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ABYEI INTEGRATED RURAL DEVELOPMENT PROJECT

PROGRESS REPORT

NOVEMBER 1979 TO JULY 1980


*Integrated Rural Development Project*
*Abyei, South Kordofan, Sudan*

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Harvard Institute for International Development

This project report has been prepared for the U.S. Agency for International Development under AID Grant No. Afr-G-1344, and for the Government of the Democratic Republic of the Sudan. Those contributing to the preparation of the report are team members Richard Fuller, Ann Byerly, William Donovan, Rick Huntington and Joseph Sharp, and project coordinator, David C. Cole.

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## INTRODUCTION

The Abyei project exemplifies a relatively new approach to promoting development in backward rural areas. It is one example of a large number of recently popular integrated rural development projects, but it differs from many of them in that it seeks to avoid the long delays inherent in the extensive preliminary studies and detailed master plans that have been prepared for some areas. On the other hand, it has sought to limit heavy initial investment in equipment and facilities that often turn out to be inappropriate for the local environment. Both of these other approaches have been tried repeatedly, but they have proven very costly and have produced limited benefits for the target populations. Their failures have caused disillusionment not only among the intended beneficiaries but also among those who hoped to relieve the burden of poverty among the poorer segments of the world's population.

In the Abyei project the attempt is being made to combine action with research - to test alternative approaches to solving the local people's perceived problems in ways that produce tangible benefits without excessive delay and at relatively low cost. As solutions are found that are acceptable to the local populace and economically feasible, they can be spread more broadly throughout the area. This experimental, or what some have called "process" approach to the promotion of rural development is believed to be more efficient, more adaptable to different local conditions and more responsive to local needs than the other major approaches.* The Abyei project is one of the first cases in which action research is being tested. Other examples are underway in the North Shaba project in Zaire and Projet Tapis Vert in Upper Volta.** All of these projects are being closely monitored to see whether they fulfill expectations. Preliminary indications are encouraging, but they also suggest the following prerequisites for success:

1) Well qualified project leaders (both local and foreign) who can live under difficult field conditions and who understand and are sympathetic to the "action research" or "process" approach.
2) Flexibility of funding and action to be able to respond to opportunities or difficulties and carry field tests through to completion.

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* See Charles F. Sweet and Peter F. Weisel, "Process Versus Blueprint Models for Designing Rural Development Projects", in George Honadle and Rudi Klauss, Eds., International Development Administration: Implementation Analysis for Development Projects, (New York, Praeger, 1979).

** Op. cit. and Projet Tapis Vert, Report for the Period June, 1978 to October, 1979 prepared by Strategies for Responsible Development, Univ. of Dayton, and Institute for Study and Application of Integrated Development, Toronto.

3) Sufficient time to produce results - often donors and local sponsors are impatient to see tangible evidence of the project's activities.
4) Sufficient political stability and support at the local and national level so that the project staff can concentrate their attention and resources on the developmental needs.

The Abyei project has encountered problems in all these areas since its inception, but has managed to survive and to mitigate many of them.

Field activities started in Abyei in early 1978 under very difficult conditions. There was considerable political unrest and tribal conflict over grazing and water rights and also over the fundamental question of whether the project area should be in the northern or southern region of the Sudan. The project initially was underfunded and had only a two-year assured time horizon. The original foreign team was understaffed and underqualified to carry out the necessary range of activities. These defects became clear within a few months and by January 1979, proposals were submitted to AID to modify the project in the following major respects:*

a) The time horizon for the initial experimental phase should be extended by 16 months to June 30, 1981.
b) Additional funding, both in dollars and local currency, should be authorized.
c) The foreign field team should be expanded from three to four full time members; a new team leader to be brought in and two other team members replaced.

These proposals were finally approved in August 1979.

In the first year the main issue was survival - as a team and as a project. Having achieved this, the project personnel in the second year concentrated mainly on laying foundations - building buildings, training workers, doing preliminary tests of various technologies. The results of the second year were incomplete and more qualitative than quantitative. Operations were plagued by supply shortages, equipment failures, lack of familiarity with the natural environment, and inexperience of locally recruited workers.** By the third year many of these problems were ironed out and the project has been able to move ahead on many fronts.

In the broadest terms, the Abyei project has demonstrated that it is possible to operate a low-cost, experimental rural development project in an extremely remote and troubled area and produce some significant results. While the process has been more difficult, moved more slowly, cost more money and required more people than originally envisaged, it has nevertheless succeeded in providing both some tangible benefits for the local people and much greater understanding of what is needed for the further development of the area.

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* See Progress Report and Proposal for Amendment of Grant Agreement, January, 1979.

** See Progress Report, April - October, 1979.

Recent Developments

The major accomplishments so far achieved include the following:

1. A good base camp has been established near Abyei town with houses, a communal dining and meeting hall, a well-equipped workshop and storage facilities. The buildings are constructed of locally-made brick, and some use local roof timbers and thatch. The meeting hall reflects traditional local design and has attracted favorable attention of local residents as the kind of structure they might want to build. It is much more permanent and better ventilated than the local houses.

2. Over 100 local residents have been trained in numerous skills such as brickmaking, masonry, carpentry, metal-working, welding, vehicle operation, maintenance and repair, well-drilling, cartmaking, use of modern farming implements, making of beehives, ox yokes and harnesses, etc.

3. Six volunteer health workers have been trained and are functioning effectively providing primary health care at four group farms and two project work sites. Also a number of traditional birth attendants, community health workers and apprentice nurses have been given supplementary training.

4. Various techniques of cultivation have been tested including use of tractor-drawn and ox-drawn implements as well as hand operated planters, herbicide sprayers and traditional farming implements. These tests have demonstrated the technical feasibility or difficulties of different systems of cultivation. Economic evaluation is awaiting the harvest of this year's crops.

5. A number of varieties of sorghum, beans and other vegetables have been tested under local growing conditions. Ability to withstand extended dry spells and waterlogging are critical characteristics for suitability in the area. Local varieties of sorghum seem better able to withstand local conditions and give better yields than some of the "improved" varieties recommended by the research stations. Also, the seed harvested from the "improved" varieties failed to germinate when used the following year.

6. Controlled feeding of sorghum stalks has been demonstrated as a highly effective means of sustaining cattle through the dry season. This can make it possible to keep milk cows near the homes through the dry season rather than moving them to distant natural grazing areas, which could make a significant contribution to the nutritional status of small children and pregnant women who stay at home in the dry season.

7. Hand operated grain grinding mills have been introduced into the area and have proven popular as a significant saver of time and energy for women who normally pound the grain with a 4 foot long wood pestle.

8. A radio station has been successfully maintained by the project since its inception. The battery of the $1200 single-side band receiver-transmitter is now charged by a $250 photovoltaic solar panel. The radio effectively reaches Khartoum, Kadugli, Juba and Wau, and is now serving as a relay station for AID communications between Khartoum and Juba.

9. Field studies have been started on the livestock sector and the household-level economy. A study team spent several weeks surveying the cattle and their environment in the dry season cattle camps and is now following the same herds in the rainy season. The household economy study is being carried out at the group farm in Mabior and is analysing the consumption and production patterns to identify the opportunities for relieving hardship and promoting development.

10. Geographic surveys of the Abyei area were carried out during the dry season and a report with maps is nearly completed on the population, settlement patterns, soils and vegetation, using a combination of landsat images and ground level observation.

Areas in which the results have been more mixed are as follows:

1. Drilling of six wells at dispersed sites indicated that water is available at depths of 100 to 130 feet, and that drilling conditions are satisfactory. However, the low-cost ($1,000) drilling rig used was not sturdy enough to drill a 4-inch hole and the low-cost PVC pumps did not work properly under field conditions. A modified water program has been proposed for the coming year using sturdier drilling equipment and improved well and pump designs.

2. Two group farms have been successful in developing workable organizations, mobilizing labor for farming activities, producing good harvests and determining how to allocate the harvests. Two other group farms have not worked so well, mainly due to tribal division and inadequate leadership. As the benefits of successful cooperation become more apparent, and as more activities are integrated into the operation of the group farms, they may become more effective. The activities currently include land clearing, farming, storage of crops, communal health worker, communal grain mill and, prospectively, a communal hand-pump water supply.

3. The joint Sudanese-foreign project team is working smoothly and effectively. Having an Abyei Dinka as field director has proven popular and further strengthened relations with the community. The Ministry of Agriculture in Khartoum has given good support when needed. Relations with the provincial authorities have been much less satisfactory, largely because of the continuing controversy over whether Abyei should remain a part of the North or be shifted to the South.

4. Original plans to set up a "local development organization" to carry on the work of the project have proven infeasible, due to some of the broader political difficulties affecting the area and the Government. The project has been able to develop effective informal working relationships with various local groups, but so far no viable structure has been worked out or even envisaged that would provide a continuing impetus for development of the area beyond the life of the project.

5. Attempts to explore the potential use of waterways as means of transportation during the rainy season were largely frustrated due to equipment failures. An airboat was tested on the Bahr el Ghazal near Bentiu in April and navigated the grass-filled waterways very successfully. Tests around Abyei were delayed until July due to lack of water in the rivers. Finally after one hour of successful operation, overheating problems led to discovery of a broken crankshaft and further tests were postponed until replacement parts could be delivered after the rainy season when there again may be insufficient water in the rivers. Two aluminum skiffs have proven popular and successful as oar-powered ferry boats at main river crossings. Attempts to use them for travel along the rivers driven by an outboard motor encountered frequent fouling problems with grass and fishnets, which do not impede the airboat.

Project Funding and Continuation

The financial support for the Abyei project has come mainly from the U.S. Agency for International Development either as direct dollar allocations or as local currency channeled through the Sudanese government. An initial authorization of $170,000 in July 1977 was used to initiate surveys of the Abyei area and begin planning of the project. A second grant of $495,000 plus £S 225,000 approved in March 1978 was to fund two years of field operations. This was augmented by $702,000 in August 1979 and by £ 300,000 in September 1980, to carry the project through an additional 16 months until June 30th, 1980. In addition to these contributions from AID, the Sudanese government has contributed £S 150,000 from its own budgetary resources, and the European Development Fund granted £S 40,000 for a school construction program.

From the beginning of the project the approval and release of funds has consistently lagged behind the needs of field operations. Sending of staff to the field has been delayed, ordering of equipment and supplies has had to be postponed till the last minute and then transport difficulties have often resulted in needed goods not being available. It has been suggested elsewhere that "even though..."process model" projects have been effective, they are difficult for foreign donor agencies to replicate because of the requirement for flexible and incremental funding." * Experience with the Abyei project has tended to confirm that assessment.

Even more important than the short run lags in project financing, however, is the current uncertainty about continuation of the project. While all the project proposals and plans submitted to and approved by USAID contained clear and repeated statements that the initial 2-3 years of the project were but the first, experimental and exploratory phase of a longer term development effort for the area, AID is now suggesting that there may not be a second phase, or that, if there is, it will be delayed for a year or two to give time for careful assessment of what has happened so far and for the preparation of a new project plan, review and approval of that plan and selection of a new contractor to carry it out. This uncertainty is already having a demoralizing effect upon the project staff, causing them to begin looking for other, less arduous assignments. If there is a substantial gap in project activities, people will leave, facilities and equipment will deteriorate and a new effort will have to recover lost ground and probably overcome some local skepticism or hostility. If the project is actually discontinued after this brief initial phase, there will be serious disillusionment and resentment among the local people.

Had the project clearly failed to accomplish its original objectives, or the local people expressed resentment and opposition to the efforts to bring development to the area, then it would be easier to understand the need for a careful review and possible termination. But this is not the case. Substantial progress has in fact been achieved on all of the major objectives. Some initial objections by the local inhabitants to some project activities have led to their being modified or dropped. The main criticism of the project at the local level now is that it has moved too slowly on too modest a scale; but at the national level the need for gradualism is better understood. Both national and local levels, however, expected an acceleration of project activities over time, not a stop-and-go process or a total halt. The unilateral actions by AID in this regard are likely to be questioned.

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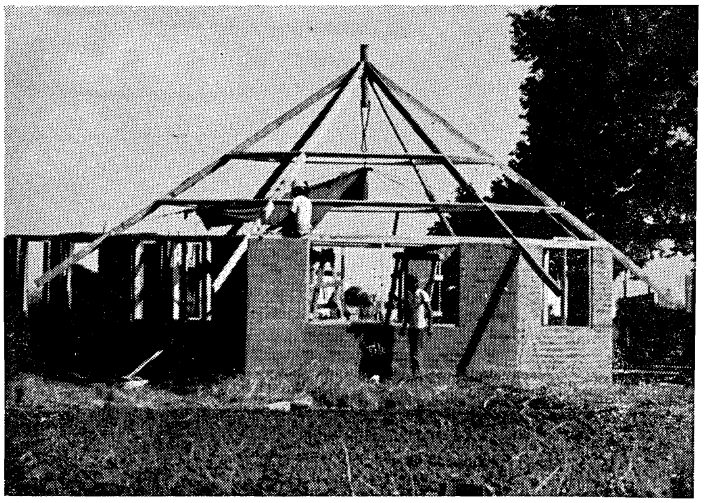
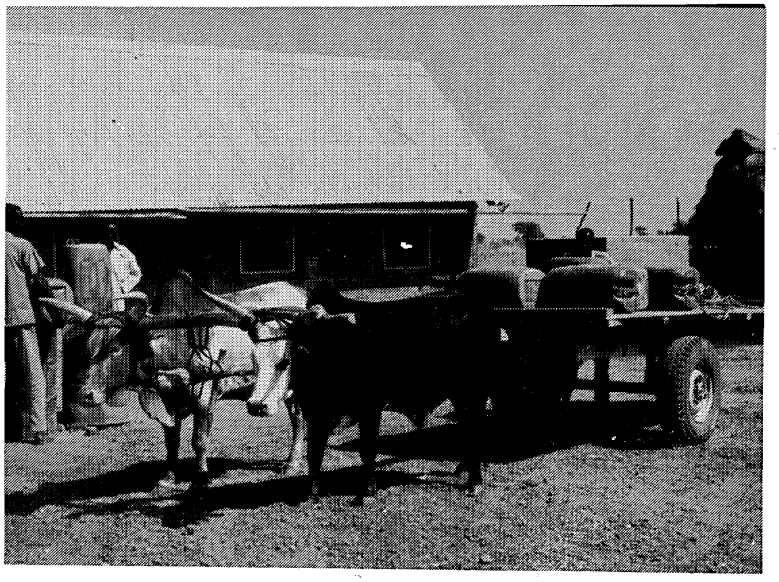
* Sweet and Weisel, op. cit., p.131.

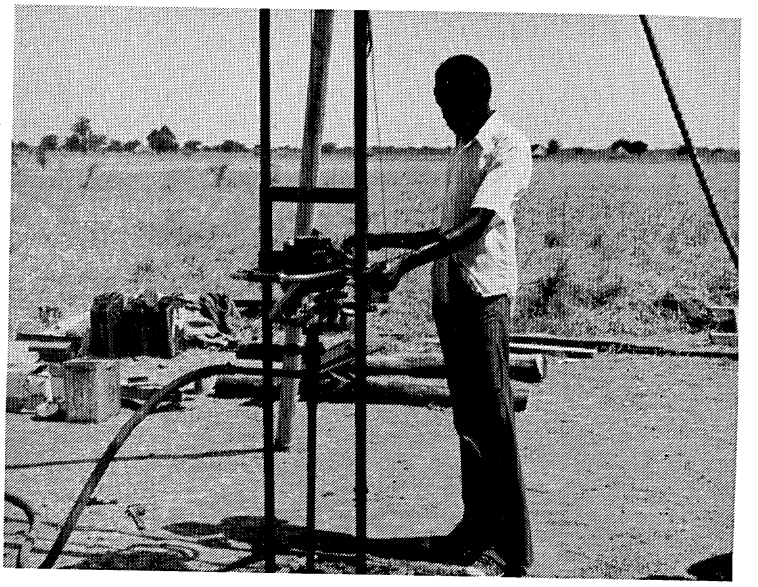
Water cart for oxen power
constructed in Abyei Workshop



The "Luak" or Dining Hall
in construction



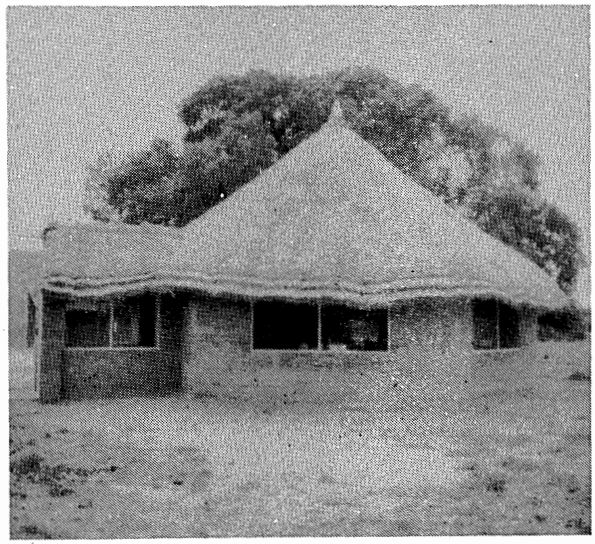
Oxen hauling water to Duop Camp



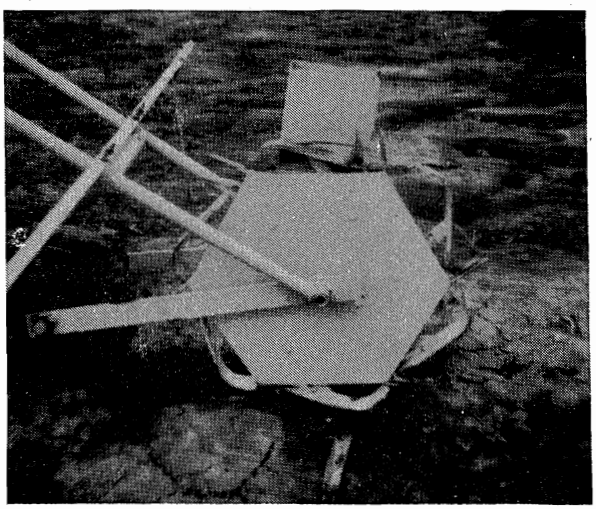
Newly trained Dinka well-driller
operating Hydra Drill

a

Oxen-pulled, locally made water cart



Completed "luak" or dining hall



Rotary jab planter from Nigeria

b

## PROJECT ACTIVITIES

### Agriculture Program

#### 1. Group Farms

The near-total absence of water during the latter part of this dry season led to many area villages being abandoned as their inhabitants moved closer to the Bahr el Arab (Kir River). It also led to a marked reluctance by members of the four group farms to undertake clearing additional land for cultivation. Cleaning and clearing of area farms commenced only in mid-May, coinciding with a break in the pronounced heat and the promise of imminent rains.

Project plans for an early seeding were disrupted when the early rains proved too sporadic to support growth of the first sowing. The discovery of poor germination by the sown variety (Gaddam El Hamam), which was totally unexpected, led to use of the local variety after a second sowing did poorly. As the Hamam seed came from last year's crop, its failure to germinate raises serious questions about its suitability for the area. Likewise, such unprecedented poor results mandates need for germination tests in the future as a matter of course.

Failure of the Hamam seed has led to those portions of the group farms originally sown with local sorghum variety being more developed than the portions which had to be reseeded later due to initial use of Hamam. Nonetheless, both portions are now well established.

Of the four farms, Thithyei and Nuenchior continue to be the most active, displaying good internal cooperation and working well with the project. Thithyei members cleared an additional 10 feddans this year, and even chose to supplement their own labor during general clearing and cleaning by hiring others to assist.

While Mabok remains an open question, with no clear sign of a real commitment to group farming, Mabior has recently shown belated improvement. Possible influences in this include: the reinforcing effect of the prolonged presence (over 4 months) of a project staffperson in the village (studying village economics); or efforts by the Ministry of Cooperatives to open a marketing coop in the village; or perhaps encouragement arising from evidence of total weed control in the early sorghum (dura) as a result of timely tractor tillage.

Each group farm did appoint a member to receive training in the duties and skills of health worker, which is also referenced in the health program section. They have each met and decided on the siting of a hand pump well for the use and benefit of all workers at each farm, and have assisted in providing labor in the attempt to drill such a well at each farm. In addition, as

a trial prior to introducing such at every farm, Thithyei received a hand-powered flour mill (of U.K. design) for use by all members through their cooperative mechanism.

2. Agronomy Trials

Field trials for 1980 have been designed to include the following:

(1) IITA Cow Pea International trial # 1.20 entries
(2) IITA Cow Pea International trial # 2.10 entries
(3) Abyei sorghum population trial
(4) Abyei sorghum/cow pea intercropping trial
(5) Zero tillage observation
(6) Sweet sorghum variety observation
(7) Sesame variety observation
(8) Draft animal tillage study
(9) Tractor cost study

These trials are focused on seeking means to improve area agricultural production. Coordination with the Provincial research staff in Kadugli was achieved in previous trials, but transfer and non-replacement of their researcher led the project to abandon the effort this year. Of course, data from these trials will be made available to those who may be interested.

There are early indications that cow pea and sesame would perhaps do better if sown later, rather than an early sowing at the same time as the sorghum. The object would be to avoid the extreme wetness of the early, heavy rains, which seemed to set them back. Also, it would allow maturity to coincide with the onset of the dry season. It has also been noted that many of the introduced varieties, including sorghums, seem unduly susceptible to different aspects of the local conditions.

Two new technicians were added to the staff to help offset the loss of Kwol Arop, our experienced agriculture counterpart through promotion to the senior Sudanese staff position and his consequent involvement in daily administrative matters to the exclusion of possible agricultural activities. These technicians have proven less able and ambitious than was hoped, but the season is not yet over.

3. Tillage

a. Tractor Mechanization Program

An intensive maintenance effort during the dry season was able to ready the four project tractors for this season's work. Effort notwithstanding, had not the fullest priority been given to securing parts required, but one - possibly two - tractors would have been available for service. In view of

the inability of the manufacturer's Khartoum representatives to supply needed parts, the project resorted to direct importation from the United Kingdom. While this largely resolved the immediate problem, it remains that private groups or individuals interested in relying upon tractor mechanization would not have such ready access to vital spares. If there is any truism to the operation of tractors and other farm equipment (if not all equipment), it is that the one part needed to restore operation is always "out of stock." (This is equally true in Europe and the U.S., but there one has ready access to many dealers, distributors and even the main factory in many cases, and supply lines are much shorter.) This early emphasis on a reliable and accessible supply of spare parts is integral to avoiding undue down time for equipment, especially when it can only redeem its heavy capital costs through performance of its function at the time it is needed. In the case at hand, when weather and soil moisture levels coincided to create favorable conditions, the equipment was operational.

The wide-level disc seeder saw extensive use this season. Sufficient rain had fallen to soften the soil to a workable state, without being so excessive as to transform it to a clinging mud. The wide-level has the advantage of needing fewer passes over a field to accomplish seeding, with two usually being sufficient in place of the three required by use of an offset disc and a seed drill. It has the disadvantage of being so large that it is difficult to move from farm to farm on area roads, and to maneuver when actually on the fields. It also has a tendency to cover seed too deeply, both delaying and reducing the percentage of successful germination, even as it fails to compact the soil around the covered seed with the same resulting tendencies. Properly operated, these tendencies do not become unacceptable. The alternative method, with the offset disc and seed drill, has the advantage of favoring more complete weed control through deeper, more thorough tilling, especially if used shortly after most weeds have emerged. Through greater precision, the seed drill tends to achieve equal stands with slightly less seed input. These advantages are offset by need for three passes over a field, a 50% increase above the wide-level disc seeder, and the consequent costs in time, fuel consumption and other direct operating costs.

Still unanswered are the basic issues of high purchase cost, operating costs and fuel supply, spare parts cost and supply, access to skilled maintenance services, and limited opportunity for operation under suitable conditions of soil and weather. How all these will be answered, especially with an aim to making this technology available to area farmers of limited means and holdings, remains a vital issue.

b. Draft Animal Program

Limited by a shortage of funds for purchase of oxen and plagued by delayed arrival of a variety of implements, this program in 1979 was restricted to use of a moldboard plow and a field cultivator. A portion of the Duob research site provided the opportunity for a limited demonstration, but it was not possible to conduct a fair test of the several alternatives in equipment, nor to achieve widespread exposure to the system in practice. Despite some strong objections to use of draft animals (oxen, i.e., cattle), as lodged principally by non-farmers, some farmers seemed ready to stand back and see what the results might be.

This year the program has had sufficient oxen, and three sites near Abyei were available for demonstration. Initial reports indicate the same sensitivity to soil and weather conditions, which so affect tractor mechanization, apply even more so to the draft animal efforts. While dependent on the softening effect of adequate soil moisture, the less powerful ox-drawn gear uses extra time in preliminary tillage, and is equally if not more sensitive to the effects of wet clay soil in reducing performance. The departure upon completion of contract of the project's draft animal specialist before this season's testing leads to questions regarding the use of the most effective techniques for given conditions, but these cannot be answered at this time. The results of the program must, however, be weighed against the factors of greater accessibility to a larger number of farmers than tractors might be expected to reach, and on the other hand the degree of acceptance by farmers for the principle of using cattle for field work.

One early outcome of the program, however, has been arousal of interest in the use of fodder for the stock during the dry season. As we were using the oxen to keep their training up, we supplemented the usual area practice of allowing open-range foraging with feeding of sorghum stalks from raised storage platforms. The obviously superior condition of these oxen in direct comparison to their own stock caused numerous inquiries and favorable commentary to circulate among area farmers and even townspeople.

c. Zero-Tillage Program

In March of 1980, both Dick Fuller (Project Co-director and Agricultural Specialist) and his Sudanese counterpart, Kuol Arop, visited the facilities of the International Institute of Tropical Agriculture in Ibadan, Nigeria. There they had arranged to observe IITA's efforts and benefit from their experience with zero- and minimum-tillage agriculture. Essentially a process utilizing herbicides for weed control and a rotary jab planter for seeding, it shows some promise

of application under Abyei's conditions. Indeed, being sufficiently impressed with IITA's results, plans were made for a trial program to be implemented this year. Four jab planters were obtained and CIBA-GEIGY (Khartoum) was contacted regarding suitable chemical supplies.

Two jab planters were obtained direct from the U.K. manufacturer, and two modified-design units were obtained from IITA. Mr. G.A. Phillips, of CIBA-GEIGY, was instrumental in supplying five different herbicides on short notice for the program. A battery-powered (D-cells) HERBI micron sprayer was forwarded from the U.K., and used for application of the herbicides.

Poor seed germination, as outlined under "Group Farms" (a.), complicated the results, but it was evident the herbicide application rates tended to be too high. All but one, however, was effective against the local weeds. ("Dual" proved ineffective against broadleaf weeds at the rate applied, although it knocked out both grasses and sorghum.) The HERBI sprayer gave good coverage, provided the operator walked the field at the correct row intervals.

Mechanically, the IITA planter proved superior to the British Groom planter. It gave superior soil penetration, left a smaller hole to cover, and gave positive placement of the seed into that smaller hole. The Groom unit's broader points tended to flip the seed back out of the shallower, larger hole it produced, and its hopper spilled seed over the top when used on rougher ground.

The possibility of using a donkey to draw the jab planter has already been aired, for this would expand the opportunity for planting larger plots of land. The hand-application of selective herbicides to these larger plots, at an optimum rate, would have the effect of increasing yields through better weed control without the concurrent increase of labor input such would otherwise require. In its turn, the rotary jab planter optimizes use of seed through more efficient application, and leads to more ready thinning and weeding due to row planting.

4. Beekeeping

While the project draft animal/beekeeping specialist was on leave in December - January, many of the hives were vacated. Upon his return, he concluded that inadequate water and food supplies had probably caused the bees to swarm and leave the project hives. No doubt they moved south to the banks of the Bahr el Arab, which retained water through the entire dry season. It was also discovered that a parasitic moth had invaded

many of the hives, there to lay eggs which hatch larvae that eat the wax honeycombs. The presence of this moth indicates lowered capacity for resistance of its activity on behalf of the bees, which is consistent with reduced food and water supplies.

It is hoped the advent of the rainy season will see the now-vacant hives re-occupied, whereupon supplemental food and water will be provided next dry season to encourage the bees to remain in year-round residence.

One positive result of the specialist's leave-taking was his return with a new design for hive construction, as seen in Nairobi. Miding, our beehive "carpenter" and Wynn's assistant, has mastered the basics of this construction, which uses only local thatch and steel tie wire to produce a weather-resistant basic hive unit.

5. Poultry

The HIID staff poultry program continues as a solely private adjunct of the agriculture program.

Two coops, one for nesting and the other for roosting, have been built using local wood poles and imported chicken/bat wire with a thatched shed type roof. A compound some 10 meters square was enclosed behind oil-soaked mat-type fencing, which did keep the chickens inside and resisted termite attacks reasonably well. Confinement was sought to segregate the chickens from contact with other chickens in the community, as they are periodically decimated by contagious diseases of one variety or another.

The mat fencing proved useless against local goats, who, under what could be called open-range philosophy, must be kept out by us rather than in by their owners. Use of several strands of barbed wire, or a form of welded-wire fencing (paige-wire), would accomplish this if placed well. (The attraction for the goats is the presence of water and chicken feed, and during the late dry season these are irresistible to hungry, thirsty goats.) The fencing and even the coops have also proven useless against depredations by a local form of wildcat and by mongeese or a mongoose-like small mammal. The wildcat is of some 20-30 lbs. size and appears to be predominantly buff-gray in color, but conditions of the encounter leave that open to question.

It has been learned, however, that isolation must be very carefully observed in all respects, for replacement of birds lost to predators with apparently healthy birds from the local market has twice introduced disease to the flock. One solution to this would be use of a short-term holding pen, to allow new birds to be observed long enough for symptoms to develop if

infection is present. Another solution would be to replace only with hybrid stock from Khartoum, but as logistics have so far precluded introduction of hybrids as basic stock, this seems quite impractical. Time and materials permitting, a more secure coop and fence could be constructed and a healthy stock built up. If predators cannot gain access, replacement ceases to be a significant problem.

The possibility of introducing hybrid stock remains of real interest, but conditons of transport are such that this would be best undertaken when an airplane is coming down to the site.

6. Dura Storage and Marketing

This program was initiated in 1979 as a means of ensuring a fair price to participating farmers and, it was hoped, of controlling unreasonable market prices during seasonal shortages. This would be a first step in the breaking of the now-vicious cycle of selling grain at a give-away price right after the new harvest (only to invest in cattle at inflated prices), and then paying grossly-inflated prices to supplement inadequate reserves shortly before the next harvest (often financed by sale of cattle at greatly depressed prices).

In 1979, adequate supplies of sorghum resulted in market prices remaining at a reasonable level, so the project did not intervene to sell much of the grain it had purchased as the initial stock for this program.

1980 proved to be a year of relative shortage, however, and real benefits were realized by program participants. The group farmers of Thithyei and Nuenchior had each placed grain in the project storerooms as of March, receiving £S 12.00/sack as cash advances. The difference between this advance and the selling price would be turned over to the farm after deduction for storage and handling and for tractor costs of the previous season.

The shortage pushed prices to £S 20.00/sack, almost double (or a bit more) the price of last year. Thithyei farm members elected to redeem the grain for their own use, paying the costs in cash. Nuenchior farm members chose to see their grain sold for market price, and left the money (less deductions) with the project as an operating and emergency fund.

Neither Mabior nor Mabok group farm chose to participate in the program.

Current plans call for an attempt both to maintain and to expand the interest at the active group farms, and to arouse the interest of the other two. It is hoped the farms as units and their members as individuals will choose to participate after the coming harvest. A key part of such an expanded program

would be development of adequate storage facilities, which is anticipated in cooperation with next season's construction program.

Construction Program

The construction program is responsible for two primary activities. First, it must provide the various structures as may be required to both support and implement the activities of the project. Second, it is to examine existing local building materials, techniques and designs, and to experiment in possible alternatives to these. To the extent possible, such experimentation is to be included in the first function.

Following initial efforts by a consultant in early 1979, a full-time specialist was recruited and arrived in Sudan in late October, 1979. The program for the 1979-1980 dry season began in November, following review of currently identified needs and priorities and the work to date.

1. Staff Housing

Due to the pending arrival of additional long-term staff, priority was given to completion of existing housing and ancillary buildings (combined kitchen, storeroom and bath units).

Two 2-room houses, having a bedroom and a living/sitting room apiece, had been nearly completed. The three-room ancillary building immediately adjacent and parallel to each house was also well along, with only four floors and the plastering of three rooms and placing entry steps to be completed. A third house stood as a roofed-over shell. It required floors, plastering, one gable wall and closing in of the eaves. No ancillary building had been started, although a reinforced concrete ring beam had been poured at ground level as a foundation for this unit.

It was apparent that the use of such a foundation on the five existing structures was not satisfactory. Numerous cracks had developed during their first rainy season, some of a serious nature. In the absence of tools to bore undercut pilings for such a beam, its use in these active soils was immediately discontinued.

Complaints of noise between the houses and their ancillary buildings were noted, and of noise from rain on the corrugated iron ("zinc") roofing. Heat from this roofing was also objected to, as was the presence of bats in one house and termites in both.

The termites were found to be consuming door casings, which had been put in place prior to pouring of concrete for floors, thus giving direct access of termites through the sub-base. They were also entering at the joint between the walls and the floors, which had been poured later. Those floors were of the

concrete-filled-rubble variety, and where the top float was thin and later cracked, termites entered here also.

Heat and noise from the zinc roofing were controlled by the design and placement of a superimposed thatch roof, attached to steel rods laid over the roofing as a welded mat.

Noise between buildings will require rerouting of traffic and access points (doors) if it is to be controlled. The role of the second building in cutting off ventilation to the first also became evident, but could only be offset if "wing-walls" were to be extended on each side of the house to direct breezes between the buildings through a wind-trap effect.

Termites were controlled by replacing the door casings once cut-down and after their "sockets" in the floors had been patched with concrete. Floor cracks can be chiseled out and patches made, but one floor is so thin overall that a second float might be justified. The seam between walls and floors is nearly impossible to effectively control at this point. Future floors will be poured as they are reached, and walls built up from them, when possible.

Completion of the existing buildings did not include the construction of the third ancillary unit, for it was sited as poorly as the other two and was in any case unnecessary in view of the camp's rather communal lifestyle. This has resulted in exposure of the third house to full air circulation, which was further enhanced by use of screened rather than solid-blocked eaves, and placement of the second gable vent higher than the first to promote a convection current under the roof unit. (The thatch overlay was able to reduce interior temperatures 5 to 7 degrees in comparison to the exposed zinc sheets.)

One ancillary building was modified to serve as an additional bedroom with adjacent locking storeroom and the radio room on the other end of the building. While this helped alleviate immediate crowding at the site, additional housing is planned for next season. A single-room bachelor "tucal" design, using a deep (1.5 meters) footing and brick foundation, with mud-mortared brick walls, steel (angle iron) door and window casings, angle-iron roof members and thatch roofing, has been proposed. With high walls and long overhangs and cement-pointed mortar joints, such would be a durable, comfortable building that would be less of a departure from traditional design than current housing at the project. At least two such units are planned.

2. Workshop Complex

Original plans called for a single shop to serve metal-working, welding and forging needs in one location, and other shops for carpentry/woodworking and vehicle maintenance and repair at other locations. For reasons of economy of time, material and future demands on scarce supervisory talents, all

these functions were incorporated in a newly-designed workshop complex. As a ring-beam foundation was already in place for the original shop design, and represented too much investment to abandon, the new design accommodated its now apparent limitations with only minor modifications. A piered wall of single course brick to a height of one meter was planned for most of the first building, with a second building to be erected due east of it with identical appearance but on a 1.5 meter deep footing and using a brick foundation. Neither building was to support a roof directly, as a series of 3" steel poles set in concrete were to support teak-pole trusses for a floating roof of zinc sheeting. This single expanse of gable type roof extends from the woodworking shop on the east, to the vehicle repair and maintenance facility extending to the west of the complex. While all three are inline under the single roof, which uses a long overhang toward the south for sun protection, they are each very visible and accessible to a single supervisor from any given spot in the complex. The use of two walled areas under a single steel roof gives good fire protection through separation of the welding/forging areas from the combustible wastes of the carpentry area or the volatile materials around the vehicle shop section.

In actual use as of late June, the shop has proven even better suited to our needs than anticipated. While it does offer the expected cool, airy effect, being under its high, broad roof, the south overhang has been adequate to store ample materials in good protection from the rain. The low "knee-walls" have led the inevitable casual daily visitors, coming to see friends employed by the project, to remain outside the buildings and talk over the wall. This leaves the work area free and reduces both confusion and the risk of accidental injury to bystanders. Noise under this single roof has been greater than expected, however, and possible controls are planned. The east wall proved too low to protect from rains coming from that direction, so was raised. This also reduces exposure to the morning sun before it rises above the gable end of the roof. Minor cracking was also noted, and was not totally unexpected. The use of single course brick with such low quality materials as are available was a calculated risk, forced by the known inability of the existing beam type foundation to bear the weight of a standard wall and roof. As the cracks are much less than those in the houses, they may even be nothing more than normal settling effects.

The installation of fluorescent lighting and blackboards permits both night classes, extended workdays for critical jobs, and lessons in reading plans and blueprints.

The entire staff has been very positive in their response to this new building, which provides a cool, sheltered environment designed for their work needs and personal comfort, thus enhancing their effectiveness. This is also the first time since the March 1978 inception of this project phase, that these functions have been carried out in a permanent structure.

3. Warehouse

In anticipation of a request that the project vacate a loaned school building which had been serving as a primary warehouse, a 10 x 30 meter unit was designed for construction in two stages. This unit would, when complete, hold all pipe, timber, structural steel, unissued tools, vehicle and equipment spares and a variety of miscellaneous project materials as well as a large volume of cement, tires or bagged grain, according to need.

More delicate, smaller items, and most tools would be placed in a 10 x 15 meter brick structure which was undertaken as the first stage of construction. Of piered, double-course brick on a deep foundation, this unit was completed in July with no sign of cracking to date. With a concrete floor and zinc roof, this design should prove acceptable to official government regulations when the project becomes the sole responsibility of our Sudanese counterparts. Designed as a long-term structure, it also uses angle-iron door and window casings to preclude termite activity. Storage shelving will be on angle iron frames for durability and termite reasons. While initially more costly, replacement will not be a factor.

Placed 30 meters southeast of the workshop complex, the warehouse is thus accessible without blocking the cooling effect of the prevailing wind during the hottest part of the year. It also has an entry-restricting counter design, beyond which unauthorized persons may not pass. This stops casual entry and innocent but troublesome opening of sealed boxes and mixing of parts and equipment.

The second stage of this design is an additional 15 meters of pole building, attached to the east side of the warehouse now complete. Either additional 3" steel pipe will be used, or teak poles set in concrete, depending upon availability and cost. Walls will be either zinc sheets on wood girts, or perforated mesh panels. Availability and cost will no doubt dictate the former. Three large racks will hold timber, pipe and steel separately, and an area of open floor adjacent to the brick section of the building will allow cement and tire storage.

4. Administration Building

Extensive staff consultations finally led to an acceptable design for an administration building that will be constructed in the next dry season. It will accommodate the project co-directors (one office), a radio-room and clerk, a finance officer, the health officer and health specialist, and an agricultural laboratory with desk space for project technical staff. Government regulations regarding storage of official documents dictate a zinc roof, but the remainder of the design can incorporate such features as cement-pointed mud mortar walls. Ventilation under

the roof and through the rooms will be given extra attention, as will overhangs and an integral verandah for sheltered passage during the rainy season.

The deep footing and a full brick foundation are now in place for this building, rising to 40 cm. above ground level. When the road reopens and cement can be brought in, a full floor will be poured and work resumed on the remainder of the structure.

5. Belvedere (Luak)

The arrival of additional staff resulted in there being no available dining space at the Duop site. Especially in view of the oncoming rains, an 8 meter hexagon was designed to serve as combined dining area for our communal meals, informal meeting area and emergency guest facility.

Situated away from existing buildings so it would not intrude on already scarce privacy, the resulting building is slightly in the shade of the large tamarind tree which dominates the compound. A large 2.6 meter window (screened opening) in each wall permits an uninterrupted view of the area fields, nearby river and distant shop and warehouse. The excellent airflow is enhanced by use of a $35^{o}$ thatch roof. To avoid the sensation of closeness wood crossties in the roof would have given, deflected (raised) wire crossties were used instead. A source of much community discussion and puzzlement while under construction, the building's final form is at once unique yet familiar, for under thatch the useful hexagon shape is visually akin to area luaks. This has been well received by area residents.

6. Generator House

The decision to utilize the present project generator to power various workshop equipment led to the construction of a generator house not far from the workshop complex. This both shelters the unit from the elements, and shelters the staff from the noise it creates. The shelter is the first use of cement-pointed mud mortar by the project, and cables from it to the workshop were placed underground in a 3/4" P.V.C. pipe. Use of four cables will permit later use of three phase motors if future shop equipment requires.

7. Multipurpose Building

Originally scheduled for completion during the 1980-1981 dry season, this building was cancelled after numerous staff meetings and individual consultations indicated it would be superfluous. Several factors led to this decision. The absence of a single, readily accessible site, suitable to the purposes and able to serve all elements of the area population (not just one area), proved an initial stumbling block. The agriculture program then

decided it would be most effective to present lessons and demonstrations (agricultural extension services) at the group farms, even as most health lessons could be delivered through other arrangements than a "multipurpose building". Indeed, the newly-completed workshop complex and the belvedere have been found to provide such space as is needed for delivery of formal lessons, and for both formal and informal meetings of reasonable size.

8. School Construction

This proved to be a disappointing setback this year. The start of the season saw early problems in the making of bricks (see "Brickmaking"), but even as these were resolved and a hope of rebuilding some momentum was renewed, outside factors arose to thoroughly disrupt the balance of the season at the two chosen sites (Banthon and Anyangadil). These took the shape of sporadic and gradually intensifying attacks on the Ngok Dinka by unidentified armed groups operating out of the forest belt north of Abyei. Some ten attacks as of this writing have been directed at livestock, people and property, with 112 houses and 33 luaks burned. Naam, Tajalei and other nearby villages have been attacked, so it is not a case of casual destruction of isolated farms.

While this has resulted in able-bodied Dinka males being far more concerned with security matters, it is hoped the government will take the necessary steps to restore order throughout the area. Given a more normal atmosphere, the program plans to attempt the construction of two single-room schools and two one-room bachelor housing units in the two villages. An attempt will be made to include the function of health/dresser station in the school design, so it may serve a dual purpose in lieu of sitting empty part of the day. Until these initial units are constructed as examples of the fairly limited effort and inputs required, it is planned to use less self-help labor than may later be relied upon. It also remains to be seen whether teachers will actually be available to operate these schools, once built, as even the Abyei schools seem hard pressed to remain open for a full term by reason of teacher shortages. This is a further argument for a multiple-function design.

9. Brickmaking

By virtue of extreme isolation from other sources of supply, the project is almost totally dependent on the production of its own brickyard for a source of a durable building material. Successful brickmaking requires at least four elements: suitable materials, in the form of sharp, clean sand, stable, clean clay, and adequate water; proper conditions of humidity and sunshine, with little or no wind; correct handling of the materials by mixers, molders and carriers, and a level, smooth surface on which

to place the freshly-molded brick; and, lastly, the simple but effective stacking and firing of the green (unfired) brick in a clamp. Provision of these elements has produced brick for centuries, throughout the world. Much of the brick made by the project in Abyei this past year was of marginal quality, although in fairness, some was far superior to any found around Abyei outside the project. Also the brickyard has managed to produce enough acceptable brick that building has not been delayed at any time.

Reviewing the elements, that of materials rightly comes first, for it is our biggest problem. The entire first season saw bricks made without access to sharp, clean sand. This season, a full day of travel around to different area sand sources resulted in the discovery and identification of sand which is visibly possessed of some coarser, sharp grains, and has less silt than the prior flour-like material used before. The clay being used is quite dark-gray and plastic, but appears to be rich in the mineral montmorillonite. This mineral expands to several times its dry volume when exposed to water, only to resume its original volume when redried. Such exaggerated expansion and contraction fits the behavior of Abyei clays, and can only be offset by the addition of coarse sand until their proportion reduces cracking of the drying brick to an acceptable level. Tests this year showed a full 45% sand was needed in pure clay to prevent cracking. When the percentage exceeded 45, however, the brick would not fuse properly during firing, and virtually "melted" when put into water. (This relates to the need for adequate volume of clay to permit uniform plating/fusing within the brick. Ideally, sand volume would not exceed 10 to 12% of the mix.)

The only real solution to this need for high sand content, which results in loss of strength under our conditions, is to find a different type of clay in the area, or to increase the temperature in the clamp during firing.

The second element is little problem to us, as the Abyei dry season has low humidity and ample sunshine. The winds early in the season were thought to be partly responsible for early trouble with cracking, but the problem proved to be the sand-clay mixture.

The third element is likewise under control. The brick pitch could benefit from a smoother and more level area for drying, but it will function as is. Handling technique is an area in need of constant spot-checking, however, as the pace at the pitch can lead to use of damaging short-cuts if not watched.

With the fourth element, stacking and firing, there is again room for improvement. Stacking still proceeds in traditional fashion, without a finger-width air space between the green brick, unless one specifically instructs otherwise.

Firing, however, is a problem of such scope as to supercede all others in this activity. When closely supervised, firing was successful. When not so supervised, in every instance the firing was too short, usually due to failure to obtain sufficient wood before firing began and running out before an additional supply could be made available. Three such would-be short firings were aborted when noted promptly, but three took place during conditions of absence or illness (or both) of these parties and resulted in the waste of the time, money and effort the firewood represented. A better record is hoped for the next season.

10. Revised Construction Schedule, 1980-1981 Dry Season

(1) Complete Administration Building
(2) Complete Warehouse, stage 2
(3) Construct 2 Single-Room Bachelor Houses at Duop (Tucal style)
(4) Construct 2 Single-Room Primary Schools/Health Centers at Banthon and Anyangadil, or other identified sites.
(5) Construct 2 Single-Room Teacher's Houses (Tucal style) at above school sites.
(6) Assist Water Program in Making Concrete Splash Aprons at wellsites.
(7) Assist Water Program in Construction of 1 Meter High Earth Bund/Dam Across Nyamora River, with Board Spillway.
(8) Construct Permanent Vehicle Shade, Relocated.

Training Program

The very active construction program of the 1979-1980 season, with all its inter-related trades directly or indirectly responsible for completion of various buildings through coordinated effort, created opportunity for numerous apprentices to receive training.

The arrival of a training specialist in December 1979, coincided with the onset of the principal construction activity. He immediately assumed responsibility for the workshops, especially carpentry and metalwork/welding, in addition to assisting the construction specialist.

Training took place at all levels, with staff disregarding job titles to provide such according to who was best qualified, emphasizing yet again the principals of team effort necessary for the effective operation of such a project.

One of the first activities of the training specialist was to identify and answer the need for specialized work areas to be better organized and equipped to perform their functions safely and effectively. Strong work benches, with appropriate special features were constructed for each work area, in sufficient number to provide adequate space for all employees. Tool storage cabinets were provided or relocated, to promote ready access and secure storage simultaneously. Where desirable, mats and sorghum-stalk walls were installed

for temporary screening of certain sections (arc welder, forging, etc.) in the interest of greater job safety for project workers and bystanders.

Training in use of tools and techniques to advance existing skills was also introduced, especially benefiting the carpentry and metal-working shops at the outset. This in-shop training was in combination with the practice of on-site training for those trades actively involved in the construction program, e.g. masons, framing carpenters, steel benders and forming carpenters. Vehicle mechanics also received training assistance, with several specialists participating.

Personnel exposed to training this year, by skill areas, are summarized as follows:

| | |
|---|---|
| Carpentry: | 3 - journeyman carpenters (skilled) |
| | 2 - assistant carpenters (semi-skilled) |
| | 3 - apprentices |
| Metal Working: | 1 - welder (skilled) |
| | 1 - assistant welder (semi-skilled) |
| | 1 - metal worker, general |
| | 3 - apprentices |
| Vehicle Maintenance: | 2 - mechanics |
| | 2 - assistant/apprentice mechanics |
| Construction: | 1 - general foreman |
| | 4 - journeyman masons (skilled) |
| | 5 - apprentice masons |
| | 16 - construction laborers |
| Brickmaking: | 4 - molders (skilled) |
| | 16 - carriers |
| Water Supply: | 1 - assistant driller (semi-skilled) |
| | 4 - drilling laborers |
| Health: | 1 - program assistant |
| | 4 - group farm health workers |
| | 8 - traditional birth attendants |
| | 4 - community health workers |
| | 3 - ox-trainers (for health & first-aid) |
| | 2 - tractor drivers " |
| | 3 - laborers (from project) " |
| | - pre-nursing students |
| Agriculture: | 4 - tractor drivers |
| | 3 - draft animal trainers |
| | 3 - field assistant |
| | 1 - beehive maker |

Future plans for the training program include continued training for the above workers, and introduction of techniques for building a variety of low-technology devices aimed at easing general conditions and labor requirements for the area residents. Initial thought favors simple grain thresher construction, also corn sheller, grain storage vats and other items as need is identified.

## Communications Program

### 1. Postal Service

The Abyei area receives no postal services. The project does receive mail periodically, when the Chevron Oil Company flies the mail from Khartoum to Muglad (and return) on their aircraft, from whence it is carried by lorry to Abyei.

The community at large does not enjoy this service, however, nor does the project (or Chevron) seek to displace the Government Postal Service or relieve it of its responsibilities.

The town council did request the construction specialist assess possible repairs to put the post office in Abyei back into usable condition. They felt restoration of the structure would lead to restoration of postal services.

While the project is very supportive of that end, the repairs requested are directed at major structural faults (principally a poor foundation). To make "cosmetic repairs" to restore its appearance would be an annual undertaking. One realistic proposition remaining open is to construct a more modest, better founded structure or complex of structures, better suited to the actual needs and resources of the area.

### 2. Radio

The project radio is now relocated to the Duop radio room, where it is connected to a pair of new antennas mounted on a 3" x 40' galvanized steel mast. One antenna is cut for 8.105 Mhz and the other for emergency night use on 4.893 Mhz. A Citizen's Band muti-directional antenna is mounted at the very top of the mast.

The TWC Transceiver operates off a single 12-volt automobile battery, which is kept constantly charged by a solar-power photovoltaic array. The solar panel is mounted on the antenna mast, where it is out of reach and away from possible harm, yet enjoys full exposure to the sun throughout the day. This battery system also powers a single 12-volt fluorescent lamp (originally for use in a truck-mounted camper unit), which facilitates the possible night-time use of the radio room.

The project radio in Khartoum had been in use at the AID building, but is now relocated to our new office, where a new antenna system was installed. The longer 4.893 Mhz antenna is reportedly not fully tuned, as such requires access to a neighboring rooftop, which is apparently a sensitive issue.

It is worthy of note that AID has acquired much more expensive Motorola radios to permit communication with their Wau and Juba offices, temporarily utilizing our frequencies. They have found they are as yet unable to communicate directly with either site, and we are providing a relay service whereby messages in each direction are passed through the Abyei radio to reach their destination.

3. Meteorological Station

The official government meteorological shelter, which is used to hold instruments, was measured and then duplicated by the project. This was to ensure data would be acceptable to the government if they should choose to use it. This shelter was erected out in the open, near the project antenna at Duop, and now contains a maximum/minimum recording thermometer, a wet-bulb thermometer, and a battery-powered anemometer. The sender for the anemometer is located about 30" up on an arm which stands off to the side of the antenna mast. A rain gauge is mounted nearby the installation. Records have been kept from the time each component was activated, and are appended in an attached annex.

4. Airboat and Skiffs

Due to delays enroute, the airboat did not reach Abyei last rainy season, and was placed in the Chevron camp at Muglad for storage. It remained there until 11 February, when it was moved to Bentiu for testing. Bentiu was chosen as the Bahr El Arab had dried up to become a series of elongated lakes, rather than a river, near Abyei. Chevron, being interested in the results for possible application to their exploration activities, provided transport for the airboat and project personnel from Muglad to Bentiu (and, later, to Abyei), assistance and accommodation.

The result of a week of testing was that the craft was able to navigate in the river, crossing the ordinary reeds, hyacinth and grasses without problem. The ubiquitous papyrus could also be traversed, but its height proved greater than the elevation of even the raised operator's seat could deal with. This left the operator unable to chart a course through the papyrus, and will necessitate cutting seat tubes and raising it another 18" to 24", along with relocating controls. This even more elevated seat was once a feature of such boats, so within their design capacity.

The use of a 1:4 aviation gas/regular gas fuel mixture eliminated a pre-ignition problem at moderate cost. Cooling was noted to be borderline acceptable under testing conditions, and the carrying capacity of the 7' x 15' hull was found best suited to no more than 5 persons or an equal weight of cargo and personnel. For freight service, an 8' x 20' (or even 22') hull would

be better, but such was not the project's purpose in selecting this boat.

While testing proceeded, two new operators were also receiving initial training, one being a Chevron employee. The other, Will Donovan, project Training Specialist, mastered the basics of the boat's operation in the event need for a back-up operator might arise.

The airboat arrived in Abyei on 3 May, and was placed by the Nyamora River to await restored water levels upon the return of the coming rains. Once navigable, the boat proved able to cross fish nets and bypass wiers without damage to or from itself. This was in strong contrast to attempts to use a skiff with an outboard motor, which had to stop constantly to disentangle grasses and one fishing net from its propellor, and damaged the net at that time. Misfortune continued to follow the airboat, however, for after all the delays in placing it in service in Abyei, it was discovered that the crankshaft of its Chevrolet V-8 engine was broken and had to be retired after only 1½ hours of additional testing (a total of 21.2 hours on the engine). The factory has replaced what proved to be a defective crankshaft without charge, but this could not be installed until the rainy season ended and the road reopened, allowing new parts to be taken in for the repair. Hopefully some further testing may be done before the waterways dry up.

Two flat-bottomed aluminum skiffs were imported from the U.S. for use as ferries at Banthon and Anyangedil, where many people cross the Bahr El Arab. The Banthon ferry, damaged during the civil disturbance of preceding years, could not be restored to service due to lack of equipment to repair leaks in the bottom of its hull (it is a one-car steel ferry).

The skiffs have proved very popular, and when first put in use at Banthon with a fare of 5pt. per person, earned £S50 in its first week of service. This popular acceptance led to the request from Anyangedil for the use of the second skiff. Motors are not used, nor are they practical; a pair of sturdy oars being ideally suited to the needs of the service. Some spare oars should be stocked in Abyei.

5. Motorcycles, Bicycles and Land Rovers

Motorcycles have been available to the project for over two years now, and we have learned such have a place in the project. They also have certain requirements for continued good service, the principal one being that each rider must be held personally responsible for a daily check of the cycle condition (lubrication, fuel, adjustments and general operation).

The four Suzuki TS125 (trail bikes) cycles have proven far superior to the two Rokon two-wheel-drive "all terrain" vehicles. While certain tools, such as a special timing device and some wrenches are needed specifically for the Suzukis alone, this does permit their reasonably-regular use. They tend to develop a loss of power and are susceptible to dirt in the carburetor and carbon in the exhaust system, and their electrical junctions are not always effective. Still, they provide useful transport in the vicinity of Abyei, and are generally responsive to our less than professional expertise at motorcycle repair. The two Rokons, however, are usually inoperative at any given time, and do not respond to repairs for long. Their general lack of reliability and relative complexity combine with poor performance in Abyei's "sticky" mud, making their use in any season limited indeed. The Suzukis are better in the mud, except that two were delivered with close-fitted street-bike fenders in front, which causes the tire to seize from mud build-up, spilling the bike and rider.

Bicycles were brought in to the project this year, and have been useful for transportation between Abyei and Duop. They are prone to tire punctures and loss of nuts and bolts, but use of Loc-Tite or similar thread sealant is expected to solve the latter problem. Adequate spares are, of course, a necessity.

Land Rovers have proven invaluable to movement of materials and personnel during the dry season, vastly facilitating the ability to reach outlying areas. The versatility of this type of vehicle places heavy demands upon the two at the project, often making it impossible to service them during regular hours. This heavy use means they also require more service than would otherwise be the case, with extensive parts replacement before and after longer trips (such as to Muglad, 5 hrs./125 miles). The responsibility for this lies mostly with the rough tracks and open-country driving which locally substitute for road use, and by the extreme heat and dust of the dry season and contrasting water and mud of the rainy season. Poor fuel quality places additional strains upon the engines, and need of an overhaul within 30,000 miles supports this view.

There is no question that vehicle life would be extended, and work further facilitated by a third such vehicle. If nothing else, it would serve to accommodate the need for increased shop time as the original two continue their inexorable deterioration.

Our DAF trucks have proven necessary to the project for the transport of sand, cement, lumber, fuel and similar supplies, but they are woefully unsuited to the local conditions. These vehicles are designed for the motorways of Europe, not for Abyei. Their level of sophisticated maintenance and continual failure in service merely emphasize their inappropriateness, and it is to be hoped that the Sudan government would seek alternatives before supplying such as a contribution to future projects.

Water Supply Program

The 1979-1980 program focused on the provision of water for human consumption through the drilling of four wells and installation of hand pumps at selected locations. The limited scope was chosen to permit testing of both drilling and pump technologies in the field, where suitability for local conditions could best be determined. This focus also reflects the realization that wells capable of sustaining large herds of livestock are beyond the scope of this program, as the ability of area aquifers to supply large herds has yet to be established. (No one wishes to see overpumping, whereby pumping exceeds the recharge rate, or to promote retaining of large numbers of cattle and other stock on a dryland range of unestablished capacity.)

Actual drilling efforts began in December, and took place in two stages, with two different drillers involved. The first well driller was contracted from late October through late December. Shipping delays in London, followed by only partial shipment and further delays in receiving necessary materials, proved very frustrating to all concerned. When the schedule was set back so badly, the driller extended his stay at the project, but pre-existing commitments caused his departure in January before well casing had reached the site to permit installation of any pumps. He was able to make complete profiles at each wellsite, by means of test holes bored to 120 - 180 feet. He found a 30 - 40 foot clay overburden at each site, followed by layers of sand and silt and occasional clay or small gravel as well. This allowed fast drilling, but also led to the collapse of each test hole not long after the drill stem was removed. It also required extensive use of Bentonite to stabilize the formation, which in turn requires extensive development before such a well is usable.

The second driller arrived in early March, and remained until mid-May. Although he was less experienced with the type of drilling being used in Abyei, the uncomplicated equipment and availability of the first driller's crew permitted him to make good time until the drilling machine began to fail. Despite a series of mechanical failures from various causes, five fresh holes were drilled and cased. Testing of the I.D.R.C. pump proved unsatisfactory, however, and it was learned the casing provided from London was not the correct internal diameter to match the pump. (This is a critical feature for this pump design, which the manufacturer now meets by supplying each unit with a length of precise-inner diameter casing in which to operate.)

The final well used a larger casing to permit testing of a UNICEF-provided India Mark II hand pump, but it was found to be too shallow because of a limited supply of steel casing.

In view of the strong response of the people to this water program, it has been proposed that a commitment be made to field a drilling team next dry season. Such a team would have the benefit of past experience and would use an alternate drilling system. It would also use a different casing technique, so that one of three pump types could be used, and would plan on the use of three different pump types in the course of the program to permit later comparisons between types. This team would also install four custom-sized pump

units in the casing already in place from the past season. For a full review of the proposal, refer to the attached annex.

Health Program

1. Volunteer Health Workers

A health worker has been selected by the people at each of the group farms. These four women receive weekly health lessons with emphasis on delivery of both primary health care and health education lessons to the group farm members. These volunteers are supported by monthly drug allotments and supplies, and have a basic kit from which to work. Initial lessons have focused on area health problems such as malaria, anemia, nutritional deficiencies, eye diseases, first-aid, care of wounds, diarrhea and oral rehydration, and mother-child health care. Training is conducted orally, and supplemented with mimeographed materials, charts and slides used as visual aids.

This program has been well received by the people, and all indications point to responsible use of the drugs and materials issued to the volunteer health workers. Two additional volunteers provide first aid service at the project brick pitch and the primary construction sites, while three project ox-trainers and two project tractor drivers have received health and first-aid training and kits for their use when working in outlying areas.

2. Traditional Birth Attendants

In May, a program to provide training of area traditional birth attendants was implemented. The aim is to improve their skills and level of care, by training them in pre and post-natal mother/child care, and in delivery techniques. The training is provided in the homes of the attendants, who were 10 in number as of July. This approach has the advantage of permitting other interested women in the vicinity to "sit-in" on the training.

Follow-up visits after actual deliveries indicate these women are practicing the techniques and health care lessons as taught. Each attendant has been issued a modest but effective kit (nasal suction bulb, surgical scissors, carbolic soap, etc.) to further improve her effectiveness.

Word of this program has spread quickly, and still more traditional birth attendants have approached the project to request training.

3. Community Health Workers

Four community health workers have received lessons from the project health specialist. This training has focused on reviewing and building upon their existing knowledge and experience. They have been instrumental in helping select traditional birth attendants for training, and have been furnished materials to permit participation in a child weighing program for children in their areas. This latter has already resulted in the accumulation of weight data, although only two of these workers are presently operating in their own communities due to security problems at Naam and Maker. Those two workers are helping in Abyei.

4. Abyei Health Center

The health specialist has been active in assisting the pre-natal clinic, which is now sufficiently well-prepared that it is able to function even in her absence. She has also been giving health lessons and examining special-need cases. From this base, she has expanded into extension of some lessons and food demonstrations directly into area homes. This has led to even greater audiences, and has graphically demonstrated how methods discussed may be implemented or adapted into the home situation.

A training course has been established for the center's five pre-nursing students, and will be implemented with the assistance of the center doctor and Zacharia. Unfortunately, our Sudanese project health officer has been of no apparent value in this or any other program activities, which tends to put an undue share of the burden on the health specialist.

Several shortcomings in the center's facilities have been identified and various construction personnel and materials have been made available for their correction. Such relate to the non-existence of tables and benches for certain needs, screening of critical windows, etc., but does not include repair of a non-operational kerosene refrigerator for want of parts. Absence of necessary refrigerated storage has led to storage of perishable drugs in a project refrigerator until further notice.

5. Dresser Stations

Government health workers have yet to become an active part of our overall program, although plans exist for their future involvement. Further professional training for dressers is planned, and some materials have already been provided to assist in diagnosis and in presentation of health lessons. The program hopes to assist in the delivery of supplies and drugs from the Health Center to outlying dresser stations in the future. It is also hoped some furniture can be provided to these stations, time and materials permitting.

6. General

In view of the widespread occurrence of identifiable health problems, the program has elected to initiate the study of a complete local village population with an aim to develop an integrated health care/sanitation/water/and nutrition program for that village on a model basis.

Coupled with existing program commitments, this will more than occupy our sole health specialist, and efforts to secure a capable, productive individual for the role of counterpart Health Officer are both very much in order and underway.

## Field Studies

As the action aspects of the project have gotten underway, as described in the previous sections of this report, it has been possible and appropriate to initiate a number of studies of prevailing conditions and practices in the Abyei area for use in the planning of longer-term development activities. These studies are designed to obtain systematic and reliable information on what we have learned from direct experience are the critical aspects of Abyei life. Thus the studies are more sharply focused than were the earlier base-line surveys done by the Development Studies and Research Center of the University of Khartoum. The current studies are also intended to permit meaningful comparisons between traditional practices and new techniques that are being tested in the action parts of the project.

1. Geographic Survey

The geographic survey was designed to gain a better picture of the population, settlement patterns, terrain and foliage of the area. Jane Hayes, a graduate student from the geography department at Clark University, spent eight weeks traveling widely throughout the area, comparing ground level observations with landsat images. Unfortunately, there are no aerial photos of the area, as they would have afforded a valuable mid-range of observation. Nevertheless, it has been possible to prepare new maps of the area that correct many errors of the old British maps, based only on ground observation, to locate correctly the villages, waterways and trails, and to apply the current names. (See Annex B.)

By combining a survey of 216 households and voter registration lists, Hayes has produced the first good estimate of population for the Abyei area. According to her calculations the total population is 29,600 in 3,700 households with an average of 8 persons per household. Previous estimates of the area's population had ranged from 15,000 to 100,000 making for great uncertainty in planning programs to serve the total populace.

2. Socio-economic Research

The research team is investigating three aspects of the Abyei situation: (a) livestock stewardship, (b) agricultural production, and (c) local socio-political relations.

The field research team consists of Richard Huntington (coordinator), Aguek Nuor (livestock officer), Maryam Niamir (research associate, livestock), Luka Biong Deng (research assistant, livestock and agriculture), and Jay Ackroyd (research assistant, agriculture). David Cole is overall research director, and William Payne and David Vail serve as design consultants for the livestock and agricultural research, respectively.

The purpose of the research is to provide detailed information on current practices and problems regarding resource production, distribution, management and consumption in the Abyei area. To document this completely would need a very large investigation. The present program focuses on limited studies which can serve as indicators of the larger patterns. In spite of this limitation, the research provides more information and more reliable data than previous studies among the Ngok or other Dinka groups. This is because previous work has focused on short-term, dry season surveys, whereas the current work documents the full annual economic cycle.

a. Livestock Research

The main part of this research is a survey of animal numbers, herd structure, animal stewardship, milk production, animal health, and pasture. This survey is similar in design to surveys previously carried out in other Dinka areas by the Council for Socio-Economic Research (Khartoum) and the Project Development Unit (Juba). This survey differs from those in that it follows up the interviewees of the initial dry season toich camp survey with a wet season survey back at their home villages.

The survey team spent several weeks in April in the toich area of Bahr-el-Ghazal Province and in the toich area along the Bahr-el-Arab (Kir) east of Abyei. Approximately 25 Ngok camps were located. We visited and interviewed the chief of camp in 19 of them. Three camps were studied in detail. In these three camps, 14 separate hearths (households) were investigated. This work included a questionnaire for the head of the hearth, the counting of all animals according to category, measuring and tagging (for later follow-up) a representative herd sample (245 animals), and discussions of animal histories and husbandry techniques. Additionally, successive days' milk production (morning and evening) was measured from two herds.

Market, pasture, and disease surveys. Data on all livestock sales at the Abyei market over a several year period have been collected and collated. Weekly information is collected on livestock prices in Abyei and in the livestock market in Omdurman. Samples of every local grass are collected and identified in Dinka and Arabic. These samples are sent to Khartoum for identification and analysis. Animal health survey is carried out by the livestock officer.

Humr livestock research. This activity was postponed this year because of the violence in that area. It is hoped that some means will be found for a Humr livestock survey during the coming year.

b. Agricultural Production

A research team began residing in April in the village of Mabior, about 12 km from Abyei town. This team is documenting the time and labor expended on every phase of the agricultural process for a sample of 15 homesteads. All of the fields are mapped and measured. All agricultural activity is recorded according to location on field, duration of labor, identity of laborer (husband, wife, child, etc.), type of activity (clearing, seeding, weeding, etc.), type of labor arrangement (personal, communal party, wage, etc.). Additionally, data is collected on the time and labor allocated to other activities such as water portage, food preparation, animal care, and house building.

The early phase of this study has documented a surprisingly intensive and complex pattern of agricultural practice among rural Ngok farmers.

c. Local Socio-political Relations

This work investigates the social structural context of Abyei development. We have documented the formation of local development institutions such as group farms and purchasing cooperatives. The degrees of success of these development organizations is viewed in light of local sub-tribal, lineage and electoral politics. We have also collected data on the nine sub-tribes of the Ngok and on how certain factions and coalitions relate to the development activities. Finally, there is the political and economic relations between the Ngok and their northern (Humr) and southern (Twic) neighbors in relation to livestock and grain marketing.

3. Health Conditions, Beliefs and Practices

During the one year that Dr. Dana Larson spent in Abyei (June 1978 to June 1979), she collected a considerable amount of material on health conditions, beliefs and practices among the people in the area. Part of this was based on a survey of women in 50 households, and part of the information came as a result of the courses that she taught to women, health workers and mid-wives. This material has now been drawn together in a Report on the Health Program, that is available on request from HIID.

The highlights of this report are:

a) The sample of 50 women had an average of 4.2 pregnancies, 3.8 live births and 2.8 living children. They normally breast fed the infants until the age of two with supplementary cow's

milk, and generally abstained from intercourse while nursing.
b) Severe malnutrition among infants is rare in the Abyei area, but perhaps one-fourth of the infants may be moderately malnourished.
c) The most common illnesses in the community were reported to be malaria, measles, whooping cough, diarrhea and meningitis.
d) Most people rely on a combination of modern health services and traditional healers. Most sicknesses are believed to be due to spirits rather than natural causes, but some are considered more suitable for treatment by modern medicine (e.g. malaria) and others (e.g. infertility) by traditional healers.

4. Evaluation of Alternative Technologies

One of the principal objectives of the Abyei project is to make careful evaluations of the main alternative ways of performing the most important economic activities in the Abyei environment. Two of the most important activities are growing sorghum and providing potable water. While the experiments with alternative techniques for carrying out these activities are still in process and therefore final results are not yet available, a preliminary analysis of them was prepared by David Cole and David Vail in a paper entitled, "Action Research in Abyei, An Approach to the Identification, Testing and Selection of Appropriate Technologies in a Rural Development Context." This paper is available from HIID.

The paper takes up both the methodology of comparing alternative technologies and also how these technological choices can be fitted into a broader planning framework that is designed to give the people of the community an opportunity to express their preferences among broad development alternatives. As more information becomes available on the costs and benefits of the various technologies, it is hoped that the relevant critical choices can be presented to the community in a way that will permit their participation in the decision-making process. Given the current uncertainties about the continuation of the project, it is questionable whether this sort of collective decision-making will be feasible.

## PROJECT STAFFING

| LONG TERM STAFF | Role in Abyei Project | Current or Previous Position | Period of Participation |
|---|---|---|---|
| **A. HIID** | | | |
| Richard Huntington | Research Director/Khartoum Liaison | Associate Professor, Harvard University | Jan., 1977 - |
| Craig Wynn | Agriculture Specialist | FAO Project, Ethiopia | Mar. 1978 - Feb. 1980 |
| Richard W. Fuller | Project Co-Director/Agriculture Specialist | Irrigation Agronomist, Government of Ethiopia | March, 1979 - |
| Joseph G. Sharp Jr. | Construction/Management Specialist | Acting Deputy Director, CARE, Inc., Bangladesh | October, 1979 - |
| William James Donovan | Vocational Training Specialist | Industrial Arts Teacher U.S. Peace Corps, Tonga | December, 1979 - |
| Ann Hershey Byerly | Health Specialist | Staff Nurse, Children's Hospital, New Orleans | December, 1979 - |
| Maryam Niamir | Socio-Economic Planning Specialist | Graduate, City & Regional Planning, Harvard University | February, 1980 - |
| E. James Ackroyd | Research Assistant | Bachelor Degree Candidate Harvard College | March, 1980 - |
| **B. SUDAN GOVERNMENT** | | | |
| Seddiq Abdalla Abdul Aziz | Project Co-Director/Agriculturalist | Savannah Project, Phase I & II Ministry of Agriculture | March, 1978 - |
| Kuol Arob Kuol | Deputy Director/Agriculturalist | Mechanized Farming Corporation, Habila. So. Regional Ministry of Agriculture | June, 1978 - |
| Bagat Minyan Chan | Financial Officer | Sudan Commercial Bank | May, 1978 - May, 1980 |
| Mariano Awet Ayong | Training Officer | Occupational Safety Officer Ministry of Health | April, 1978 - |

| LONG TERM STAFF (cont.) | Role in Abyei Project | Current or Previous Position | Period of Participation |
|---|---|---|---|
| Aquek Ngor Kual | Livestock Officer | Graduate, Institute of Veterinary Studies, Khartoum | January, 1979 - |
| Salvatore Atem | Health Officer | Health Assistant Ministry of Health | March, 1979 - |
| Abdel Nasser Dau Alei | Community Development Officer | Dept. of Community Development Ministry of Social Affairs | April, 1978 - |
| Fathei El Sedig Jamil | Forestry Officer/Logistics | Forestry Officer, Savannah Project. Ministry of Agriculture. | April, 1978 - |
| CONSULTANTS | | | |
| Richard A. Cash | Health Program Adviser | H.I.I.D. Fellow Harvard University | January, 1978 |
| Bruce Eaton | Water Well Driller | Chief Drilling Supervisor Operation Waterhole, Zaire | October, 1979 - January, 1980 |
| W.J.A. Payne | Livestock Consultant | Consultant to U.N.D.P., F.A.O., I.B.R.D., I.B.D., Huntings Technical Services | January, 1980 |
| David J. Vail | Agricultural Economics | Associate Professor & Chairperson, Dept. of Economics, Bowdoin College | October, 1978 January, 1980 |
| Jane Jedd Hayes | Geographer | Candidate, Clark University Graduate School of Geography | February, 1980 - May, 1980 |
| William R. Claybaugh | Water Well Driller | Peace Corps Volunteer, Site Supervisor, Kairouan Wells Project, Tunisia | March - May 1980 |

| CONSULTANTS (cont.) | Role in Abyei Project | Current or Previous Position | Period of Participation |
|---|---|---|---|
| Keith J. Brodie | Airboat Operator/Trainer | Aeronautical Engineering Degree Candidate, Mass. Institute of Technology | June - Aug. 1979<br>May - Aug. 1980 |
| John W. Thomas | Consultant on Local Organization | H.I.I.D. Fellow<br>Harvard University | May, 1980 |
| David H.P. Maybury-Lewis | Consultant on Research Activities | Chairman, Dept. of Anthropology,<br>Harvard University | May, 1980 |
| PROJECT COORDINATOR | | | |
| David C. Cole | | Coordinator for Rural Development, H.I.I.D.<br>Harvard University | November, 1976 - |

David C. Cole
23 July, 1980

ANNEX A

# The Abyei Water Program
# Results of 1979-80 and Prospects for 1980-81

The water program of the Abyei project in 1979-80 called for the drilling of four wells and installation of hand pumps at the four group farms. As described in the reports of Eaton and Claybaugh, a number of problems were encountered from logistic delays to breakdown of equipment to failure of the pumps to work under field conditions. Consequently, although ten holes were drilled and all struck water, only five of them were screened and cased, and only one was supplying water effectively at the beginning of the rainy season when operations were halted for this year. Despite failure to establish the four working wells as planned, much was learned in the process that should provide the basis for a more effective water program in the coming year.

To gain a clearer understanding of what was learned about both the potential and problems of the water program in Abyei, we brought together the well-drillers, the pump designers and manufacturers, and other consultants for two days of meetings, July 16th and 17th, 1980. This is a report of those discussions and a proposed program for 1980-81 that emerged from them. This program will require additional funding if it is to be implemented.

The loudest message received as a result of this year's activities is that water is extremely important to the people of Abyei during the dry season, and the failure to meet expectations generated by the well-drilling was very disappointing both to the people and to the project staff. We now

believe that we have much better understanding of what is required to carry out a successful water program under Abyei conditions, and we have hopes that this is a program the local people could continue on their own without further long-term technical assistance. Given this possibility and the significance of adequate water supplies, we believe it would be a serious mistake not to supply the limited additional resources needed to carry this program forward for one more year.

I. What's Been Learned So Far

1. There appears to be adequate water in the range of 90 to 120 feet below the surface in all the areas where drilling was done. As this covers areas to the east and southeast of Abyei town, where no drilling had been done previously, this gives encouragement that adequate underground water can be found throughout the area.

2. The drilling has encountered more sand and less clay than originally expected. This makes the drilling relatively easy but requires more effort and drilling mud (Bentonite or Revert) to hold the walls until the casing can be installed. It also confirms that the rotary mud drilling technique was the best choice for the existing conditions.

3. The motor driven Hydradrill, that was originally selected as a quick and inexpensive instrument for exploration, was adequate for drilling two inch holes to depths of 150 feet or more in the Abyei conditions, but it was not sturdy or big enough to drill the four inch holes required for installing the well-casing. While the machine did drill five four-inch holes, it broke down repeatedly and was worn out at the end of the process. Further drilling will require some other type of machine.

4. The so-called IDRC, PVC pump did not function properly at Abyei. The basic reason appears to have been a mismatching of various components of the pump, poor design of the check valve, and perhaps insufficient development of the well. The underground portion of the pump consists of a check valve and piston that fit into the well casing (rather than into a separate cylinder as with most piston pumps) and the fit must be very good for the pump to work properly. While we had originally ordered matched casing, pistons and check valves from the manufacturer of the pump, the unavailability of casing at that time led us to substitute casing from England. We did not appreciate either the limited tolerance of the pump to variation in the inner diameter of the casing or the variability of inner diameter in different pieces of casing. As a result of this experience, both we and the manufacturers are convinced that the check valves and pistons should be fitted to and supplied with an appropriate length of PVC pipe that can then be joined easily with other pipe even of moderately varying diameter to form the well.

5. A second critical element of the pump is the pump rod. While steel rod or galvanized iron pipe could be used, they are both heavy and waste much energy in a 100 foot well. Wood is a more buoyant alternative, but may be difficult to find or expensive in the Sudan. It is possible to use PVC pipe as a pump rod, but the size of the pipe needs to be adjusted to the size of the casing and the depth of the water table to achieve efficient performance. This aspect of matching is still in an experimental stage with the manufacturer, and until it is adequately tested, it remains an uncertain feature of the pump.

6. The check valve had no means of being anchored in a fixed position at the bottom of the casing. It also did not permit a sufficient flow of

water up into the casing. These two features resulted in the check valve moving up and down in the casing with each pump stroke, thus reducing the flow of water and greatly increasing the amount of effort required to work the pump. The manufacturer has designed and is testing a new check valve that is expected to overcome these difficulties.

7. Well development was done with mechanized bailers and using water pressure from water pumps. The preferred method would be to use an air compressor. Also it is difficult to remove the Bentonite drillers mud when the well is being developed because the Bentonite does not dissolve easily. One solution would be to substitute Revert which will dissolve after a few days. Another is to use a Bentonite solvent.

8. There is some question as to whether the above ground parts of the PVC pump are sturdy enough to withstand heavy use and normal abuse. One wood pump handle broke after several days of operation, but it had a 45kg counterweight. If the pump can be made to work with less effort and possibly higher leverage than 2 or 3 to 1, it should exert less strain on the handle and the pumper.

II. Future Prospects

1. The immediate priority is to get the existing wells functioning at Duop and three group farms (one well is reportedly functioning at one of the group farms). Four of the wells have already been screened and cased with 2 inch PVC pipe. These wells can only be completed in their present form by installing the 2 inch PVC pumps. We have a piece of the PVC casing that was used in each of these wells immediately above the well screen so it should be possible to fabricate check valves and pistons that will be compatible with the casing. If the tests scheduled for September of the various components of the PVC pumps prove successful, then it should be possible to take

these components to Abyei and install them in the wells at Mabior, Mabok and Duop after the end of the rainy season (e.g. in November). If these tests do not prove satisfactory, it will be necessary to drill other wells or give up the program.

2. If new wells are to be drilled in the Abyei area, we believe they should be capable of accomodating several different types of pumps rather than just one. There is still much debate as to the ideal type of pump for Abyei. In a recent background paper on the Abyei water program a rough comparison was made among the three main pump alternatives - the India Mark II, the Moyno, and the IDRC pumps. A major questions relates to the maintenance problems of each, and this can only be learned with time and operating experience. By constructing wells that can handle all three types of pumps, it will be possible to make substitutions if experience shows that one is deficient. The main requirement for this is to have wells with an inner diameter of at least 3 inches with casing either of PVC or metal pipe.

3. This in turn sets the minimum requirements for the drilling rig which must be capable of drilling at least a 4 inch hole. We have noted that the Hydradrill is not sturdy enough to drill 4 inch holes on a continuing basis. The question then is what type of drilling rig to use. One possibility is to move up to heavier, more expensive motor-driven rigs such as the Hossfeld exploratory drill, which costs about $3,000 and weighs about 1,400 lbs. The other possibility is to move to hand powered equipment thereby reducing fuel dependence and the need to keep complicated engines working.

4. The concensus of our technical discussions in Cambridge was that it made most sense to move to the hand powered rotary mud drilling, as this

involves only a modification - rather than a major change - of the technique which has been utilized and proven effective so far in Abyei. Also much of the required equipment is already in Abyei. The main items that will be needed are a hand powered piston or diaphagm pump for circulating the mud, and heavy duty 2 inch steel pipe to serve as the drill pipe. A list of all the required components and their estimated costs is appended.

5. The minimum program for the coming dry season (1980-81) is to install pumps in the three wells that are already drilled and encased. This will require the return of Bruce Eaton, our original well-driller, for 6-8 weeks in November - December along with the component parts of the IDRC pumps. As there is no remaining funding for the water program, and no uncommitted funds in the project budget we will need additional funds to do this.

6. If we are to go beyond this bare minimum and introduce both an improved method of drilling and a well design that are believed to be better suited to the needs of Abyei and also offer a better chance of being adopted and carried on by the local people, some further technical assistance and equipment would be needed. We propose that the well-driller, Bruce Eaton, stay on for two-three more months to train the local Dinka drilling team in the manual rotary drilling techniques on 5 additional wells. We would also propose to bring in all three types of pumps (the Moyno, the Mark II and the IDRC) so that they could be tried and evaluated on a comparative basis by the local people.

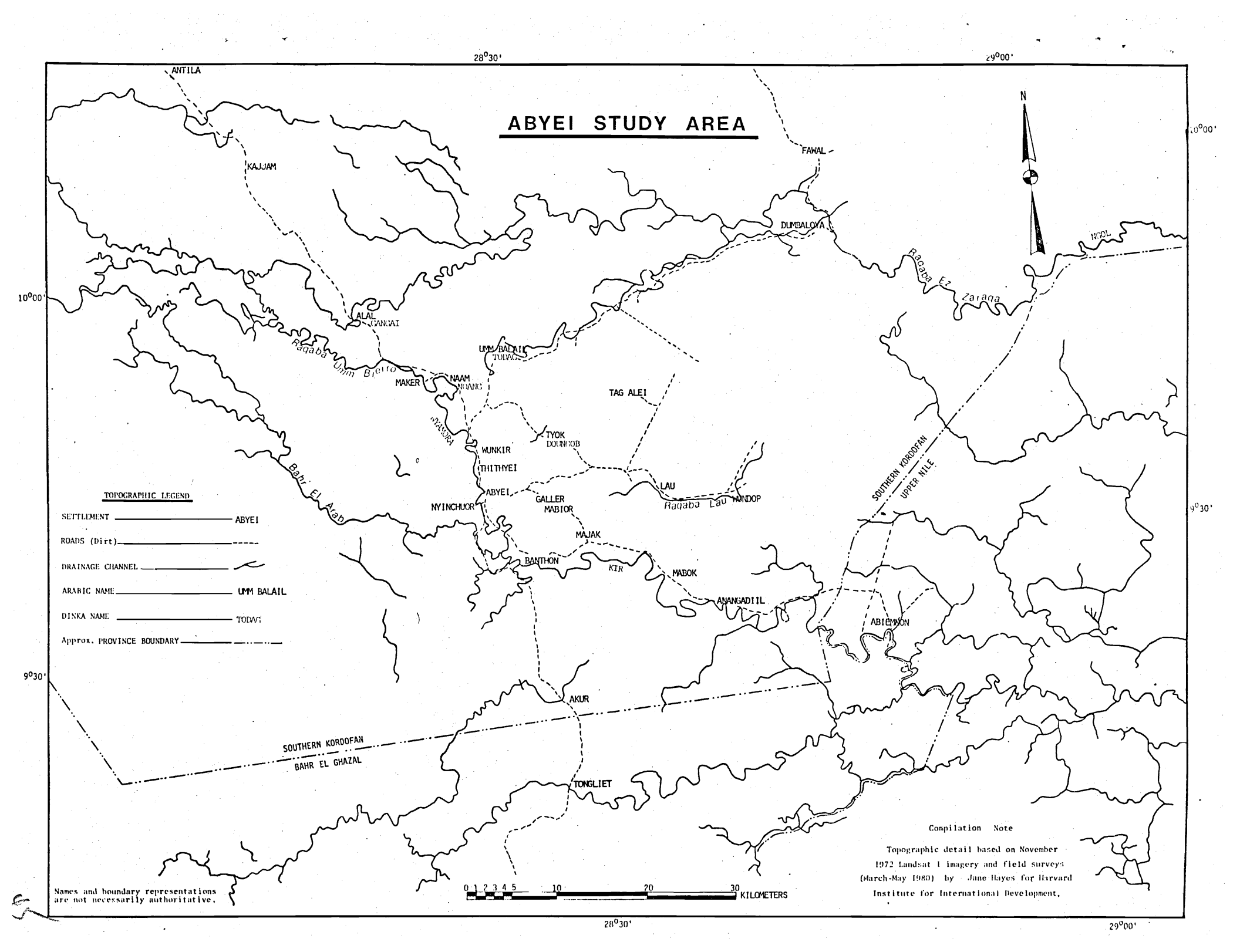
7. In as much as the continued support of the Abyei project beyond June, 1981 by either the U.S. or the Sudanese Governments is now uncertain, we feel it is important to seek some way in which the critical water program

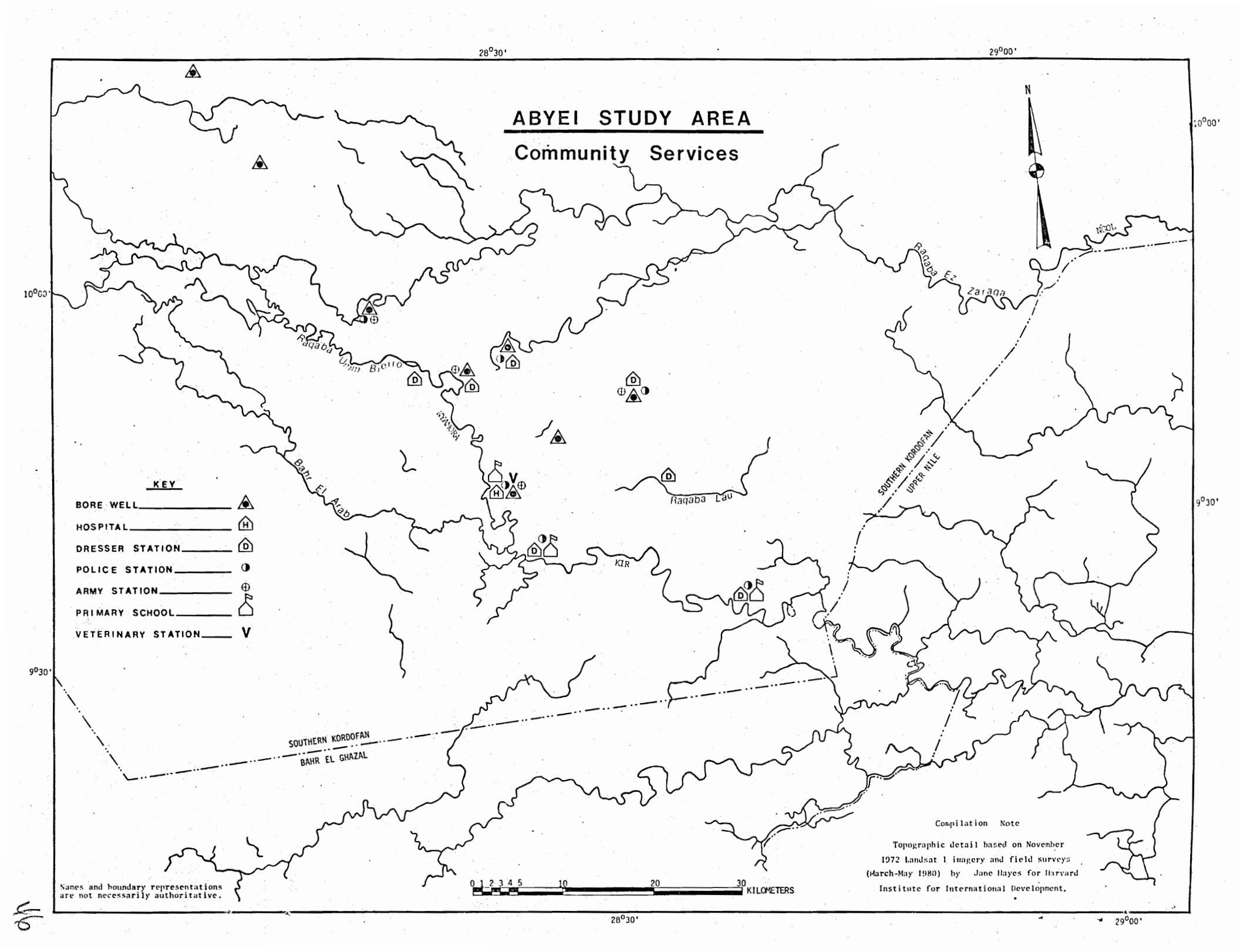
can continue under its own steam. So long as the political status of Abyei is unresolved, it seems unlikely that the South Kordofan provincial government will carry out a significant water program there. The best hope that we see is to try to organize local water groups of 10-20 households that can pay for the costs of a well and then take responsibility to maintain it. At the same time, an attempt should be made to constitute the well-drilling team as a local enterprise that will drill wells, install and maintain pumps for the local water groups. The equipment and supplies purchased under the project for the water program could be turned over to the new enterprise as part of their initial capital. The cost of the wells, using the manual drilling technology and either the IDRC or Mark II pumps, should be low enough ($500 to $1,000) so that the local inhabitants could afford to pay for them on a group basis. Given the limited time available until the end of the project, there is no assurance that such a locally based drilling enterprise and water user group schemes could be worked out, but we believe they offer the best hope, under the circumstances, for continuing the critical water program.

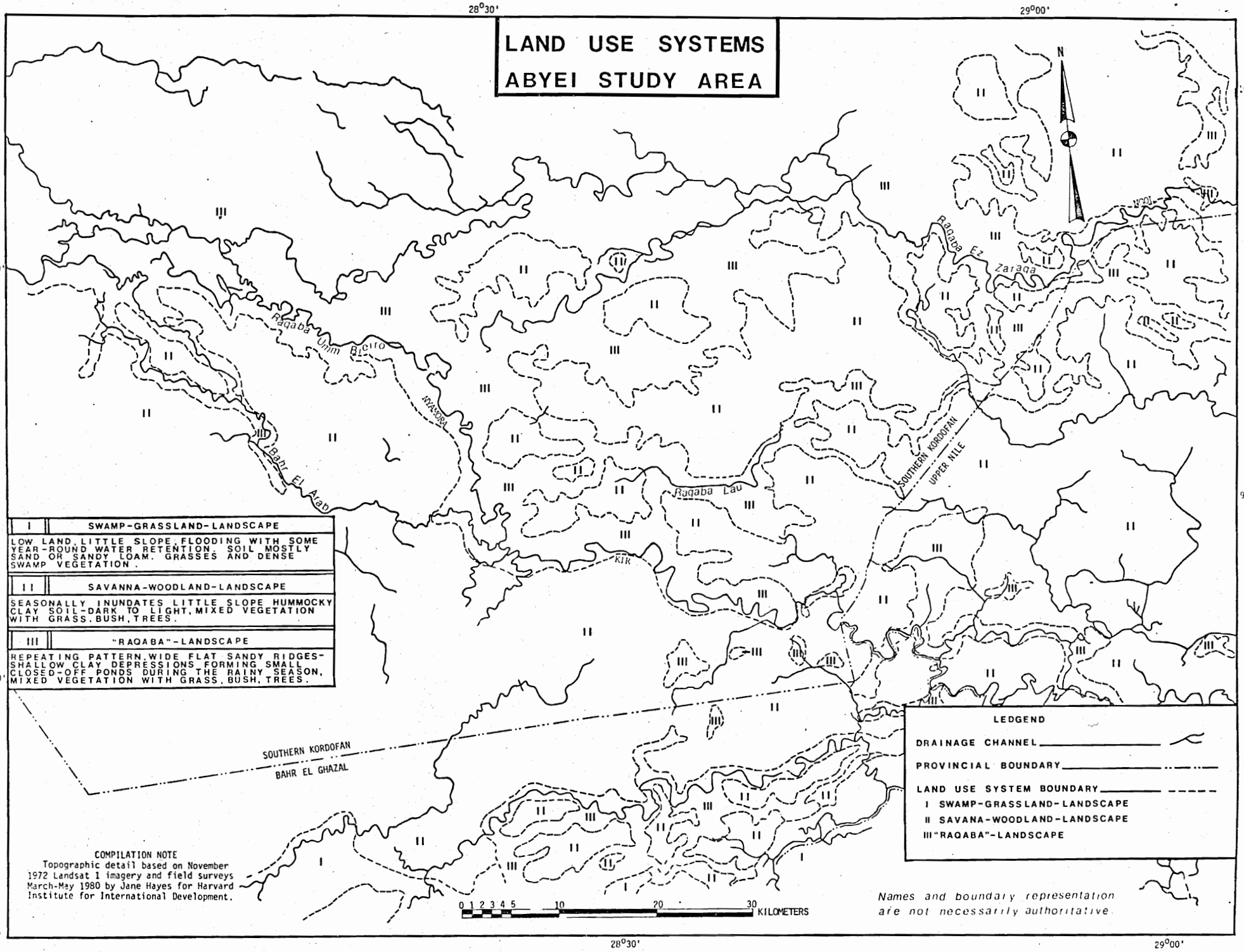
In addition to providing technical assistance on drilling, we propose to assign a rural sociologist-anthropologist to the task of helping organize the water groups for a period of three months.

ANNEX B

MAPS OF ABYEI AREA


ABYEI STUDY AREA
28°30'
29°00'
10°00'
9°30'
N
ANTILA
KAJJAM
FAWAL
DUMBALOYA
HCOL
Ragaba Ez Zaraga
ALAL
GANGAI
Ragaba Umm Bierro
UMM BALAIL
TODAG
MAKER
NAAM
NGANG
TAG ALEI
NAQRA
TYOK
DOUNGOB
WUNKIR
THITHYEI
ABYEI
NYINCHUOR
GALLER
MABIOR
LAU
Ragaba Lau NGONDOP
Bahr El Arab
SOUTHERN KORDOFAN
UPPER NILE
MAJAK
BANTHON
KIR
MABOK
ANANGADIIL
ABIEMNON
AKUR
SOUTHERN KORDOFAN
BAHR EL GHAZAL
TONGLIET
TOPOGRAPHIC LEGEND
SETTLEMENT ABYEI
ROADS (Dirt)
DRAINAGE CHANNEL
ARABIC NAME UMM BALAIL
DINKA NAME TODAG
Approx. PROVINCE BOUNDARY
0 1 2 3 4 5 10 20 30 KILOMETERS
Compilation Note
Topographic detail based on November 1972 Landsat 1 imagery and field surveys (March-May 1980) by Jane Hayes for Harvard Institute for International Development.
Names and boundary representations are not necessarily authoritative.


ABYEI STUDY AREA
Community Services
28°30'
29°00'
10°00'
9°30'
N
NOOL
Raqaba Ez Zaraqa
Raqaba Umm Biero
NYAMORA
Bahr El Arab
Raqaba Lau
KIR
SOUTHERN KORDOFAN
UPPER NILE
SOUTHERN KORDOFAN
BAHR EL GHAZAL
KEY
BORE WELL
HOSPITAL
DRESSER STATION
POLICE STATION
ARMY STATION
PRIMARY SCHOOL
VETERINARY STATION
0 1 2 3 4 5 10 20 30 KILOMETERS
Names and boundary representations are not necessarily authoritative.
Compilation Note
Topographic detail based on November 1972 Landsat 1 imagery and field surveys (March-May 1980) by Jane Hayes for Harvard Institute for International Development.


LAND USE SYSTEMS
ABYEI STUDY AREA
28°30'
29°00'
10°00'
9°30'
N
Raqaba Umm Biero
Raqaba Ez Zaraqa
Bahr El Arab
Ngaoba
Raqaba Lau
Kir
SOUTHERN KORDOFAN
UPPER NILE
SOUTHERN KORDOFAN
BAHR EL GHAZAL
I SWAMP-GRASSLAND-LANDSCAPE
LOW LAND, LITTLE SLOPE, FLOODING WITH SOME YEAR-ROUND WATER RETENTION. SOIL MOSTLY SAND OR SANDY LOAM. GRASSES AND DENSE SWAMP VEGETATION.
II SAVANNA-WOODLAND-LANDSCAPE
SEASONALLY INUNDATES LITTLE SLOPE HUMMOCKY CLAY SOIL-DARK TO LIGHT, MIXED VEGETATION WITH GRASS, BUSH, TREES.
III "RAQABA"-LANDSCAPE
REPEATING PATTERN, WIDE FLAT SANDY RIDGES-SHALLOW CLAY DEPRESSIONS FORMING SMALL CLOSED-OFF PONDS DURING THE RAINY SEASON, MIXED VEGETATION WITH GRASS, BUSH, TREES.
LEDGEND
DRAINAGE CHANNEL
PROVINCIAL BOUNDARY
LAND USE SYSTEM BOUNDARY
I SWAMP-GRASSLAND-LANDSCAPE
II SAVANA-WOODLAND-LANDSCAPE
III "RAQABA"-LANDSCAPE
COMPILATION NOTE
Topographic detail based on November 1972 Landsat 1 imagery and field surveys March-May 1980 by Jane Hayes for Harvard Institute for International Development.
0 1 2 3 4 5 10 20 30 KILOMETERS
Names and boundary representation are not necessarily authoritative.

## STUDIES BASED ON THE ABYEI PROJECT

1. "Popular Participation in the Abyei Project," Richard Huntington, HIID Discussion Paper, May 1980.

2. "Action Research in Abyei: An Approach to the Identification, Testing and Selection of Appropriate Technologies in a Rural Development Context," David C. Cole and David J. Vail, HIID Discussion Paper, March 1980.

3. "Abyei Rural Development Project, Report on the Health Program, June 1978 - June 1979," Dana Larson, M.D., October 1980.

4. "Land Use Analysis/Population Survey: Abyei Study Area, South Kordofan, Sudan," Jane Hayes, October 1980.