while the primary canals are devoid of any vegetation. However, silt covers the sides and bottom of all canals. There is a considerable amount of debris in the tertiary canals, including paper, branches of trees and leaves.

Snails: The secondary canals have some species of operculate snails, and the intermediate snail hosts are rare. In the tertiary canals, however, the following species were found in large numbers:

- Bulinus (Physopsis) globosus
- Bulinus (Bulinus) truncatus rohlfsi

Bulinus (Bulinus) forskalii, which is not a host, was also found in moderate numbers.

Human-water contact: Washing clothes, bathing and swimming by both children and adults was observed.

Other observations: Seepage from rice fields was noticeable. High prevalences of urinary schistosomiasis were reported from three villages near Tillabery: Sakoira, Namarigoungou and Sarakoire.

D.1.c Konni I

This irrigation scheme contains about 1,360 hectares, growing cotton and wheat. It is irrigated with water from a reservoir behind Tierassa dam. The reservoir had water, and it is usually full between the end of August and October. Primary and secondary canals are concrete-lined, while the tertiary ones are not.

Aquatic vegetation: None of the canals had vegetation, but the secondary ones had debris. The reservoir had vegetation.

<u>Snails</u>: None of the canals had snails, but in the Tierassa reservoir <u>Buli-nus (Bulinus)</u> truncatus rohlfsi was found on the plants and on rocks at the banks. Both plants and the rocks are covered with a thick layer of periphyton, mainly green algae. The water is fast in the primary canals, and the secondary and tertiary canals are usually left dry. This is probably the reason why they do not harbor snails.

<u>Human-water contacts</u>: Bathing, swimming and washing are common at the reservoir. No human activities were observed at the primary canal because the banks are steep, nor at the secondary and tertiary canals because they are left dry.

The Zango Dam and reservoir: This reservoir is a supplement to the reservoir behind Tierassa for irrigation of Konni I scheme. The reservoir behind Zango Dam has water in May, and like the reservoir at Tierassa, is full from the end of August through October.

Only one shell of <u>Bulinus truncatus rohlfsi</u> was found, but probably more occur at different seasons of the year. Rocks are covered with algae. Seepage was noted at the beginning of the main canal from the reservoir. This encourages breeding of snails and mosquito larvae. The main canal is lined with concrete; it is very clean and no snails were found. There were human activities at the reservoir.

#### D.1.d Galmi

The perimeter contains 262 hectares, irrigated from a reservoir. It grows mainly onions. The reservoir had water in May, and it usually fills up between the end of August through October. The Galmi is a tributary of the Magia.

Aquatic vegetation: There was no aquatic vegetation in the reservoir or in the canals.

 $\langle (1) \rangle$ 

<u>Snails: Eulinus truncatus rohlfsi</u> occur in large numbers in the reservoir and on rocks near the edge of the water. The snails were especially abundant at the beginning of the main canal, on debris and on the concrete lining.

Other observations: The reservoir and the irrigation scheme are not far from the SIM clinic and many of the cases at the clinic have activities at the reservoir and the canals.

#### D.1.e Kawara

This is about 52 hectares, but the reservoir and the canals were all dry. It has been operating for about 18 years. No snail shells were found. There is only a well, which the people were using.

#### D.1.f Djiratawa

This irrigation scheme is in the Goulbi Valley, about 15 km. south of Maradi. Eventually, it will cover about 500 hectares. The scheme is irrigated with pumped subterranean water, and the canals are narrow and shallow and lined with concrete.

Aquatic vegetation: None, but there is a thick layer of algae on the concrete banks.

Snails: No snails of any kind were found.

Human-water contact: No individuals were using the canals, which are narrow and contacts are not possible or convenient. Probably also no transmission of schistosomiasis takes place in this scheme.

#### D.1.g Ibohamane

This irrigation scheme is near Tahoua and contains about 750 hectares. The reservoir behind the dam was completely dry, as were the canals. The canals are lined with rocks, with little concrete in between. No snail shells were found in the reservoir or in the canals.

#### D.2 Other Freshwater Bodies

#### D.2.a Reservoir at Tera

This is a large reservoir behind a dam that is not used for irrigation. Only one snail, <u>Bulins (Physopsis) globosus</u> was found on the rocks of the dam near the water edge. Probably more are found in other seasons. The human-water contact is tremendous at this reservoir. No information is known about the prevalence of urinary schistosomiasis in the area.

#### D.2.b Lake Madarounfa

This is about 20 km. south of Maradi, near the border with Nigeria. In two parts of the lake there was a heavy growth of water lilies, <u>Nymphaea</u> spp., but

no snails of any kind were found. The human-water contact is very considerable at this lake, as well. There is no information about the prevalence of urinary schistosomiasis in the area.

#### D.2.c Dogondoutchi

In a pond formed by a natural spring east of Dogondoutchi, there is a heavy growth of aquatic vegetation and considerable human activity. Only <u>Bulinus</u> (<u>Bulinus</u>) forskalii was found and this is not a host for urinary schistosomia-sis.

### D.2.d Dosso

No aquatic vegetation, but considerable debris, including palm leaves, is present in a pond about 35 km. east of Dosso. Only <u>Bulinus (Bulinus)</u> forskalii was found in large numbers, and it is not a host for urinary schistosomiasis. However, the habitat looks ideal for other bulinid snails which are hosts of <u>Schistosoma haematobium</u>. It is likely that the snails are present, though they were not encountered.

#### E. Summary and Recommendations

Surveys carried out in different parts of Niger and included in mimeographed reports by O.C.C.G.E. show that urinary schistosomiasis is far more widespread and prevalent than has been thought. Field trips to rice irrigation schemes at Libore and Tillabery, where water is pumped from the Niger River, indicate that both snails and the infection in humans are common. Examination of irrigation schemes in the Maggia valley near Birni N'konni and at Galmi indicated presence of the snail intermediate hosts of urinary schistosomiasis. Laboratory records at the Clinic of the Soudan Interior Mission (SIM) near Galmi indicated many cases of urinary schistosomiasis in patients who have come for other ailments. This suggests that prevalences would be high if epidemiological surveys were carried out in the various villages near the irrigation schemes. Laboratory records at the same clinic also showed a high prevalence of malaria. The snail intermediate host for intestinal schistosomiasis, Schistosoma mansoni, is found in one area, that of Gaya, and the infection has just been diagnosed among inhabitants of some villages in the area. Thus, in Niger there seems to be a clear impact of surface water irrigation schemes on prevalence of both schistosomiasis and malaria.

The following recommendations are therefore made to deal with the situation.

#### 1. Establishment of a Central Authority

The Government of Niger should establish a strong, central inter-agency authority for planning, constructing and administering irrigation schemes and other water resource projects. This authority or commission should have broad delegated powers under the law and should not be directly responsible to the usual administrative agencies. The commission should consist of and require cooperation between irrigation, agriculture and public health agencies. The present <u>Genie Rural</u> and ONA'!A could serve as the nucleus for this commission, but there should be representation of the public health authorities on the commission. The decisions of the commission should be based on advice received from experts in the usually constituted departments of the government or from technical assistance provided by international agencies such as the World Health Organization, the Food and Agricultural Organization, the UNOP and others.

The commission should control all aspects of irrigated schemes, including establishment of water-use practices, control of the volume of water used on each farm, improvement and maintenance of the distribution system and enforcement of sanitary and vector control measures. It should be able to forbid agricultural practices known to encourage the transmission of disease. Such activities should increase crop yields, raise the standard of living and improve the health of people using the perimeters. With regard to new irrigation developments, the basic environmental sanitation and snail and mosquito larvae control measures should be carefully planned and "built into" each project from the very outset.

Within the commission, the health agencies should be responsible for preparing budget estimates and statements of justification for the recommended public health measures for water resource projects. The commission should be responsible for reviewing the final plans for all water and land resource projects to make sure that the various interests such as irrigation, agriculture and public health have been properly considered. Similar interagency commissions have been operating well in the Sudan, Zaire and Zimbabwe.

## 2. Collaboration

USAID should collaborate with the Niger Ministry of Health and with O.C.C.G.E. about matters dealing with epidemiology and control of schistosomiasis. The personnel at O.C.C.G.E. who are seconded from O.R.S.T.O.M. (Paris), are very familiar with the schistosomiasis problem in Niger. One or two persons from the Ministry of Health should associate with O.C.C.G.E. to observe surveillance methods, snail sampling and snail identification techniques and diagnosis of the infection in humans.

USAID/Niger and the Niger Ministry of Health should also collaborate with USAID/Cameroon and the USAID Schistosomiasis Research Center in Yaounde. The latter center should be operating toward the end of the year. Third country training in Yaounde can be provided to one or two persons, preferably biologists, from the Ministry of Health in Niamey. Graduate training for one or two persons from the Ministry of Health can be arranged through USAID/Niger, USAID/Cameroon and the Schistosomiasis Research Center in Yaounde.

#### 3. Improving Existing Irrigation Schemes

a) In existing irrigation schemes, proper maintenance of canals is important, and this includes the removal of silt and acuatic vegetation. Silting in irrigation canals reduces water velocities and encourages the growth of aquatic weeds. These conditions, in turn, create suitable snail and mosquito larvae habitats. The prevention, reduction or cleaning of the deposited silt in canals not only ensures the proper functioning of an irrigation scheme, but also helps to control snail and

 $\prime_{(l_j)}$ 

mosquito larvae. The design of distribution systems should keep most of the sediment that enters the canals in suspension so it can be carried through to the fields.

Removal of silt and aquatic and bank vegetation can be done mechanically by dredging and scraping, or manually by pulling and cutting. This should be done regularly. This job can be assigned to the cooperatives in the existing irrigation schemes in Niger. The use of chemical herbicides against canal vegetation should be avoided because some of these may be toxic to crops.

- b) In addition to clearance of weeds and mud in irrigation canals, twice or three times a year applications of the molluscicide Bayluscide (niclosamide) is also recommended. Both a powdered formulation and an emulsifiable concentrate are available. The molluscicide operation will cost about \$5,000 per application for a scheme of 250 hectares.
- c) An L-shaped screen to serve as a mechanical barrier should be installed at the beginning of the main canal to hold back debris to which snails are attached.
- d) Seepage from canals or fields should be avoided.
- e) To control snails in reservoirs, the design of the reservoirs should avoid bays at the margins whenever possible. Also, removal of weeds and debris discourage snail breeding. Small reservoirs may be fenced to prevent human access, and in this way prevent transmission. However, where access to the reservoir is necessary, providing a water supply take-off below the dam reduces the need for contact with the main body of water. This is recommended by the World Health Organization (1965).
- f) Primary health care should provide chemotherapeutic treatment for infected individuals in the community, especially children. Fortunately, drugs with few or no side effects are now available.
- g) Health education about the ravages of schistosomiasis and malaria should be strengthened. Emphasis should be placed on advising the people not to pollute the water with their excreta.

## '4. New Irrigation Schemes

a) Where irrigation water is pumped from a river, the pump should be at least three meters away from the bank to reduce the chance of pumping in snails. The pump should also be provided with a strainer to hold back all debris to which snails may be attached. A mechanical barrier, as described for the existing schemes, should be installed at the beginning of the main canal to hold back any debris which escapes the action of the strainer on the pump.

 $<sup>\</sup>frac{1}{As}$  recommended by Malek (1962) for irrigation schemes operated by pumps from the Nile in the Sudan.

- b) Canals should be constructed with grades that ensure nonsilting; i.e. with high velocities. Where the flow is sluggish or where canals are used for night storage, conditions favor the establishment of snail colonies.
- c) Distribution systems should be designed so that whole sectors may be isolated in order that secondary and tertiary canals may be dried out periodically as a snail control measure. This procedure is actually being practiced in Konni I, and may be the reason why no snails were found in the canals of this irrigation scheme.
- d) Attempts should be made to screen settlers of new irrigation schemes. Urine examinations should be conducted and if individuals are found infected, they should be treated.
- e) Siting of new villages should be carefully planned. The villages should be situated, as much as possible, far from the irrigation scheme. Water for human consumption should be supplied through wells.

## 5. Cropping Systems

Double cropping with rice requires more water in the canals and fields than alternating crops. Therefore, rice cultivation followed by cotton or any other crop that demands less water than rice is probably unfavorable for establishment of snail colonies and mosquito larvae breeding. This should be encouraged.

## ANNEX K

## ASSESSMENT OF THE ENGINEERING ASPECTS OF IRRIGATION IN NIGER

#### Glenn Anders

## Table of Contents

		Page
Α.	Summary	K-1
	1. Design and Construction Costs	K-1
	2. Water Sources	К-2
	3. Water Supply and Management	К-З
	4. Institutions and Support	K-4
в.	Design and Construction Costs	K-7
	1. System Design	K-8
	2. Construction Contracting	K-10
с.	Water Sources	K-13
	1. Niger River Valley	K-13
	a. Topography	K-13
	b. Hydrology	K-15
	c. Irrigation	K-17
	2. Watersheds and Intermittant Streams	К-20
	a. The Groubi Valleys	K-21
	b The Komadougou	K-22
	c. Other	K-22
	3. Groundwater	K-22
	a. Alluvial Aquifers	K-23
	b. Dalcols	К-23
	c. Ader Doutchi Maggia	K-24
	d. Goulbis	K-24
	e. Korama Basin	K-25
	f. Others	K-25
D.	Water Supply and Management	K-26
	l. Pumping	K-26
	a. Motoria Pumping	K-27
	b. Non-motorized Pumping	K-29
	c. Wells and Intakes	K-31
	2. Application	K-32
	a Rice	X-32
	b. Cotton	K-33
	c Chich	K-33
	3. Conveyance	K-34
E.	Institutions and Support	K-35
	1. ONAHA and the Genic Rural	К-36
	2. Frivate Sector	K-44

.

 $\chi_{0(1)}$ 

## ASSESSMENT OF THE ENGINEERING ASPECTS OF IRRIGATION IN NIGER

#### A. SUMMARY

The following assessment of the engineering aspects of irrigated agriculture in Niger can be summarized as follows:

## A.1 Design and Construction Costs

The costs of designing and constructing most types of irrigation systems in Niger are very high by Sahelian standards and are among the most expensive world-wide. These high costs, combined with the low productivity of most existing systems, have curtailed the financing and development of new irrigation systems.

Most studies and resulting designs of larger irrigation systems are produced by a few European engineering firms financed by external donors. This is not particularly competitive nor cost-conscious and probably results in higher costs and more expensive than necessary designs. However, economies in study and design costs would probably be unwise; if anything, study and design should be improved in large as well as in small systems by more fieldwork and informed analysis which may increase these costs.

Some savings may be attainable by simplifying overall system designs. There is tendency towards overdesign (i.e. larger structures, keavy reinforcement, redundancies, etc.) which is an understandable reaction to and guarantee against uncertainties in construction, management and maintenance.

Substantial savings (10-15%) in construction costs can be achieved by giving parcel holders responsibility for completing tertiary and quartenary works and final leveling and bunding. This will, however, lengthen the construction time and require assistance to, and management of, the farmers' work.

High construction costs are also to a large extent a result of limited competition among the small number of construction contractors capable of irrigation works. Only three or four European contractors in Niger have the technically skilled personnel and type of equipment required for the topographic and hydraulic precision and timely completion of extensive irrigation works. On the other hand, the uncertainty of national budgeting and donor financing contributes to high costs since contractors must absorb the overhead of maintaining expensive technical personnel and equipment while awaiting project and contract approvals. Associated cost factors are the difficult transportation links to land-locked Niger and the risks of political instability.

Force account construction by the government irrigation agency ONAHA would probably not result in significant cost savings in most cases, unless ONAHA could become a truly autonomous, independently managed state-owned company. Although such a change is not current government policy, ONAHA can be strengthened to serve the vital role of the intermediate "umbrella" technical assistance and contracting agency for irrigation development.

There appears to be considerable scope for, and potential cost savings in, developing the capability of local contractors to construct (and, in certain cases, help design) irrigation works. This includes farmer organizations, private jobbers (e.g. pump mechanics, well diggers and oxen drivers), and small companies with heavier equipment.

### A.2 Water Sources

The continuing severe reduction in the duration of the flood stages of the Niger River, as well as all other watercourses in the country, is necessitating the modification and redesign of many pumping systems and wate: supply channels.

The difference between the pumping system heights and the elevations of the lower river stages often exceeds suction head limitations, requiring a changeover to vertical axis, submerged systems. Re-excavating channels and the purchase of additional piping has been a particular burden for smallholders with vegetable gardens along the river banks.

In small watersheds, the sporadic, heavy rainfalls and consequent "flash" flood streamflow cause heavy erosion and sediment transport. This shortens the lives of infrastructure (i.e. dams) due to siltation and requires larger works to contain, control and route floods. Therefore, gravity systems fed by reservoirs in upstream catchments do not appear cost effective. The shallow, alluvial aquifers, and some deeper phreatic water tables and confined formations in certain regions have considerable potential for irrigation water supply for smaller-sized systems. Large diameter, nand-dug wells can easily tap many of these supplies, although yields at shallower (5-6m) well depths limit system design.

Stabilized shallow wells with casing and, in streambeds, with capping is a proven, cost-effective intervention. Little is known about the design and performance of small pumps with shallow wells; this requires investigation. Higher-yielding tubewells with submerged, multi-staged pumps may be a technically feasible next step for larger systems.

## A.3 Water Supply and Management

Pumpsets are seldom reasonably matched to their operating head and discharge conditions, hence pumping efficiencies are low from the outset. Thoughtful design and rational procurement of pumping systems is a rarity.

Endemic to almost all motorpump systems, large and small, are poor placement, careless operating practises, inconsistent maintenance and/or lack of spare parts. The large variety of motor and pump types exacerbates this situation and seriously hampers the transfer of technology.

Electric pumping is much less costly for either the larger systems located within several kilometers of a high-voltage line, or for smaller systems which can be linked to a central generator.

Small motorpumps can be cost-effective in irrigating high-value market gardens. However, human-powered (i.e. diaphram and foot) pumps and animal traction water-lifters are less technically demanding and less costly intermediate technologies, although they do not appear to be used.

The potential for windpumps appears limited by low average windspeeds. High capital costs still limit the applicability of solar pumping, although testing and trials of new systems should continue.

'AØ'I

The design and condition of canals is important but does not appear to be a major operational difficulty or inefficiency in most systems with two important exceptions: canals deteriorate rapidly when operations are constrained by other factors; and, at the parcel level, head ditches and furrows are seldom well-maintained.

In all sizes and types of systems, the greatest source of inefficiency and waste is over-irrigation at the farm level: in rice perimeters, many farmers transplant late, and others irrigate with available water even when the crop is mature, both causing large increases in water use; in mixed-crop systems with permeable soils, water is applied less frequently but in large amounts, resulting in high, deep percolation losses; and, even in small gardens, application rates were found to be twice that required.

#### A.4 Institutions and Support

The Nigerien institutions involved with irrigation engineering are young, somewhat disaggregated, and not well developed. The government institutions are the MRD's "Genie Rural" Department, and semi-autonomous ONAHA. Private enterprises consist primarily of several European engineering firms, construction contractors, and equipment dealers as well as a few Nigerien jobbers and small contractors. Several private voluntary organizations are also sources of technical services. Finally, and most critically, are the farmer organizations.

The "Genie Rural" is apparently charged with technical control of feasibilitylevel study and design and construction contracts, as well as general supervision of ONAHA. It is a ministerial department with a relatively small staff of engineers and technicians which is technically responsible for all rural construction and equipment.

ONAHA has, in five years, grown into a large semi-autonomous, state-run service agency for irrigation design, construction, management, and production. Due to budgetary support costs and questions of cost-effectiveness, its mandate has just been revised and limited to maintenance of public-financed systems and technical assistance to their farmer organizations. However, in the medium-term ONAHA will continue as the state's

103

K-4

irrigation construction agency. ONAHA's organization will be streamlined accordingly.

The responsibilities for irrigation development within the MRD are divided between the Genie Rural and ONAHA. This seems to be a somewhat diffuse institutional arrangement. It appears to create operational difficulties between two disparate administrative units, to disaggregate the mass of technical knowledge, and to complicate interactions with other government departments as well as with donors. One clearly focused, pre-eminent and autonomous institution would probably be more effective and responsive.

There is certainly a need for a major upgrading of the limited irrigation know-how at all levels within the MRD. Concise, tailored, intensive training could provide this: irrigation design, efficiency, and scheduling for engineers and managers; basic hydraulics and crop requirements for mid-level technicians; and, fundamentals of crop water use for extension agents. Another important informational need is specific technical feedback from research units.

The establishment of a governmental "career track" in irrigation would help to concentrate and build on the existing manpower base through promotional incentive. The MRD reassignment system tends to dilute existing irrigation experience in that rewarding reassignments are usually diagonal, i.e. to move up, personnel often move to another unit or project. Formation of an irrigation "corps" along the lines of U.S. organizations would focus a specialized cadre on the subsector.

The technical staffs of the Ministry of Hydraulic and OFEDES which are, inter alia, responsible for groundwater resources should also be included in irrigation development. As surface water sources continue to be limited by drought and their potential more completely exploited, groundwater becomes an increasingly attractive source for irrigation supply. Yet, all government technical assistance seems to be directed at surface water irrigation supply.

Supporting services for irrigation are as yet underdeveloped in the Nigerien private sector. A wide range of construction, maintenance, and supply services

K-5

could be provided cost-effective through contracts with small enterprises, private jobbers, and even farmer organizations. Technical control and equipment credits or rental (possibly from ONAHA), as well as specific training, would be necessary.

Farmers and farmer organizations are the end-users and, consequently, most directly responsible for saving water and application efficiency. Of primary importance are clear, monetary and organizational incentives for conservative water use, and a culturally-tailored, widespread, and frequently repeated training program in on-farm water management. This is a critical necessity as the farmer organizations are moved toward autonomy.

Private voluntary organizations and, to a minor extent, the Agriculture Extension Service appear to be the only institutions providing any technical assistance for smaller, private irrigation systems. These systems would profit from more informed technical guidance, particularly in pump selection and crop water requirements. The institutional possibilities for assistance need examination.

120<sup>5</sup>
#### B. DESIGN AND CONSTRUCTION COSTS

The costs of constructing irrigation systems in the Sahel are variable, but consistently high. A recent FAO/OMVS report gives an average 1983 cost of \$13,000/ha (i.e. per net cultivable bectare) for West Africa compared with comparable costs of \$8,500/ha for the Near East, \$6300/ha for Latin America, and \$4,500/ha for the Far East. The 1975-1980 cost inflator for irrigation development in West Africa is about 30% per annum over twice that of other regions of the world. Although these development costs can be extremely variable, the averages and trends are significant. As pointed out by the World Bank and the CILSS, high costs are currently a serious limitation in the expansion of irrigated agriculture in the Sahel.

The costs of irrigation development in Niget are extremely high even by Sahelian standards. The current Genie Rural planning figure is \$15,000/ha and ONAHA's 1982 estimate is \$12,000/ha for development of an irrigated perimeter with total water control in the Niger Valley. Recent "hard" costs include the 260ha system at Toula completed in 1980 at over \$10,000/ha and the 220ha perimeter at Firgoun completed (partially by force account) in 1982 for only slightly less. Gravity-fed systems with associated dams, reservoirs, and supply canals can cost even more: the recently-completed 500ha system in Galmi cost approximately \$17,700/ha. By comparison, Upper Volta's ONBI estimated 1983 costs at about \$9000/ha for systems with pumps and tubwells and \$4500/ha for gravity-fed systems with small dams for systems no larger than 100ha. Unit costs in Mali and Senegal vary widely but only exceptionally surpassed \$10,000/ha during the last year.

Unit costs can, of course, also be much lower for simple less-intensive irrigation systems. Improving "floating" rice or recessional sorghum cultivation with flood control earthworks cost about \$8,000ha and small (1-3ha) improved gardens with motorpumps usually cost less than \$3000/ha. The composition of these costs and the factors contributing to their inflation will be discussed below.

206

#### B.1 System Design

The design of the systems themselves influences cost of development. For the purposes of this analysis the following table breaks down the total costs into approximate percentages which can be attributed to each of the major components of different categories of irrigation systems.

	Total Water	Improved Water
	Control	Control
Study, Surveys, Designs,		
Plans, etc.	15%	5%
Water Supply: Pumps	107	
Wells	10%	60%
Dams	40%	
Major Canal Network	30-40%	10-20%
Parcels: Ditches, Bunding,		
Leveling	15%	10%
Flood Protection	15%	5%

First, and toremost, the most critical element in system design is the technical study design and control process itself. This generally accounts for only 5-15% part of the total costs. It is, however, vital in order to produce a workable system. Since so many irrigation system designs throughout the Sahel are inappropriate, and some even technically unfeasible, major economies in the design process would probably be self-defeating. These costs .y well increase, if that's what it takes to improve the present system designs.

Let experience indicates that irrigation systems are too often designed in ignorance of the existing natural and agricultural milieu. This occurs almost as frequently in small, privately-developed system design, as in larger, more organized, state or donor-financed ones. The only difference is that smaller, lower-investment systems can usually be modified (or dropped) more rapidly to compensate for design flaws. Ignorance of the physical and human dimensions of an irrigation intervention at a particular rural site is found as often in offices in Europe as in those of the host-country's own capital city. Examples are rife: problematic soils, misjudged flood levels, cut-off access ways, etc.

1,01

The solution is fieldwork; interdisciplinary fieldwork, when possible, but more and better fieldwork to understand the situation and learn from what exists and what's been tried. Increases in overall study design costs which will lead to better understanding should result in a less expensive, more workable irrigation system.

The cost of the water supply infrastructure is a highly variable portion of the total cost of a system and depends on whether dam construction is involved. Also, the proportional cost for the water supply hardware is larger in the smaller systems. Water supply is the most fundamental component of a system and the cost is relatively fixed. The capital costs of pumps are generally less of an issue than their operating costs. But as noted in the SOGREAH- LBII Rehabilitation Study, motors and pumps are often poorly matched to their operating (head and discharge) conditions resulting in far less than optimal efficiencies. Electric pumps are one solution to this due to their operational flexibility. However, at off-grid, small systems diesel motorpumps will continue to be the prevalent technology. The choice of pumpset is usually based on availability or donor procurement procedures rather than on operating conditions and performance needs.

In the case of water supply from a gravity system, construction of the dam and delivery canal are usually the major costs in the system. For instance, at the Konni and Galmi developments, over 50% of the capital cost is attributable to dam and canal construction. Since the life of the dams limited by high rates of siltation and the costs of such large-scale infrastructure are so high, a more economic alternative might be pumping from tube wells. This is discussed under Water Sources.

The other large component of total cost is the major canal system. In systems with full water control, this is inevitably carefully constructed on compacted fill and lined with concrete slabs. This lining may not be necessary in areas with heavier soils or laterites. A less-expensive, less-durable lining may also suffice. But, the important distribution and measurement functions and the problematical maintenance of primary and secondary canal networks precludes significant economies in this part of the system. If anything, the observed need for measuring weirs and flumes could increase the proportional

000

cost of these networks. Still, the size and complexity of these networks often appears to be an unnecessary substitution of capital infrastructure for management and labor.

The costs of irrigation works can be most directly and effectively reduced at the level of the individual parcels. Farmers who can find the labor necessary to cultivate and harvest an irrigated parcel (especially one cropped in rice) should also be able to mobilize the labor required initially to layout that parcel. Leveling the parcels, building bunds, digging head ditches and installing low-cost turn-outs do not require a construction contractor. Simple demonstrations, basic topographical control (i.e. vertical levels) and appropriate tools would enable farmers to develop their parcels on their own. The amount of work required is estimated at 200-300 person-days. Furthermore, farmer participation in the initial construction would increase a sense of ownership and maintenance responsibility, which may yield dividends in future savings on operating and rehabilitation costs.

Construction by farmers does however require close and conscientious technical assistance. Surveying and staking are critically important. Also, due to the disaggregation of the work and loss of direct contractual control the final completion of the irrigation system, and consequent initial production will be delayed. However, the savings in development costs, estimated at \$1000-2500/ ha, and the gains in farmer involvement appear well worthwhile. Farmer participation has been proposed for the AID-financed OMVS/IDP perimeter construction based on the experience of SONADER in Mauritania. The SOGREAH-LBII Rehabilitation Study for Niger also proposes farmer participation.

## B.2 Construction Contracting

Most of the larger irrigation schemes in Niger have been designed and constructed by a small number of French companies. SATOM and SCET are two well-known consulting engineering firms responsible for the design of a large number of irrigation systems in Niger as well as throughout Africa. SOGREAH is in fact one of the consulting engineers for the large IDA-financed rehabilitation project.

Contracts for the construction of irrigation systems in Niger have usually been awarded to one or more of three French construction companies, Dragages, SATOM and Jean Lefevre. These companies often subcontract to smaller Nigerien firms for various smaller portions of the work. these three large construction contractors have both the high-priced engineering staff and costly earthmoving equipment necessary to plan, execute and control the large and precision civil and earthworks required by any but the smallest (i.e. less than 5 ha) irrigation systems.

Few, if any, Nigerien building contractors have this capital and capability. A considerable amount of earthmoving is usually necessary for the construction of the major canal network and drains, flood protection dikes and channels, and preliminary leveling, even in relatively minor irrigation systems. Per unit of area, this work requires substantial energy inputs, for the most part motorized, due to the limitations and low productivity of labor and animal traction in the Sahel. More critically, this type of work requires a considerable degree of technical field control in design, layout and leveling to ensure efficient use of the critical resource, water. Only in small irrigated gardens and at selected exceptional sites are these inputs unnecessary.

The small number of contractors who possess the requisite technical experience, personnel and equipment, has led to limited competition for such work, and hence, higher contract costs. On the other hand, the higher contracting costs are also a product of the uncertainty, irregularity and delays in both Nigerien and donor government plans and financing. For this reason, contractors must often support heavy overhead costs to keep high-value personnel and equipment in place often under difficult conditions in expectation of future work. Realistic, medium-term planning of specific projects and donor-government guarantees and perhaps even retainers, may be a way of moderating these risks for the contractor and resulting costs to the project.

However, the underlying problem remains the lack of a local technical capability

to construct (nevertheless, design) irrigation works. This has led both the Nigerien government and donors to create and strengthen the parastatal, ONAHA, as the state's implementor and manager of irrigation works. This would, it

210

was thought, lower costs, ensure a reliable design and construction capability, and develop competent national personnel. Therefore, ONAHA has become, in part, a government engineering and construction company with a substantial staff and equipment pool. So far, based upon the ONAHA-executed works at Namari-Goungou and Firgoun, this has not resulted in significant reductions in costs and has increased the charge to the national budget.

Although ONAHA's relative youth (five years) may be a large cause for its inefficiency and non-competitiveness, it is doubtful that a large state construction institution can ever be competitive in real terms with private contractors, except in the riskiest, most financially unattractive circumstances. Recent experience in Mali is indicative: the unit construction costs for earthmoving quoted by the Malian rural works parastatal, OTER, for a recent project were the same as those quoted by two private contractors. Although OTER has completed a number of irrigation works it is not considered to be particularly cost-effective in its operations.

A surer way to increase local capabilities, and competition would probably be to develop or strengthen small Nigerien construction contractors. These small contractors (some of whom have already done subcontracting for the larger French firms in irrigation work) are, generally, most capable in small building construction. With adequate incentives, experience with and access to heavy equipment (through rental or purchase arrangements) and technical assistance and control, some of these contractors could become capable and cost-effective in irrigation work. Technical control is, however, critical; it is the role which a technically-strengthen ONAHA could most appropriately and effectively fulfill. This is further discussed under Institutions and Support.

# C. WATER SOURCES

There are basically three major types of water sources used for irrigation in Niger:

- The Niger R\_ver and its major tributaries from which water can be diverted during flood stages, or (increasingly more common) pumped year-round into an irrigation system;
- Small watersheds and intermittant streams whose runoff can be trapped or collected in depressions or small dams, to provide water for recessional, gravity-fed, and/or pumping systems; and,
- Groundwater in both shallow alluviums and several deeper aquifers, found primarily in ancient river valley formations, from which water is pumped to surface systems.

Each type of water source has different constraints for irrigation. A more detailed description of each type of source follows.

# C.l Niger River Valley

A 550 km-long reach of the Niger River runs NW-SE through the western corner of the country. The watershed within Niger covers 485,000 km<sup>2</sup>. There is an additional 700,000 km<sup>2</sup> of ancient watershed surrounding the "dallols" or fossil riverbeds in the Niger River Basin north and west of the river. The flow entering this section of the river arises from the drainage of basins and the discharge from the interior delta (macina) and lake region in Mali.

### a) Topography

Within Niger, the river valley can be subdivided into three topographically distinct securions:

- From the Malian border southeast through Niamey for approximately 300 km, the valley alluviums extend several kilometers wide. The river has a slope of about .00012-15.
- (2) Southeast of Niamey the river runs between sandstone cliffs for about 100 km. Here the river has little slope but changes course several times (this is called the "W"). The valley is narrow and enclosed in this section; and,
- (3) From the "W" to the Nigerien border, about 130 km, the valley again widens to about 4 km with a very slight river slope of only about .00008.

:AV

Examining the first section northwest of Losso, the valley is made up of a large several kilometer-wide floodplain through which wanders the riverbed itself, often with several branches. In this plain there are many levels of alluvial terraces formed by the river's meander. This plain is also cut divided by ancient bedrocks, newer outcroppings and former dunes which yield a considerable micro-relief and delimit elongated basins between them. The soils in these basins are generally hydromorphic clays, which are well-suited to rice cropping.

The floodplain is often bordered by wide colluvial terraces which lead up to short cliffs marking the Continental Terminal. These terraces are densely incised with drainage ravines. These soils are shallow and highly mineralized from their parent rock and contain large deposits of eolian sands. They are not suited to irrigation, and are responsible for difficulties encountered at four existing perimeters (Sakoira, Tillakeina, Tillabery and Lossa). However, the edges of the floodplain also contains older, lower colluviums, high alluvial terraces and river banks which are not flooded and are composed of well-drained sandy, silty clays. These are well-suited for small irrigated polders with mixed crops. The southeastermost section of the river runs through a wide, sedimentary valley of approximately 400 km<sup>2</sup>. Tributary, seasonal streams contribute significantly to the river's flow in this valley and annual rainfall attains 1000 mm. This permits rice cropping through the cold dry season (October to May).

The soils in the floodplain of this valley are generally hydromorphic and clayey and well-suited to rice. However, the edges of the flood plains are composed of terraces and slopes made up of sandy-silty alluvial and colluvial soils. These formations are generally good aquifers with significant yields at shallow depths (+ 3m).

 $A^{\dagger}$ 

# b) Hydrology

The hydrology of the Niger River is relatively well-known. The river's regime is shown by the hydrograph on the following page. It is characterized by a gap between the high river stage in February and the rainy season in June to October. The flows of the river from April to July fall to at least a tenth of the mean annual flow. The river is lowest in June. A ORSTOM-SOFRELEC study indicated a 50-year, 10-day average low-stage flow of 16m<sup>3</sup>/s at Niamey. The lowest daily flow recorded at Niamey was 0.6m<sup>3</sup>/s on July 4, 1974.

Since 1971 there have been particularly severe series of low river stages due to several factors. The first is the low annual rainfalls of the last decade. a trend which may be transitory or cyclical. Second is a physical anomaly of the river basin which is probably due to an evolution of the hydrological regime in the lake basin in Mali causing a more rapid drainage of this basin, and consequently more precipitous changes in downstream flows. Finally, outtakes due to human development upstream has no doubt altered the river's regime although the impacts of these actions are not precisely known. Therefore, hydrologic studies based on data from the years prior to 1970 should be used with caution since they do not reflect the tendency of accentuated river stages. In fact, it would probably be more realistic to consider the average 10-day low-stage flows of 1973-74: 6m<sup>3</sup>/s at Niamey. More recent hydrologic data indicates that 1983-84 river stages have even . lower flows. Assuming that consumption for human industrial and human needs will reach lm<sup>3</sup>/s in 1990, and that the flow downstream of Niamey must remain several  $m^3/s$ , one realizes that at approximately 1  $m^3/s$  needed for 500ha of irrigation little flow remains for agriculture upstream from Niamey without storage.

A major purpose of the proposed dam at Kandadji will be to store water in both to augment the flow at low river stages and supply irrigation for an additional 140 000ha downstream (110 000ha of terrace land for mixed cropping and 30 000ha of flood zones for rice crops).



## c) Irrigation

Three systems of traditional agriculture are practised in the river valley:

- rainfed cuitivation of millet and sorghum on the eroded, sandy terraces bordering the valley;
- long-stemmed or 'floating" rice cultivation which is planted with the rains in the riverbed and flooded as the river rises; and
- vegetable gardening (primarily onions, sweet potatoes, manioc, etc.) during the cold season on the river banks and watered by hand.
   Since 1953, a number of large, modern irrigation systems have been built in the valley. A cropping calendar of these systems and its relationship with rainfall and river stages is shown on the following page.

All along both banks ci the river small vegetable gardens are cultivated from November to April during the higher river stages. Well-developed sites are found at Say, Gotheye, Gaya and Niamey. These gardens are located on the river banks and alluvial and erosion terraces which are not flooded during high river stages and peak flows in January-February.

The soils are shallow, sandy-silty colluviums with varying proportions of clay, and sometimes rocky. They generally have high infiltration rates and low water storage capacities.

Water is generally brought to these gardens by a channel or series of channels which are dug, often cooperatively, from the flood zones at a depth below the high river stage. Water is lifted 1-1.5m out of these channels with buckets or calabashes and poured doto either a small basin or another canal which feeds a small, rudimentary system of canals. Flows in these systems are on the order of 0.5-1.5 1/s or less. Individual gardens seldom exceed  $300m^2$ .

The reduced duration and accelerated recession of the flood stages of the Niger in the past 3 years (1981-83) has caused severe water supply problems for these gardens. Due to the rapid flood recession, the water supply channels empty several weeks before the end of the crop cycle. The large amounts of labor necessary to deepen the supply channels, and the cost of motorpumping are often beyond the means of the farmers or the returns from some of the crops. Yet large number of 1-3HP gasoline- and diesel-fueled







centrifugal pumps are now in use along the river. Several problems have been noted with these new pumping operations. The small earthen canals are rapidly scoured by the higher velocities of the pumped water; erosion and consequently leakage were widely evident. Pump and intake handling and placement are also poor, resulting in heavy wear and shortening life of pumping equipment.

Two major types of modern irrigation systems have been established in the Niger river valley. The first, and most numerous type, is located in the clayey, gleysols of the basins or former channels in the riverine flocd plains. These are generally not larger than 500ha (200ha average) and, being part of a riverine flood zone, have an elongated form with an accented microreliéf. The principle of these systems is to enclose a topographically and pedologically suitable area with a flood protection dike with large capacity intake and drainage structures and a water control system. At present, 20 such systems cover about 6,000ha, of which 3,900ha are actually under irrigation.

There are three levels of water control in these systems:

- Simple flooding: Perimeter dikes with intake and drainage structures and channels; controlled flooding from a river depth of 1.7m into the interior; diked terraces flooded to a depth of 20-70cm; and gravity drainage.
- Controlled flooding: As above, with water supply and drainage ensured by a central pumping system connected with the river.
- Controlled submersion: As above, with leveling and complete supply and drainage canal systems; water depths are controlled to 10-20 cm.

A second type of irrigated perimeter is on the colluvial terraces along the edges of the river valley. These perimeters are small, less than 100ha, and are not numerous (7 perimeters totaling 550ha). They are comparable to the "small" irrigated perimeters financed by AID in Bakel, Senegal. The soils at these sites are similar to those well-drained, sandy, transported and eroded materials described previously under vegetable gardens.

ŷ,Û

Since these sites are located at the valley's edge outside of the flooded zone large flood protection dikes are not necessary, but pumping is. Lifts range from 5-10m. The irrigation system is generally composed of a network of canals at least partly lined with rock or concrete (usually in poor condition) from which parcels are watered in furrows. Cropping is mixed: cereals, vegetables, fruits, etc.

## C.2 Watersheds and Intermittant Streams

## Ader-Doutchi-Maggia:

Most watershed catchment systems are found in the Ader Doutchi Maggia. This region is in the center of Niger, between isohyetes 850mm and 550mm, and covers about a million hectares. Although slopes are relatively gentle in the region the topography is marked by three large valleys (Keita, Badeguicheri, and Maggia) up to 2km wide which are drained by well-eroded seasonal stream beds, which can be as deep as 100m below the surface of the surrounding plateaus. The sides of the valleys are steep cuts over which large quantities of runoff fall, often causing flash floods.

Although the soils of the plateaus are generally poor ferrugineous sands, the soils in the valley bottoms and stream beds are deep, sandy-silty clay alluviums of considerable agricultural importance.

The rate of erosion is high; the runoff is heavy and abrupt and carries large amounts of sediment. For example, erosion in the watershed above Ibohamane can be estimated at approximately 2250 tons/ha/year. The extreme variations in the intensity of rainfall in the region makes correlations between rainfall and runoff difficult. Annual flood flows are likewise highly variable with extreme peaks.

Part of this large volume of runoff can however be collected by earthen dams. Seven dams were constructed in the late 1960s. These are earth-filled, several meters high, with volumes varying from 250,000 to 6,000,000 m<sup>3</sup>. Water is supplied to the irrigation systems (15 to 450ha) directly downstream by way of a central gate and delivery canals. Several large dams at Konni and at Galmi were completed recently. These are characterized by bigger reservoirs, long delivery canals, and much larger irrigation systems (500-2500ha). Sorghum and cotton are generally cultivated in these irrigation systems, although vegetable crops are also prevalent (at Galmi, the predominant crop is onions).

The catchment systems have several drawbacks which in many cases caused severe limitations or abandonment. Due to the high rates of erosion in the watersheds, sedimentation in the reservoirs is heavy, rapidly reducing the storage capacity and water supply. Most of these dams lose half their capacity in 10-15 years due to siltation. The high intensity rainfall in the region also causes flash flooding which is difficult to route out of the system; three dams have been severely damaged by floods. In order to design for these flood flow conditions, costs are exceedingly high.

An indigenous, simple type of water catchment is also practised in this region. In the flatter parts of the stream beds (slopes of .001), farmers dig small bunds and ditches to hold and distribute water after the rains. As the surface water dries up, the crops (sorghum and cotton) are later watered from small wells dug to the shallow alluvial water table in order to bring the crops to maturity. Intense rainstorms, and consequent heavy runoff and flooding late in the season, frequently destroy these small catchments which are located in the flood zones.

## a) The "Goulbi" Valleys

The three valleys of Maradi, Kaba and Tarka are all part of the same hydrographic system which has developed in an arc around Maradi. These valleys are 2-8km wide, but receive heavy runoff which causes flash flooding down the watercourses. Studies were conducted in the 1960s on the possibility of a catchment system with downstream irrigation. These studies indicated that the extremely high and rapid flood stages would cause difficult design problems and very high costs. Groundwater appears to be a better source of water supply in these valleys as discussed later.

930

## b) The Komadougou

This river has its source in the Jos highlands of Nigeria, delimits the border between Niger and Nigeria for a distance of 150km, and drains into Lake Chad. The river is intermittent with an average flow of 9.5m<sup>3</sup>/s during 5-6 months of the year. Several large depressions along the river bed store large quantities of water throughout the year.

Since the 1960s two types of irrigation systems have been developed in the Komadougou. The first consists of gated dikes across various arms of the river which retain water for flooded rice cultivation within the diked area. Rice cropping has diminished due to the severe reduction in flows over the last few years. These basins also provide a supply of water for winter vegetables and wheat during the dry season. These crops are cultivated on the river terraces; water is lifted up from the marshes or reservoirs with chadouf or small (1-2HF) motor-pump.

The Kamadougou's flow is affected by upstream dams in Nigeria. Exploitation of the surface waters in the river is apparently a bilateral problem which is still under discussion.

## c) Other

Seasonal, and sometimes perennial, water supplies are available in natural basins (or marshes) found in many valleys. These include the marshes of Goure-Maine-Soroa, the Korama basin and Lake Chad. Recession cultivation is practised widely in these areas, but chadoufs and small motorpumps are also utilized for garden irrigation on the banks.

# C.3 Groundwater

There have been a number of hydro-geological surveys of Niger over the last 30 years. An "atlas" of groundwater resources was published in 1978. The Ministry of Hydraulics has records on about 1000 wells, although a large number of recent wells, many financed by PVOs are not as yet indexed. Supplementary studies are still necessary for a better idea of the potential of those aquifers which have limited recharge.

J.J.

# a) Alluvial Aquifers

Substantial quantities of groundwater are found in the deep alluviums of most of the dry, ancient river valleys in Niger. Many of these valleys are variously called "dallols", "goulbis", or "koris" depending on the nature of their seasonal flooding. The soils in these valleys are often fertile, but the small intermittant water flows and the totpography do not favor surface water collection. Most of these valleys contain some type of small, irrigated development supplied by shallow large-bore wells.

#### b) **Dallols**:

The dallols are ancient riverbeds in the form of 2-30 km wide, sedimentfilled valleys, generally running in a north-south direction and emptying into the Niger River Valley. Their soils are generally poor, sandy, and heavily leached. However, they also contain a series of basins with heavier soils which become marshes in the rainy season. (A few deeper basins are permanently saturated). Somewhat more fertile colluvial deposits are found on their sideslopes.

Stream flows from runoff are relatively small, diffuse, and mostly localized in the northern upstream reaches. The groundwater resources are substantial and are recharged by several large continental formations as well as by local infiltration of rainfall and runoff. The groundwater available in the alluviums of the dallols is estimated to be about 1500 1/s in the northern reaches to the 7000 1/s in the south (FAO-UNDP). This is sufficient for small-scale developments in the north and, where the soil quality permits, larger irrigation development in the south. The most ideal sites for irrigation are, of course, the basins, due to the heavier soils and proximity to groundwater (several meters).

Traditional irrigation consists of recession cropping and watering small gardens from the marshes with calabashes. Crops include sweet potatoes, corn and vegetables. Several PVO's are supporting projects to top the shallow aquifers with concrete-cased, large-bore wells with yields of about 1 1/s serving individual, small 1/4-1/3HP gardens. There is considerable physical potential for expansion of irrigation systems within the dallols.

2.3,2

K-23

#### c) Ader Doutchi Maggia

This region is also described under Watersheds. This series of valleys has alluvial aquifers which are recharged by runoff from the surrounding hills. These aquifers 6-20m thick, and in areas where the valleys' slopes exceed about 1%, they are often cut and drained by erosion ravines. In areas with bedrock gypsum deposits, the groundwater may contain 500-1000 mg/l of salt. Well yields vary from 1 1/s to as much as 6 1/s at pumping depths less than 10m.

Traditionally, there has been widespread use of the groundwater for the irrigation of onions during the cold dry season. Water is drawn from shallow wells and distributed by small ditches into  $10-20m^2$  border strips. Several PVO projects in the area are involved with casing and improving these wells.

The SOGREAH-LBII Study recommends exploitation of these shallow aquifers as an economically interesting investment: a 15m deep well yielding 5 1/s could irrigate about 1.7ha. A hydrological investigation of the valleys to quantify the groundwater resources will probably be a part of the IDA project.

### d) Goulbis

The goulbis are riverbeds with intermittent, seasonal flows with numerous pockets of permanent surface water. Their shallow aquifers are recharged both by runoff and continental formations which they cut. Groundwater levels are from 2m to 10m from the surface. Heavy streamflows and flash floods during heavy rainfall are a problem. Their soils are very heterogeneous, variously hydromorphic and consist of recent alluvial deposits with good agronomic potential.

There is a considerable number of traditional market gardens irrigated from shallow wells in the goulbis. A number of studies and projects have been undertaken as well. The BIRD-CCCE Maradi productivity project has developed 500ha irrigated from tubewells. BRGM has completed a favorable study of the goulbi at Tarka. PVO's are also assisting market garden developments with improved wells.

122

#### e) Korama Basin

The shallow aquifers in the basin are sand formations recharged by runoff and are frequently exposed on the surface in the form of marshes. Their thickness varies from 10-20m with annual 1-2m fluctuations in depth. Well yields are good: 2-5 l/s.

The basin has good agronomic potential. The area around marshes is cultivated by recessional cropping and by small gardens watered with chadoufs and shallow (2m) wells. The basin appears to offer a good mix of water, land and labor resources for continued development of small group irrigation systems with motorpumps.

# f) Others

Shallow alluvial aquifers are found in several other valleys. The aquifer in the Goure-Maine-Soroa is a 20-30m thick sand formation with good yields on the order of 2-3 1/s; ACDI is financing 6 pilot perimeters in the Diffa Department. In the Agadez-Irhazer region, there are about 1000ha of small gardens irrigated from the Kori (stream) beds with large, deeper wells and animal-traction systems; both FED and CWS have improved about 500 wells. Localized, shallow aquifers are also found in the valleys of the right-bank tributaries of the Niger and in the Komadougou Valley.

## C.4 Deep Aquifers

These aquifers will only be briefly noted:

- The Continental Terminal of the Dogondoutchi syncline contains a sand formation under pressure which is drained into the dallols.
- The Hamadian Continental is a sandstone formation which extends throughtout most of Niger to a depth of several hundred maters. It is an immense reservoir, widely tapped by both tube and large bore wells with only negligable effect, and is artesian throughout large portions of the valleys discussed above with yields up to 2 l/s/m.
- The pliocene formation of Manga drains into the region around Diffa.
- The sandstone formations of Agadez and Irhazer is being studied and appears to have interesting potential.
- The sandstone formation or Bilma is also a substantial water resource.

### D. WATER SUPPLY AND MANAGEMENT

All irrigation systems consist of some method of tapping water at its source and conveying it to plants. This generally requires some energy input to move or life the water, as well as infrastructure to store, convey, and distribute it. These inputs represent expensive operational and capital investments in water, and often yield surprisingly high unit costs for water. Water then becomes another high-value input, like labor, fertilizers, pesticides, etc. and as why investment, the goal is to use as little of the input as possible for the greatest possible effect.

In irrightion systems, the optimum efficiency is the minimum amount of water supplied to the system that will ensure the requisite soil moisture for the root zone of the particular crop. The system from the water source to the plant root has three major sections: the supply mechanism (pumping or gravity-fed), the conveyance network (canals and pipes), and the method of application (basins, furrows, sprinklers, etc.). The following discussion examines the efficiencies of each of these parts of the system.

## D.1 Pumping

As river stages and water levels decrease, pumping from both surface and ground water sources becomes increasingly important. Most existing pumping systems in Niger have poor inefficiencies, with high rates of costs) of energy per unit of water delivered. The various causes of poor efficiency can be grouped into three major categories:

- Many pumps and motors are not matched to the physical conditions. Each pump operates most efficiently at a particular combinations of lift and flow and motors at particular combinations or load and speed. These pump and motor characteristics are seldom well-matched to the operating conditions in the field. Furthermore, the characteristics provided by pump and motor manufacturers are often different from those under field conditions.
- Pumps, motors, and associated piping are often poorly set-up. Pumps out
  of level or incorrectly fastened, motors unshaded or unventilated, and
  piping crimped or leaking are all onerous operating conditions which lower
  efficiencies.

Most importantly, pumping systems are seldom operated and maintained with requisite care. This results in a whole range of operating problems. The most critical: pump washer and gasket replacements, motor tune-ups, cleaning intake basins, and renewing pipe joints and fittings.

# a) Motorized Pumping

A comprehensive diagnostic of the types and condition of larger pumpsets in seventeen perimeters along the Niger River was undertaken in the SOGREAH-LBII Study:

- 1. Most pumpsets operating were outside of their optimal technical conditions. Intake and discharge levels were poorly defined. Pumpsets were adjusted or displaced to suit physical circumstances rather than optimal operating conditions. Of 23 pumpsets (diesel or electric), 15 had operating times in excess of the average maximum recommended for the particular pump or motor; some could be overhauled but most were in need of replacement.
- 2. At five perimeters with electric motors, power averages (excluding extremes) varied widely from about 300 to 800 kwn/hr/yr. Assuming generous average total head of 5 m and an annual water requirement of 28000 m<sup>3</sup> energy needs should not exceed 300-400 kwh/ha/yr at normal pumping efficiencies. For diesel powered pumping systems rates of fuel consumption were equally variable (100-300 1/ha/an). The figures are only indicative since the date base is highly uncertain and the cropping condition variable.
- Most operational problems are "classic" results of a lack of maintenance, especially of spare parts stocks.
- Most intake canals and bassins were silted up, vegetated poorly located and often too high for adequate provision of water during low river spaces, re-surveys and considerable dredging.

There is also a substantial savings to be gained by replacing diesel motors with electric where possible. A comparison of pumping systems at two comparable perimeters Toula and Saga indicates operating costs of about 8,000 CFA/ha for an electric system and 22,000 CFA/ha for a diesel system. The substantial savings in both operating and maintenance costs would enable the high cost of installing a line (2.50 millon CFA/km) at a perimeter, such as the 125-ha Karagorou, to be paid off in less than 10 years.

Nº b

The size of pumping stations or economies of scale appear to have little significant effect on overall costs of the system. Costs are so dependent on the efficiency of pump operations that the size of the station should be a function of the operational set-up, rather than of savings in capital investment. At larger perimeters, several smaller pumping stations, each the direct operational and maintenance responsibility of an autonomous farmer group or cooperative, would no doubt result in more accountability and better operations.

Little information is available on smaller pumping systems for gardens along the rivers, marshes or shallow wells. These portable motor-pumps are small, horizontal-axis centrifugal pumps powered by 1.5-5HP diesel motors. They range in cost from \$300-1000. Several issues pertinent to the use of these pumpsets are discussed below.

First, the private motorpump systems observed in use appear to suffer from many of the same operating problems as those discussed above at larger statedeveloped perimeters. The motorpumps are purchased based on price and availability, rather than being chosen to meet specific operating conditions. Furthermore, these operating conditions usually vary widely, as is the case along most rivers in Niger where the total pumping head may double. Therefore, many operate at highly inefficient combinations of head and discharge. Operating procedures and maintenance are generally also rudimentary; crimped and leaking piping, dirty air filters and silty intakes abound. There is obviously a greater private incentive to keep these pumpsets operating, so many of these pumpsets are kept running in a condition at which a state-financed pump would be abandoned. Furthermore, and perhaps most important, most private operations observed are only on high value market gardens and crops.

A second issue is the operational limits of these horizontal axis centrifugal pumps. In Niger such pumps should have a theoretical maximum met positive suction head of about 8 meters. In practise, due to the often harsh operating conditions it is probably unwise to exceed 6 meters. This poses operational constraints especially where the water source is shallow wells, few of which provide sufficient yields at that level for a motorpump. A 2HP motorpump would have discharge of about 12 1/s at a lift of 6m; even the best yielding

1,01

6m-deep wells in the Ader Doutchi yield only a quarter of this. The sites with shallow-well yields comensurate with this type of pumping system are only found in a few locations in the Maggia and other former river beds.

Therefore, widespread use these inexpensive motorpumps (i.e. to avoid the need of more expensive vertical-axis or submerged system) would proabably require investment in deep, larger-diameter, step-type wells in order to lower the pump and increase yield (even in the most permeable alluviums). A more technically-sound solution would seem to be tubwells with submersible pumps. The IDA Rehabilitation project will finance an investigation of this alternative.

A final issue involves the labor saved with small motorpumps. This can be summarized as follows:

Crop	Water Regulrement	Labor Hand Watering	Labor Pump	Cost of Pumping 6m @ 3 CFA/m <sup>3</sup>
Wheat	13 500 m <sup>3</sup>	920 days	80 days	48 750 CFA
Peppers	16 150	1060	160	58 775
Onions	9 700	640	95	25 000

This shows that for these high-value crops, the cost of small motorpump is operation equivalent to a daily labor cost of only 50-70 FCFA, and explains the profitability and proliferation of motorpump use for small gardens along the Niger and Komadougou rivers.

# b) <u>Non-motorized pumping</u>

Several methods of water lifting or pumping are possible in Niger. Numerous recent reports (Vink, 82; Morris-Norman, 83; Claude, 83) have described in detail these methods of waterlifting for small-scale, artisanal irrigation. These methods and their characteristics can be summarized in the following table:

Method	Cost \$	Water Power HP	Discharge 1/s	Head m	Irrigated Area
Hand-hauled container	10	.03	1/2-1	1-3	Small gardens of approm. 200 m <sup>2</sup>
Chadouf: balance-beam	25	.04	1-1 1/2	2-3	Vegetable gardens à wheat over approx. 5000 m <sup>2</sup>
Dalou: Animal-Drawn	200	.08	.8-1.2	3-10	Gardens of approx. 5000m <sup>2</sup>
Chain-disc pump	300	• .2	3-4 1/s	3-5	1-2 ha.

K--29

More detail on these methods can be readily found in the above referenced reports. This discussion concerns itself with the major constraints and possible developments of these methods.

In each of the water lifting methods listed above the capacity of the "system" and, hence the area it can irrigate is limited by the amount of power which can be generated by humans and animals. However, the capacity of these systems is further reduced by the mechanical efficiency of transfering of that power. For instance, the use of a simple lever arm, the chadouf, almost doubles the working power of a human in lifting water any given height. The same amount of human energy can lift more water (or use deeper source) and consequently, can be irrigate more area. The chadouf lever-arm system is mechanically about twice as efficient as a basic rope and bucket. However, this increased efficiency is usually only obtained for an increase in capital cost (i.e. the construction of the chadouf).

Likewise, there are several other types of human-powered pumping systems which are even more mechanically efficient and can further increase capacity, and hence, irrigated area (at a cost). For instance, several types of foot-operated, plunger pumps are effective for low-lift (2m) situations. Large capacity rubber-diaphram pumps (e.g. the East African "Jumi" pump) have capacities of up to 4 1/s and a maximum lift of 10m. The costs of these pumps can vary from \$20-150. Similarly there are more mechanically efficient systems than the dalou for useing animal power. The most well-known are chain and bucket, or chain and disk "flow" pumps which are capable of discharges of 4-6 1/s at lifts of 3-5m. The cost of these pumps is several hundred dollars. There appears to be considerable scope for testing and trials of these types of pumps, as an intermediate alternative to more expensive, and technically onerous motorized pumpsets.

Pumping power could also be provided by solar and wind energy in Niger. Unfortunately, the limits on the scope and time for this assessment did not enable an investigation of these options. There is a mission-financed

windpump (Dempster?) near Maradi which is apparently operational. The wind speed data obtained from the meteorological service in the Niamey area is not, however, encouraging:

Velocity	Percent of Recordings
0-2 mph	55%
2-10 mph	36%
10-14 mph	6%
14-30 mph	3%

Efficient multi-vained metal windpumps cost several thousand dollars and would probably not be cost-effective for these low windspeeds; minimum cut-in windspeeds are on the order of 5 mph. Even less-expensive, "artisinal" sail-type windmill would not, at first glance, appear to be effective. For example, calculating power from the equation,  $P = KAV^3$  and assuming a sail windpump with a characteristic of  $K = 7 \times 10^{-6}$  and  $A = IIr^2 = II(10)^2 = 312.14$ , the power at a wind speed of 5 mph would only be  $P = 7 \times 10^{-6}(312.14)(5)^3 = .27$  HP.

At current prices, generating this much power by a photo-voltaic solar system would cost about \$3000. Clearly, an even less cost-effective possibility.

ONERSOL conducts testing programs of photovoltaic power systems. These programs should be supported and followed, for their results could identify less-costly more efficient solar systems appropriate for irrigation supply. Windputping also warrants further investigation to determine its feasibility in selected locales. Certainly, as a first step technical information and pumping records should be obtained from all existing windpumps in the country. If these are favorable, a next step would be the purchase and testing of several African-manufactured systems: the Arusha-type and VITA sail windmills and the Kenyan Bob Harris multi-vaned windmill.

## c) Wells and intakes

A final, but important, point in this discussion of pumping systems is the capacity of the wells and intakes associated with the systems. Much of the efforts in assistance to small, garden irrigated development has been directed toward improving traditional wells. This usually consists simply of stabilizing the sides of the wells with reinforced concrete casings. These appear to be cost-effective improvements and, of course, should continue.

NO

On the other hand, little or no effort is being made to improve well yields and actual pump intake conditions. Several possibilities come to mind: larger-bore, step wells with interior pumping platforms; radial pipe shafts extending out from shallow wells; catchment aprons with large storage pits; and subterranean dams and catchment galleries. These all appear to have limited applications at specific sites in Niger and may be cost-effective by increasing system capacities (well yields) with no increase in operating costs. These techniques are worthy of trial in the PVO well-improvement activities.

# D.2 Application

At the field level, the efficiency of water use can be ascertained by the ratio the amount of water used by a crop and the amount of water delivered to the field. While the latter is relatively easy to measure with water control structures (weirs, flumes, special gates, etc.), the former can be an exceedingly complex study of the particular soil, plant root structures and transpiration rates. This discussion is limited to an examination of selected crop water requirements in comparison to the application rates observed in selected systems and the inefficiencies associated with them.

#### a) Rice

The major requirements for a crop of rice during the wet season in the Niger River valley have been estimated in the SOGREAH-LBII study and in several other references to be less than 10 000  $m^3$ /ha including conveyance losses. ONAHA's 1982 Annual Report shows that at Toula, one of the more intensely managed and more productive perimeters (9-10 T/ha of paddy annually), approximately 15600m<sup>3</sup>/ha of water was applied. This is a very low application efficiency of about 60%.

The same ONAHA report on Koutoukale notes that at the 210ha perimeter full pumping was prolonged from the 100 days scheduled to 131 days in order to ensure water for these large number of farmers (30%) who were late transplanting and whose crop was maturing at a later date. This represented

3

an additional operating cost of about 2 million CFA. Of eleven perimeters surveyed on the date after which pumping should have ceased (i.e. crop maturity) nine of the perimeters had 60-80% of the parcels still requiring irrigation.

# b) Cotton

At the 1300-ha Konni I perimeter, ONAHA records show 1947464 m<sup>3</sup> of water delivered during the month of November for 418-ha of cotton nearing maturity. This averages 4659 m<sup>3</sup>/ha. The crop requirement during this period can be estimated from the "A" pan evaporation Epan = 268m. Assuming a Kpan = .70 and a K<sub>2</sub> = .65 then the crop water requirement would be

ET = Kc Kp ET pan = 121 mm or 1210 m<sup>3</sup>/ha. This is comparable to the SOGREAH estimate of 1100 m<sup>3</sup>/ha and therefore yields a field irrigation efficiency of only 26%, low by any standard (average values are 50-60%).

# c) <u>Onion</u>

At a small well-irrigated garden in the Dallol Bosso, a farmer was observed in April applying 2-281 bucketsfulls on a 1.5 x 1.5m basin each day, or the equivalent of 24mm on a developing ( $\pm$  60 day old) crop of onions. The crop water requirement can be estimated from the following:

ETpan = 12.8, Kpan = .65, Kc = 1.1 and, therefore ET = 9.2 This farmer was lifting and applying directly well over two times the quantity required by the crop.

Examples of excessive water application rates abound. Even in the water-starved Air region, the GTZ found that potato and wheat crops were receiving 60% and 30% respectively more water than necessary. This and those examples described above are indicative of the over-irrigation and consequently low efficiencies of water use prevalent at all different levels and types of irrigation systems in Niger. There appears to be a fundamental lack of understanding of crop water requirements at the field level which results in exhorbitant over-use of the critical (and expensive) resource. This should be a fundamental consideration in formulating an assistance strategy for irrigated agriculture.

## D.3 Conveyance

Conveyance loss is the difference between the quantity of water put into a system at the supply and the quantity actually delivered by that system to the soil. Conveyance efficiency is therefore the percentage of the water supplied to the system which is actually delivered by the system. Conveyance losses generally consist of the water lost in canals due to leaks or seepage in surfaces, evaporation of the water and use, and also includes water leakage in pipes.

Conveyance losses are generally less critical in Niger than pumping problems and application inefficiencies. These losses are an important factor in the larger systems with longer and more numerous canal runs. This includes many of the perimeters in the Niger River valley, especially the systems on lighter-soils of the terraces, and the gravity-fed systems where supply canals are lengthy and interior cancel networks extensive. For example the extraordinarily long 15-km long supply canal at Konni has high losses in evaporation, seepage and "pirate" use even though it is relatively new and concrete lined. The SOGREAH-LBIT Study recommends considerable cleaning and, in some cases, reshaping and sealing of the canals in the 17 perimeters diagnosed. The need for reshaping and sealing canals is widespread in most older irrigation systems in Niger. Regular canal maintenance, cleaning and patching as necessary, are the critical problems in large conveyance systems.

A major aspect of the design of conveyance networks in larger perimeters which is often overlooked is its operational feasibility vis-a-vis the farmer organizations. Canal systems are usually laid out to minimize design complexities and construction costs, based upon the physical factors of topography, types of cropping, and desired parcel sizes. A factor which should influence the layout of a canal system is the size of the managerial or organizational units of water use. In many cases, such a design would result in breaking down larger perimeters into a number of smaller systems and

っう

"sub-primary" canals. An apparent example of this approach is found in Senegal on the 550ha SAED perimeter of N'Dombo Thiago, which is divided into 50-60ha autonomous units. This is ten years old and is considered to be relatively successful, albeit with considerable French technical assistance. It surprising, but perhaps indicative, that the very thorough SOGREAH-LBII Study does not even consider this possibility in its recommendations. It is an approach which warrants study.

In the smaller irrigation systems in Niger, the major issue does not appear to be maintenance. The intensive labor on these works and the rudimentary nature of the canals usually ensures constant re-working of the system by hand. Rather, there are major conveyance losses in these rudimentary canal systems due to seepage. These systems are often on more permeable, sandy soils and, due to the low level of investment in them, are not lined. This is an especially critical problem in low-capacity systems with lower flow rates where seepage is a relatively greater portion of the slow flow in the canals. For instance, the GTZ found canals losses as high as 20% of the water supplied in some "Dalou" animal-lifting systems in the Air. Therefore, efficiencies and water use could be substantially improved in the smaller systems by the introduction of low-cost techniques of canal lining. Little investigation has been done in Niger apparently on the possibilities of low-cost surface sealing and lining. This is a small investment which could payoff in substantial water savings.

### E. INSTITUTIONS AND SUPPORT

Competent technical organizations, both public and private at the national and local levels, are a <u>sine qua non</u> of irrigated agricultural development. Such organizations are evident in all countries with widespread irrigated agricultural development. In the United States, the combination of the Federal Bureau of Land Reclamation, Agricultural Research Stations, local water management or irrigation districts, and private farm equipment dealers was a driving force behind the rapid expansion of irrigated agriculture over the last several decades. India is known for its heavy government involvement in, and strong agricultural equipment industry support of, irrigation development. Egypt has a special Ministry of Irrigation. All of these are organizations made up of trained and experienced irrigation engineers and technicians.

27

In Niger, The Autonomous Office National des Amenagements Hydro-agricoles, (ONAHA) was created in 1979 with the encouragement of the donors specifically to be the lead organization in the accelerated development of irrigated agriculture. The Genie Rural (Department of Rural Engineering) retains technical planning and control responsibilities. The Institut Pratique du Developpement Rural (IPDR) is the supporting institution which gives basic training in agricultural/rural engineering. The Nigerien private sector includes several large French engineering and construction firms (SATOM, SCET, Dragages, and SATOM) as well as several foreign-affiliated equipment dealerships (CAMICO, Metal Niger, Peryssac, etc.). A few small Nigerien enterprises are presently involved in irrigation works, and then as subcontractors. Last, but not at all least, small "jobbers" and farmers groups also provide low-level, yet valuable technical support services to irrigated development.

## E.1 ONAHA and Genie Rural

ONAHA was created by the Nigerien Government several years ago to 1) develop new areas for irrigated agriculture and 2) manage and promote agricultural production in all state-developed irrigation systems in collaboration with local cooperatives. At its inception ONAHA inherited management responsibilities for about 6500 ha of irrigated areas (most systems are on the order of several hundred hectares, but some are over a thousand) and the plans for the development of several thousands of hectares of new systems.

Most recently, due to budgetary pressures and ONAHA's lack of cost-effectiveness in the construction and management of irrigation systems, a modification of ONAHA's role was recommended. This was confirmed at a Ministerial-level meeting in February, 1984: ONAHA would be streamlined and its role limited to first, ensuring the maintenance of irrigation systems and providing technical assistance to farmer organizations and, for the medium-term, developing with private contractors of new irrigation systems. ONAHA, however, is and will probably continue to be Niger's pre-eminent irrigation institution.

Organizational charts for ONAHA's central office and its regional office at Tahoua, as well as a generalized scheme of its interaction with the cooperatives, are found on the following pages. The new directive cited above will probably not substantially alter the structure of the organization, yet it will considerably reduce the amount of personnel and material in many operational services.

In 1982, ONAHA's professional staff included of five graduate engineers (approximate BSc equivalent) at the central office; one of whom was at the regional office at Tahoua, and three engineer technicians, one of whom was in a regional office. ONAHA's central office was also assisted by four expatrict advisors, whom are graduate engineers.

Whereas, ONAHA is charged with implementation and management, the Genie Rural (Rural Engineering Division) of the MRD is responsible for the initial studies and plans (most of which are completed by expatriate firms) as well as technical oversight of ONAHA's activities. Genie Rural's staff includes several graduate engineers, one of whom who has received specialized training in irrigation. The ONAHA-Genie Rural relationship is difficult and somewhat contentious. Due to the division of responsibilities, ONAHA's staff feels, with some justification, that despite their experience, and proximity to the problems of irrigation in the field, they are cut off from the study and planning of irrigation development.

In the field, ONAHA generally provides a "Chef de Ferimetre" at each statefinanced irrigation system. The present organizational set-up at the perimeter-level is illustrated by the schema on the following page. Although the size of ONAHA's field staff will be substantially reduced, there will continue to be the Government's man, in the form of an ONAHA "Responsable/ Conseiller", at each perimeter in which the State has a significant financial stake.

The professional level of various "Chefs de Perimetre" varies widely: At the new 2500ha Konni system, the chief was an "Ingenieur-Agronome" with a technical diploma from a regional agricultural college, while at the 260ha Toula system along the river the chief was an "Ingenieur d'Agriculture" graduated from the National Agricultural School IPDR at Kolo. Smaller systems, such as those in the Ader-Douchi-Maggia, are overseen by agricultural or extension agents. Several larger irrigated perimeters have expatriate engineers financed by the concerned donor organization.

apph



New.



\_



STRUCTURES O' ENCADSEMENT LES A.H.A.

K-40

Few of the Nigerien engineers who work for ONAHA or the Genie Rural are irrigation specialists. Many have general public or rural works engineering backgrounds with no graduate or specialized coursework in irrigation. The lack of practical irrigation training and experience at all levels in ONAHA's present technical staff severely limits its ability to carry out even its newly streamlined responsibilities (i.e. ensuring maintenance and providing technical assistance). Very little "technical" advice can be provided by staff who do not know how to determine crop water requirements or irrigation efficiencies. A list of technical training topics is found on the next page.

 $\Delta^{d0}$ 

```
Irrigation Training Topics:
 Soil, Water, Plant Relationships:
     Potential evapotranspiration
       ETP = 0.0075 x RS x T<sup>o</sup> F
RS = KS x RA x S^{1/2}
       RS = KT x RA x TD1/2
       Methods for estimating KT
 .
     Crop Evapotranspiration
       ET (crop) = ETP x KC
       KC values using FAO methods
   Yield response to water
       Climatic suitability - mean temperature requirements given by FAO
       FAO crop yield reduction factors for crop growth cycle and each
       growth stage
       Water - fertility interaction, general relationship for several
       crops, data plotting
     Water available per meter of soil for various soil textures
     General soil tension relationships, bars and atmospheres
     Soil parameters
       Infiltration Races
       Bulk Density
       Field Capacity
       Root Depth
Irrigation Methods:
     Irrigation efficiencies
     BHP required = 1/s x TDH (in m)
                          76 E
Water Measurements:
    Volumetric
_
    Float method
    Orifice place
-
    Weirs
      Triangular
      Rectangular
      Trapezoidal
    Measuring flumes
      Parshal
      Trapezodial
Water Conveyance:
    Energy and friction losses
-
    Manning's formula for open channel and full pipe flow
Soil Conservation & Water Harvesting:
    Terrace spacing and slopes
    Terrace storage capacities
~
    Use of runoff to increase available moisture (water harvesting)
-
    Contour furrows
Precipitation & runoff relationships:
    Drainage areas of streams in area
```

- Rainfall data
- Estimation of peak flow and runoff volumes

241

- Runoff as percentage of precipitation.
This lack of irrigation savy could probably be remedied within the short to medium term by two straightforward measures. The first is practical training; specially crafted engineering programs for the various professional levels could be set up in Niger, possibly in conjunction with the IPDR at Kolo. Genie Rural and ONAHA staff could attend sessions during off-seasons for several afternoons during the work week. The sessions would combine review of the basic principles of water management and irrigation with the direct application of these principles to resolve the types of problems typical in Niger.

The second measure to be taken concerns career incentives. As it now stands, the technical staff of the MRD is reassigned every couple of years to different positions in different programs, projects, or departments (including ONAHA) within the Ministry. For instance, an ONAHA staffer or "Chef de Perimetre" could be reassigned to a position within the Ministry working with a credit program or in the field with a cereals project. There is a strong incentive for the staff to be mobile since visibility and movement are usually the best politics for a promotion. This diagonal reassignment dilutes the irrigation experience within the MRD. To hold competent staff and to increase experience in this critical specialty the MRD might well set up a special career track in irrigation. Special bonuses or "primes de tecnicitá" could be awarded to select technical staff who guarantee to specialize in irrigation. Cost-effective irrigation development will depend on support services by well-trained and motivated technical personnel.

Another and perhaps more fundamental issue is the most effective role for ONAHA in the development of irrigated agriculture in Niger. Granted, as discussed earlier, the record of ONAHA's performance to date has not been good. On the other hand, at its inception ONAHA was given the heavy burden of a large number and wide range of poorly managed, inefficient and expensive irrigation developments. The recent GON decision to streamline ONAHA and to extract it from management appears to have been sound. The SOGREAH-LBII Study proposes to strengthen and use ONAHA for all but the most technically complex design and execution of rehabilitation works. However, this will be a medium term initiative since all indications are (and the GON agrees) that statemanaged construction is generally not less costly than private.

小片

K-43

A more interesting role for ONAHA is as the GON's preeminent irrigation institution which serves an autonomous general contractor or umbrella organization under which smaller private construction firms could work. OHANA could be the general contractor for studies, designs, procurement, and construction for irrigation systems throughout Niger. All the information and experience with irrigation development might be best consolidated in ONAHA. It would then be able to provide knowledgeable technical advice and assistance as well as contracting services to all types of irrigation development, large and small. This, of course, may imply a small reduction in the Genie Rural's responsibility for irrigation.

## E.2 Private Sector

A detailed examination of the private sector involvement in irrigation development is beyond the scope of this assessment. Fortunately, this involvement in the engineering aspects of irrigation is so small that several key issues are app. It in even a brief overview.

Private sector activity in irrigation engineering can be catagorized into four groups: large construction contractors, equipment suppliers, private jobbers, and farmer groups. Large tecnnical design firms are also involved, but these were discussed earlier under Design and Construction Costs.

The several large construction contractors were also discussed in the section on Capital Costs. As noted in that section, only large European firms presently have the necessary capabilities in technical control and heavy equipment to build larger irrigation systems. The issue is to transfer or develop these capabilities in the smaller private Nigerien firms. Nigerien contractors are only involved in a subsidiary, sub-contractual capacity in irrigation development. Few presently have the experience or equipment necessary for irrigation work. The challenge is to direct their efforts towards irrigation works, through incentives and assistance.

Less is known about equipment supply and private small "jobbers". There certainly appears to be an obvious need for a more responsive system to provide spare parts. A major portion of smaller pumping equipment and of

(t)

K-44

spare parts comes from neighboring Nigeria, and, in several cases, from Togo. In the Komadougou area, most small pumps were purchased in Nigeria. CAMICO in Niamey stocks, sells and repairs pumping equipment, as do a number of European-affiliated firms. Generally, for small pumping equipment service and assistance "après vente" is almost unheard of.

Work by small jobbers is particularly widespread throughout the irrigation subsector. They are the private, usually self-employed, well-diggers, masons, mechanics, metalworkers, and even oxen drivers who provide invaluable services for the construction and maintenance of irrigation systems. They are highly mobile, resourceful, and generally accept whatever work can be found. Several projects have been directed at developing these skilled entrepreneurs, especially in mechanics, well-digging and metalworking, although only the LWR and a French volunteers' project have focused on the support of irrigation development. This informal system of hands-on technicians warrants further investigation and, possibly, assistance and incorporation into irrigation development planning. Few irrigation project documents even mention this valuable and helpful human resource.

Finally, and often least considered in engineering analyses, are the farmers and their organizations. Since farmers are the end users of irrigation works, their involvement in design and operations engineering is vital. As the GON implements its recent policy of making irrigation systems autonomous and farmer groups totally responsible, the technical burden on farmers will increase.

An evaluation conducted several years ago for the decentralization of statecontrolled (SAED) irrigation perimeters in Secagal is illustrative. The evaluation defined and seperated out the significant tasks which are necessary to run a typical perimeter. (e.g. transplanting, irrigation rotation, etc.). These tasks were then arranged in a matrix with the different "actors" at the perimeter (primarily the director, production/extension agents, and farmers) and their respective decision-making responsibilities. Of some 40 decisions, 26 were made at the director-level and only 1 was made at the farm level. After decentralization, 12 decisions would be made at the farm level. The decision-making responsibilities at the intermediate production/extension level also more than doubled by decentralization. If farmers and their organizations are to become self-supporting, they too will need tailored training programs and incentives in water management.

As the farmer organizations become increasingly autonomous, they have to be responsible for a greater range of tasks:

- Irrigated cropping practises
- Requirement and timing of water applications
- Organization of water use rotations
- Apportioning the flows in canals
- Measurement of flow times
- Cleaning and sealing canals
- Fuel and lubricant (or power) purchase and metering
- Pump operation and maintenance.

There does not appear, at this time, to be any programs in action or planned to accelerate the training of farmers in the execution of these tasks. Motivation does not replace formation. Carefully crafted intensive training programs in water management are imperative for successful itrigation development.

A final note is pertinent to the responsibilities of farmer organizations. Farmers can and should be encouraged to provide a number of irrigation support services to one another on a fee or barter basis. For instance, ONAHA's plans call for only one in several farmers to own/operate animal traction equipment; plowing services will be "rented" by the others. Along the Komadougou, many farmers rent out motorpumps, in order to share the costs and utilize excess pumping capacity. Farmer groups could also organize and mobilize themselves to provide maintenance services, such as canal cleaning and small-scale leveling and earthwork, under contract to each other, to cooperatives or to ONAHA. The service capabilities of the non-formalized rural sector need to be encouraged to develop and grown.