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TECHNICAL REPORT ON SOIL/WATER ACTIVITIES

Sept 1, 1994

I. PURPOSE

This is the second of two reports on the soil/water (S/W) program in the GNRM Project. The first ("Summary") report gives an overview of the philosophy behind the approaches and activities undertaken by the program. This report details these activities and the status of each at the time the S/W position was terminated to give those remaining with the Project an opportunity to evaluate what has happened in this program and why and to better understand its strengths and weaknesses. It is also hoped that the external review team will have access to this document. The comments given here are frank discussions and relate to specific activities at specific sites.

II. INTRODUCTION

The Soil/Water program was able to succeed in an extraordinary number of activities in spite of serious constraints which impacted both the Project as a whole and the S/W program in particular. (While the former constraints are known to the other TAs, the latter are discussed in section V of this report.)

As presented in the first ("Summary") report, the S/W program developed a workable approach to the complex problem of how to present and develop a natural resource management program in the conditions found in the Fouta Diallon. The program was based on developing a willingness among the villagers to participate in the program, creating a basic knowledge of what is involved in natural resource development (as well as community development) and then the transferal of relevant and appropriate technologies to the farmer while, all the time, developing the infrastructure required for them to continue these activities after the Project is terminated.

This report lists the actual progress of the S/W program during the 15 months of work on AID approved activities. It tries to be precise about why and how these activities were undertaken and how each one worked out under the conditions that existed at the time. It is not philosophical in nature but it is meant to be informative for those who are interested in how this particular program evolved in this particular social, physical, biological and administrative environment. Although the technical and work philosophies evolved throughout the period of activity, they are presented first in order to orient the reader for the remaining report.

III. TECHNICAL PHILOSOPHY

The natural resources management aspect of the Project was originally justified by the fact that the Fouta Diallon Highlands are the source of 3 major and several minor rivers in Africa.

Environmental degradation in the Fouta as well as changes in rainfall have resulted in these rivers flooding more during the rainy season, drying up during the dry season and carrying a heavier sediment load, causing havoc to the dam projects along the rivers. The obvious response is to determine the best way to decrease runoff, decrease erosion and, therefore, more evenly distribute the outflow of water from the area over the entire year. This more global orientation of the S/W program is entirely consistent with the more anthropocentric Goal and Purpose stated in the Project Paper, where increased agricultural productivity, income and standard of living for the villagers were highlighted.

The S/W program gave high priority to stabilizing soils through the control of erosion. Early reports often suggested that erosion is minor problem in the Fouta and that poor soil fertility was the major problem for Fouta farmers. During the Participatory Rural Appraisal it became apparent, however, that under the cultivation techniques used in the Fouta, erosion is a major cause of poor soil fertility. In both the tapades and the outer fields, the yearly cycle begins with clearing and burning. Nitrogen and sulfur are lost when the organic matter is burned but potassium and phosphorous are left behind. With the soil covered with ash, the first rains carry the potassium into the soil and the phosphorus reacts with the surface layer. Once runoff begins, the organic matter that remains is washed from the surface of the fields and into the rivers. As runoff increases, the surface of the soil is washed into the rivers along with the phosphate adsorbed to these surface particles. What remains in the system is some percentage of the potassium which was collected by all the vegetation during the entire fallow period and the rest is lost to the system forever. This yearly repetition of removing nearly all organic matter and all nutrients but potassium from the soil has resulted in a continuous decrease in soil fertility and an increasing difficulty for a proper vegetative cover to develop during fallow years. This and the fact that fallow periods are becoming shorter, the time that a newly cleared field can be used to produce a crop has also decreased - in some areas from three years to one.

Erosion is, in fact, serious in its own right in many areas in the Fouta. In the Diaforé watershed, areas that were cropped in former years are now laterite crusts. The replacement of agricultural lands with bowal is an ongoing process there and is a direct result of erosion removing the shallow fertile layer overlying laterite rock. In the Koundou watershed, where very steep slopes are used for exterior fields, erosion is severe. Even the tapades are frequently located on slopes of 10% or more. Soil fertility problems in the Diafore watershed are also severe but exacerbated by runoff from the large surface are (35-45% of the total land) covered in bowal. The Dissa watershed suffers much less from soil fertility problems due to its rainfall pattern and topographic features.

In any program of soil fertility improvement or maintenance, soil stabilization must be the first step. An important associated activity is flood control. All three watersheds suffer from the destruction of inner fields by the erosive effects of water entering from upslope. The acid soils in Diaforé watershed are certainly due, in part, to the leaching effects of the large amount of water that enters the lowland fields from the surrounding bowal, whether from water flowing directly from laterite crusts or from water dumped into flooding streams. Diversion digs, dams and walls to divert exterior water are essential to any efforts to improve and maintain soil fertility in these fields.

During the Sekou Touré regime, the government understood the importance of soil stabilization. The forest guards were given the job of forcing farmers who cleared exterior fields to build contour walls to control erosion. These walls are seen throughout the Fouta. Even though their effectiveness in controlling the loss of soil is obvious to the most casual observer, the authoritarian approach to this activity has resulted in the abandonment of this technology following the change in government. The basic technology of determining contours has been forgotten (if it was ever successfully transferred to the villagers) and re-introduction is required.

An important technical philosophy held by many people and that has impacted on the Project, including the S/W program, is that "all technologies we need to extend are known and simple". This belief has resulted in the belief that the extension of these technologies to farmers is a simple matter of direct transfer of information and techniques. The experience of the S/W program in the Fouta Diallon has shown quite the opposite. During its short existence in the field, the accepted and extended methods of composting, reforestation of springs, how springs are usually capped and the commonly used approach to irrigation were all seen to fall short of the needs, abilities and realities of the Fouta Diallon farmers. These technical aspects of these problems are discussed elsewhere in the report but the philosophical aspect must be noted here: serious errors can be made if donor agencies buy into the philosophy that "everything is known and is simple. Experienced technicians must be included in TA teams and their expertise made use of.

IV. WORK PHILOSOPHY

The GNRM is a four-year project which was established to inject appropriate technologies, abilities and understanding into the recipient population which will improve their lives in a sustainable manner (i.e. while improving or protecting their natural environment). The recipient population is cautious and suspicious and therefore is generally reticent to subscribe to the Project's activities. In addition, the nature of rural village society is to incorporate changes slowly - very slowly. Due to the extremely short period of time available for the Project to do its work (4 years), frequently unsustainable methodologies must be used to transfer the knowledge base and convince the villagers that they are useful.

There are some sustainable technologies which can be introduced to a select subgroup of villagers (paysans pilots) which will continue to circulate throughout the target area even after the Project leaves. In many cases, however, certain investments must be made to ensure that key activities can succeed during and after the Project's intervention. Examples of these are the capping of springs or rivetting of wells; specialized training of individuals to perform critical activities in support of the development in the area (para-vets, blacksmiths, etc); the destruction of selected termite hills in garden areas; and, although controversial within the GNRM, the purchase of materials for the long-term support of desired activities (refrigerators for the para-vets and phosphorous fertilizer for the most P-deficient, yet otherwise potentially productive soils, for example). These capital inputs are, perhaps, outside the direct mandate of the Project but, without them, most of the Project's activities will either lack the participation of the villagers or will not be able to be undertaken in an efficient (and, therefore, sustainable) manner due to the lack of the required knowledge and infrastructure.

To make the quantum leap in ability, understanding and desire among the villagers who, with good reason, resist change, the Project must take advantage of any means possible to instill the desired traits in the villagers during the short period of time available to the Project. These include incentives for learning and participating in Project activities (small one-time payments in money or in kind), travel and Project-elevated status among their peers (Comités de Gestion, certificates of ability, etc).

Unfortunately, the GNRM Project to date has been confused between the provision of capital investment and incentives required to create the prerequisites for sustainable agricultural development and the "sustainable" activities that we are trying to leave behind us (see "Constraints", section V). A consistent approach has not yet evolved and requires participatory study and action. Even though the Project is nearly half over, it can profit from the development of philosophy that will permit the technicians to transfer the technologies available in an efficient and effective manner.

V. PROGRAM ACTIVITY TO DATE

A. Water Conservation

1. Dams, contour walls for infiltration

One of the easiest programs to sell to villagers has been the construction of structures to protect their springs and increase dry-season water availability. It must be stated here that we have not had the time to analyze the effectiveness of these structures on the dry-season water table or spring flow but certain assumptions have been made and activities have been based on these assumptions. It must be stressed that any or all of these assumptions may be partially or wholly wrong but they are probably not. In any case, there is no simple way to continue this work without accepting them.

a. Assumptions:

1) Water in the water table at a well or spring comes from rainwater which falls upslope from the point of water collection.

2) The surface contours generally reflect the subsurface contours which the water within the water table will follow.

3) By increasing infiltration up the hill from the point of water collection, the amount of water passing that point will increase.

4) Water entering the water table close to the point of water collection will pass that point sooner than water entering the water table in an area farther up the slope (i.e., increasing infiltration in the farthest reaches of the water catchment will have the greatest chance of increasing the water available later in the dry season).

b. Activities:

Koundou Watershed:

Contour dikes and walls were built in Donghol, Diawbhé, Guémé and Kagnégandé for the sole purpose of increasing infiltration to increase water availability during the dry season in the springs and well built earlier by the Project.. Except for Guémé, where the Project assisted 50 villagers in the construction of 4 Km of contour walls, these were all minimal efforts and in most cases too close to the water source to be effective late in the dry season. There has been little follow-up (there was no counterpart from late Dec until late June) but, if work were proposed during the cool months of Jan-March, when people have more time, much more could be accomplished. A small portion of the area covered in walls at Guémé has been planted in trees.

The village of Lay-Fello requested Project support to build protective dams above their spring. Lack of transportation and technical expertise resulted in our not being able to respond to this invitation.

It should be mentioned that the contour walls built in Telibofi, Kokolou and Tyankoye may easily have a positive effect on springs located downhill from them, even though the Project has neither identified nor improved sources below the latter two villages.

The areas high in the mountains above Kokolou, Tyankoye, Telibofi and N'Dentari are ideal for the construction of infiltration dams. Huge boulders and steep-sided ravines provide an excellent place to close off water courses with small dams which will result in large reservoirs of water. These not only should have an effect on late-dry-season water availability but could also decrease some of the gully erosion in the external fields below. If undertaken, this should be done during the January-March (slow and cool) period.

Diaforé Watershed:

Contour walls have been constructed within the water course of the Gollo spring (near Ley Diaforé) to decrease flooding and in the bowal above with the hope of increasing infiltration. The latter area was planted in trees but may be too close to the spring to have any late-dry-season effect on flow rates (the original site chosen for this activity was farther up slope - and even that was very close to the spring). If this approach seems interesting to the Project and Gollo spring is sufficiently important to the villagers, locations far above the spring might be treated in the future.

Dissa Watershed:

Dams and Contour walls were built by the villages of Donta and Falloulaye before the Project capped their springs. They were both for protection of the spring and to increase infiltration to improve stream flow. Both villages were very animated and considerable work was accomplished in a very few work days.

The area between the spring and the cliffs at Donta provide a similar situation to the area above Tyankoye but, due to the short distances involved, may not have much effect on the reduced (8L/min) June and July outflow at their spring (by mid August, flow was above 15L/min).

Fotongbé has a serious water shortage. Of the springs observed, the topography does not permit an estimation of where groundwater comes from which feeds the springs on the north side of the entrance road into the watershed. The spring on the south side of this road is most likely fed by the large, relatively flat field behind the spring, making it difficult to plan or predict the results of infiltration activities in this area. If springs can be found high above the village from which water could be transmitted to the village, every effort must be made to maximize infiltration above those springs.

B. Water Management

1. Potable Water

I consider this to be the most important activity of the Project for the following reasons:

- It is an easy, sure and quick way to gain the confidence of villagers
- It is sufficiently interesting to villagers that they are willing to participate in other, less interesting (to them) Project activities, thus permitting the maximum of influence in the minimum of time.
- It provides an activity around which the village can be organized both for the initial work and for maintenance. This organization can be used to organize other resource users' committees.
- By eliminating the need to compete with animals and spoon water from muddy holes during the dry season, it simplifies women's lives and has the potential to decrease disease, thus giving villagers more time to participate in Project activities and to

pursue introduced concepts after Project termination (see technical comments and philosophical approach on well and spring activities, Annex I).

In spite of these compelling reasons, this activity has been considered a companion activity to the Project and the question continually arises: When will we have completed all the necessary wells and springs in our watersheds?

Today, perhaps fewer than 50% of women in the three WMUs have potable water readily available (i.e. < 700m away). While the provision of potable water to half the population is a significant accomplishment, each remaining unmanaged spring and well provides the Project an opportunity to gain villagers' respect and to get them involved in Project and other development activities.

To date, the Project has capped 16 springs (7 in Dissa, 2 in Diaforé and 7 in Koundou), improved 13 wells (7 in Diaforé and 6 in Koundou) and dug 5 wells (2 in Dissa and 3 in Koundou). The locations of wells and springs and their situation are listed in Annex II.

While considerable potential still exists for improving the lives of the target population by improving their wells and springs (Annex III), one of the greatest potentials for the rainy season (on a cost-benefit ratio) is for improved rainwater catchment. In my wife's study of the effects of the provision of potable water on the local population, she looked at the importance of rainwater collection - a subject that Chris Erwin (PCV/Dissa) and I had discussed earlier. My wife found that women frequently gather rainwater, usually from the tin-roofed houses but also from selected trees and from thatched roofs, as well, to decrease the quantity of water they have to carry from their springs or wells. However, the collection system is inefficient and, in 15 tin-roofed houses studied, only 10% of the roof was guttered. The size of the catchment vessel used (which were not usually moved when full) would permit the collection of 6-20mm (with a strong mode at 10mm) of rainwater. Thus, 90% of the water running off the roof is not efficiently collected and, if a 30mm rainfall occurs, 2/3 of the water captured from the small guttered catchment area is lost to overflow. This provides an important opportunity to decrease women's work during the difficult agricultural season and at a time when spring flow is at its lowest (May-July). If tin roofs were guttered and cisterns were built (a very cheap way of creating substantial water storage), water could be available within the village during the entire rainy season - particularly early in the rainy season when workloads are at the maximum and spring flows are at their minimum.

The Dissa PCV expressed great interest in this approach and had, in fact, guttered his own roof with bamboo. I hoped he would take on this activity and provided him with cement and a written request for support from the WMU director (a requirement for PCV's special activities) to place demonstrations in each village in the watershed. Since no PL-480 money was available, I am unsure if his interest waned or if the Project simply could not provide the required support.

2. Small Scale Irrigation

Small-scale irrigation is an important part of the soil/water program (Annex III). The sites identified with the highest potential for irrigation were N'Dentari, Tyankoye and Néna in the Koundou watershed, Foréya and the Kouné swamp in the Diaforé watershed and Manisigi, Farinta, Tanéné and the huge bas-fond below Farinta in the Dissa watershed.

One of these, Manisigi was determined by AID's Dan Jenkins to be too marginal to follow up on: the spring feeding the reservoir dried up during the dry season. The alternative, using the dam to provide a reservoir, would have resulted in the loss of an area presently being used for gardening (behind the dam) and could not be certain to have stored enough water (est: 3/4 ha-meter) to do any worthwhile irrigation late in the dry season, when it would be most useful.

In the Diaforé watershed, the proposed Kouné 5-ha managed perimeter (presently a swamp) has been on hold until a dispute over the land has been settled, something the LTC was unable to do during their association with the Project. The proposed Foréya irrigated perimeter ran into several technical problems (For the proposal to develop Foréya bas-fond and subsequent reports, see Annex IV & V) but still has potential if the soils fertility can be improved. In the calculation of how the water would be captured and used in the two-ha field it became apparent that the generally accepted ("already known, simple") method of irrigation accepted by the development community - flood/furrow irrigation - would be inappropriate for this situation due to the limited amount of water available after February and the high infiltration rate of the soil. A system of storage basins and hand irrigation (similar to what the S/W program set up at Tyankoye) will be the most efficient means of irrigation. These and the other sites, which are in various stages of completion are discussed in the "Description of technical activities", Annex II and IV.

A foot pump has been purchased by the Project and demonstrated in two watersheds where it was believed to have the highest potential. The technology was not appreciated, probably because the garden areas were not set up for furrow irrigation - the easiest way to use the pump. The CED has written to ask the manufacturers of the pump to supply the Project with suggestions on the most advantageous ways to use the pump and it is anticipated that certain gardens (N'Dentari, Néna and/or Foréya, for instance) might be set up to the specifications of the manufacturers of the pump and the pump demonstrated again (although the problem mentioned above concerning furrow irrigation at Foréya will have to be addressed). It is an interesting technology but will have to be adapted to the local farming systems - or vise-versa.

3. Diversion canals, walls

The prevention of uncontrolled runoff water from entering fields and villages from upslope is a basic factor in managing soils and their fertility. Some canals built many years earlier have been observed but recent attempts at controlling water are frequently insufficiently or poorly designed and have been of limited use to the villagers.

The program to help villagers protect their fields from inundation is most advanced in Diaforé where villages and tapades located in the lowlands receive runoff water from the surrounding bowal. After a highly successful program to support the villagers at Dow Koratongo (and an utter failure at Ley Koratongo), four additional villages in the watershed have requested support in designing diversion structures, organizing workdays and the loan of tools. The latter aspect of the program has been an interesting one and should be reviewed. The loan of tools unavailable to villagers (breaker bars, picks, shovels, wheel barrows) gives the Project a certain power over villagers' work days that makes sure that the turnout of labor will be substantial. Substantial village participation, even in activities important to villagers, is not always guaranteed and many workdays for other activities (captages, for instance), where Project-supplied tools are not a factor, have had to be rescheduled.

A canal was dug at Dow Koratongo in 1993. The first activity in 1994 was a diversion wall on the bowal above Kouné. Villagers here wanted to have a cement-stabilized wall to control the runoff but tests and estimations suggested that the wall could cost as much as 2.000 FG/meter. A wall was built without cement and filled behind with gravelly soil from the surface of the bowal. Where major flows cause the wall to break, cement will be used to stabilize the rocks. Grass has been transplanted from the bowal to help stabilize the soil in the wall and, therefore, the wall itself.

In addition to the wall on the bowal, villagers have built a structure to force the flow of water from one stream bed to another. While it is possible to do what they want to do, I doubt that the present structure will work. In Gadha Diaforé Kouné a primary "diversion wall" was demonstrated. Built upstream from a normal diversion wall, it should deflect and decrease the force of the direct stream flow against the diversion wall, thus reducing the chance of wall failure and break-through. This technology should be checked at G.D. Kouné to ensure that it was built to sufficient specifications and should also be employed at Kouné.

Gabions should also be mentioned here. Although expensive (about 2.500/m^2 of the cheapest chicken wire), these could be an alternative to cement or used for special situations. Although we have purchased wire screen for demonstrations and the sites where they could be used exist, the Diaforé technician was still in the process of identifying villagers who should participate in the demonstration of this technology.

There are many fields and other villages in Diaforé (we saw several fields in Gonku, alone) that could profit from water diversion structures. Interested farmers or village representatives should be taken to see the various canals and walls - especially during the rainy season. There are also many fields in the Koundou and Dissa watersheds that could profit from these structures. The GR counterparts in Dissa and Koundou should be taken to Diaforé to see these structures and their effects during the wet season, if possible.

C. **Soil Conservation**

1. Erosion control structures: Dams, diversion canals and contour walls

Dams and canals have been discussed above. By controlling runoff water, you control erosion. Contour walls within the fields, however, have the potential to play a more important role. By slowing water down and spreading it out behind a contour wall, the fertile soil which the water is carrying is deposited behind the wall. The farmer sees this effect and realizes the amount of fertile soil he is losing. In addition, the richness of the trapped soil and the extra water that infiltrates often results in a marked increase in the growth and production of the plants behind the structures. The farmer sees, first hand, the importance of natural resource management.

In 1993, the Project installed demonstration contour walls in Diaforé (Foréya) and Koundou (Telibofi). While there was interest in the technology in 1994, especially in Telibofi, no technician was available in Koundou during the optimal part of the year for the construction of contour walls (Jan-March) and it was clear that the technology was not going to be sought after by all the villages where it would be useful. In late April, when it was certain that no counterparts would be assigned on time to do it, I arranged for the temporary (i.e., day-to-day) hire of two technicians to help introduce a program where, if farmers learned how to make the equipment needed, learned how to use it and then traced and built their own contour walls (i.e., proved that they had learned all aspects of the technology) they got paid 30 FG/meter (calculated to pay approx 1.500FG for a full day's labor). Although the "rent-a-logue" in Dissa watershed was unable to focus on this program, the one in Koundou was able, in a 6-week period, to train farmers who went on to trace and construct 17Km of contour walls! (See "Success Stories", 6-months' report, June,1994). The PCV in Koundou, after being very outspoken against the idea of paying farmers to do what they "should be doing", found that everyone was too busy to build walls this year - until she began offering the incentive. It should be noted that many farmers had not seen the demonstration at Telibofi and only had her word that it was a good idea. After she began using the contract/incentive idea, the men and women she trained built 5 Km of contour walls at Kokolou and Linsan-Saran, on some of the steepest slopes in Koundou. This was an incredibly successful program at this watershed and should be repeated one more time in the villages that need to stabilize steep slopes but did not benefit from the program this year. As mentioned in Section III, above, it is essential to keep in mind that it is difficult to induce farmers to add hours to an already long day to undertake conservation work which, while well understood by the technicians - and perhaps by the farmers -, does not result in immediate observable benefits and therefore holds little immediate interest for the farmers. Therefore, the use of small payments or other appropriate incentives can provide the necessary push to get farmers to make the extra effort to learn new technologies and use them. If, after several years of seeing the beneficial effects of their activities, they are still not convinced to continue using the technology, the technology was never sustainable in the first place.

Diaforé watershed farmers built an additional 5 Km of walls in their tapades during the latter part of the '93-'94 dry season with another 3 Km promised to be built in the exterior fields after the rains start. Most of the walls completed by June were at Gonku, a highly motivated village which has steep slopes. The lack of timely transfer of promised payments in this watershed may have limited participation.

It should be mentioned that many of the walls built were small and were covered with soil from erosion during the first rains. It is essential that these walls be visited and the farmers shown the importance of building the walls up where needed. We must get the idea across that they have completed 99% of the work in building the rock walls and that the maintenance of the wall, the remaining 1% of the work, will decide if the walls will work or not. Perhaps, if the contract/incentive approach is used again next year, a minimum wall height could be required.

D. Soil Management

1. Animal traction

The animal traction program in Dissa highlights the importance of training technicians the Project philosophy as a first step in activities where new approaches are being introduced. The program got off to an excellent start technically but lost its luster due to a complete lack of understanding of credit on the part of the WMU technicians and, therefore, on the part of the farmers. This developed into a major setback for the Project because it got derailed on the question of credit and "sustainability" when the important advantage of animal traction (that it removes some of the most difficult, time consuming menial labor from the workload of the women and gives it to the men) became secondary. With this experience behind us, the program began again in 1994 with a new approach which requires farmers to provide their own animals and plows before the Project pays for their training. The CED program held a training in Koundou this year using this approach. In addition, I suggested that we subsidize 10% of the cost of other farmers hiring our animal-traction-equipped farmers to plow their land for one year to entice farmers to evaluate the advantage of this approach. It was turned down in March (when there was time to conduct the program) but it was accepted in June when the CED TA proposed it. Unfortunately, there was not enough time to put the program into place. I would suggest that this program be approved (as a one-time-thing) and properly developed well in advance of the 1995 rains.

One of the spinoffs of the animal traction program is the need for stables to protect the animals from theft, a popular pastime in at least the Dissa watershed. It should be noted that the animals don't really need a roof over their head but everyone in the WMU seems to think it necessary. The first stable designed by the GR technician was of brick and tin (see designs, given to the Dissa GR tech.) at a cost of 540.000 FG - enough to build an entire village. By the time a design was developed which cost less than 250.000 FG and an internal agreement as to how the Project would help in their construction (the Project would pay 50% of the cost up to a total cost of 250.000 FG, i.e., the Project will pay 50% up to a maximum of 125.000 FG. If the stable costs more, the farmer pays all the rest), the owners of the animals were all defaulting on their loans. One farmer built his own small stable with a dirt floor but the rest of the animals continued to be guarded in various other, usually unsatisfactory ways.

As part of this program, the stables were to be used to demonstrate how to re-connect animal husbandry and crop production systems to provide labor and improve soil fertility. With this in mind, brick compost pits were built which were to provide one (solid) wall for the stable so that the rest could be made of almost anything and still be strong. I am still suggesting the use of coiled barbed wire with empty cans strung along the wire as an alarm against theft. In addition, by putting a single 4.500 FG rebar (fer-a-beton) into the construction of a low wall, even if a thief breaks part of the wall down, the rebar will block the exit of the animal. Whatever is built, it must be used to integrate animal husbandry and crop production through the production of animal wastes that will be used in a compost or applied as a mulch or soil additive in the tapades or inner fields and gardens (see Soil Fertility, below).

2. Termite Control

During our participatory rural surveys, nearly all the farmers in Diaforé and Koundou watersheds identified three major problems in their lives: water availability, wild animals and termites. In the Diaforé watershed, farmers say that eight years ago termites began destroying crops and now cut down up to 60% of their corn, rice and manioc crops. This is the poorest of the watersheds where villagers go without food (except for oranges) for up to two months a year. It took over 14 months to get approval for USAID-trained National technicians (who had already destroyed over 3,000 termite mounds in the Fouta for the FAO and FIDA projects) to use insecticides used in the USA to control a limited number of termite mounds in participating villages. Due to the late approval (mid July, 1994), 1995 will be the first year when a realistic program can be launched. Whether this will be financed solely by the Project, shared costs with the farmers or 100% paid by the farmers, a program must be developed early in the year, termite mounds selected, chemicals purchased and the program conducted on a timely basis. I suggest that (1) the Project pay all technical and transportation costs for the 1995 termite control program (2) the farmers select the mounds and do all the work as directed by the LPV and (3) farmers decide whether to pay for the chemical products

(3.300 FG/mound) or to use "traditional" products at no cost to them (gasoline, extracts of néré and télé, etc) as a part of the experiment conducted by the LPV.

I have requested LPV to conduct laboratory tests on the traditional products they use (they should at least be shown to repel termites if not kill them on contact). The test they have shown me to date proved that extracts of burned néré and télé (ie, full of cinders - perhaps the active ingredient??) will drown termites after 12 hours while pure water did not. I suggested that they observe continuously after the application of any products (preferably simulating field conditions: i.e., dousing rather than submerging the insects in the product) and give the time at which half of them are killed, thus simulating LD-50 studies conducted on chemical poisons. How they will determine the repulsive capability of various products (which could also disrupt a termite community sufficiently to keep it from re-establishing a queen and therefore eliminating the colony) and when this will be done will be up to the A/F TA, the COP and/or to my successor.

In any event, high priority should be given to the research into "traditional" methods (even if butane gas or gasoline is determined to be effective). I personally believe that, with some guidance and a lot of support (i.e., hand-holding, direction, timely funding and the promised transportation rather than the Project's history of poor financial, moral and logistical support), the LPV technicians can conduct an important piece of research which will be extremely useful throughout Africa and elsewhere. I have given the LPV director, Mr. Baldé, the name of a researcher in Brazil who is working on a similar problem - this contact should be followed up.

E. Soil Fertility

The soil fertility program was to be based on the actual fertility of the soils with which we work because P deficiency and soil acidity (pH <5) are common in the Fouta. The latter can be corrected somewhat with compost but the former cannot unless the compost is enriched in this element. It was my hope that, in selected fields where P was limiting, we could make long-lasting changes in soil fertility with proper (minimal) lime applications and, subsequently, large applications of (rock-?, partially acidulated-?) phosphate both as an investment in support of farmers and as a demonstration that would be interesting throughout Africa. In May, 1993, 81 soil samples were taken from the three WMUs and submitted to the OMVG soil laboratory in June. This lab, rather than the Bareng research lab, was chosen by Bill Polidoro, AID's Project officer. No money was available from PL-480 at the time so I advanced 125.000 FG (which has never been refunded) so that they could get started. The Director of the lab was efficient: he hired a technician from Conakry who bought reactants and they had completed 75% of the work in 6 weeks. Money was still not available and the Director used his entire month's salary to pay the technician and materials. The technician returned to Conakry and the work stopped. A month or so later, when the money did become available, he accepted the repayment (about 80% of the contract amount) but the work was not begun again. After my return from vacation in December, the Director said he would complete the work but required an advance on the remaining money before he would go to Conakry to conduct the K^+ analysis and get the remaining materials required for the P-sorption curves. Since this was another period when no money was available (until March), we met several times to discuss the work but nothing was done. When PL-480 money did appear, he never did. The samples are still on his laboratory floor, as far as I know.

In July, 1994, the soils were sampled again. This time samples were sent to Bareng's laboratory. This lab, although an integral part of the Bareng research program, lacks a lot of equipment. Last year the Project promised to buy them some materials and pay for the repair of some of their equipment. One year later, nothing has been done - although this is apparently due to Bareng's not providing the Project with the sources and costs for the purchases and repairs.

I also proposed a second approach to soil fertility determination: accept the USDA/ Soil Conservation Service's offer to share costs in getting selected soils classified using the USDA classification system. This system uses soil parameters which permit the direct transfer of technology between soils of the same classification: all the research done on similar soils worldwide could be used to resolve local problems. In keeping with USAID's belief that all applicable technologies are simple, known and locally available, the Project Officer decided that the existing soil-related information (incomplete 50,000:1 soil maps using the FAO system) was sufficient. The FAO classification will, of course, suggest local technologies that may (or may not) be transferable over short distances but the use of the worldwide body of knowledge will not be possible.

In brief, my approach to soil fertility was either unacceptable to USAID or not possible to accomplish due to the constraints that exist within the Project. Some advances were made, however:

1. Inorganic Fertilizers

Research reports from Guinea and the Fouta indicate that phosphate deficiencies are a major constraint to agricultural production in some areas. P has the unique qualities of being adsorbed in tropical soils, particularly acid soils, so that the soil and the plants compete for applied P. On the other hand, research that I conducted in Hawaii as a graduate student showed that large applications of P can have residual effects for up to 20 years. Soil samples analyzed at the OMVG laboratory showed that, in Diaforé for example, 61% of the soils sampled were deficient in P, 41% with very severe deficiencies (Annex VI). If P is limiting in the soil, it will be limiting in the plants and animal manure and, therefore, in any compost made from these materials. Ashes provide the natural source for P in the watersheds but, in order to get sufficient quantities from P-poor plants, entire forests would have to be burned. Obviously, to determine the importance of P to the production system, inorganic fertilizer would have to be used in on-farm trials. As a totally inorganic approach, I wanted to propose a demonstration of P saturation at Foréya. Although unsustainable in terms of the farmer's ability to purchase large quantities of P, it is very sustainable as a 20-year investment which, if managed properly, could possibly increase crop production indefinitely. I contacted IFDC to see if they might want to collaborate by supplying the required materials from their mines in Africa (Niger or Lomé) - they could not. I was prepared to use locally available 12-24-12 fertilizer but required a laboratory assessment of how much would have to be applied to this soil to "saturate" its P-sorbing capacity. I provided and discussed the analytical techniques and purchased the one difficult-to-find reagent required by OMVG but the analyses were never done.

A second approach to introducing P into the cropping cycle is to apply inorganic fertilizers to compost piles. This is discussed below.

2. Organic Matter

My Organic Matter Management program was based on introducing the concept of the "Cycle of Fertility" (the relationship between animal and crop production, See Annex VII). On the animal side of the program, I began working with Centre de Formation d'Elevage to help me develop a complete program but soon found that more time and expertise would be required than I had. As a result, in December, 1993 I sent a proposed SOW for an animal scientist TDY to Chemonics. I have since rewritten it following guidelines provided and it is now at Chemonics again.

On the organic matter management part of the program, I planned on bringing in J. Landeck to help set up the program. As International Director for Rodale's regenerative agriculture extension program, his experience in OM management was needed and his years' of experience working in the Fouta made him an ideal person to help develop a tight OM program for this area. I planned to send my counterparts to Rodale's center in Senegal in late Aug, 1993 and to hire local specialists in composting to carry out an extensive training of villagers and to support my counterparts. USAID felt that composting was another example of "simple technology, already known". Both my request for Landeck's TDY and my use of a local specialist were cited in the ADO's response to the GNRM TA's memo about my eliminating my position as proof that a S/W TA was not needed to run an organic matter management program.

Concerning counterpart training in Senegal, I faxed Rodale/Senegal in July, 1993 and wrote to them in August with no response. I left for vacation in early October and contacted J. Landeck in the USA in November. He put a training program together in January but, with two of my three counterparts gone for long-term training, I waited for their replacements before arranging the training. Replacements were assigned in mid-June, appeared in late June and went for training at Rodale in late July. They returned on August 16 but I have not yet seen a trip report on their experience.

Composting holds an important place in any program of sustainable soil fertility. Composting is a simple technology but it does involve several technical nuances that can make it acceptable -or totally non-acceptable - to farmers. My experience with composting in the South Pacific showed me that these nuances can change regionally - the problems in Africa are different from those in the South Pacific. By speaking with local experts I have found that, like the South Pacific, the necessity of digging a pit for a compost (the most common approach being extended both in the Pacific and in the Fouta) is one of the great blocks to the acceptance of this technology. Unlike the Pacific islands, the importance of weed seeds in compost and manure is a major factor for rejection of the technology here. Because locally built composts are seldom sufficiently well made or cared for, they seldom reach the temperatures required to kill these seeds. There are studies that show that African women will refuse any technology (including fertilizer) if it increases their weeding burden. Caution must be taken to use immature plant material, stalks and stems of plants or ensure a hot compost mixture.

Since the training for my counterparts was not possible before the rainy season last year and because I was concerned about local nuances in compost production, I arranged for a compost expert from Bareng Research Institute to conduct the training in Diaforé and Koundou and one from Foulaya Research Institute to do the same in Dissa. These went well and some 20 composts were established as demonstrations in Koundou and Diaforé and 9 in Dissa. At my request, two types of composts (pit and pile) were demonstrated at Diaforé and Koundou and these plus a third type (a brick, three-section compost bin, which was to be used in connection with the construction of stables for the traction animals) were demonstrated in Dissa. In Dissa and Koundou, even though the animatrices tried to support the program, the program suffered from the lack of soil/water counterparts.

The NRM PCV in Koundou was requested on numerous occasions over 8 months to follow up on one compost pit in her village that had been emptied in December. The material was used on an off-season garden (which she worked in, too) but the pit was not refilled, even though all the ingredients were close at hand. She was never able to find the time or interest to follow up.

The PCV in Dissa has his own compost pit and arranged for a successful farmer from outside the watershed to visit the Dissa villages to promote the use of compost. Since this was carried out independently of the compost program that the Project started last year (there was no S/W counterpart in place at the time), his efforts were less effective than they might have been.

In Diaforé, where there was a counterpart, the compost made the previous year was distributed on tapades before planting. The results on their effect on yield must be followed up and shown to farmers.

Due to the slow start and low acceptance rate of the compost technology and to the short duration of our Project, I suggested that, for the 1994 campaign, the Project entice farmers to build composts themselves by offering to add 1 Kg of 11-24-12 fertilizer to each $1m^3$ of compost (pile or pit) they make. After the success of my contour wall program, I was certain that farmers would see the advantage of this program, too, and we could ensure that a large number of farmers would try this technology, resulting in a large number of farmer-prepared "demonstrations" and permitting the Project to introduce some phosphorous into the cropping system. This idea was determined "unsustainable". Instead, AID permitted a "few selected farmers" to be picked for demonstrations of the effect of using fertilizer in compost (<u>not</u> what I would like to show farmers who may not be able to obtain fertilizers). I suggest that, in 1995, my original idea be presented again, keeping in mind the importance of providing farmers with incentives to try out new technologies.

It should be mentioned that our Admin Assistant, Moctar Diallo, has his MS in soil science and can help coordinate soil-related activities. In addition, Mr. Touré of the Projet RAF, who was so successful as my "rent-a-logue" in Koundou, should be considered if someone needs to be hired for specific activities.

IV. EXTENSION

This is a subject I feel strongly about: We have not used extension effectively. In February, 1993 I circulated a memo where I stressed that extension would be the most important part of my program and felt it could be for the others as well. I suggested a full-time person to help an overloaded TA team put these programs (including *fiche techniques* and Radio Rurale spots) together. I requested catalogues or other sources of A/V material on conservation, erosion, etc and suggested that we have a program where themes are developed by the TA and A/V person, the counterparts be brought to Labé to be briefed on the subject by a specialist on that subject (the TA and/or others) and then the counterparts introduce the program in the villages. At about the same time I submitted a full page of needed extension materials (video cameras and video/TVs for each watershed, photo cameras, projectors, tripods, PA systems, etc, etc). The original suggestions should be reconsidered.

Twelve months after this detailed request was submitted, we had a single TV and video-recorder, a slide projector and screen (with a second one of each on the way), a good amplifier and two microphones. The A/V specialist, chosen in September, was hired in April (1994) and spends two days a week working for the GNRM Project. I have worked with his full-time assistant (who is an animal scientist by training and was rated as our last choice in our interviews for an A/V person) to teach him how develop a video program with little success. He is lacking in imagination and incentive. In brief, extension has been a poorly supported activity which, in turn, has poorly supported our programs.

What is needed is a dynamic extension program which will introduce our Project to our villagers. After two years of working with villagers, it is apparent that they are still not sure why we are there. Due to confusion from several levels of authority within the Project, this is not surprising. The production of a video on what sustainable development is all about (i.e., the Project is there to help villagers do their own work to improve their lives) could greatly simplify the Project's job - and might also force the Project to agree on why it is there and how it has to work.

A video format is suggested because the videos that I have succeeded in developing have been very well received in the villages. The field technicians and the CED TA have been impressed by the ease of video production and the effectiveness of videos in capturing the imagination of the villagers. I have trained the CED TA and several of the DNFC technicians how to use the camera and how to take usable tapes, although a considerable amount of practice is still required. With only one video camera and one TV, this will take a long time.

Other topics (in addition to the subjects listed above) where video programs would be of great use would be:

- What is the Project's philosophy/approach on development: who does what and, especially, what is expected of the villagers in our approach to development (virtually everything).

- The introduction of each Project intervention (separately): philosophy, approach, advantages, what the Project offers and what we expect. These can take advantage of all the work we have done already and include interviews with participants.

- What is research and how it impacts on the farmer: what does our research volet do and how they should take advantage of the results.

- General and specific crop production techniques.

- Basic environmental videos: the hydrologic cycle, organic matter and soil fertility, erosion control, pollution (esp, groundwater, drinking water, etc), the effects of bush fires, etc.

V. CONSTRAINTS

The soil/water program, by the very nature of its mandate, was particularly hard-hit by three of the Project's more serious constraints: A) confused Project policies, B) lack of sufficient and timely funds to finance activities and C) lack of counterpart staff.

A) Confused Project policies

The difficulties of defining the concept of "sustainability" as it related to our Project and its programs - as well as its program activities - coupled with how the Project was being administered resulted in a critical and chronic lack of accepted guidelines on what we could or could not do with Project funds. The need to provide short-term "incentives" to speed up the transfer of technical concepts and abilities (eg, short-term programs which pay farmers 3 cents per meter for farmer-built contour walls, subsidize farmers who hire traction animal teams to till their land, the donate small amounts of badly needed phosphate fertilizer for each cubic meter of compost material amassed, etc) and the purchase of required materials to support activities central to Project goals (eg, refrigerators for each watershed to store veterinary medicines) was confused with the lack of "sustainability" of these activities. Lacking the ability to make these decisions within the Project (AID required their approval for even these minutia), the TAs were unable to develop timely programs while cajoling COP approval or awaiting AID approval which were often delayed until the proposed programs were unworkable.

Another policy which profoundly influenced the S/W program was the covert and unilateral decision to eliminate the S/W program without discussion with the incumbent, the other TAs or with any of the Guinean Nationals in the Project. When the Nationals were officially informed of the decision (months after the incumbent was notified to leave and his replacement was being chosen), discussions of the matter were eliminated through an unrelated but well-timed discussion of possible decreases in their prime (salary supplement) payments. Considerable resentment and uneasiness was created from December, 1993 onward due to AID's and the COP's handling of a situation that could have been simple and straight-forward.

B) Lack of Project funds

PL-480 money was required to finance all in-the-field operations (including fuel for the vehicles, material and hired labor costs, petty cash to finance meetings, etc). Due to the way it was administered, it was available for approximately six months of the 15 months that the S/W program worked on AID-approved activities. Due to the importance of the timing of S/W activities, the poor timing of the availability of these funds often resulted in profound embarrassment in front of participating villagers when the Project could not pay for work performed, failed to keep promises to villagers or had to undertake activities at inappropriate times during the calendar or agricultural year. Even though the other three programs of the GNRM Project suffered from the unavailability of funds at crucial times, the S/W program suffered inordinately because some of its activities include a construction aspect. These latter activities (wells, springs, dams, research) depended on the timely availability of much larger amounts of money than are required by most of the activities undertaken by the agroforestry, commercial enterprise or women's issues programs. The timing of the funding had a particularly important effect on the program in the Koundou WMU where, after nearly four months without funds, money became available two weeks before my departure on vacation. A considerable amount of work was carried out in my absence which did not follow my suggestions and which has resulted in structures that have not served the Project nor the villagers as well as they could. Although a certain amount of this is to be expected from spring-related activities carried out in the rainy season (other projects had the same experiences), this has undoubtedly affected how the S/W program has been viewed.

C) Lack of counterpart staff

Long-term training is an important component of any development project. However, we learned from the FSR Project in Mali that sending Nationals who are in key positions in an ongoing project is extremely disruptive to the success of the project itself. I specifically discussed this point before the Project began and was assured that long-term training would not be offered to our counterparts. In fact, one month after my return from annual leave and six months after the S/W program was accepted by AID and the activities begun, two of the three S/W counterparts were sent off for training. Although immediate replacement was promised, two of the three watersheds had no S/W technician for six months. To make things more difficult, the S/W counterpart in the Dissa watershed (the "showpiece" watershed due to its proximity to Conakry) became acting Director for four months as the Director became sick, died and was finally replaced.

To make the point, during the entire time the S/W technician has been in the country (nearly two years), there has been a plan of work accepted by AID (since June, 1993), PL-480 money available, TA supervision and the counterparts in place and available for four months in Diaforé watershed, one month in the Koundou watershed and approximately two weeks in the Dissa watershed. The extraordinary accomplishments achieved in spite of these and many other project-derived constraints is testimony to the resourcefulness and hard work of the Guinean staff in their collaboration with the S/W TA.

SOIL/WATER PROGRAM
Summary of a Program

Sept. 1, 1994

PURPOSE

The purpose of this paper is to provide a brief overview of the soil/water initiative developed for the GNRM Project to be used in developing a program in the absence of a soil/water TA. A discussion of the state of individual activities in the GNRM soil/water (S/W) program will be submitted separately.

INTRODUCTION

The GNRM Project was initially developed as a natural resource management project. It's importance was based on the fact that the Fouta Diallon Highlands (often called the "water tower of West Africa") is the source of three major rivers that provide water to six neighboring countries as well as many minor rivers serving its neighbors. Early in the development of the Project, commercial agricultural production and small enterprise development were added to reflect their importance to <u>sustainable</u> natural resource management practices as well as AID's recent emphasis on the development of the private sector.

The purpose of the Project became, therefore, "to improve the management of natural resources for profitable and sustainable agricultural production in three watersheds of the Fouta Diallon Highlands". Specifically, the NRM component is to:

a) Develop a knowledge and information base on natural resources within the basin, the long-term impacts of current and improved practices and technologies and mechanisms available for improving the natural resource base.

b) Assist communities in prioritizing NRM issues and to develop action plans

c) Test and transfer technologies and interventions with primary action taken on "reducing erosion and runoff, enhancing soil fertility, improving water resources, forest management, improving crop production, etc."

d) Train DNFC technicians in the practices and extension of NRM practices.

THE SOIL/WATER PROGRAM

The Soil/Water position in the GNRM project is being terminated after two years of activity. As with the other two Project programs, the program has been developing with a 4-year prospective and, therefore, the change in Project emphasis has caught the program in mid stride in many of its activities. This report is an attempt to identify the parts to the Soil/Water program that I would like to be considered for inclusion in Project activities in the future. It is anticipated that the Project's TA team will sift through this material and progress from there based on their own ideas, philosophies and backgrounds. Because the evolution of a program is complex and includes analysis of opportunities and available technologies (with an eye on their sustainability) as well as the development of a philosophy, a separate report will be written in an attempt to present as much background as possible on specific activities undertaken during the first half of the Project.

This report is a discussion of a soil/water program that I outlined at the beginning of the Project and later developed as a means to help Management Consultants, the NGO in charge of our monitoring and evaluation program, in developing a questionnaire for their M&E activities. Table 1, below, is the result of these activities and is being used to put the Project's S/W activities into perspective. This will also provide the format for the discussion which follows. Priority activities for the S/W program of the GNRM Project are emphasized in bold (Note: the A/F program would be expected to emphasize a different subset of these activities and add others not listed here).

Table 1: SUMMARY OF POSSIBLE SOIL AND WATER CONSERVATION/MANAGEMENT ACTIVITIES FOR NRM DEVELOPMENT PROJECTS

WATER CONSERVATION	Increased Infiltration (esp at high elevations in the watershed) - **Dams; contour walls**/digs/plants; reforestation; reservoirs Physical Protection of Springs/Wells - **Dams; contour walls**; grassed "tête de source"
WATER MANAGEMENT	**Provision of Potable Water** - **springs; wells; piped systems; rainwater catchment** Pollution Control **Small-Scale Irrigation** - Dams[1]; **managed springs; shallow wells; open stream use**; managed flooded perimeters[1] Water Diversion Methodologies - **Diversion canals/walls**; grassed waterways
SOIL CONSERVATION	Reforestation (steep lands, edges of water catchment basin) Windbreaks; Alley Cropping Erosion Control - **Barrages** (gully erosion); **contour walls**/digs/plants, esp in tapades and fields (sheet erosion); **diversion canals**; grassed/protected waterways; conservation tillage; (improved) cover crops)
SOIL MANAGEMENT	**Animal Traction** (being taken over by CED) Intensification of Production on the Most Suitable Lands Terracing **Termite Control**
SOIL FERTILITY	**Inorganic Fertilizer** Organic Matter Maintenance - Fosse fumier; **compost**; green manure; mulch Basis of Soil Fertility - Erosion control (the lightest soil fraction is the most important); effects of OM on soil physical and chemical properties **Night Parks and Stables** - Construction; maintenance; manure collection; animal health

[1] These activities, although programmed, are on hold while certain technical and social problems are solved.

SOIL/WATER PROGRAM PHILOSOPHY

A. Water Conservation/Management

In the broadest sense of water conservation and management, the sustainable increase of clean water on a year-'round basis in the springs, streams and rivers of the Fouta (and therefore in Guinea's neighboring countries) is the long-term goal. The narrower definition of water conservation and management for improved living standards (i.e., more high-quality water year-round for personal use or for agricultural production) is fully compatible with the broader goal. Increased infiltration means lower soil erosion which, in the long run, means higher agricultural production. In other words, there is no conflict between developing a basic water conservation/management program and the stated Project purpose - the results are just not as obvious in producing marketable goods as, for example, compost production might be. For sustainability, however, a basic water conservation program is essential.

1. Water Conservation

Nearly all villages in all three watersheds identified the provision of potable water as a high priority. As described elsewhere, this provides a readily acceptable means (to the villagers, who are frequently suspicious of outsiders) to organize their villages, develop an understanding and extract labor on related and non-related Project activities that they might otherwise postpone (indefinitely?). Where done properly (in Koundou), there were so many opportunities for water conservation activities that there was insufficient time available to my "rent-a-logue" and insufficient logistical support for the PCV to provide all the technical and organizational guidance requested by villagers. Tremendous potential for increasing infiltration and decreasing runoff exists in the Koundou watershed, particularly far above the villages of N'Dentari, Telibofi, Tyankoye and Guémé but all villages in all watersheds - particularly those with a water crisis late in the dry season - can profit from this program.

Recommendations:

(a) The theme of increasing potable (and other) water availability must continue to encourage the villagers to undertake activities which are strictly water conservation-directed.

(b) In terms of follow-up, the infiltration walls, bunds and dams that were put in place must be monitored and repaired when needed.

(c) To improve late-dry-season water availability, additional structures need to be built in the farthest reaches of the water catchment basins for each of the springs or wells involved, prioritized by the severity of dry-season water shortage and by the geophysical realities of the site. The areas to be developed as infiltration sites need to be delimited and at least one or two structures built before the Project is terminated so that villagers can see their effect and act accordingly in the future.

(d) An extension program must provide sufficient explanation of why and how the infiltration activities work so that the villagers will continue to construct and maintain these structures well after the Project is completed (i.e., the hydrologic cycle, etc).

Anticipated Results:

- Increased awareness among villagers of the concepts involved in water conservation
- Decrease in erosion and fertility loss from all fields, particularly inner fields
- Increased infiltration and groundwater recharge
- Improved year-round water availability on a micro-scale and a reversal to the trend toward flood-drought cycles in watersheds
- Increased village organization and participation around commonly accepted goals

2. Water management

In the narrower definition of water **management** for improved living standards and marketable production, the provision of potable water and irrigation water are priorities. The activities required to accomplish these goals are also totally compatible with the broader goal of watershed-level water management. Controlling the flow of surface water to increase its infiltration and, thereby, increase its availability through the dry season is a long-term goal. The provision of potable water sources and the development of small-scale irrigation are the short-term prerequisites for the larger, integrated program.

a. Potable water:

The provision of potable water or the management of water points to facilitate water collection is the most requested intervention in the watersheds. As mentioned, this activity provides the easiest means for the Project to obtain village cooperation and trust. The technology and short-term availability of funds, however, are beyond many of our villages' means and, therefore, must be undertaken by the Project with the requirement of active village participation in any construction activity. In terms of future activities in this area (the most pressing examples being the captage in Tanéné and water transmission at Falloulaye), USAID has apparently assured the GNRM TA team that there is sufficient expertise in DNFC and BTGR to handle their needs. I have also been trying to train both the engineer we have been using at Dissa WMU (Chiek Sylla) and the new Dissa S/W/Agronomy counterpart in some of the newer (for Guinea) water transmission technologies by installing a system in Donta. In case DNFC or BTGR fall short of USAID expectations, these people could be asked to help in other watersheds.

Recommendations:

(a) I still consider this activity central to our approach to villagers and to sustainable NRM and suggest that it should be an ongoing activity (I estimate that fewer than 50% of our village women have potable water reasonably close by - within 700 meters).

(b) Concerning well and spring management, in general, much more work needs to be done to empower the Comités de Gestion to take over full responsibility for this, including technical maintenance. Insufficient time has been given to this aspect of the program, largely due to the lack of S/W counterparts and the limited input from the animatrices in this area (with the possible exception of Koundou watershed).

(c) Apparently our Project is not supposed to spend time on health training (in our case, water sanitation), but a PCV could be provided materials and support to do something on this very important issue. Improved health does not necessarily follow the provision of potable water due to persistent unsanitary practices. While money and time is spent to eliminate water-borne diseases in the water being collected, simple changes in water handling are required to eliminate the introduction of diseases through handling. Reducing disease will increase villagers time to engage in productive activities.

(d) One of the greatest, as yet untouched potentials is rainwater collection during the rainy season. I was working with Chris Erwin (PCV, Dissa) with the hopes that he would carry out a demonstration program of cisterns and low-tech water catchment basins. He was very interested. I wrote the required request to the WMU Director for him in June but, as of August 25, he has not begun.

Anticipated Results:

- Interest the villagers in participating in the GNRM program
- Act as a focal point for improving village organization
- Introduce villagers to the concept of "natural resource management" - what managing their resources can do for them
- Provide incentive to undertake NRM activities they may not otherwise undertake (flood and erosion control, tree planting, etc)
- Decrease women's workloads, particularly late in the dry season
- Improve health among villagers.

b. Irrigation:

The potential for irrigated agriculture during the dry season remains high and is still not fully developed. Several perimeters were developed last year without the TA or WMU technicians taking into consideration many of the suggestions I made before I went on vacation (see technical report for details). Regardless, most of the perimeters had no reason to suffer from a lack of water last dry season (until, perhaps, in April when evapo-transpiration became a limiting factor for the plants). I will write and leave for the TA team a detailed list of suggestions for corrections to be made at each site which should facilitate watering and decrease the cost per unit of yield (in money and/or in labor) as compared with last year. Most of the potentially irrigated areas have been identified in all three watersheds. Due to the high cost of nearly any irrigation system and the limited amount people make from agriculture, the Project will have to subsidize costs if these are to be established. Profits from their use should permit the systems to be maintained. The importance of these improved irrigation systems for easing women's workload as well as expanding production, however, can not be over emphasized.

Suggestions:

(a) The suggestions listed here and elsewhere on irrigation (and soil fertility) should be considered well before the start of dry-season planting to permit the development of a timely program of off-season production.

(b) Polypipe transmission lines for irrigation water provides tremendous potential, particularly in Tyankoye, Nena and N'Dentari (Koundou WMU); in Donta and Tenéné in Dissa WMU and at Foréya in Diaforé WMU. The limiting factor in the potential for increased off-season production through irrigation is the marketability of produce. We can easily flood the market with the crops that villagers could produce using the irrigation water available and good agricultural varieties and practices. This could result in problems of reimbursement for the system, if this is to be required. Personally, I believe irrigation systems should be installed as a long-term investment at a subsidized cost or a yearly rental for the farmer.

(c) Irrigation with hoses (water under pressure either by siphoning or from elevated storage) should be compared with the present approach of watering-can irrigation due to its relative speed and ease. If the spring above N'Dentari is to be used for irrigation, this is an ideal site for this test in the Koundou WMU, as is Tanéné in the Dissa WMU.

(d) Flood irrigation (apparently the only form considered by irrigation engineers - yet the most wasteful of water) should be avoided where water is limited and/or the soil has a high infiltration rate.

(e) Input on the foot-pump has already been forwarded to the CED TA. These will also be discussed in the "Technical Report". These have considerable potential but more investigation is required into their practicality and profitability.

(f) Serious consideration must be given to markets and storage requirements for any produce which comes from irrigated perimeters. Although the CED has addressed the problem effectively in the past, the potential for flooding the markets and discouraging the farmers is a constant threat.

Anticipated Results:

- Given sufficient infrastructure and technological ability, farmers should be able to increase their production considerably for food diversification, to alleviate food shortages, to provide income and to improve nutrition and health.

- With increased food security (using off-season crops), farmers will be more likely to intensify rainy-season agricultural activities, thus reducing the environmentally damaging slash-and-burn, extensive agriculture now practiced.

- With the realization that intensive diversified agriculture not only increases productivity of cultivated lands but also reduces the risk of famine, farmers will realize the importance of soil fertility enhancement and maintenance. The acceptance of fertility-promoting technologies such as organic matter maintenance and soil stabilizing techniques should increase.

c. Control of water flow:

This is basic to all NRM activities. The uncontrolled loss of water causes erosion, loss of soil fertility and lowering of the water table at the village level and flooding and siltation downriver. Any structure, plant or activity which increases infiltration will potentially decrease erosion. Diversion canals and protected waterways to direct excess water along a harmless path to the streams will further protect soils and homes. The higher these can be used in a watershed or micro-catchment (i.e., the sooner untamed water can be controlled), the better.

Suggestions:

(a) The highest priority is diversion canals: they are simple, understandable and, in most areas, easy to design, install and maintain. Diaforé is the most advanced in this technology.

(b) As with water conservation work, the incentive to do this type of work must be developed among villagers. Education and the ability to show short-term gains (here, protection of villages, fields, soils, etc from water damage) have the highest potential to do this.

c) The loan of Project tools for specific organized activities has also enticed timely village participation. The ability of the Project to loan tools to villages who want to do water management work and our assistance in helping villagers learn to organize themselves for these activities is essential to the sustainability of the NRM program.

Anticipated Results:

- These activities are of short duration and their results are seen quickly thus providing an easy means for villagers to understand what we mean by NRM and how to manage this particular natural resource.

- Villagers will understand the importance of learning and using simple technologies (particularly tracing and following contour lines) in their approach to NRM

- Villagers will learn the required technologies

- These activities also provide the village with the opportunity to organize and work together on something that benefits the entire village

B. Soil Conservation/Management/Fertility

1. Soil conservation

Short of terracing and other techniques that are not common to Africa, soil conservation is closely linked to water conservation/ management techniques and requirements. The control of water should reduce erosion. Diversion canals and contour walls, etc, offer the greatest potential for conserving tilled soil. Our ability to intensify production on the best fields (see soil management and fertility) should permit soils at risk to be reforested or covered in improved pasture.

Suggestions:

(a) Diversion canals, contour structures and erosion dams, particularly in and near the tapades, should continue to be promoted.

(b) All soil conservation structures presently in place should be visited regularly (particularly from mid July to mid Sept) and repairs be made by the farmer where necessary (with full explanation of why each breakthrough of a wall has occurred). This would be an ideal time to point out the soil-saving ability of these walls.

Anticipated Results:

- Villagers will learn the required technologies.
- They will learn that they can have impact on their own fields if they are willing to employ the technologies as they are taught
- They will learn that the placement of soil conservation structures is only the beginning of the process - that these and any other structures must be maintained and improved if their effect is to be long-term.

2) Soil management

The management of soil is a complex mixture of when, where and how the farmer uses his land - some of which has been discussed under the soil and water activities discussed above. The guiding principle for soil management should be to intensify production from the most fertile and least endangered land as well as increase off-season production with the idea that this should take pressure off of the more endangered and/or less-fertile land. This approach will not work unless the villagers see the advantage of taking the marginal land out of the production cycle since they could continue to use this land for income-generating production if they had the time to do so. Village interest in water conservation would provide a means to convince them to reforest these areas.

On the land that will be used, intensive farming must produce more and better crops. One simple way in Diaforé, where people go without staple food for as much as two months each year, is to continue the destruction of termite mounds within and immediately surrounding the tapades (farmers say termites destroy up to 60% of their rice, corn and manioc crops). In Dissa and Koundou, where there are significant flat areas, the use of traction animals will be of significant use in decreasing the drudgery of the work, lightening workloads (especially for women) and decreasing the time lost to this activity so that timely planting and weeding can be undertaken. Obviously, these soil management techniques must be used in conjunction with soil conservation and fertility activities as well as improved varieties and improved cultural techniques.

Other improved soil management techniques, including contour plowing/planting, should be incorporated into any agricultural program.

Suggestions:

(a) Increase efforts to support animal traction in the short-term. The construction of the stables in Dissa and subsidization of the hiring of traction animal team (to interest people in the concept) must take priority. Yearly training of farmers and animals should be well advertized, well timed and well planned. The efforts in 1994 by the CED in this regard are acknowledged.

(b) The negative effect of animal traction on erosion and weed production must be monitored and eliminated.

(b) The termite control program must be put into shape. If traditional methods are shown to work, these should be extended aggressively and termite destruction "parties" should be organized in each village where villagers do not do it themselves (to show them that they can do it). If no effective non-toxic method can be found, chemical treatments should again be offered for the two next years (but on a timely basis and with farmers sharing in the cost) and villagers encouraged to keep the termites out by physical methods.

(c) Farmers should be convinced to turn marginal lands into woodlots or improved pastures with the arguments that they can increase water availability during the dry season (for domestic or crop production) coupled with increased wood for fuel or construction and high-quality pastures for animals.

(d) Improved tillage techniques (furrow-dikes, contour furrows, passive terracing using alley cropping, etc) have not yet been introduced to the program. With the emphasis on production agriculture, these may prove to be easily-incorporated and worthwhile techniques to include in the agricultural package.

Anticipated Results:

- The overall drudgery of plowing will be decreased and the responsibility of the remaining work will be shifted from men to women

- The drudgery of transport should also be decreased through the use of animal-drawn carts

- Agricultural productivity will increase and the ability to control erosion, weeds and storage loss will be improved.

- If a localized, non-chemical means of termite control can be found, a profound increase in production and decrease in maintenance work will be experienced throughout Africa and South America.

- The technologies for increasing production while decreasing soil erosion, and the importance for the latter, will be transferred to farmers.

3) Soil Fertility

The management of soil fertility is the core of the soil/water program. It is essential to increase soil fertility to increase and intensify agricultural production and to persuade farmers to abandon marginal lands. The basis of increasing and maintaining soil fertility, however, is the elimination of erosion: the first soil fractions to be washed from a field by runoff water are the most fertile. The common practice of burning fields before the rains start (and then watching all the ashes - and fertility - flow off the fields with the first rains) is singularly self-defeating. For this reason, considerable emphasis has been placed on soil conservation activities.

Considering the components of soil fertility, the common practice of burning organic residues (our villagers even burn manure in order to make the potassium and, particularly, the phosphorous immediately available) results in the loss of both nitrogen and sulfur. While the agricultural system presently used accommodates this loss (by extensive planting or use of low-N-requirement crops such as fonio rather than managing for high yields), this represents a significant opportunity. It is doubtful that burning can be stopped but programs to increase mulching and composting (using materials that are otherwise burned) can increase the level of these elements in the soil.

According to research reports, potassium is not a limiting nutrient in most Guinean soils. Due to our interacting problems with funds and the OMVG laboratory, our soils have not yet been analyzed for K. Regardless, K will be increased with nearly any soil fertility-enhancing activity we undertake. Phosphorous, on the other hand, is limiting in many of our soils, particularly in Diaforé (see table, below).

Table 2. THE % OF SOILS SAMPLED IN THE THREE WATERSHEDS SHOWING THE FOLLOWING TRAITS:

SOIL TRAITS \ WMUs	Dissa	Diaforé	Koundou
Acid soils pH < 5.0	7%	51%	29%
P Deficient: mild (10-15 ppm)	7%	13%	14%
P Deficient: moderate (5-10 ppm)	29%	8%	14%
P Deficient: Strong (<5 ppm)	7%	41%	21%
Total P deficient soil	43%	61%	49%

While N can be manufactured in place (eg, by legumes) and K is apparently abundant in much of the parent rock in Guinea, P deficiencies must be taken very seriously. If there is little P in the soil, it will be low in the plants, in manure and in compost, thus becoming the limiting factor among the macro-nutrients. For this reason, the S/W program attempted to target this element which, unlike other nutrient elements, can have a residual effect that can last up to 20 years. A program which will both entice farmers to make compost at the same time as enriching their soil with P is strongly suggested - such as that turned down for the 1994 season where any farmer that produces compost will receive 1Kg of high-P fertilizer, applied directly to the compost, for each 1m^3 of raw compost made. Due to the short duration of the GNRM Project, "crash" programs like this are required to transfer technologies as broadly as possible in the short time we have.

In addition to the nutrient status of the watershed soils, soil organic matter management provides an important opportunity to increase soil fertility. Again, the burning of organic matter in the outer fields should be one target: attempt to have the leaves used in composts or mulch and the cut branches and trunks in contour walls. Burning greatly simplifies the work in extensive agriculture and, although limited success might be expected in controlling burning in general, any progress in this direction will be a benefit.

In tapades or inner (intensive) fields, many women already mulch extensively. Composting, particularly as it is extended presently (requiring a pit to be dug first) is not readily acceptable (as was the case in S. Pacific countries). Composting, although an important and "simple" technology, has several nuances which make it difficult to extend. Therefore, considerable energy must be put into determining and solving the social and technical problems endemic to our watersheds. From my experience to date, I recommend surface-built composts constructed during the rainy season (August-Sept., when farmers have a breathing space in their schedule and considerable immature plant material is available), avoiding seeded plants. The use of existing pits dug for other purposes for dry-season composts can be extended but I recommend composting corn stalks and other non-leguminous materials with high quantities of manure and regular watering. Leguminous material are best passed through domestic animals before composting (see next paragraph). The S/W/Agronomy counterparts and the animatrices have now had training in compost production at Rodale/Senegal and this program should be on good footing in the future.

The interdependence of animals and crop production is understood by most farmers in our watersheds but the efficiency of the interaction is limited. While they know the value of manure and build shelters for their small animals where manure collects, often the manure is not used. The greatest source of manure, cattle, is not readily available because of the animals are kept away from the villages during much of the year. The obvious response to this is night parks and stables in association with the storage of legume hay and ensilage. Several attempts to begin this program in Dissa, the most promising site because of the animal traction owners' obsession with protecting their animals from theft, have run into financial and staffing (counterpart) snags (see report on program status). The request for an animal science TDY who could put the program on solid ground has also been long in the processing (I first submitted this to Chemonics in December 1993). Sites for night parks have been located, if not established, in the other two WMUs but the program is not yet underway.

Suggestions:

(a) I have made arrangements with Bareng's soils laboratory to analyze samples from all three watersheds. Samples from two WMUs have already been submitted but no PL-480 money is available (they need an advance to buy fuel for their generators). Chemonics has agreed to advance the money once the samples from Dissa are submitted. These analyses must determine both P and K levels and the results checked for accuracy (split samples?).

(b) A program to apply hi-P-fertilizer to <u>all</u> farmers' compost pits should be approved for 1995 (it was refused for 1994 except for "demonstration") to encourage farmers to make compost piles with a special effort to get P in the most P-deficient soils. The application of lime to composts might be considered for the same reason but high OM applications can tie up acid radicals (aluminum reacts with P to form nearly inert compounds).

(c) The compost program, with the return of the technicians from Rodale/Senegal, should be well under way for the tapades. An organic matter management program for the exterior fields should be developed based on less intensive technologies (reduced burning, etc).

(d) Demonstration stables and night parks should be established with a complete program of animal husbandry and manure/urine collection and use (see "cycle of soil fertility").

(e) Any fields where we work must be analyzed for the risk of erosion. No field at risk should be fertilized in any manner before it is protected from serious erosion with diversion canals and contour structures, as needed.

Anticipated Results:

- Farmers will learn a number of technologies which will increase and maintain soil fertility and how they interact
- Once integrated packages are developed by each farmer (based on the technologies extended by the Project), soil fertility will increase as will the quantity and dependability of agricultural production
- With the increase of stable production, farmers will decrease their exploitive extensive agricultural approach.

SUGGESTED PRIORITIES FOR FUTURE GNRM S/W PROGRAMS

The overriding factor in what programs will be continued, emphasized, added or eliminated will be: How will any S/W programs be carried out in the absence of a S/W TA? Tom would undoubtedly take over the termite control activities and Steve has already begun working on the introduction of animal traction but what about the rest? When the S/W TDY comes over, with whom will he work? If he wants to work with the Genie Rurale Techs (my present counterparts), what will the new agronomist do in the meantime? Will the TDY hire a team of contractuals, as I had to do when I had no counterparts at Dissa and Koundou? (I strongly suggest against this for a multitude of reasons but, if it is necessary, people with at least the willingness of Touré must be found and people like Pe must be avoided.) Many questions have been asked to date but few answers have been provided, so my suggesting specific priorities is difficult, at best. In any event, once this has been worked out, my suggestions for priority activities are listed below, based on the anticipated results of each program as discussed above (I have changed the titles a little to permit a prioritized list). What the TA team develops may look entirely different from what I present here but, hopefully, they will be working with all the information required to develop a program that will work (i.e., the suggestions below may be modified in any way that fits the realities of the Project as it has been modified).

Priority 1. WATER MANAGEMENT

A. Potable Water

Even in the absence of erosion control and soil fertility enhancement, the availability of adequate potable water is a major desire among villagers and can continue to be used to bring villagers into the project and provide a basis for NRM training and willingness to work on other NRM activities (reforestation, for instance). This view was confirmed in F. Gilbert's recent report.

B. Small-Scale Irrigation

Again, in the absence of other programs, improving irrigation capacity and efficiency will provide villagers the opportunity to grow off-season crops for consumption and sale. This is an obvious priority for the new agronomist, as well. I still believe that the Project should pay for these systems (particularly polypipe-transmitted water at Néna and N'Dentari, for example) as long-term investments, whether a system for recuperating all or part of the cost is put in place or not.

Priority 2. SOIL/WATER CONSERVATION

A. Contour Walls/Bunds/Planting and Diversion Canals

Before time is wasted in increasing soil fertility, only to watch it wash away during the rainy season, soils must be protected. An active and well-thought-out follow-up program on the

30 km of contour walls/digs/trees that have been put in place in the three watersheds is needed to make this enormous effort worth while: 99% of the work is done but it requires the last 1% to make the system work. NOTE: Like composting, activities on the contour are easily misunderstood and improperly carried out by villagers.

Diversion canals are essential for the success of the previous technology. The main reason for failure of anti-erosion technologies is water coming from outside of the field. Many villages are still suffering flooding but many more individual farmers are faced with serious erosion problem in their fields from runoff water entering their field. This must be controlled by the villagers but better village organization and technical expertise are clearly required.

B. Infiltration and Flood Control Dams

These activities are probably less important than soil fertility management to agricultural production for profit. However, in terms of sustainability of NRM activities and a means by which village organization can be improved, these have important potential. These activities are best done during the slowest season and usually by men, so they should not interfere in other programs and should have a positive effect on the Project. Koundou has the highest need for this activity but both of the other BRPs can profit, as well. It can be "sold" as a means to increase water availability in the dry season and to protect soil fertility in the fields below the structures. Irrigation possibilities could also be investigated.

Priority 3. SOIL FERTILITY

Once the soils are stabilized and protected from inundation, soil fertility enhancement and maintenance are of value. I have discussed the importance of short-term, Project-subsidized input of inorganic phosphate fertilizer in villagers' fields (through composts). I also wish to emphasize the importance (to sustainability) of linking animal production and crop production. Therefore, two priority activities are:

A. Night Parks and Stables (and all that goes with them)

As shown in the attached drawing, the "cycle of soil fertility" should be an integrated program. The help and input from an animal scientist (the SOW for this TDY is at Chemonics) will be invaluable. If we can succeed in getting a few demonstration sites set up and running, I believe that, at least in Koundou and Diaforé (where the animals are around <u>somewhere</u> most of the year), this could be an important technology.

B. Composting (and other OM management activities)

Although this is a sub-section of the "cycle of soil fertility", it is listed separately because of its importance and because it can be extended in the absence of the other activities of the "cycle". I suggest that a program of chemical fertilizer application to compost pits (1 Kg 12-24-12, or thereabouts/meter^3 of organic matter) be put into action next year with considerable sensibilization to maximize participation. I also suggest that, in fields with very low phosphorous, 2 Kg be applied/M^3. This is especially true for low-P sites that the Project is trying to develop (Foréya in Diaforé and Tyankoye in Koundou, for example).

EXTENSION PROGRAM FOR S/W-RELATED NRM

Listed as the first activity of the NRM component in the Project Paper is the need to "develop a knowledge and information base on natural resources within the basin". Without changing the knowledge base of the villagers, they will never understand the importance of NRM and, until they understand its importance, the transfer of necessary technology will not succeed. The most important information that needs to be instilled in the minds of the villagers is listed below. There are several methods of getting this information to villagers and they should all be used, but our experience suggests that slide and video programs attract the most attention and interest - and video programs are the easiest to produce, distribute and display (given sufficient equipment at the PMU to produce them and sufficient equipment in the WMUs to show them).

Table 3. IMPORTANT CONCEPTUAL TOPICS TO BE EXTENDED IN THE AREA OF SOIL/WATER CONSERVATION AND MANAGEMENT

WATER
- Basics of the hydrologic cycle
- Effect of conservation activities on water availability from springs/wells: Infiltration dams, contour walls, reforestation of uplands
- Groundwater Pollution

SOIL
- The "cycle of soil fertility": animals and crop production: (See the design, attached).

This is comprised of 9 sub-topics: (1) The use of weeds for fodder, animal bedding and compost; (2) Night parks and stables for animal health/protection and manure production; (3) Composting technology and methods; (4) Use of compost (and other materials) to maintain soil fertility in the tapades to produce more food (and animal feed as a byproduct); (5) Storage methods for crops to eliminate loss; (6) the sale of these crops for profit and exchange; (7) Good nutrition to protect health to permit higher production in tapades and fields; (8) Improved field practices to increase food and fodder production and (9) the storage of animal feeds.

- Soil organic matter: Its importance to soil fertility and crop production (The effects of soil OM on soil chemistry and physics)
- Crop nutrients, nutrient deficiencies in plants and how (with locally available materials) to remedy the problems

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PLUS The proper use of inorganic fertilizers (Actually a plug for composting)
- Erosion control (Linked with water conservation)
  (How contour structures and plants, dams, grassed waterways, conservation tillage, culture in bands, alley cropping, etc help to hold the soil and how that improves soil fertility.)
- Termite control: Traditional and chemical methods

The importance of the extension component cannot be overemphasized, which is why, in February, 1993, I suggested we get this part of the program going and submitted a full-page list of equipment needed to make it work. We now have some of the materials necessary to put together an effective program and, since May, 1994, we have a part-time person to do the work.

Suggestions:

(a) We need to analyze the present situation and make plans accordingly. As a start, I suggest that we have the following:

Working against us:
- Lack of Project time (Project has two more years)
- Limited materials for extension and limited support (human and material) for developing and launching an extension program
- Lack of villagers' time (they have a pretty full plate!) and the resulting low priority farmers give to some Project activities
- Villagers' slow rate of acceptance of many new ideas/technologies
- Technicians' poor attitude toward villagers
- Villagers' distrust of outsiders
- Villagers' lack of a basic understanding of cause and effect in some environmental matters (eg the hydrologic cycle)

Working for us:
- Lack of interesting things to do in the village (they are a captive audience if you have an interesting show at the right time of day/night and the right part of the agricultural calendar)
- Villagers' nearly universal desire for potable water, the control of termites and the control of wild animals - two with which we can offer help.
- Villagers' desire for greater water availability (esp in dry season)
- The visible effects of erosion on fields and soil fertility
- Villagers' (particularly mens') "slack time" during the coolest part of the year (i.e. - availability for work on conservation activities when work is easiest to do)
- Villagers' desire to increase agricultural production
- Villagers' understanding of the importance of many of our interventions (OM management, anti-erosion, intensification of production, etc)

(b) We take full advantage of Ismahel Souaré's time. We need to decide what types of programs we need and to prioritize them.

I suggest an emphasis on videotaping slide shows and presentations for the reasons mentioned above - but this needs to be a team decision. I have tried to work with both him and Mr. Baldé, his assistant, on how to develop an extension video but it has been largely unsuccessful due to Mr. Souaré's unavailability and Mr. Baldé's incapacity. Apparently there is a woman at Radio Rurale who understands the technical aspects of the video editor and perhaps we can find someone who can work with them on how to design effective programs.

(c) If you are in agreement with the power of video programs, we should buy at least one more video camera plus a TV/VCR for each BRP. These should not be considered capital purchases but, rather, operating costs. The TV/video system use could be programmed - they could be put to good use virtually every night of the week in a different village.

ANNEX I

WATER MANAGEMENT: COMMENTS ON THE PROGRAM

I. INTRODUCTION

The exact place for the potable water activities within the GNRM Project workplan is still somewhat uncertain. They have been considered more of a subsidiary activity rather than a priority theme. They are found under both "eau et sol" and "actions d'accompagnement" in the watershed workplans and are listed as a "target of opportunity" in the PMU workplan and its reporting. Dr. Koenig pointed out in her TDY (women's issues) report, however, that if the Project wants to permit women to participate in the Project's activities, some means must be found to free up some of their time. She identified the provision of sufficient (and safe) water to women as having the greatest potential to free women's time early in the Project and, thereby, to ensure Project success. She went on to say that, at a later date, the introduction of grain mills would have a similar effect.

Indeed, a large percentage of the men and women in the Project's villages identified water as their most important constraint and the provision of secure water sources as their first priority. Other than the four drilled wells that the FIDA project established (two in Koundou, one in Diaforé and one in Dissa), no potable water was available over the approximately 300 Km^2 area of our three watersheds. At a time when villagers were reticent to work with the project, nearly all villages were willing to provide materials and labor to improve their water supply. The Project's success in this area has had significant ramifications for other Project activities. This activity was used to establish management committees in each village, a group of men and women who the Project plans on developing into the core of a more wide-reaching Resource User Groups, which will manage the natural resources in the entire "terroir villageois". Additionally, villagers were willing to support other activities (reforestation, etc) as an adjunct to water source development. This year, 9 improved wells and 11 capped springs provide water to many villages where, last year, there was none or the available water was of extremely poor quality. Recipient villagers' interest has changed from having clean water to increasing the amount of water that is available. Rather than the Project having to convince villagers to build water control structures (infiltration dams; diversion canals; contour walls, bunds and vegetation etc), villagers are coming to the Project requesting help in this area. It is anticipated that, in a similar manner, villagers will become much more interested in actively managing soil fertility following their successful control of soil erosion.

There has been discussion within the Project about limiting this activity in time and in the number of wells and springs to be improved, considering these activities to be outside the scope of the GNRM Project. While it is a waste of time to improve all water sources in all villages, we need to reconsider our approach to these activities based on Koenig's comments and the fact that they are clearly an important catalyst to village participation in the Project. Other AID projects have recognized the provision of potable water as important to saving women's time so that they can reinvest it in adopting project technologies (Burfisher and Horenstein, 1985. Sex Roles in the Nigerian TIV. Kumarian Press, p.35). Failure to take into account women's workloads and the need to reduce the time spent in un-productive activities could jeopardize the success of our Project.

Rather than being an "add-on" to the Project, the provision of potable water in our villages is a central activity which draws reticent farmers toward the project and facilitates all other Project activities. This should be a continuous activity, taking advantage of each opportunity to provide potable water as long as it can be demonstrated to save sufficient amounts of women's time at a reasonable cost. These projects should also implicate villagers more and more in technical matters including design and construction.

II. TECHNICAL COMMENTS

A. Springs

The first year's well and spring activities began late and, due to funding and other problems, continued into the rainy season and began again in November. As a result, many springs were captured when they had considerably stronger flows than they have during the driest months (April, early May). Most springs come out at ground level, making it difficult for women to collect it. These were captured using a method which stacks water up within the structure so that it pours out at a higher elevation, making it easier for women to catch it in their buckets or other containers. At high flow rates, this "stack it up and let it pour" or "blocked-spring" approach worked well but in several cases it failed to provide water as the dry season continued and flow rates decreased. In most cases this was anticipated and a well-like structure was built so that women could bucket water from the well when the water was not flowing or the flow was too slow. Unfortunately, in two cases in the Koundou watershed (Telibofi and Totiko), the catchment system resulted in the spring moving to another exit. For this reason, the "catch and carry" method will be used in all future captages unless it is impossible or unless a test prior to the captage shows that the spring is capable of sustaining water flow under the "stack it up and let if pour" system.

B. Wells

The Project has improved several existing wells with excellent results. We use the brick-revetment method. We have dug several wells in low areas where water was guaranteed with only one minor problem - the need to deepen it to follow the dry-season water table. We have attempted to dig four wells on higher ground with the hope of providing water to village women at a point considerably closer than they had to go before. One well (in Dissa BRP) has not yet reached water, a second is presently dry and the others provide limited amounts of water. These will all be deepened and it is anticipated that they will all prove useful to the women in the respective villages. The cost, amount of effort and chance of limited success suggests, however, that the Project should only work with guaranteed locations (existing wells and wet lowlands) to avoid the cost, frustration and upset among the villagers associated with well-digging problems.

C. Rainwater Catchment

Water storage is an expensive business, especially for isolated farmers. For something to be "sustainable", either it has to last a long time (as an investment) or it must be reproducible at the village level. In Koundou and, especially, Diaforé, the former should approach should be taken to water storage in relation to rainwater catchment.

Tin roofed houses are the most obvious sources of rainwater. These should be guttered with tin gutters (simply bend tin strips in a V shape) with a downspout to a storage tank. The downspout should pour water onto a plastic (window-type) screen at an angle in such a way that the screen will be continually washed clean by incoming water. The storage tank should be large enough to store the water collected from the entire roof during a 60-80mm rainfall, although excess capacity is always a good idea. The possibilities for tanks include:

1. Cisterns (below-ground): Inexpensive, strong, long-lasting, only requires a layer of water-tight plaster. Problems: women have to pull water up, animals (and children) can fall in if it is just a hole. Suggestions: Dig a 1-2m^3 hole, build a 50 cm wall above ground, plaster and cover with cement lid with a screened inlet and a door for obtaining water.

2. Rock- or brick-and-cement reservoir (above ground): More expensive (must be stronger) but will permit a faucet for access to water. Plaster and cover in same manner as a cistern but a dall can be used for access rather than a door since it will be used for cleaning only.

3. Roofing tin reservoir: Inexpensive but difficult to obtain and easily damaged.

4. Several large containers which can be moved and filled in sequence. This is similar to the system villagers use now and, because it requires input, is only as efficient as the person in charge. One type of large (immovable) jar is made with cement plastered on the inside and outside of a wire, bamboo, etc, basket. If several of these are placed side by side, the downspout could be moved to fill each one in turn. Not recommended.

III. PROVISION OF POTABLE WATER TO VILLAGERS: A PHILOSOPHY

A. Introduction

One of the first activities that is requested by village men and women, alike, from the GNRM project is help in providing the village with safe, consistent and convenient drinking water. Before the Project began, a total of only four acceptable water sources had been made available to the villagers in all four watersheds by the FIDA project. The situation we found during our first Participative Rapid Rural Assessment was that women frequently walked a kilometer or more to fetch water which was of dubious quality if not outright polluted. The dry season exacerbated the situation: water became more polluted, wells and springs dried up and women spent more time walking and waiting. Regardless of the level of suspicion the villagers held for the Project, they were nearly unanimous in their willingness to work with Project technicians to improve their water situation. This was viewed as a perfect opportunity for the Project to introduce it's basic unit of development: the Resource User Group (RUG) or Comité de Gestion. This group, comprised of both men and women, are empowered within the community by the Project's continuous reference to them, work with them and communication through them to the village. The RUGs are taught to think within a NRM framework and are instrumental in instituting the activity the Project associates closely with the improvement of wells and springs: reforestation of the "tete de source". It is anticipated that the RUGs will develop into the core of the managers of the "Terroir Villagoir", once the Terroirs are established.

In keeping with the desire to decrease the drudgery and time wasted in women's work, lavoirs and abreuvoirs were built where necessary to provide for existing needs. This also provided the ability to control where these activities are located to avoid the chance of contaminating their water source.

B. Philosophy behind the prioritization of the sites to be improved

Because there is not enough time, money or necessity to improve every water source, a method of selection and prioritization of the existing sources had to be made. The first step was to do an inventory of all wells and springs identified by the villagers either during the 1993 PRA or during subsequent Project activities (note: several other sources, particularly springs, have been identified since the PRA, probably due to the increased confidence in the Project among the villagers). The following list of selection criteria are suggested by the S/W TA but have not been officially discussed or accepted.

1. Need

The first priority was based on villager need: the distance village women had to walk to fetch water, especially during the driest part of the year. The number of women using any one source was also taken into consideration. If 200 women in a village of 500 used a polluted well even after a clean water source was provided for the other 300 women, a second well/spring in this village might be considered before improving a well/spring in a village of 100 if all other things were equal.

2. Water quality

High priority was also given to the quality of water the women had available at any given distance. If the closer water sources were badly polluted, the distance to the second closest source was used to determine priority.

3. Year-round water availability

Springs and wells that dry up during parts of the year receive lower priority than one that provides water year 'round.

4. Additional water management possibilities

In situations where a spring provides sufficient water at a site and elevation which would permit the irrigation of potentially productive land and if an individual or group is interested in taking advantage of this resource, these springs receive additional importance in the prioritization mechanism. Similarly, small wells have been dug where the potential for irrigated agriculture is high.

5. The ease of the work

A spring or well that is easy and/or is inexpensive to improve received higher priority than those more costly activities, other things being equal. Shallow, existing wells that need only be enlarged and encased were often done before wells that needed to be newly dug simply because of the impact of our activities on the villagers (ex: Kouné, in the Diafore BRP, had four shallow existing wells improved at the same time rather than waiting until all the other villages had a water source).

6. Other

There are always extenuating circumstances which play a role in the prioritization of activities. Project need required that a well be established in Sinthourou in the shortest period of time after a PCV was placed there as no other safe water source was available in less than 1 1/2 Km.

7. Who pays?

For **community** water sources, the Project pays for the study, design and development of the source. The village must supply all materials available to them and all unskilled labor.

Groups, comprised of villagers from many families, may not have to pay for purchased materials if agreements are signed showing that they are establishing a sustainable enterprise. They do, however, have to provide all locally available, needed materials available to them and provide all unskilled labor. In addition, they must open a savings account and begin saving for repair and replacement costs.

If **an individual** requests any form of infrastructure for personal use in a profit-making enterprise (irrigation, for example - the construction of wells, caps on springs, pipes, etc), they would be expected to pay for at least half of the materials as well as providing needed, locally available materials and all unskilled labor. Study and technical costs as well as educational opportunities may be paid by the Project depending on the situation.

To interest individuals and groups in using labor-saving technologies, these technologies may be demonstrated by the Project providing the required training and loaning the necessary materials from the Project for a period of time so that the participants can determine their value. If they wish to purchase these materials themselves after the loan is over, the Project can help them obtain credit and/or purchase the materials with the participant's own money.

ANNEX II

BRP REPORTS OF THE STATE OF WELLS AND SPRINGS IMPROVED IN 1993 OR TO BE IMPROVED IN 1994.

I. OVERVIEW OF ACTIVITIES

A. DISSA BRP

1. Springs with a flow in Dissa BRP

Nom des Source	Description	STATUS
Farinta	Captage with 5+ m^3 reservoir below which uses excess water for irrigation	Completed Flows constantly
Hafia	Captage par puits with 1 m^3 storage	Completed but needs minor repairs to improve drainage. Flows until February
Khatya/Tanéné	Captage par puits with about 1 m^3 storage	Completed Flows until February
Falloulaye	Captage with pipe flowing to site of reservoirs	Spring to be protected, reservoirs to be built, transmission pipes to be laid"
Donta	Captage with pipe flowing to reservoirs. Pipes laid to mosquée	System needs to be completed (lack of funds)
Dar-es-Salaam	Captage par puits.	Completed. Must be observed.
Tanéné	Captage and storage tanks for irrigation proposed	People agree to activity. Lack of funds = no activity

2. Wells and springs without a flow in Dissa BRP

Name of well or spring	Description	STATUS
Koulaya	Shallow well to bedrock beside a marigot. Water is good.	Completed but nearly dries up in May. Hole could be dug in bedrock for add'l storage.
Hakudedhandi	Shallow well beside a marigot. Water is bad.	This may have to be moved to a new location if water can't be cleaned.
Khatia	Incomplete well, oversized diameter, approx 8 m deep.	Must be completed in April 1994 - continue at normal diameter.
Sinthourou	Captage par puits with 1m^3 storage	Just completed, Must observe

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B. DIAFORÉ BRP

1. Springs at Diaforé BRP with a flow

Name of spring	Description	STATUS
Koumbama I	Captage with a reservoir at same elevation as captage	Considerable work remains: Line storage well in reservoir, put top on reservoir, move lavoir, misc.
Koumbama II	Captage par puits with $1m^3$ storage	Minor work needed: put in pipe to create circulation in well, build lavoir, build abreuvoir
Gollo	Captage with reservoir proposed	Due to low water availability and distance from the three villages that use it, three wells should be improved instead.

2. Wells and springs without a flow at Koundou BRP

Name of well or spring	Description	STATUS
Kouné I	Shallow well	Good water, needs new door on well
Kouné II	Shallow well newly dug for PCV	" " " "
Kouné III	Shallow well	" " " "
Kouné IV	Shallow well	" " " "
Dow Diaforé	Shallow well	Good water
Dow Kouratongo	Shallow well	Good water
Gonku	Shallow well	Good water
Gadha Diaforé	Proposed well	Need AID approval
Gollo	(Proposed well?)	Outside the BRP but uses Gollo spring. Need AID approval
Ley Diaforé	Proposed well	Need AID approval

C. **KOUNDOU BRP**

1. Springs at Koundou with a flow (liters/minute)

Nom des Source	Description	STATUS
Guémé	Our first captage. Open flow with well.	High flow with rains, nearly dries in May
Tyankoye	Captage with excess used for irrigation: Open flow with well.	Flows all the time (well never used). Must review irrig. sys.
Donghol	Captage with open flow 1/2 m^3 storage	Flows all the time, storage never used
Diawbhé	Captage with open flow 1/2m^3 storage.	Dries up in May, must use storage
Totiko	Captage ceased working in Dec. Now destroyed	Can be rebuilt as subterranean captage*
Ley Fello	Recently rebuilt with 2m^3 storage tank.	Must monitor through the year.

2. Wells and springs without a flow at Koundou BRP

Name of well or spring	Description	STATUS
N'Dentari I	Shallow (5m) well	Rebuilt for irrigation
N'Dentari II	Shallow (7m) well	Rebuilt for potable water
Télibofi I	Deep (14m) well	Very good shape
Télibofi II	Deep (16m) well	Very good shape
Tenkéré	Very deep well (29m)	Newly deepened: must monitor
Kagnégandé	Deep (18m) well	Newly deepened: must monitor
Hamdallaye	Deep (16m) well	
Kokolou	Deep (20m) well	Newly deepened: must monitor
Sigon	Captage par puits (never flows)	Water always present in 2m^3 storage

* For details on specific wells and springs, see the next section of this annex.

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II. DETAILS OF WELL AND SPRING MANAGEMENT ACTIVITIES

A. AUGUST 1994 ASSESSMENT IN THE DISSA WATERSHED

DAR ES SALAM :

Captage par puits was completed in June, 1994. Follow-up visits should be made throughout the year to observe it and to train the Comité de Gestion about its proper management.

SINTHOUROU WELL (completed Feb, 1994) AND SPRING (completed July, 1994):

This is the site of a PCV. A well was completed in Feb, 1994 but the water was dirty and it dried up in April. The spring was capped (par puits) in July. This will have to be monitored throughout the year. The PCV could be given responsibility for empowering the Comité de Gestion in this village.

KHATYA WELL (begun and abandoned in 1993):

The well digging was suspended when the digger ran into rock and gave up (our not being able to pay him didn't help). I tried from March, 1994 to get it restarted but, to date, nothing has taken place. Now, no money is available and it is now too late in the season to begin. We need to explain all this to the villagers and arrange for this to be completed in April, 1995.

TANÉNÉ/KHATYA SPRING (completed in 1993):

This capped spring flows until April but late in the dry season, people take from the well, where water was available all dry season (In April, 1993, this was only a wet trace on the ground, essentially abandoned by the villagers). The area is still muddy and can use some general improvement to make it easier to keep clean. The PCV in Sinthourou could be given the responsibility for this (?)

TANÉNÉ SPRING (not yet improved):

This is the most exciting spring in the watershed to date (est 20 l/min in April and positioned high above a large field with ongoing maraîchage). A simple captage (a 15 m long wall along the rock face with two pipes carrying this to a storage tank) should be sufficient. The WMU techs say that Khatya and Tanéné villagers are interested in the captage and irrigation systems. A written agreement should be developed and the project undertaken - at any time of year (since it will be a "catch-and-carry" type).

FOTONGBÉ (site of a proposed captage):

There are two springs on the left side of the entrance road as you drive up the hill from the government highway. The lower, shaded spring we hoped to work with was completely dry - down to a rock bottom. Worse, the nearby spring that they said is perennial has about 5 liters of water in it (although it was slowly refilling as water was being removed). We looked at the other spring (opposite side of the road) and found that it was no better than the first perennial spring. If these are their only springs, we can not help these people other than trying to increase spring flow through reforestation and cordons pierreux. Springs in the hills above the village might be sought and water brought to the village in polypipe.

FALLOULAYE

This spring was capped in June, 1994. By the end of July, the undersized pipe (no money to buy proper sized pipes) resulted in water flowing out of the door on top of the captage. There is surface flow that enters the back of the captage which must be deflected. The villagers want to build one large (4.5m dia) reservoir below the captage. Before they do this, the area needs to be surveyed to determine where water can be taken by gravitation. The area has been cleared and BTGR/Kindia contacted. The villagers want to pump the water to the top of the hill (next to the mosquée) and feed water to the rest of the village from there. They are willing to pay for the pump and all operation, upkeep and repairs if we can help them with technical information.

KOULAYA (well completed in 1993):

This well was deepened (50 cm) in May down to bedrock. Later in the month the water level dropped so low that it was abandoned by villagers, who began to use the filthy water in the center of the marigot. If it is possible, this well should be deepened next May by chiseling into the bedrock to provide a storage of at least $1/2m^3$.

HAFIA (captage par puits completed in 1993):

There was always clean, clear water available in this well. There are also several leaks around the captage which should be plugged, if possible. The lavoirs need to be rebuilt: higher, leaning outward, roughened surface, and the drainage from the cement floor needs to be improved (by using a pipe?). My request for 30.000 FG to do this work was denied by USAID.

HAKUDIDHANDI (well completed in Feb, 1994):

This well, which serves two villages, had poor quality water after it was built so the walls were cemented closed in May and the well was deepened into pure, white sand. This does not appear to have corrected the problem. It is unclear if this well can be saved. If not, a new well should be dug at a site chosen by the villagers if financially possible and technically practical.

FARINTA (captage and reservoir completed in 1993):

This has been a successful captage and reservoir. The irrigation system using the overflow water has just been completed and some effort will be required to make it work properly. Someone must be trained in how to care for the system - but not by the WMU's self-acclaimed plumber (Mr. Keita, the magasinier). A list of minor repairs has been give to Mr. CAMARA, the GR technician, who will hopefully follow through. The irrigation system will require regular maintenance at the reservoir to keep sand from plugging the system. The abreuvoir should be covered during the rainy season (animals don't use it then).

DONTA:

Their middle spring was capped in May and had a flow rate of 10 l/min at the time (in July it dropped to 6l/min which should be a minimum). It is excellent water! Two storage tanks are being completed, one (1m^3 storage) is for the villagers around the spring and the second (about 10m^3 storage) is to feed the rest of the village through a piped water system to the mosquée and on to a second village center. Pipe will be laid from the reservoir to the mosquée before my departure but completion of the job depends on the availability of PL-480 money. The villagers have built infiltration walls above the spring but much more could be done with dams closer to the cliffs behind the spring.

There are two other springs in Donta. The first is far below the village, requiring women to descend and carry water back up the hill. The piped water system should eliminate the necessity to cap this spring. The second spring, a kilometer on the other side of the capped spring, is not flowing but oozes from a rock during the dry season, across 10-15 m of muddy surface, to enter a stagnant pool. This would have to be capped with a well but might benefit from a buried gravel drainage channel and pipe laid in the mud to facilitate water collection. Trees have been planted around this spring as well. Serious work will have to be undertaken upstream from this area if the flow of this spring is to be increased.

B. AUGUST 1994 ASSESSMENT IN THE KOUNDOU WATERSHED

DIAWBÉ SPRING (the blocked-spring type completed late 1993)

In May, this spring was still flowing at over 2.5 l/min. Excellent captage. Additional lavoirs need to be built. The village has done some work in increasing water infiltration from the fields above the spring but must be encouraged to do more.

KAGNIAGANDÉ WELL (completed late 1993)

This well was deepened in May, 1994. Villagers did some work to increase water infiltration in the fields above the well but much more needs to be done. There is a second (unlined) well close to the new well which might be used if the bottom were lined and a pump were installed.

GUÉMÉ SPRING (our first captage, completed June, 1993)

This has been a difficult spring due to the large volume of water that comes from the bowal during the rainy season, all the leaks below and outside of the captage itself and the fact that the area virtually dries up at the end of the dry season (in late April, 240ml/min flow rate into the bottom of the well associated with the captage). Most of the leaks have been blocked but more work may be required at the end of the '94-'95 dry season. Villagers and Project personnel constructed 4 Km of contour walls and digs to increase infiltration and part of this area will be planted by the Agroforestry team. More contour walls must be built at the furthest reaches of the catchment basin if they want to increase April/May flow rates.

TOTICO (Completed late 1994 behind the L-Saran market)

Here we were not successful in elevating the water table - the spring appears to have moved rather than fill up the reservoir. The captage ceased to flow on Feb 25 and I had it destroyed in April to see if we could get the spring back. A flow (est 5 l/min) did reappear. Next April, this should be recapped by digging a trench from the spring across the entire valley floor (about 4 meters), an exit pipe placed at the lowest position leading downslope, the hole lined with plastic downstream (as a subterranean dam), backfilled with gravel to within 15 cm of the surface, the top covered with plastic and the whole thing buried and the surface planted in grass. This subterranean captage should be able to provide potable water even when there is a surface flow in the valley.

KOKOLOU

A well used by all villagers, located in the center of the village, dried up each year (8cm water in June). It was deepened in July and should provide an important option for this village. Totico spring has been their other perennial source of water.

TYANKOY (blocked-spring type completed in mid 1993)

A flow of at least 7.5 l/min continues throughout the dry season. It has a bad odor from March to May, which is typical of this time of year. (The women say that at this time each year, the "snake in the spring" vomits. No snake was sighted). I believe that either (a) at this time of year, the water table begins to drain from an area that has stagnated (however this might have happened) or (b) the temperature(?) or some other environmental condition at this time of year causes something to grow in the spring creating the odor. If it is the former, there is little we can do. If it is the latter, sterilization may be possible.

Overflow from this spring is used to irrigate a garden across the road from the spring. I suggested catching the (clean) excess water at the spring's outlet and putting it into a large reservoir on the other side of the road. When I was on vacation the present system was built which collects water after it passes across the road, inefficiently screens out the debris and sends the water off to two basins, the last of which continually leaks into the garden. I suggest we try my original design and attempt to irrigate using a hose as a siphon or under pressure (drawings elsewhere).

TYANKOY (as yet uncapped)

This series of springs has a tremendous potential because they converge, forming a stream high above the road. It can easily be piped to both central Tyankoy as well as to Telibofi (see technical report). The villagers were convened on April 13 and the proposition discussed in detail and they accepted the idea of sharing their water with Telibofi in trade for help with a system for Tyankoye. (Telibofi has not yet been informed of the idea.) It is the opinion of an AID engineer that the villagers will not be interested due to the work involved (digging 20m of a 30cm-deep trench for each man in Tyankoye and 10m for each man in Telibofi). It would have enormous potential for irrigation, too, but interest and markets must be studied.

TELIBOFI SPRING (blocked-spring type completed in late 1993)

This is our least successful captage. When it was completed, the spring moved to a site 15 m away from the original site and later even that dried up. I recall that it was not a perennial spring (although it had been many years ago) and, therefore, should not have been capped to start with but in my absence (on vacation), the villagers convinced the engineer and the WMU team that the spring should be capped. I think they believed that the act of capping the spring would make it perennial. The captage has been broken and at least partially removed.

They did not show us the true perennial spring, located in the woods just outside the village. I believe that this was because they consider the water there of low quality (it filters through organic muck and therefore smells bad). A captage could clean that water up! They do have two perennial wells in the village now and the second Tyankoye spring could be developed to provide water in the village, if desirable.

TELIBOFI WELL #1 (improved existing well, completed mid 1993)

This well, located in front of the mosque, was deepened during May, 1994. It should provide sufficient water year round.

TELIBOFI WELL #2 (newly dug well, completed late 1993)

This well was also deepened and should provide sufficient water year round.

N'DENTARI WELL #1

This shallow well was built for irrigation water next to the garden below N'Dentari (again, during my vacation). It is associated with a spring but dried up during the dry season. It has been deepened and should provide irrigation water year round next year.

N'DENTARI WELL #2

This shallow well was also built for irrigation water for the garden. This year it was deepened and improved to provide potable water for the three villages who share the garden area and the well.

LAY-FELLO SPRING AND WELL (blocked-spring type capped in late 1993)

This captage was also built while I was on vacation. It's original design forced the water table to rise 20cm before it could flow into the structure, effectively stopping the flow of this spring. I broke down the inner wall in April, 1994 to show the villagers that we hadn't plugged the spring and I had it remodeled in July as a "catch and carry" type with a $2m^3$ reservoir below the spring. The shallow well (dug to bedrock) that was used during the entire dry season last year will be left unmodified. The village, which has never been very animated, decided at one time to build a series of flood control/infiltration dams in the valley above the spring. Due to lack of transportation and personnel at the WMU level, this was never organized. This should be followed up.

Here is an interesting example of the technical problems encountered. The engineer who built the reservoir put a faucet high on the side of the reservoir so that women could put their buckets under it and ran the pipe to the faucet to the bottom of the reservoir on the inside. I had to explain to the Director (who explained to the engineer) why this does not provide the faucet with all the water in the reservoir. The faucet was then placed on the bottom of the reservoir and other arrangements made to facilitate its access.

DOGHOL (blocked-spring type completed mid 1993)

This captage, with a flow rate of 12 l/min on March 31, stopped flowing altogether in May. Three villages gather water here which causes some interesting social problems. After a meeting in early May that lasted until midnight, the Comité agreed to open the door on the storage well and permit the women to take water from there. This village also requested help in building infiltration dams to increase dry-season water availability. With severely limited time, six contour walls were built a few hundred meters above the spring. More dams should be built as far back in the valley above the stream as possible.

SIGON (captage par puits completed in mid 1993)

I was unable to get to this spring this year but no complaints have been heard about the captage.

C. AUGUST 1994 ASSESSMENT IN THE DIAFORÉ WATERSHED

GOLLO (LEY DIAFORÉ) SPRING (proposed for a captage in 1994)

This spring is used by three villages: Ley Diaforé, Gollo and Gadha Diaforé. The spring is formed by several "seeps" from the mud and root masses of trees in a valley surrounded by bowal. It will be a very difficult captage. The flow rate was 3.4 l/min at 9 AM and 1.2 l/min at 6:30 PM. My theory is that the difference due to the increased evapo-transpiration rate of the trees during the hot afternoons (see a separate report). The villagers have already provided their share of the materials for the captage and reservoir and have built contour walls just above the spring to try to increase spring flow. Part of this area will be fenced in and planted this year by the agroforestry program as a demonstration.

I requested that a study be conducted on how this spring was used in April. The PCV and WMU animatrice spent 12 April there and found that it was not used much, although everyone who visited the spring was anxious to have it capped. I believe it would be better (even though it will be more expensive) to improve one well in each of the villages (Gollo and Gadha Diaforé are both well over a kilometer away). The captage could still be done but it would not be as important to get it water-tight.

WELLS IN KOUNÉ (three improved, existing wells and one newly dug well. Work was carried out in Dec, 1993 and Jan, 1994)

Kouné is an important village in the Diaforé BRP which has been promised much but received little. Four improved wells were established there to avoid potential political/social problems between the village and the Project and one well dug to provide safe water for the PCV located there. The existing wells were selected based on their perennial water supply and were spaced evenly over the long (>1 km) village. All improved wells are producing water, although the dug well had to be deepened. All the doors are broken (poor design) and must be fixed or replaced.

SPRING #1 IN KOUMBAMA (spring-block type, completed in late 1994)

This spring was capped but then the outflow moved slightly and had to be capped again...and again. Due to a lack of a downward slope in any direction and a solid-rock river bed below the spring, a well was not be dug to store water. Instead, a reservoir was built at the same level as the spring whose depth depends on how high the water can be stacked up above the original spring outlet. Depth varies up to 25 cm but a considerable amount of water leaks around the captage and directly into the river bed. This area is now used by women for washing their clothes and dishes while their second spring (below) is used for drinking water.

To try to improve the captage, a well was dug in the reservoir. This needs to be lined with cement and the top put on the reservoir. The lavoir also needs to be moved up the hill.

SPRING #2 IN KOUMBAMA (catch and carry type, completed Jan, 1994)

This was a much more successful captage. Due to the fact that it is near the bottom of the marigot, it is basically a captage par puits although it does have an overflow (still producing 4.3 l/min on March 31). This overflow is usable if it is piped to a abreuvoir.

The overflow from the spring originates underneath the cemented cover of the spring and is unaccessible. The well is not drained and water enters the well (from the top) only when water is drawn from the well. The overflow must be modified to take water from the bottom of the well so that water circulates. In addition, a site needs to be prepared and lavoirs built to decrease the amount of mud which presently results from women's washing activities. The abreuvoir should be built at the end of the wet season.

WELL IN DOW DIAFORE (improving existing well, April 1994)
WELL IN DOW KOURATONGO (improved existing well, March 1994)
WELL IN GONKU (improved existing well, April 1994)

These shallow wells are providing good quality water. They should be followed and work done with the Comités de Gestion to manage the wells and the areas surrounding them.

These were the first wells that were improved under the new system where a well digger and mason were being paid to do the work but, at the same time, teaching someone from the village how to do the work. The hope is that it will become less expensive to do wells if trainees will volunteer their labor to their own village or due to competition as more people have the expertise. The problem of class presents itself: only certain classes of Peul men can dig wells. Forcing other classes of villagers to learn this trade will be a waste of time. This is one of Africa's great problems.

ANNEX III

DETAILED REPORTS OF POTENTIAL WATER MANAGEMENT ACTIVITIES

The following discussions are not meant to be exhaustive either in identifying the potentials that exist in the three watersheds or how to treat any particular site. Likewise, they are not meant to suggest what should be done at the expense of other activities. The following are a few of the ideas which I have had over the past two years to help guide or stimulate these or similar activities should they be deemed worthy of pursuing.

I. Potable Water

A. The piped water system for Tyankoye, Telibofi and, if desired, Ley-Fello (Koundou)

Before discussing the possibilities here, this activity should be put into perspective. The Project has provided potable water to all three prospective villages (the spring at Tyankoye, two wells in Telibofi and a spring/reservoir at Ley-Fello). Of the activities discussed in this Annex, this is the most interesting from an engineering point of view and, if done right, from a social and organizational point of view. In terms of Project priorities, however, I suggest that it ranks low - on the level of a school, for instance - and should, therefore, be undertaken as a PCV project, if at all. Both Christian and Leslie have expressed interest in following it through but they will need moral support from the team. I try to include as much detail here as I can in order to facilitate the work, if desirable. It is the view of Dan Jenkins - a view I respect highly - that it will be difficult to motivate the villages involved sufficiently to get them to do their share. I believe it can be done, however.

In April, 1994, villagers took me to see a stream above Tyankoye that had a flow rate of approx. 101/min. Most of its flow infiltrates into the ground before falling over a cliff and settling in a small pool where women from Telibofi and Tyankoye collect it for washing clothes or to take back to the village. From the pool, the stream becomes a muddy trace across the road about 200 m toward Telibofi from the spring that the Project has already capped. The stream is 200 m distance and some 30 m in elevation above the small pool. The pool is 300 m above the center of the village where the mosquée is located and where villagers want a hydrant. Tyankoye has a population of 97 and the nearest villages, Telibofi and Ley Fello (at a distance of approx. 600 m and 100 m) have 208 and 60, respectively. While Tyankoye has one spring capped already, women walk a considerable distance to get water there. The diversion of the Tyankoye stream would have major impact on the availability of water in all three villages at a very reasonable price.

The stream should be simple to divert due to the steep terrain through which it flows. The water can be diverted from the stream bed with a small but solid cement structure or, if a clean natural basin could be found, a subterranean captage. A protected pipe (to resist flood damage) would carry water to a small settling basin just below the captage where it would pass through a sand filter

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and then go by pipe to a secondary basin below the cliffs, in the area of the pond now used by women. Here, the rocks and debris that made it through the filtering system at the intake would be removed and natural aeration would permit a certain amount of water purification. Water would then be divided in some predetermined ratio between two storage basins. Water in these latter reservoirs ($6m^3$ in volume, each) would then be transmitted to the villages with the excess water passing through an overflow into the original stream bed. Water would then feed into a 32mm polyethylene pipe to each village. The storage basins could also be placed in the village but excess water could become a problem and the effect on the trees in the original stream bed might be permanent. Depending on the final design, this water could be fed to a series of fountains in Tyankoye, Telibofi and (?) Ley Fello.

The Project should require the villages involved to conduct a considerable amount of water conservation-related construction and planting in the mountain above Tyankoye as well as the labor for burying the pipe and building the fountains. The area above the spring is presently used for rice production and grazing and the villagers are not at all keen on the idea of planting trees, although they expressed interest in cordons pierreux. Infiltration dams between the boulders would be ideal.

At least one villager from each village would be trained in maintenance. System designs would be developed with these representatives and they would be intimately involved in the construction phase to ensure that they understand all aspects of it. They would be the presidents of the management committee in each village and be responsible for weekly inspections, monthly maintenance and paid repairs, as required. A contract would be developed between the elders of the villages on how the water will be divided and the financial and management responsibilities will be divided. Given amounts from each village will be paid into a new maintenance account at Credit Mutuel and monthly payments for water use will be deposited on an agreed-upon rate until 1,000,000 FG are deposited, at which time payments will be reduced but not eliminated. Committee presidents will be responsible for this account. When maintenance costs bring the account below this level, rates will rise again.

An approximate budget for materials is listed below. Note that, in this area, deep wells cost over 1,000,000 FG each.

1)	Captage:	50.000 FG
	Steel exit pipe (12 m, 48 mm):	60.000 FG
	Primary Basin:	50.000 FG
	Secondary (storage) Basin:	150.000 FG
	Polypipe to Tyankoye center (500 m):	625.000 FG
	Fittings for polypipe (5 couplings):	100.000 FG
	Fountain:	100.000 FG
	Misc materials:	65.000 FG
	TOTAL:	1.190.000
2)	Polypipe to Telibofi (700 m):	875.000 FG
	Fittings for polypipe (7 coupl, 8 "Ts")	120.000 FG
	Secondary (storage) Basin:	150.000 FG
	Misc materials:	75.000 FG

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Fountain:		100.000 FG
	TOTAL:	1.320.000 FG

3)	Polypipe to Ley Fello (400 m):		500.000 FG
	Fittings for polypipe		40.000 FG
	Secondary (storage) Basin:		150.000 FG
	Fountain:		100.000 FG
	Misc materials:		50.000 FG
		TOTAL:	840.000 FG

Costs for technical specialists should be minimal (<1.000.000), depending on the level of expertise AID and GNRM deem necessary to develop a good system.

B. The Spring at Falloulaye (Dissa)

During the second PRA conducted in the villages in Jan, 1994, the population of Falloulaye identified water as their major constraint (as they had the year before). The village, the largest in the watershed, is long (approx 1 km) with a hill in the center. Women from the heavily populated upper village must walk up to 1Km, climbing down a 60 m slope to the spring where they used to scoop water out of a small basin of sand where the water exits the ground (this is now capped and flows from a pipe, but the distances involved are the same). There is a foot pump some 600 m from the lower village used by women from that part of the village.

This year, the villagers have constructed a considerable number of infiltration and flood control structures and agreed to reforest, permanently, the denuded valley above the spring. The Project, with considerable village participation, capped the spring and identified where storage basins and transmission lines could go. Using crude devises, I estimated that the spring is actually several meters below the level of the lower village so that, either the fountain would have to be put on the lower side of the village (which is still closer and more convenient than the pump now used - but the villagers are not interested in this), or a pump will have to be used. The villagers are willing to buy, install, run and maintain the pump at their own cost. This is a merchant village: they can afford and are otherwise well placed to manage the pump.

This project deserves serious consideration. I am presently training an engineer and the GR counterpart in Dissa to be able to install such a system if it is decided to follow through. The effect on women's time and energy would be considerable.

A summary of the situation is as follows:

Village population: 650
Flow rate (late May): 10 l/min
Distance to village: 800-1500 m with a 60 m hill in the middle.
Level of villager interest/willingness to work: very, very high
Spring: Capped with "catch and carry" system in June, 1994
Reservoir: site selected for 12m^3 round reservoir
Methods of piping: (1) gravity to reservoirs below the village

(2) pump to high point, gravity through village

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Estimated costs:
Settling and transmission basin at spring: 300.000 FG
Primary storage tanks ($12m^3$) - below mosquée and at the mosquée (for the pump system): 250.000 FG each
Transmission to village to point below mosque and point below lower village: 2.500.000 FG plus surveying charges
Transmission from upper reservoir: 500.000 FG
Secondary reservoir below lower village ($4m^3$ each): 100.000 FG
Fountains in village: 60.000 FG each
Pump: Paid by villagers.

C. Captage at Donta (Dissa)

This captage was completed in June and provides an exceptionally good tasting water (10 L/min in April with a 6 L/min minimum in July). 1.085.000 FG in materials and more for skilled labor has been approved for transmitting this water throughout the village. The first line should be installed by the time I leave but may not be hooked up. The potential to transmit this water to a second village center above their first water source should be looked into. I have been training the BRP GR tech and Cheik Sylla - a private engineer from Pita - how to lay the pipe and install anti-air locks and "clean-outs". This is an important installation as a demonstration for both the transmission of potable water (eg. Tyankoye-Telibofi-Ley Fello, Falloulaye) and irrigation water (eg. Tyankoye, N'Dentari, Néna, Foréya).

D. Captage at Gollo Spring (Ley Diaforé - Diaforé)

This is a difficult captage because the "spring" is comprised of several "seeps" from the mud and roots over a large area. The flow becomes very low (2-3 l/min in April) but it has been one of two sources of water for three villages during the dry season. Although the Project has improved a well in Dow Diaforé, it is too far from the other villages for regular use. I have recommended that selected perennial wells be improved in each village. Regardless, there is no doubt that all three villages will continue to use the spring. Village interest is very high. The villagers' contribution to the spring captage (rocks and gravel) were deposited within a week of the Project's request.

If it is decided to cap this spring, sealing the spring from the inflow of surface water during the rainy season would be difficult. It could be done as follows: Perforated PVC pipes would be placed from each major "seep" to a small cement gathering device which will permit flood water to pass over it but permit a continuous collection of spring water. Rocks, gravel and cement should cover the area capped, similar to the second spring at Koumbama. Water should be transmitted through a protected pipe to a reservoir 30 m below the captage (permitting a "catch and carry" captage - the only type that would work here). A barbed wire barrier would be placed around the area where animals may be attracted by mud. A drinking trough would be built for the animals outside the barbed wire fence and a clothes washing structure built

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for the women in an appropriate location to eliminate the possibility of pollution.

The area is surrounded by bowal with small areas vegetated with scrub trees. To increase infiltration in the area with the hopes of increasing spring flow, contour walls were built in a 1/2-ha area of bowal between vegetated areas above the spring and were planted and will be protected.

II. SITES OF EXTRAORDINARY IRRIGATION POTENTIAL

There are many possibilities for irrigated agriculture in our watersheds and several that are already in use. The following are sites that have the greatest potential for advanced, robust, low-effort, simple systems at reasonable cost using polypipe. Each should have a written agreement between the owner of the land and the people who work the land and each should have an account and a procedure for repairing and eventually replacing the systems.

A. NÉNA, Linsan Fulbé (Koundou)

This is a private garden but is an ideal spot for a demonstration on how to use water under pressure. Their water comes from two directions, one of which provides water at a high elevation (6m) at a distance of less than 100m. With a small storage basin (1-2m^3) at the top of the hill, 25mm polypipe could be used to bring the water to the center of the garden and, from there, a garden hose could be used to water the garden. This would greatly facilitate the job and permit the desired expansion of the garden without increasing the effort of watering. The total cost should be less than 200.000 FG.

B. Tyankoye (Koundou)

The two possible sources of water have been discussed above: improvement of the existing system to more effectively use the excess flow from the capped spring or use of the second (high-elevation), yet uncapped spring. In either case, my original proposal should facilitate watering here: water of relatively high quality should be stored in a large (several m^3) reservoir and either made available at fountains in several sites throughout the garden or, at least, siphoned from the reservoir and, in both cases, distributed through a garden hose. If built properly and with proper garden management, this should be a sustainable technology.

C. N'Dentari (Koundou)

When I was first brought to this area, we picked a site on the flat bench above the swamp (where the garden nursery now stands) as the best site for the garden. The owner suggested a site above the spring, also on the bench. I suggested that a hole be dug in the center of the swamp for irrigation water. On my return from vacation, the garden had been established in and around the swamp and two wells (at a cost of nearly 2.000.000 FG) had been built for irrigation water. Women used water from holes dug in the mud as much as from the wells because they were closer. Late in the dry season, the wells dried up (requiring deepening) and women got all of their water from a hole dug in the center of the swamp. Now, one well has been improved to provide potable water year round to the women from the three villages who work there and the other has been modified to provide irrigation water.

There are two possibilities for this area. The first is to move the garden up on the bench as originally proposed and irrigate from the one well and a simple hole dug in the bottom of the swamp. The foot pump might work well here by raising water to the level of the bench and, through pipes, to the garden area. From there, water could be stored in a small basin (1/2 m^3) from which women can fill their watering cans or a furrow irrigation system could be arranged during the initial set-up period of the garden (the soil appears to be heavy enough to permit the latter approach).

The second possibility is to use water from the village's lower "spring", presently used for washing clothes. A simple catchment system could be designed which would improve conditions for clothes washing and any excess water would be funneled into a polypipe and carried to a basin ($4m^3$?) some 120 m distance below the spring. Depending on the design, this could provide water under pressure (as was proposed for Tyankoye) to the field between the hill going up to the spring and the stream bed as it passes the clôture of the house on the plain. The potential for both of these sites is considerable and, depending on the Project's philosophy, both might be developed and the results compared. The cost of both of these would be far less than the cost of a single well.

D. Spring at Tanéné (Dissa)

The people of Tanéné did not tell the Project about their spring during the first PRA (Jan/Feb, 1993). When we were shown the spring, there was no question that it is the most interesting spring seen to date in the Dissa watershed. It has an exceptional flow (estimated 20-30 l/min on April 6) despite the fact that most of the catchment area has been cleared and is being used as crop land. The area immediately above the spring has already been planted by the Project. The spring is located below the village but perched some 5-10 m above a large, apparently fertile field. The field is already being used for off-season farming but the extent and ease of the work can be positively influenced by using the spring's excess flow to fill basins high in the field or by watering the horticultural crops with a hose, taking advantage of the pressure built up in the system. All of the land in the area apparently belongs to Khatia (soussou) and the field below the spring is being cultivated by people from Khatia. The relations between Khatia and Tanéné seem to be very good. The two villages have apparently agreed to the project but written agreements must be made describing the rights of each village. Hopefully both villages will have rights to garden space and some system for handing over any unused, irrigatable land to someone who will use it. A repair fund must be established, as with all the other systems, and agreements developed for land use and responsibility for maintenance.

This system would be similar to those proposed above except

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that water should be collected in a large (15m³) reservoir just below the spring and water under pressure made available at "fountains" (faucets) at various parts of the field below.

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E. **Kouné (Diaforé)**

The (est) 5-ha mare in Kouné is inundated from a large bowal surrounding it and remains flooded due to a solid rock bench at an elevation of approx 1m above the floor of the mare. The proposal was made to cut a channel to permit the control of the level of this water which would permit flooded rice production in the rainy season and off-season production of vegetables, etc (See drawing, attached).

LTC attempted to secure agreement from the villages claiming interest in the area but, apparently, one of the villages that claims rights to the swamp refuses to comply. They seem to believe that the Project will either pay a lot of money to buy the land or that it wants to mine the area for gold. I have recommended an educational trip for representatives from each village to an area where flooded rice is being produced to convince them of our intentions as well as to show them their responsibility to the project. This has not yet happened.

F. **Foreya (Diaforé)**

A report on the progress at the Foréya bas-fond was written on January 21, 1994 and a second discussing the situation was written on February 9. These are attached. Three important events occurred since that time:

1) The stream virtually dried up in April. Underground flow resulted in sections of the stream having an actual flow rate but much of the stream bed was dry. There is still potential to build a dam and pipe water to the site but subsurface flow may make such a dam ineffective

2) The users of the land began their conflict again. The LTC believes that, when the Project told the farmers that the original plans for a large reservoir behind a dam was not possible, there was sufficient upset that the conflict resulted. Regardless of the cause of the flair-up, the two antagonists ended up in regional "court" in Kouratongo when the owner of the disputed land (a Noble whose parents owned the parents of the two "ancient captives" who now work the land) arrived to say that the whole issue had been settled in 1984 and presented the signed papers to prove it. They reaffirmed the 1984 agreement and, according to our BRP technicians, there is no longer a land conflict. This should be verified.

3) In early August, the entire field we wish to irrigate was inundated by an 84mm rainfall ("worst in 20 years") washing away the fences and a good percentage of the nursery plants. Obviously, this is a difficult area to manage!

ANNEX IV

PROPOSAL FOR THE INTEGRATED DEVELOPMENT OF THE FOREYA BAS-FOND

January 21, 1994

INTRODUCTION

The Diafore watershed is the poorest of the three watersheds being supported by the GNRM Project. It is composed of an estimated 35%-40% bowal, leaving limited areas for agricultural production. It has the poorest soils of all three watersheds, one-third of which have severe phosphate deficiencies (1-1.5 ppm extractable P where 15 ppm P is required for most nutritious crops. In addition, termite activity is more devastating in this watershed than in the others, attacking crops and, according to the farmers, can destroy up to 60% of their manioc, maize and rice crops. Termites also consume animal manure, leaves and twigs used as mulch and compost piles of any sort which has resulted in farmers giving up any attempts to increase soil fertility. As a result, villagers in this watershed suffer two months of food shortages. The National Development Plan only strives to make the villagers in this watershed self-sufficient in food production. If the Project wants to have an impact in this watershed, maximum use must be made of the limited potentials that exist there.

One of the more potentially productive areas in the watershed is the small (approx 2 ha) field next to Foreya and an adjoining field (approx 1 ha) which belongs to Ley Diafore. The potential exists due to a constant stream flow which can be diverted onto the flat fields. Stream flows in January exceed an estimated 100 liters per minute, decreasing to less than 60 liters in the driest part of the year (ref: 10 April, 1993 visit of Dan Jenkens). A flow of approximately 75 M^3/day should be sufficient to irrigate the entire bas-fond area (with some excess) if it is done by hand (whether by hose or watering can - not by "flood" irrigation during the driest part of the year). The possibility of an additional (guaranteed) crop after the rainy season would be of great importance to this population. LTC settled land disputes here and has obtained written approval from the present users to improve this area for fish production and off-season agricultural use.

The villagers have requested that the three small ponds that they use for fishing be improved to increase fish production. This can easily be included in the program, although a low-tech fishing system (<u>Tilapia</u>-based, continuous fishing) rather than the higher-tech fish-husbandry system (which includes feeding fish with purchased fish food). The latter system that has been introduced several times in West Africa but has not appeared to be successful.

Two major obstacles must be overcome before the fields can be cropped efficiently, particularly during the dry season. First, the area will have to be irrigated. A dam could be built. According to a recent estimate made by the BTGR/Mamou, the dam would have to be 2m high and would cost between $15.000 and $22,000, depending on the water distribution system. As a long-term investment and the importance of a second, off-season crop in this area, this may be a reasonable Project expense.

The second problem is the extremely low P level in the soils, will require a large application of either an active rock phosphate or a phosphate fertilizer. At $20/50KG bag, this would cost between $400 and $1200/ha, to be determined by calculating P sorption curves. As the effects of applied P will last for 10-15 years if no further applications are made (and much longer if the small quantities removed in harvests are replaced yearly), this should be well worth the investment. Nitrogen, the other limiting factor, will be produced in composts, which will be an integral part of the development strategy. This integrated strategy will include:

Preparation:

A. Soil/water management

- Dam construction: 2 meters high.
- Distribution system (Subsurface pipes leading to a series of reservoirs in mid-field which are fed by gravity as water is removed for irrigation.
- Stabilization of stream banks/protection of land from inundation (clear debris from stream bed, construct dikes alongside, fortify dikes with plants (see A-F section) and gabions, where needed).
- Stabilization of land (diversion dikes above fields to control run-on, terracing with contour walls)
- Soil preparation with a basal application of phosphate rock or fertilizer.
- Soil improvement through organic matter management (night-park manure management, composting, mulching with A-F planted legumes).
- Animal traction (?)

B. Agroforestry

- Stabilization planting along stream dikes (bamboo, grass species)
- Water-course protection (fruit and other plantings within 10 Meters of stream bed)
- Fodder/mulch production (plantation planting of legumes as part of water-course protection and in marginal areas)
- Limited alley cropping to determine applicability and acceptance.

C. SED/Women's activities

- Help with obtaining and managing credit
- Develop land use contracts with land owner
- Market analysis to determine what should be grown.
- Support in crop production (through hired specialists) to train farmers in appropriate production technologies.
- Market creation through "farm days" which include food preparation which includes important off-season crops (potatoes, tomatoes carrots, eggplant, etc)
- Training in organization/animation/management of production groups
- Support in developing transportation systems (animal traction?), quality control systems, financial management, etc.

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ANNEX V

THE FOREYA DAM PROJECT: SOME THOUGHTS

Feb. 9, 1994

HISTORY

Diafore is the poorest of our watersheds. The National Development Plan for the country only specifies the need to bring the Diafore area up to a level of self-sufficiency (many of the villages suffer a two-month period of malnutrition/undernutrition).

The people of Foreya have two small, naturally occurring ponds (a third pond exists which belongs to Ley Diafore) which they use for fishing, among other things. During our PRA, the villagers asked if the project could help them increase the production of fish from the ponds. Anyone can fish in the ponds and the quantity of fish is very limited. Initial suggestions included the use of an appropriate foot or hand pump to pump water from a perennial stream into the ponds to maintain their volume. The concept of building a dam at Foreya came from AID's Dan Jenkens. The intention was to provide a simple, labor-free means to keep the three ponds full. Meantime, Mr. Kallo of USAID has been studying how to increase fish production. The BTGR/Mamu, who is responsible for these types of activities in our watershed, was requested in July to study the area and make recommendations. After they cancelled two field trips with me, they visited the site in my absence (during my vacation) and proposed a 2 M high, 25 M long dam which would cost an estimated $20,000 plus plumbing (approx 1 1/2 Km of conduit of some sort will be required). Even before this study suggested that the dam would be somewhat expensive, we had discussed the comparative advantages of irrigated agriculture and increased fish production. The former would be simpler, much more productive in terms of calories and protean and would probably more profitable, monetarily, than the latter. Additionally, the Foreya bas-fond is one of few particularly promising sites in an otherwise very poor watershed. Julie Fisher, in her role with the LTC, has settled the land dispute which existed in the area and reports that the villagers are very interested in the development of an irrigated perimeter and are willing to do whatever is required to help it succeed. Given the inadequacies of the preliminary study, a follow-up study will be required. However, we have a few questions and options to discuss. These should include:

Concept: Is a dam the best solution?

Dan Jenken's basis for recommending a dam was that he did not believe villagers would pump the required amount of water to keep the fish ponds full. He felt that a dam would provide the water without effort. While this may be true, people may be willing to pump water for irrigating off-season gardens. Presently, the nurseryman irrigates about 1/4 ha of seedlings by hand. Similarly, the women's hot-pepper gardens and an onion/tomato garden (about 3/4 ha total) are irrigated by hauling water up from the stream in watering cans. Would these people be willing to pump water for large-scale agriculture and, if pumps were available, would more people work the area if allowed to? This will have to be discussed with villagers if, in fact, we decide against building a dam. This still does not resolve the question of the fish-farming potential, requested by villagers in Foreya.

Design: Is a 2M high dam required?

The (est) $30,000 project (dam plus canals) is based on the need, established by BTGR, for a 2M high. This results in an approximately 25 M long dam. If a 1M high dam were sufficient, this could be built within the confines of the existing stream bed (approx. 5 M across). One of many options would be to build a "removable" dam (i.e., several cement pillars supporting sets of wooden planks which can be removed as the rainy season approaches to decrease the chance of flooding). On the negative side, this system increases the responsibility on the part of the villagers and, therefore, increases the possibility of damage from flooding if farmers do not properly maintain the dam. Similarly, the dam would have a shorter life expectancy and possibly require frequent repair or replacement. However, it greatly decreases the size and cost of the dam and the size of the resulting reservoir without severely decreasing water availability during the dry season. In brief, serious considerations to practical alternatives to the 25 M long dam need to be given.

Bill Polidoro suggested that perhaps the second meter of the dam (the part protecting the flood plain) could be made with gabions instead of cement to decrease cost. This sounds like a possibility but we should consult with more experienced technicians than ourselves to develop a system which is inexpensive yet will do the job.

Justification: Why? (Economic or humanitarian)

The Diafore watershed has a serious problem of market access. The construction of a $30,000 dam to support the production of tons of tomatoes or bushels of lettuce for a severely limited market is unjustifiable. On the other hand, this watershed is one of the poorest in the Fouta with food production problems so severe that many villagers go malnourished and undernourished for two months a year. Given the National goal for this watershed of self-sufficiency, the production of off-season crops to reduce the dependence of the villagers on rainy-season yields would more than justify this and other proposed long-term investments in this area. On the other hand, an economic analysis based on the construction of a low-maintenance dam that would irrigate the 3 ha area for a 30-year (?) period may actually prove it to be economically justifiable.

Further, Mike McGuyhe commented that, in their experience, farmers who are not self-sufficient in agricultural production (this includes sufficient excess to obtain other needs by trade) "mine" their mineral resources from desperation. If this is true, the dam and the resulting agricultural production could permit many more villagers to become self-sufficient and, therefore, receptive to the goals of the GNRM Project. One good example of this was discussed at our symposium where farmers involved in the Dalaba project, after developing successful, lucrative (and time-consuming) garden plots, decreased their efforts on their outer fields to take advantage of the higher productivity in the gardens.

Use: Who, how, when and for what?

To maximize both economic and humanitarian gain, this intervention should benefit the greatest number of people within the watershed. This suggests that agreements be made between the land owners and members of other villages within the watershed for off-season production - if possible. The land owner may be agreeable if the land is improved significantly by the participants as they use it during the dry season but is made available to the owner during well-defined months of the rainy season. Alternatively, users could pay 10% of their produce to the owner, which would be a significant increase over his present crop (fonio). The quantity of water available for irrigation is sufficient through January for any activity desired but later in the year, shortages could cause problems in apportionment of water must be prepared for.

Other considerations:

As discussed in a previous memo, the soils in this bas-fond are extremely poor in phosphorus. To maximize the utility of this land, phosphate fertilizer should be applied at a cost of $400-$1,200/ha. This investment would be sufficient for 10-20 years and longer without further additions, depending on how the soil is managed. If we are willing to consider this option, laboratory analyses need to be conducted.

Although Mr. Kallo's work may prove otherwise, the only low-maintenance fish culture I know is based on using Tilapia. If he agrees that this is the best fish to use, we should contact the regional environmental officer to obtain written approval to introduce this somewhat aggressive species into Guinea's streams (if it has not already been introduced somewhere).

Recommendations:

We need determine what we are willing to do and what we want the villagers to do. Then we need to ask a well-trained, experienced engineer who is not caught up in the "mega-development" mind set to review all of our ideas and help us design an "appropriate" irrigation system. We then need to work with the villagers to see if they are willing to conform to our recommendations and provide their input to the program (long- and short-term).

cc:\
Dan Jenkens
Bill Polidoro

O.M.V.G. ANALYTICAL RESULTS FOR SOILS FROM 3 BRPs

N° LABO	pH H2O	pH Kcl	Delta pH	PPM Phos	% Mat. Org.	Ca + Mg Meq / 100g	K+ Meq / 100g	Al +++ Meq / 100g
1001	5.17	4.83	−0.34	15.9	7	5.12		
1002	4.48	4.50	0.02	13.25	8	3.08		0.03
1003	4.62	5.03	0.41	17.20	6	3.40		0.07
1004	4.59	4.38	−0.21	10.50	8.2	2.80		0.04
1005	4.20	4.66	0.46	12.00	5.5	2.52		0.06
1006	5.87	6.78	0.91	25.10	10.5	4.84		
1007	6.48	6.15	−0.33	29.10	14	5.12		
1008	6.11	5.67	−0.44	12.00	13.3	4.68		
1009	5.81	5.71	−0.1	8.00	7	4.12		
1010	5.56	4.95	−0.61	37.10	3.6	4.52		
1011	5.33	5.36	0.03	1.325	5	4.12		
1012	5.43	5.58	0.15	71.50	13	4.08		
1013	5.20	4.96	−0.24	6.50	4.5	4.48		
1014	5.35	5.20	−0.15	23.80	8.5	4.44		
1015	4.70	5.09	0.39	58.30	6.3	3.52		0.002
1016	5.20	5.25	0.05	8.00	14.2	4.32		
1017	5.80	5.85	0.05	45.00	8	4.40		
1018	5.54	4.93	−0.61	73.50	5.5	4.72		
1019	6.06	6.00	−0.06	39.70	6	4.92		
1020	6.13	5.75	−1.38	17.20	13	3.56		
1021	5.83	4.48	−1.35	5.30	2.5	3.56		
1022	5.47	6.34	0.87	11.90	22	3.44		0.03
1023	5.61	5.01	−0.6	60.00	2	3.60		
1024	4.92	4.74	−0.18	18.50	15	4.20		0.02
1025	6.60	6.26	−0.34	60.00	6.9	3.28		
1026	6.84	6.91	0.07	9.27	15	3.56		
1027	5.26	4.74	0.52	1.325	13.5	3.16		
1028	5.35	5.62	0.27	1.325	17.5	3.32		
1029	5.52	5.30	−0.22	68.90	9	2.60		
1030	6.10	5.75	−0.35	10.60	5	4.36		
1031	4.80	4.58	−0.22	68.90	10	3.24		0.04
1032	4.97	5.63	−0.66	5.30	17.5	3.16		0.05
1033	5.33	4.70	−0.63	11.50	8.5	3.52		
1034	4.78	4.81	0.03	5.30	15	3.68		0.01
1035	4.84	5.05	0.21	5.30	14	3.26		0.03
1036	5.75	5.75	0	3.97	8	3.96		
1037	5.96	5.63	−0.33	5.30	15	4.20		
1038	4.50	4.40	−0.10	23.80	11	3.16		0.002
1039	4.48	4.43	−0.05	23.80	2	1.56		0.01
1040	4.94	5.08	0.14	6.60	13.5	4.16		0.03
1041	5.42	5.08	−0.34	2.60	8.1	3.16		
1042	4.93	4.73	−.2	29.00	2.9	3.12		0.01
1043	4.56	4.56	0	19.80	10	3.60		0.02
1044	5.34	5.58	0.24	31.80	2	4.32		
1045	5.82	5.32	−0.5	38.00	5	3.20		
1046	5.22	4.94	−0.28	2.50	6.4	4.84		
1047	5.41	4.96	−0.45	29	7	3.32		0.01
1048	4.90	4.78	−0.12	15.50	13	3.24		0.03
1049	4.75	4.46	−0.29	1.325	11	3.44		0.02
1050	4.15	5.01	0.86	1.325	19	3.84		0.03
1051	4.20	4.93	0.73	37.10	12.5	3.20		0.01
1052	5.10	5.07	−0.03	2.60	10	4.56		
1053	4.96	5.27	0.31	1.325	8.5	3.16		0.01
1054	5.00	5.15	0.15	1.325	9	4.40		
1055	4.88	4.98	0.10	2.60	10	3.60		0.003
1056	5.08	5.53	0.45	2.60	1	4.40		
1057	5.25	5.00	0.25	3.50	6.5	4.32		
1058	5.08	5.26	0.18	1.325	5.5	3.96		
1059	4.74	4.75	0.01	3.50	6	3.20		0.05
1060	5.21	5.27	0.06	3.50	6	2.92		
1061	5.16	5.29	0.13	1.325	17	4.40		
1062	5.36	5.62	0.26	37.10	5	4.32		
1063	5.23	5.52	0.29	12.00	12	3.40		
1064	5.18	5.45	0.27	3.97	10	3.52		
1065	4.14	4.64	0.5	2.50	7.5	4.00		0.07
1066	5.62	6.18	0.56	2.50	12	3.60		
1067	5.52	5.39	−0.13	2.50	17	3.80		
1068	4.98	5.10	0.12	2.50	9	4.52		0.01
1069	4.92	4.51	−0.42	38.00	15	3.60		0.07
1070	4.56	4.77	0.21	6.60	19	4.00		0.03
1071	4.49	4.28	−0.21	21.20	3.9	3.36		0.02
1072	5.12	5.56	0.44	47.70	11	3.28		
1073	5.38	5.95	0.57	1.325	10	3.56		
1074	5.62	5.90	0.28	9.27	4.00	3.52		
1075	5.72	6.24	0.52	26.50	15	3.24		
1076	5.28	5.15	0.13	26.50	7.6	3.20		
1077	5.07	4.69	−0.38	10.50	4	3.20		
1078	4.64	4.90	0.26	1.325	8.6	3.28		0.04
1079	4.20	4.93	0.73	1.325	9	3.60		0.06
1080	4.48	4.47	−0.01	18.50	10	3.20		0.01
1081	4.54	4.70	0.16	2.60	7.8	3.40		0.07
1082	4.68	5.00	0.32	18.50	9	3.20		0.04
1083	4.48	4.83	0.35	11.90	11.5	3.20		0.02
1084	4.79	5.03	0.24	8.00	22	3.32		0.01
1085	4.48	4.42	−0.06	14.50	15	3.44		0.02
1086	5.10	5.60	0.50	8.00	10	3.36		
1087	5.25	5.47	0.22	2.60	2	3.08		
1088	5.25	5.42	0.17	37.10	5	3.20		
1089	4.39	4.69	0.3	1.325	6	3.72		

Diafore

Dissa

Koundou

Diafore'

DIAFORE

1	Ley Kouratongo, Toggo 1_1 vice président	1001
2	Ley Kouratongo, Toggo 2_2 vice président	1002
3	Secteur de Donta sol de versant périodiquement cultivé	1003
4	Ley Kouratongo, Dougouvoulen 1_1 Elhadj	1004
5	Ley Kouratongo, Dougouvoulen 1_2 Elhadj	1005
6	Ley Kouratongo, Kessouré 1_1 Mr. Karim	1006
7	Ley Kouratongo, Kessouré 1_2 Mr. Karim	1007

DISSA

8	Secteur de Khatiya sol de montagne en jachère depuis 8ans	1008
9	Secteur de Fotongbé vallée (amont) exploitée après 1 ans	1009
10	Secteur de Donta village de méremo bas-fonds annuellement exploité sans engrais chimique	1010
11	Secteur de Khatiya sol de versant portant pour la 2eme fois du manioc.	1011
12	Secteur de Donta, sol de tapade intensevement exploité sans engrais.	1012
13	Secteur de Hafia bas-fonds à l'aval du barrage de Malassigui riziculture plus culture potagères.	1013
14	Secteur de Fotongbé en jachère depuis 1984	1014
15	Secteur de Hafia bas-fonds à l'aval du barrage en jachère	1015
16	Secteur de Donta sol de côteau sur pente douce après la jachèrede 8 ans	1016
17	Secteur Fotongbé vallée exploité après 1 ans de jachère	1017
18	Secteur de Donta village de Merema, bas-fonds annuellement exploité avec apport d'engrais chimique dépuis 4 ans.	1018
19	Secteur de Farinta sol de vallée annuellement sollicité pour les cultures vivirères et maraîchères.	1019
20	F14 Kassouma rocky sheld on slopes (well drained) 0..15cm x 2	1020
21	Dissa devant le barrage en plain champs.	1021

DIAFORE

22	Kouné Mar surface	1022

KOUNDOU

23	Fello profondeur (2) 0 - 15cm	1023

DIAFORE

24	Kouné Mars sous-sol	1024
25	Ley Fello (3) surface	1025
26	Guémé surface (3-15cm) bas-fonds intérieur sous le pont	1026
27	Linsan-Saran fello 2 - 10cm jardin	1027

KOUNDOU

28	Linsan-Saran Hansaghéré 2- 10cm garder next	1028
29	Wonsouré sel grumel stat pland surface 4 samples	1029
30	Fello surface	1030
31	# 12, Grume Koundou	1031
32	# 10 Wosure Werry sol O2 plateau O - 10cm	1032
33	Karsouma F 15	
34	# 13 Kansouma 12 km Linsan Linsan-Saran	1034
35	Linsan-Saran Fello surface mid-slope	1035
36	Ley Fello profondeur o_25cm	1036
37	Linsan Saran Hasarque sol	1037

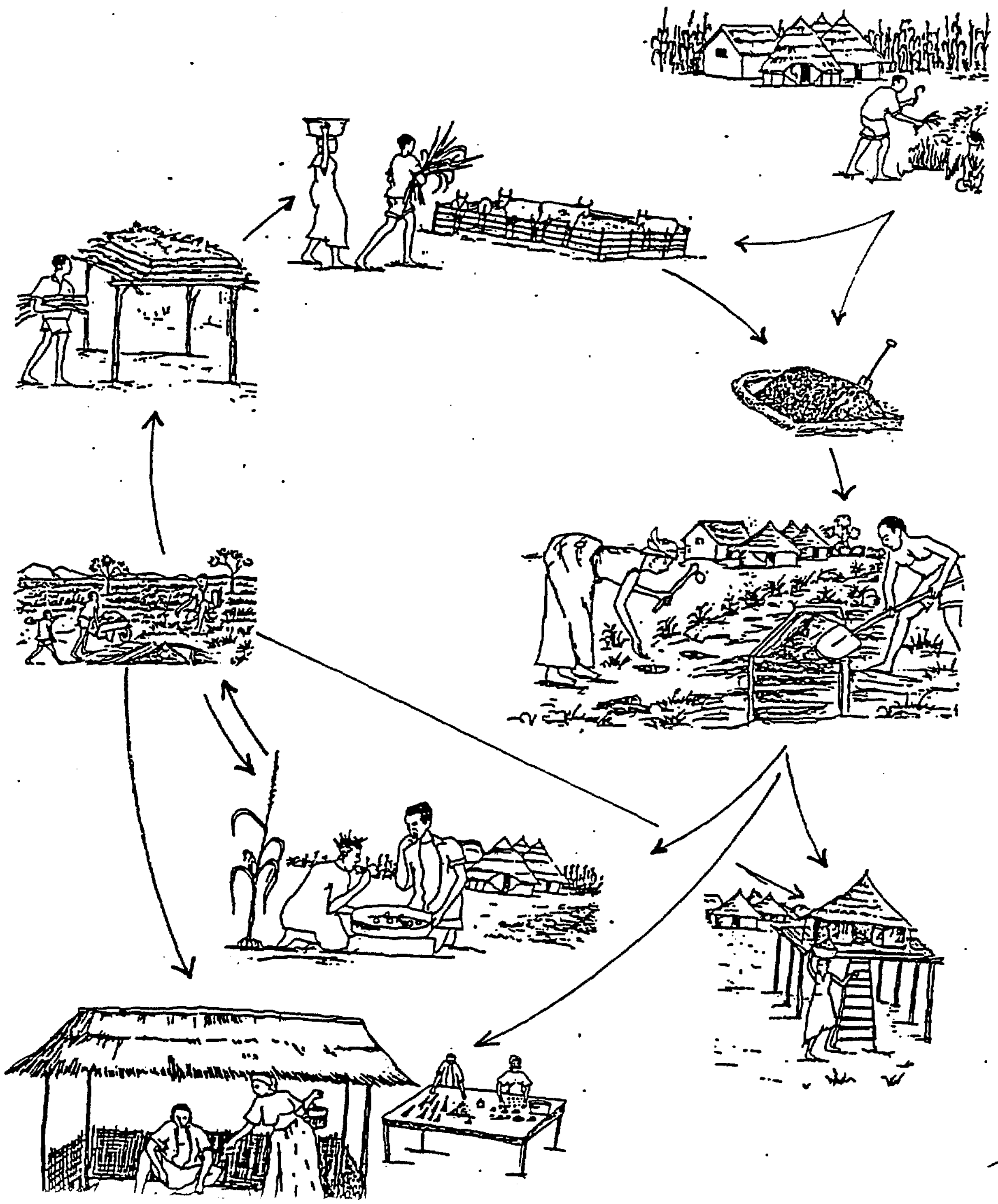
DIAFORE

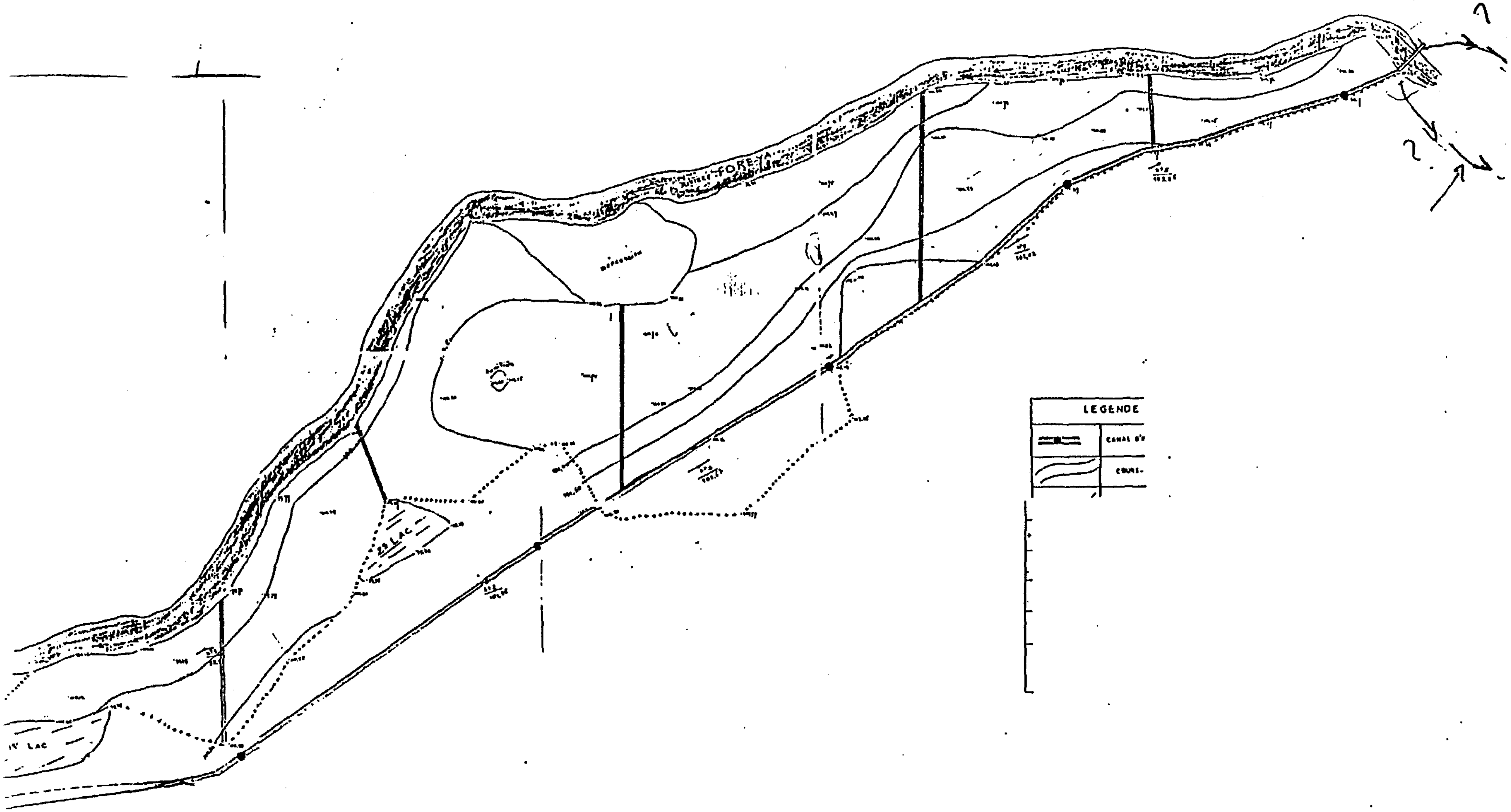
38	Dow Kouratongo, Dougouvoulen 1_1	1038
39	Dow Kouratongo, Dougouvoulen 1_2	1039
40	Dow Kouratongo, Kessouré 2_1	1040
41	Dow Kouratongo, kessouré 2_2 1041	
42	Gadha Diaforé, Toggo 2_1	1042
43	Gadha Diaforé, Toggo 2_2	1043
44	Koumbana, Toggo 2_1 Elhadj Abd	1044
45	Koumbana, Taggo 2_2 Elhadj Abdou	1045
46	Kouné, Toggo 1_1 Diariou Low P (2.5)	1046
47	Kouné, Toggo 1_2 Diariou Hi P (29.1)	1047
48	Kouné, Dougouvoulen 2_1 Abdoul Djibril Mod P (15)	1048
49	Kouné, Dougouvoulen 2_2 Abdoul Djibril low P (1.3)	1049
50	Foréya, Dounkiré 1_1	1051
51	Foréya, Dounkiré 1_2	1051
52	Dow Diaforé, Toggo 1_1	1052
53	Kouné, Kessouré 1_1 Djiwo Gallé	1053
54	Kouné, Kessouré 1_2 Djiwo Gallé	1054
55	Dow Diaforé, Toggo 1_1	1055
56	Dow Kouratongo, Toggo 1_1	1056
57	Dow Kouratongo, Toggo 1_2	1057
58	Dow Kouratongo, Toggo 2_1	1058
59	Dow Kouratongo Toggo 2_2	1059
60	Kouné - Tapade 1_1 Dougouvoulen Oumou Sadio	1060
61	Kouné - Tapade 1_2 Dougouvoulen Oumou Sadio	1061
62	Kouné, Toggo 2_1 Oumou Fali	1062
63	Kouné, Toggo 2_2 Oumou Fali	1063
64	Gadha Diaforé, Toggo 1_1	1064
65	Gadha Diaforé, Toggo 1_2	1065
66	Koumbama, Toggo 3_1 Modi Abdoul	1066
67	Koumbama, Toggo 3_2 Modi Abdoul	1067
68	Dow Kouratongo, Kessouré 1_1	1068
69	Dow Kouratongo, Kessouré 1_2	1069
70	Dow Kouratongo, Dougouvoulen 2_1	1070
71	Dow Kouratongo, Dougouvoulen 2_2	1071
72	Diaforé - Kouné, Toggo 1_1	1072
73	Diaforé - Kouné, Toggo thierno Fta. Binta	1073

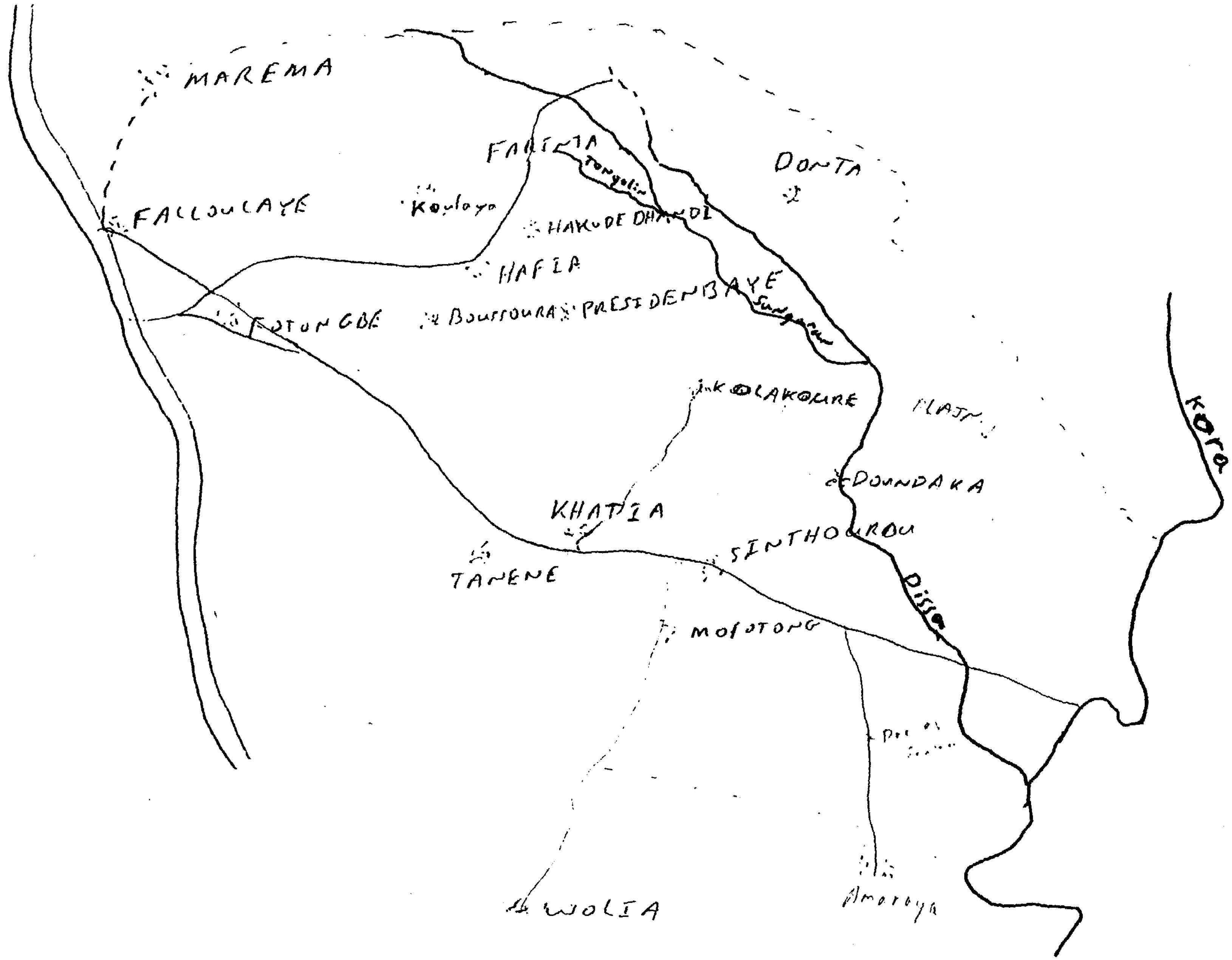
12

74	Foréya, Dougouvoulen 1_1 Aissatou Lamarana	1074
75	Foréya, Dougouvoulen 1_2 Aissatou Lamarana	1057
76	Diabéré - Méré, Toggo 1_1 Mr. Diallo	1076
77	Diabéré - Méré, Toggo 1_2 Mr. Diallo	1077
78	Ley Diaforé, Kessouré 2_1	1078
79	Ley Diaforé, Kessouré 2_2	1079
80	Koumbama, Dougouvoulen 2_1 Maimouna	1080
81	Koumbama, Dougouvoulen 2_2 Maimouna	1081
82	Dow Diaforé, Kessouré 1_1	1082
83	Dow Diaforé, Késsouré 1_2	1083
84	Ley Diaforé, Késsouré 1_1	1084
85	Ley Diaforé Késsouré 1_2	1085
86	Koumbama, Toggo 1_1	1086
87	Koumbama, Toggo 1_2	1087
88	Koumbama, Dougouvoulen 1_1	1088
89	Koumbama, Dougouvoulen 1_2	1089

CYCLE DE LA FERTILITE DU SOL




FOREYA
2e LAC
LEGENDE
CANAL D'
COURS-


MAREMA
FALLOUCAYE
Kouloya
HAKUDE DHANOL
HAFIA
FOTONGBE
BOUSSOURA
PRESIDENBAYE
Tongolin
DONTA
KOLAKOURE
DOUNDAKA
KHATIA
SINTHOUROU
TANENE
MOFOTONG
WOLIA
Amoroya
Kora
Dissa

1:200,000

ACTIVITIES FOR GENERAL BRP-WIDE MEETING

7:00	Collect participants from distant villages
9:00	Welcome & purpose of meeting (BRP Director)
9:15	Prayer (Imam)
9:20	Description of the purpose* of our Project (Director)
9:30	General Description of what we have done this year (Director). Slides/videos here(?)
11:00	Presentations by each village: their experience with the Project.
13:00	Eat
14:00 1415	Responses to village comments (Director and Technicians)
15:00	Plans for next year: explanation of handouts (prioritize village needs); description of what the village representatives are going to do to prepare for our visit.
16:00	Question/answer/discussion
17:00	Prayer (Imam) and end of meeting

looks good

* Need to be very clear here

ACTIVITIES FOR VILLAGE MEETINGS

8:30	Arrive in village
9:00	Begin meeting with whomever is there: Purpose of meeting.
9:15	*Discuss results of prioritization exercise. List specific activities desired (each tech take his/her turn)
11:00	Read prioritized list of specific activities. (Develop tentative timetable for villager inputs.) ← premature?
12:30	Eat
13:00	Visit sites of proposed activities and discuss more detail with villagers. Write up details.
16:00	Go home, submit notes for typing.

and explan. of purp. of proj.

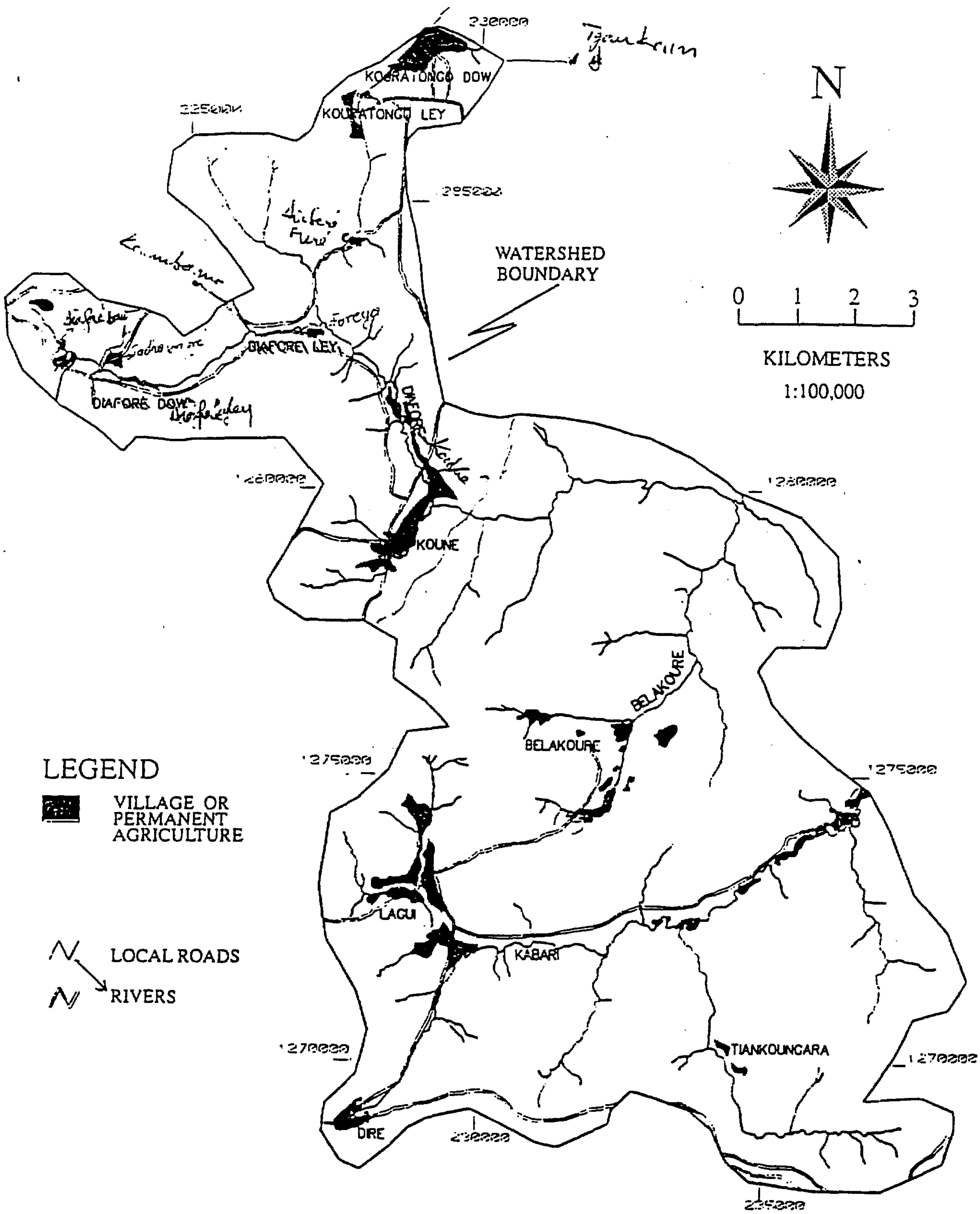
(Committee membs. w/ names of technicians)

Committee membs. should present results first?

if we are limited by time (i.e., other activities, too many villages, upcoming activities [Feb.]), could we cut it off here? i.e., 1/2 day meetings preferable

Once we get their results, I think we can only give an initial, off-the-cuff response; we should prob. study/analyze results bef. trying to decide on village inputs sites

*I thought the priority exercise would be done in each village? Is it appropriate to do it with the whole group of villages during the general mtg?



MAP 1: DIAFORE - TOUGUE
1989 VILLAGE LOCATION MAP