XN-ABE-841-A
ISN 65582

DRAFT

AFRICAN IRRIGATION OVERVIEW

IMPLICATIONS FOR DONORS

(Chapter VII)

This study is an output of
Water Management Synthesis II Project
under support of
United States Agency for International Development
Contract AID/DAN-4127-C-00-2086-00

Jon Moris
Derrick Thom

Utah State University
Agricultural and Irrigation Engineering
Logan, Utah 84322

April 1985

-31

DRAFT

AFRICAN IRRIGATION OVERVIEW

IMPLICATIONS FOR DONORS

(Chapter VII)

Executive Summary 1

Issues 7

1. Where and When to Subsidize? 8
2. New Projects or Rehabilitation? 9
3. Drainage or More Irrigation? 10
4. Large- or Small-Scale Irrigation? 10
5. Direct Investment or Price Support? 11
6. Public or Private Development? 11
7. Hydro-Power versus Irrigation? 13
8. Hardware or Management? 14
9. Conjunctive Use of Groundwater? 16
10. River Basin Authorities versus Individual Schemes? 16
11. Scope for Alternate Energy Sources? 17
12. Swamp-Rice versus Rainfed Rice? 18
13. Rightholders versus Cultivators? 19
14. Full Control versus Supplemental Irrigation? 21
15. Technology Transfer or Technology Development? 21

Gaps 22

1. Irrigation Engineering 23
2. Manpower and Sector Planning 23
3. Project Documentation 24
4. Vertisol Management 25
5. Weed Control 26
6. Maintenance 26
7. Irrigation Extension 27
8. Intra-Household Economics 28
9. US-Based Irrigation Expertise 29

AID Strategy 30

1. Cooperation with Other Donors 32
2. Incorporation of Irrigation into FSR Projects 33
3. Scheme and Systemic Malfunctioning 34
4. RBAs and Irrigation Planning 36
5. Remote Sensing Applications 37
6. Women-In-Irrigation-Development 38
7. NGOs and the Private Sector 38
8. Deepening of US Capacity 39

Bridging the Gap 40

EXECUTIVE SUMMARY

Implications for Donors (Chap. VII)

1. Virtually all expert observers recommend against expanding finance for irrigation by the mere addition of new projects. We concur that top priority must go to institutionalization and rehabilitation.

2. An initial analytic step which WMS II could provide is to clarify which kinds of activities contribute most directly towards deepening institutional capacity in the irrigation sector. Terms like "planning" and "extension" are often used loosely, without recognizing either AID nor recipients know how these terms actually apply within irrigation.

3. AID should recognize that it will usually be a small donor in relation to irrigation. This suggests that to get maximum benefit from a wide spectrum of field activities AID should adopt a collaborative approach where many of the primary costs are borne by other donors.

4. U.S. expertise available to work on African irrigation is very thin, in part because of AID's small commitment in this area, but also because of language barriers (French, Arabic, Portuguese) and the predominance of the former colonial powers (France, England) in giving assistance. To change this situation will require a vigorous and planned effort, possibly by means of "tag-along" or rotating post-doctoral fellowship arrangements.

5. It should be recognized that the U.S. government is supporting African irrigation through World Bank/IDA funding to field projects. To date, the Bank has rarely used U.S. expertise for evaluating its irrigation projects. However, the weak performance of these projects indicates there is much scope for improvement. A joint AID/Bank effort aimed at strengthening institutional support for irrigation ought to be considered. (Ronald Ng is reviewing the Bank's extension and monitoring activities, and could serve as the liaison for such an effort.)

6. AID already had under way several "farming systems' research" (FSR) projects in countries where irrigation is important, e.g., Sudan, Niger, and Tanzania (among others). Because these are already operational, an irrigation "add-on" component could be rapidly implemented. There is a strong case to insist that FSR projects pay more attention to irrigation.

7. Many African countries have established river basin authorities (RBAs) of one type of another. We have noted the RBAs are usually

the only base for existing irrigation planning in a given country. AID should explore a "package" of modest support measures aimed at buttressing the institutional effectiveness of such agencies. Possible components might include:

- Training at the M.S. level (initially in the U.S. but with theses done in the home environment), followed by in-country workshops;

- Africa or region-wide seminars to direct RBA attention to new concepts, procedures and resources (e.g., farmer participation, remote sensing); and

- Devising simplified planning and monitoring procedures adapted to African conditions (rapid reconnaissance, etc.).

8. A major gap is the almost total absence of information on irrigation manpower on the African continent. A systematic approach to training for irrigation requires information on staff training needs, which is simply not available. (Remedying this gap might be a suitable area for WMS II project involvement.)

9. Another unexpected gap is in regard to irrigation economics, a key policy concern given the high costs of irrigation investment and the many complications arising from incorrect estimation of labor costs. Each REDSO office should have at least one irrigation economist, perhaps a rotating fellowship position, to rapidly expand the number of those familiar with African irrigation economics.

10. AID's regionally-based REDSO offices would seem to afford a useful base for assignment of interns who would rapidly acquire a broad comparative experience. Such staff should have already completed a field assignment (M.S. or Ph.D. in a African rural setting). The REDSO framework allows maximum flexibility in arranging staff assignments, and spreads the load of support over several countries. We recommend a focused program to deepen the irrigation expertise located at the REDSO level.

11. Priority attention should be directed towards the choice of crops to be irrigated, and the question of competition for labor between irrigated and rainfed staple crops. It seems obvious that high-value market gardening depends upon low transport costs and a concentration of demand. It also seems that forage utilization is an important objective where farmers are involved with livestock. These are all agricultural economic considerations which must be more adequately integrated into future irrigation planning.

12. Scheme management as presently found in Africa depends heavily on various internal routines -- precedents, rules of thumb, and administrative procedures. While rarely documented outside the

agency concerned, these have an enormous influence on farmers' productivity and commitment. Both in regard to improving participation and women's involvement, the adequacy of such institutional arrangements is critical. We suggest that dialogue and comparative research on these procedural, "O&M" aspects would be a suitable area for any special studies AID might fund.

13. Many observers have stressed that irrigation maintenance constitutes the weak link undermining the long run viability of African irrigation schemes. Rates of depreciation for equipment remain extremely high, while already constructed physical works rapidly deteriorate. Further investment in new projects or, for that matter, in the mere physical reconstruction of old ones, cannot be justified until a better understanding is reached on the causes of poor maintenance. This topic cries out for multidisciplinary analysis, and should receive high priority in future research.

14. One likely reason for poor maintenance is a failure of incentives in regard to women's participation in irrigated farming. The significant role of African women in many irrigation systems is not as yet matched by their control of resources or access to profits. In large part this is a consequence of the comparatively weak unification of household production (as contrasted with Asia or Latin America). AID should explore procedural innovations which would increase women's leverage within the emerging systems for irrigated production. Some assistance might also be given to a small unit in FAO looking at women in African agriculture, perhaps by means of funding for a linked associate's position.

15. How to increase farmers' own involvement in African irrigation systems remains an unresolved need. It is clear that as presently being implemented, irrigation on Africa's larger schemes excludes farmers from almost all aspects of managerial control. As long as this tendency persists, irrigators will see themselves as tenants and will continue to resist making private constributions to facilitate scheme irrigation. A comparison between introduced systems and spontaneous or traditional ones might pinpoint how to generate greater farmer commitment. (We note also that this topic is receiving priority attention from various European donors, and has been the focus of efforts by Harry Underhill in FAO over the past few years.)

16. Detailed analysis of the skills farmers possess and need is not available for the various systems of African irrigation. A comparative documentation of "extension" as it actually occurs is essential before donors impose their own ideas (e.g., the World Bank's "T and V" system). Another gap is in regard to how to use irrigation as a drought relief measure. In Kenya, Ethiopia, or the Sudan the incoming "farmers" may be destitute pastoralists with little experience of irrigated farming.

17. Greater involvement of the private sector remains an official U.S. government objective. In Africa, it is complicated by the presence of outside minorities and the pronounced duality of the agricultural sector. Some possibilities for donor support include:

- A systematic effort to retrieve the substantial experience of private consultancy firms, which have been very active in the design of African irrigation schemes. Here there is a large literature found mainly in England and Holland not available within U.S. academic collections.

- Encouragement of exchanges of expertise within African countries between the large-scale commercial sector and the public or PVO agencies helping small-scale irrigation.

- Establishing better technical "backstopping" for NGO and PVO irrigation projects.

- Possible credit assistance to the small-scale "market garden" farmers oriented around purchase and maintenance of pumps. However, great caution must be exercised since such projects are quite risky.

18. The evident lack of feedback from operational systems into project design arises because of a deep split between civil engineers doing construction and external agronomists (often FAO-provided) assisting crop production. In most African countries, irrigation engineering as a discipline does not yet exist. Donors should encourage any measures which facilitate the emergence of irrigation engineering as a unified field, combining aspects of design, construction and management.

19. AID/Washington needs to recognize that because of its few irrigation-related projects in East and Southern Africa, the usual "participant training" device for deepening in-country technical skills cannot be relied upon. If African countries are to send staff for training in the USA, they must do so under some other mechanism. We see this as an opportunity to shape an emerging professional discipline, but warn that as presently given, much U.S. training is likely to be inappropriate to African conditions.

20. In regard to technology choice, this report has identified numerous problems. At a minimum, donors can avoid compounding managerial difficulties by introducing unsupportable "orphaned" equipment. They can also buttress in-country repair and servicing capacity, an objective AID has several times adopted (Senegal, Mali) but which appears exceedingly difficult to accomplish. Perhaps an exchange of experiences between countries and donors would help? More fundamentally, there are obvious gaps where present technologies are inadequate:

- An absence of low energy pumping systems, which would be within reach of smallholders' financial capability;

- Development of systems combining full irrigation for one crop cycle and supplemental irrigation for the rainfed crop;

- A frequent failure to anticipate multiple uses (livestock, households, etc.) of irrigation water;

- A need for an exchange of ideas about animal traction equipment suited to lighter weight African cattle;

- Exchange of experience concerning working in heavy clay soils; and

- Development of a means for applying supplemental irrigation to rainfed cereal crops during within-season droughts.

21. Irrigated production in Africa encounters severe difficulties related to soil exhaustion, nematode and pest buildup, and a proliferation of terrestrial and aquatic weeds. Because these are delayed impacts, their significance in depressing crop yields has probably been underestimated. We have no clear solutions, but note past U.S. assistance to the National Academy of Science for exchanges of technical information on such topics.

22. Another area of comparative U.S. advantage concerns support for agricultural applications of remote sensing (LANDSAT, etc.). Contrary to some U.S. opinion, a continuation of these activities drawing particularly upon U.S. weather monitoring capability is vital. (For example, such data was the best firm evidence that Africa's current drought was not primarily man-caused.) Cross-linkage of regional precipitation patterns to river-basin planning is a strategic necessity for the USA and any other donors concerned about African food availabilities. A missing element has been to focus on the "early warning" aspects, so that countries with installed irrigation capacity will have enough time to shift priority towards food grain production in the rainfall deficit years.

23. In general, environmental complications (especially those related to health) constitute a significant constraint upon African irrigation. Individual countries may lack the technology and interest to engage in long-run environmental monitoring. As in the past, donor pressure has been the main reason for inclusion of this focus in project designs. The presence of UNEP in Nairobi, which has often sponsored useful work on energy and environmental aspects of African agriculture, offers a possible base for expanded attention to this aspect of African irrigation. There is also need to exchange information on public health costs associated with different types of irrigation technology.

24. This report would not have been feasible without access to the irrigation "network papers" provided by London's Overseas Development Institute (ODI). ODI is already in touch with many of Africa's irrigation practitioners, but the task has grown to unmanageable proportions beyond ODI's present resources. Since a substantial proportion of the passive membership in ODI's irrigation network are Americans, modest assistance from AID might be welcomed.

25. Finally, it is a regrettable fact that politica. priorities often determine donor interests. For African irrigation, an irony we have pointed out is that several poor socialist countries have major irrigation potential and may control their neighbor's potential as well. This is certainly the case for Ethiopia and Guinea, and to a lesser extent, also for Angola and Tanzania. It is <u>not</u> in the national interests of western donors to let short run political considerations dictate where assistance will be given in African irrigation, neither now nor in the future. It would be in Africa's interest to insure that each western embassy is provided with a map on which the continent's major river drainages have been drawn to reinforce this elementary point.

CHAPTER VII
IMPLICATIONS

Issues

The literature already contains three useful listings of the main issues donors should weigh when appraising irrigation development. Two come from AID-financed studies (Berry et al., 19__; Steinberg, 1983: 35-65) and one from the OECD (Carruthers, 1983:68-75). Drawing most heavily on Carruthers, we suggest 15 points on which policy decisions are required in African irrigation:

1. Where and when to subsidize?
2. New projects or rehabilitation?
3. Drainage or more irrigation?
4. Large- or small-scale irrigation?
5. Direct investment or price support?
6. Public or private development?
7. Hydro-power versus irrigation?
8. Hardware or management?
9. Conjunctive use of groundwater?
10. River basin authorities versus individual schemes?
11. Scope for alternate energy sources?
12. Swamp-rice versus rainfed rice?
13. Rightholders versus cultivators?
14. Full Control versus supplemental irrigation?
15. Technology transfer or technology development?

Familiarity with the general arguments advanced by Steinberg and Carruthers is here assumed. We have emphasized instead the special features which may alter standard prescriptions when one is dealing with African irrigation. It will also become apparent that there are not too many continent-wide prescriptions. On most issues, each country has peculiarities which will require extra attention in choosing an appropriate strategy.

1. Where and When to Subsidize?

The first issue to consider in regard to irrigation investment is, according to Steinberg, "Who pays?" (1983:43). By now, the relevance of criteria for cost allocation should be obvious. We have seen that African irrigation tends to become inordinately expensive, that smallholders cannot afford major capital improvements, that the typical peasant farm is "energy starved," and that African governments cannot assume increased recurrent cost burdens. Furthermore, well-intentioned plans for double cycle cropping -- introduced primarily to boost farmers' cash flow as a means of enhancing benefits and repayment capacity -- are not technically advisable under typical African conditions.

Thus, deciding "who pays" is a core issue which must precede consideration of all others on our list. It is fairly clear that under typical African circumstances irrigation simply cannot pay its own way until the accompanying farming system has reached a fairly advanced stage of commercialization, e.g., supplemental irrigation for Kenyan coffee farms or valley-bottom irrigation on Zimbabwe's large farms. The implication for donors is, therefore, that some element of subsidy is inevitable if a country intends to proceed in developing irrigation. The operational question is then not whether to subsidize, but where, when and with what consequences? If so, a financial appraisal is not enough: a country must also look at the economic costs and returns, both at the enterprise level and for the sector as a whole.[1] Questions to weigh include whether to finance initial construction on a grant basis, leaving the host country to concentrate on financing recurrent costs?[2] Can the nation afford to exempt its irrigation schemes from duty on imported inputs? Should an irrigated cereal crop enjoy a

---

[1] An excellent study which does distinguish between financial and economic considerations, private versus social profitability, and marketing as well as production costs is the five nation Stanford comparison of rice in West Africa (Pearson et al., 1981).

[2] Grant-financed initial construction may, in fact, leave countries in a worsened situation because of their acute recurrent cost constraints. Here see Finney (1984) and the whole literature on this topic.

protected local market? What about concessionary food imports? Would rainfed agriculture give higher or more reliable returns from a similar level of subsidy? What aspects can be left for on-farm financing, given that irrigation as presently encountered tends to be highly risky?

2. New Projects or Rehabilitation?

Obviously, in those countries like Niger or Tanzania where the rate at which already developed irrigable land is going out of production exceeds the development of new irrigation, rehabilitaion should take first priority. In recent years, this has indeed been the emphasis among most donors. However, experience with attempted rehabilitation shows the issue is not so clearcut:

- Engineering considerations tend to predominate during rehabilitation, when in fact the greatest need may be for "O&M" modifications.
- The need for rehabilitation is usually linked to a lack of adequate maintenance procedures. Unless these can be instituted within the local system, physical reconstruction will effect only a temporary improvement.
- Where the main system has been allowed to badly deteriorate, the costs of reconstruction can be just as high as for the building of new schemes.
- The pyramiding of new loans on top of old ones creates a crushing financial burden beyond the support capacity of many schemes.
- If the root cause for failure to do maintenance is a tight recurrent cost constraint influencing the whole system, this situation needs to be diagnosed and dealt with at a policy level first.

Thus, while the balance of effort in Africa probably should be directed towards improvement of existing irrigation, it does not necessarily follow that physical reconstruction of these schemes under external loan financing is what is needed. A carefully done, case-by-case comparative analysis of "O&M" deficiencies which makes rehabilitation necessary within existing schemes would appear to be precondition before effective remedial measures can be instituted.

3. Drainage or More Irrigation?

This report has argued that rainfall intensities are such in tropical Africa that drainage must be provided alongside any water supply improvements if these are fairly substantial in size. Farmers' lack of equipment and resource constraints make it unlikely they can add drainage works by local effort. A particular technical problem is how to achieve adequate drainage on the very flat alluvial plains in parts of the Sahel, e.g., along the Niger River or near Lake Chad. Elsewhere for the most part existing schemes can utilize the topography for drainage (provided that care is taken in the initial design). Health hazards and the removal of weeds from drainlines constitute a serious, often overlooked problem. For these reasons we should avoid replicating in Africa the arbitrary division between drainage and irrigation engineering which is found in the USA.

4. Large- or Small-Scale Projects?

If in Africa small-scale projects are not necessarily cheaper to build, they are nevertheless easier to withdraw from; managerial assistance by an NGO rather than the government is more feasible; they represent a smaller financial commitment; field layouts can be more adapted to farmers' needs; and there is at least a theoretical possibility farmers will be more involved and consequently more committed. We recommend, therefore, a bias towards assisting small-scale projects and technologies, traditional as well as modern. This recommendation is heavily qualified by reservations outlined in earlier chapters, and also touched upon by Carruthers (1983:70-71). It ignores the fact that schemes requiring large reservoirs or major canals are bound to be large-scale in nature. It also conflicts with a pervasive opinion within AID/Washington that small projects are just as demanding of supervision and management as are large ones. While this may be true, the consultants drawn upon in this study were nearly unanimous that in Africa smaller, flexible projects on average outperform the larger ones. One final point: these arguments do not rule out experimentation within large systems to decentralize scheme functions and increase farmer participation, e.g., as the Dutch have attempted in the Office du Niger.

5. Direct Investment or Price Support?

Carruthers warns that for irrigation to succeed, agriculture must be profitable (1983:71): "There is clearly no point trying to enforce water charges or other taxes if farmers do not have a reasonable income." He outlines a downward spiral where governments try to maintain low food prices while allocating an over-valued exchange rate and imposing inefficient bureaucratic controls on agricultural production. When production stagnates, the availability of cheap food aid on concessionary terms removes the pressure to allow a raise in farmgate prices. The dangers of this situation are by now well recognized (World Bank, 1981; Bates, 1981), particularly within USAID. (However, if we accept this argument at the farm level we must also recognize its validity at the country level, where adverse terms of trade vis-a-vis the industrial nations have a great deal to do with the current difficulties of irrigated cotton production in the Sudan or sugar production in Malawi.)

The central economic issue remains how to introduce irrigation technologies in systems where because of very small farm sizes and low productivity farmers cannot individually afford expensive capital improvements. While better prices might raise the ceiling on affordable investment slightly, the gap between smallholders' existing technology and what outsiders might recommend continues to be very wide. This explains why so many countries have introduced intermediary institutions whose service charges in turn depress farm prices.

6. Public or Private Development?

Carruthers is probably correct in insisting that irrigation development is one sphere of economic activity where both public and private initiatives are required (1983:72-73). This message will not satisfy either side in the continuing debate over "privatization," incentives and bureaucratic reform. The situation is further complicated in Africa because here "private" does not describe a unimodal cluster of firms. Instead, as a rule the "private sector" in African countries is sharply bi-modal, being split between traditional small-scale farming (and trading) and large-scale, export-oriented

"plantation" agriculture, as often as not owned by outsiders. A third group are the missionaries and other NGOs, but helping smallholders rather than the plantation crop sector.

While large-scale operators may cooperate with public agencies in sharing experience (something we recommend), their scale of operations is so much larger that on vital managerial aspects they have little that is suited to the smallholder. As noted above, this disparity explains why many African governments of all ideological complexions have been forced to establish intermediary service organizations to assist irrigated smallholder farming. Furthermore, most activities needed for developing irrigation -- testing of materials, design of new systems, modeling of aquifers, integrated planning of groundwater and surface supplies, controlling of saline intrusions -- are not activities the private sector will underwrite (Carruthers, 1983:72). Nor are the individual African regimes eager to see non-national firms play a larger role by being given privileged access to credit or preferential donor assistance. Thus, AID/Washington's policy mandate to give greater assistance to the private sector runs directly counter to local political realities in many ex-colonial African nations. To the extent that "aiding the private sector" will mean giving assistance to outsiders (e.g., Lebanese in West Africa or Asians in East Africa) or even to tribal elites, it often cannot become a stated policy. A possible resolution would be to encourage activities which bring both sectors together and to deepen institutional resources (training, research and extension) available to the whole irrigation subsector.

In regard to small-scale operators, AID has much greater flexibility for rendering support, but comparatively less to offer because such systems are so different from our own. There appears to be a genuine "technological gap" at the micro-irrigation end of the spectrum, where farmers are irrigating market gardens from very limited supplies. As a donor, AID could also underwrite credit for small-scale operators -- though this should be linked to training because of high risks and frequent failures. AID could do much more to insure technical backstopping for various NGO, PVO and Peace Corps projects active in small-scale irrigation. An assessment of "technology backstopping"

needs for small-scale NGO projects might be a suitable topic for an all-Africa workshop.[3]

7. Hydro-Power versus Irrigation?

Hydro-power generation and irrigation needs can come into competition in several ways. If irrigation is developed upstream from power generation, the loss of water can necessitate a significant reduction in hydro-power generation -- as, for example, Tanzania's irrigation schemes in Mbeya Region above the Mtera and Kidatu dams on the Ruaha River. Where power generation lies on the upstream side, the need to maintain flow even in the rainy season will reduce water storage available for dry season irrigation. But much the most important interrelationship concerns the cessation of annual flooding on rivers where this may have been significant to farmers, e.g., the Aswan High Dam on the Nile (Waterbury, 1979). In West Africa, on the Senegal and Niger Rivers, farmers practiced "decrue" (or "recession") farming, planting their crops on river terraces as the floodwaters receded. While not "irrigation" in the strict sense, this tradition made maximum use of scarce moisture and existing clay soils in an otherwise barren environment. It is sufficiently important that the new upstream dam on the Bafing River (a major source of the Senegal's fow) has been designed to provide an artificial "flood" through controlled water releases. For similar reasons, some have proposed that Tanzania's Steigler's Gorge Dam (not yet financed) should also allow for controlled downstream flooding in the Rufiji Delta (_____). In either case, the artificial "flood" will lack the sediments which are mainly deposited in the reservoir's upper end.

One might question spending time on this issue when throughout this report large projects have been downplayed. However, three added facts are relevant. First, the tradeoffs between hydro-power, dry season irrigation and "decrue" (or equivalent, downstream pump) farming are a significant issue in three countries high on USAID's priority list

---

[3] AID policy on the public versus private issue is discussed at some length in Steinberg (1983:57-60).

(Egypt, Sudan and Senegal) and also in systems which derive their water from neighboring countries, e.g., Somalia and Mozambique. Second, Africa has a tremendous, though underdeveloped hydro-power potential. At some time in the future the continent will surely overcome its structural disabilities within the international exchange system. It would be very helpful to have worked out in detail the interrelationships between power generation and agriculture before further large schemes are launched. Third and perhaps most appropos to this report, it is discouraging to see high voltage transmission lines passing right over irrigable lands in countries where water pumping still depends on diesel engines. Hydro-power in Africa has largely been used for industrial development, not irrigation. Since the continent does have such large reserves of untapped hydro-power potential, the present energy constraints within irrigation ought to be viewed as an inheritance from the past and not a constraint upon future development.

8. Hardware or Management?

Many think this is the overriding question to be addressed in African irrigation. It is difficult to answer, because the usual means donors employ to gain influence over project management is through financing increments to "hardware." Without building new schemes, would donors be allowed to assist on "O&M" issues? In Africa, the answer might well be "yes" for the simple reason that Ministries of Agriculture find themselves hard pressed to plan and supervise irrigation development.

In the section on irrigation management, seven types of "software" were identified as potentially contributing to the effectiveness of irrigation in Africa. Not all are operational at the moment -- which partly explains glaring gaps and weaknesses in many of Africa's present schemes. Let us recapitulate what the seven types of management include. First, there is the general planning and supervision at the sector (Ministry of Agriculture or Irrigation Board) or river basin level. Second, there is often a temporary but strategic managerial phase responsible for scheme construction -- particularly if surface irrigation of more than say, about 50 ha, is contemplated. Third, one

often finds in Africa a scheme or agency management in charge of a given perimeter or system: sometimes a formally organized settlement scheme (as in Kenya's NIB settlements or Zimbabwe's lower Sabi schemes), other times maybe just a small PVO unit. Fourth, there is always a need for hydraulic ("main systems") management of the pumping or intake facility and the linked distribution mechanisms. Fifth -- though this is often the missing element in Africa to date -- there may be a user organization involved in water allocation, dispute resolution and maintenance. Sixth, we must also recognize on-farm water management, which will involve the control of land, soil, crops, water and people. And seventh, over time there may emerge need to manage the socioeconomic and environmental impacts of irrigation. Of these seven levels where "software" is definitely required, few authorities on irrigation recognize more than three or four. Because of the particular problems encountered in Africa, here irrigation advisors need to become cognizant with all seven.

A principal message of this report has been that these levels are rarely considered jointly. Each managerial unit concentrates on its phase in the project cycle in the hope that ultimately crops will be grown and farmers benefit. Indeed, one cannot even tell from the literature on most schemes what managerial practices are in general use. One suspects that as currently implemented, irrigation "management" concentrates on physical construction -- always a particularly demanding task in Africa -- with "scheme" management coming in once a perimeter is "handed over." Enough is known about field difficulties (disease outbreaks, fuel shortages, power outages, sidelined pumps, poor seed, bird damage, crop spoilage, and missing or high cost transport) to suggest that there is very little margin for error.

We need to recognize that field operations under typical African conditions encourages an opportunistic, day-by-day management style which differs greatly from the procedurally complex routines outsiders often recommend. In stating Africa's need for better "software," we are not implying that the "high technology" routines coming into vogue among U.S. irrigation engineers represent a good, or even workable, solution.

Instead, the argument is that the managerial sphere must be where attention is concentrated in an effort to earn how and why existing systems "go wrong." Only then can one select among "software" options and design more effective forms of training.

9. Conjunctive Use of Groundwater?

Where water supply from flowing rivers is so difficult, the question naturally arises whether instead irrigation should not draw upon "tubewells" (or "boreholes," as they are called in Africa). At a policy level, the answer obviously must be "yes" -- but strongly qualified by recognition that pumping has a particularly bad record in Africa and that there may be large areas where the low yield from wells cannot support anything beyond a very small patch of irrigation. What donors could assist with is in promoting the exchange of experience between those working on household and community supplies, often based on pumping, and the irrigation sector in the same country. European donors such as SIDA and the Dutch have put heavy investments into development of community supplies in Africa, and have accumulated valuable experience.

10. River Basin Authorities versus Individual Schemes?

We have noted that many African countries have created river basin authorities responsible for planning resource development in their respective areas. The degree of executive involvement varies, ranging from those like Senegal's SAED, carrying direct operational responsibilities for small-scale projects, to those with purely planning functions like Tanzania's RUBADA (for the Rifiji Basin) or Kenya's TARDA (for the Tana and Athi River Basins). The prior existence of such agencies gives an additional option to donors interested in assisting African irrigation. In many countries, donors have three basic probabilities: (a) assistance to individual field projects; (b) support to the irrigation section in the Ministry of Agriculture; or (c) support to one or more river basin authorities (RBAs). The policy issue then becomes to determine under which circumstances irrigation agencies, ministry units, river basin authorities, or individual projects merit

which kinds of assistance? No general answer applicable to all of Africa is possible. The priority placed on irrigation differs from country to country, as do the levels of performance shown by outwardly similar organizations. One can, however, identify the advantages and disadvantages of assisting the RBA-type units.

The principal advantage is the fact already noted that RBAs are often the only administrative units which already possess a rudimentary irrigation planning capability. If an aim of assistance is to deepen in-country technical capabilities, then the RBAs constitute a feasible starting point. Most are parastatals, and as such, have a better chance to attract and retain specialized staff. Irrigation planning is usually already within their formal scope of operations, so that complicated negotiations and new legislation are unnecessary.

Their orientation towards planning can also become an obstacle, if it becomes an end in itself or if inappropriate methodologies are adopted. Vincent (1984:28) warns that American concepts of river basin planning can be quite detrimental in an African context. And, one might add, very expensive: development agencies can soon develop an enormous appetite for an interminable series of "preliminary investigations."

In view of the latter danger -- which African experience indicates is quite real -- we suggest that AID might concentrate on developing more appropriate and cost-effective training and research methods for RBAs. Among these might be:

- Training at a Master's level in irrigation-related fields;
- Regional or Africa-wide seminars to direct attention to new concepts, procedures and resources (e.g., farmer participation, remote sensing applications); and
- Derivation of simplified planning and monitoring techniques which would be more cost-effective under African conditions.

11. Scope for Alternate Energy Sources?

If African peasant farmers depend mainly on human or animal power, and if irrigation agencies have such difficulty obtaining fuel, why cannot other forms of renewable energy be employed? Each of the alternative source -- methane, windpower, solar power, photovoltaics,

49

and even new domesticates like water buffalo -- has its adherents. The record so far, however, suggests once again that caution be exercised. Any alternate energy source which itself requires complicated technology is likely to malfunction in the harsh African environment. Similarly, any "appropriate" technology which is vulnerable to neglect or misuse is also likely to fail.

In the longer run, it may be feasible to power small-scale equipment from photovoltaics (provided the vandalism problem can be overcome), just as the inclusion of lucinae stands within a surface irrigation system could provide the raw material for biogas generation. A more risky and still longer-run option would be to copy Brazil in using sugar byproducts (ethanol or alcohol) derived from irrigated production for powering scheme equipment. All three options are techically feasible today, but represent fairly high risk possibilities in the more remote parts of Africa for primarily managerial and environmental reasons. What is clear is that energy costs continue to rise, while farm operations remain energy-starved for want of a cheap and readily accessible fuel. Thus, further experimentation is warranted, and meanwhile the calculation of energy budgets (both in the ecological and in the financial sense) ought to accompany any in-depth analysis of proposed irrigation developments.

12. Swamp-Rice versus Rainfed Rice?

Africa has its own traditional varieties of "upland" rice, which appear to have been domesticated within West Africa itself (Harlan, 1985). In recent decades, flood-basin types from Asia have been replacing upland rice in the coastal, West African countries even though proportionately rainfed rice production is still far more significant. Nevertheless, by draining valley bottom lands ("swamps," though many dry out seasonally) and switching to wet rice varieties, per hectare yields can be greatly increased. Most state-sponsored have been of the "swamp rice" or valley improvement kind. Since, as we have seen, seasonally waterlogged lands are widely found throughout tropical Africa, the issue arises whether or not valley improvement schemes are as cost-effective as equivalent investment in "rainfed" upland production. At the country

level, several USAID analyses have addressed this question -- usually in the form of a crude contrast between "irrigated" versus "rainfed" development -- with the usual result being to recommend concentration on rainfed production.

In reality, it is not quite so simple. The valley-bottom "vertisols" represent some of the best agricultural land available provided they are intelligently used with suitable technologies. The division between "irrigation" and rainfed" cultivation is here also arbitrary, since what usually occurs is not full irrigation, but rather a combination of drainage, impoundment (for "wet" rice), and some supplemental water to extend the soil moisture regime. Within individual countries of West Africa one finds a diversity of rice production systems extending along a continuum of gradually increasing investment intensity. While some "polder" type swamp schemes can be extremely expensive, others based on slight modification of farmers' existing technology are not. The Stanford comparison of rice production in five West African nations gave different results for each country and for individual systems (Pearson et al., 1981). We therefore recommend an updating of the Stanford analysis employing present prices and incorporating additional crops (wheat, sorghum and cotton), while focusing more agricultural engineering attention on the technological issues inherent in valley-bottom improvement.

13. Rightholders versus Cultivators?

Tenure problems arise as an issue because in Africa those controlling plot rights -- whether they are bureaucratically appointed managers or male kinsmen in charge of a compound -- often cannot provide the labor irrigated production requires. Since this is also true for much of Asia's irrigation, observers may have been slow to recognize its ramifications in the African context. The "problem" exists because in either of the two contexts -- scheme or compound -- those recognized adminisratively and socially as rightholders are under minimal pressure to acknowledge cultivators' claims over irrigated land and its production. For example, when irrigation schemes insist upon retaining rights of eviction over tenants, they create a psychological climate

wherein the individual farmers will be unwilling to invest in long-term improvement, or sometimes even in canal maintenance. Similarly, if household bonds are weak and a woman anticipates being dispossessed (of either her home or her share of crop returns), she is unlikely to provide the substantial labor input which irrigated rice or cotton requires. If the household head is away on labor migration -- as African males often are -- the woman left behind may have no authority to incur capital investment or even to receive production credit. The looseness of household ties in traditionally polygamous Africa constitutes a major difference from many parts of Asia (and Madagascar) where a fairly tight integration of household activities underlies the success of irrigated production. The "success" stories like Taiwan are often countries where the tradition of unpaid family labor has been strong. In Africa, to the contrary, those expected to do much of the field work do not receive support from the larger social system to insure a fair distribution of profits. Thus, agricultural economic analysis, which assumes that households operate as a family firm with shared resources and profits, can yield quite misleading results if uncritically applied in an African context. There is ample evidence that those doing field work are not utilizing irrigation to the full extent which is technically feasible. While one can guess at their reasons, such guesses constitute an insufficient base for policy formulation.

We recommend, then, that targeted research under various social and technical systems must be undertaken. Furthermore, donors who finance irrigation projects are in a position to insist that procedural changes are made which give greater security to cultivators. It is a strange situation indeed that in rural systems where women had quite strong traditional rights to irrigated food crops, under "modern" bureaucratic schemes they lose these safeguards. Some fairly simple procedural improvements are usually feasible. One could insist, for example, that daughters as well as sons could inherit plotrights; that whoever is in day-to-day charge of the crop can be issued credit; and that houseplots can be owned by families outright (thus safeguarding the value of house improvements). Some countries have already implemented such changes;

exchanges of operational experience might facilitate the diffusion of better procedures aimed at increasing household security and intra-household equity.

14. Full Control versus Supplemental Irrigation?

It will be noted that the question usually posed, whether to stress irrigated versus rainfed agricultural development, has not received as much emphasis in this report. Here we suggest an intermediate position makes the most sense. We note that commercial farmers in East and Southern Africa have usually found it necessary to develop supplemental irrigation in order to achieve reliable crop yields. If so, the same need probably exists within smallholder farming. Regularization of rainfed crop returns by stabilizing planting dates and eliminating the within season dry spells might represent a more desirable (and water conserving) objective than "full" irrigation with its heavy water demands. The main problem is, of course, the high cost of present technologies for achieving this objective. Generally, the large-scale farmers in Africa employ movable piping and overhead sprinklers, requiring heavy initial investment. Some suggest that drip irrigation represents an ideal compromise where water is scarce, but here, too, practical difficulties -- termites and impure water -- are encountered. Perhaps the answer is to incorporate water harvesting during the rainy season; or else to add a rainfed, supplemented crop grown alongside the area used for "full" dry season irrigation. We do not yet have answers, but the need to pay more attention to partial irrigation seems obvious (repeating a point made vis-a-vis "swamp" systems).

15. Technology Transfer or Technology Development?

The final issue is one which underlies many aspects of this review: the selection, adaptation and support of irrigation technologies. Questions which come under this rubric have surfaced again and again in this review. For example, it is clear that some irrigation techniques must be accompanied by certain technological capabilities (e.g., freedom to import parts or access to streamflow data) before they can be used effectively. But which ones depend upon which "upstream" support

capabilities? Again, when should African governments accept "orphaned" equipment imported at donor insistence? (This has been a frequent issue in irrigation because rapid repair is usually essential.) Which aspects of US, Egyptian or Asian irrigation experience can be transposed directly into African practice? Are there "miracle" technologies (like drip irrigation) which might dramatically improve output within African irrigation? Can systemic weaknesses at the local level be offset technologically by increased investment? Why are even simple technologies like pump-set operation so problemmatic in rural Africa? Can given technological packages such as Dutch polder techniques be disaggregated and employed selectively? When and where should donors sponsor technologies which are new to Africa, such as overhead sprinkler irrigation or satellite-based "early warning" systems?

Whatever one might conclude theoretically, such questions are at present answered largely by default. Particular donors almost invariably stress the kinds of technology already in use at "home" or developed in their former colonies (e.g., the "Gezira" system). It is clear that for the large-scale commercial producers who enjoy exemption from currency restrictions, the standard "off-the-shelf" solutions from advanced nations can usually be made to work under highly standardized, plantation crop situations. However, as soon as one must deal with typical smallholder situations in the more remote communities, technologies tend to become quite problemmatic unless carefully adapted to circumvent local constraints. The adaptation and support elements are often overlooked in programs aimed at direct technology transfer. Since irrigation is essentially a repetitive activity, involving a network of support institutions, we recommend that donors put greater stress on deepening local technological capabilities.

Gaps

The scope of work for this overview specified that it should identify priority areas needing further attention -- the "gaps" within present research or within the existing distribution of institutional effort. What are, then, the most significant missing elements whose lack contributes to the present low efficiency of Africa's irrigation?

1. Irrigation Engineering

At several points in this report it has been pointed out that irrigation engineering in the American sense is largely absent from Africa, except perhaps in the Sudan and Egypt. When tasks requiring irrigation expertise arise, decisions tend to be made either by civil engineers (at the design and construction phases) or by agronomists (in scheme operation and water management). Few of the civil servants who staff Africa's river basin authorities and ministry-linked irrigation units are actually professional irrigation engineers. Most come to their assignments from other professions, and see themselves more as employees of the agency than as irrigation managers per se. As a consequence, the handful of qualified irrigation engineers in each country will be preoccupied in dealing with donors and reviewing new projects. While the manpower gap is being gradually closed by recruitment of newly trained professionals, "irrigation engineering" does not exist as an integrated field combining elements of design, construction and water management within a single discipline.

On the one hand, this situation leaves room to shape the emerging discipline in ways more suited to Africa's needs -- as, for example, in combining aspects of drainage and irrigation right from the start.[4] On the other hand, it also explains the technical void encountered in most countries on matters related to water management. Without enough trained professonal staff, African irrigation agencies rely heavily on outside consultants and on accidents of bureaucratic precedent to determine their managerial systems.

2. Manpower and Sector Planning

Few African countries have in hand systematic plans for the strengthening of manpower support for irrigation development. Most have never analyzed staff needs in the irrigation subsector, nor do they have

[4] In-country programs for training irrigation engineers constitute an obvious area where fairly modest donor commitment might have major long-run impacts. If we look at numbers being trained, Egypt is at present by far the largest source for African professional manpower in relation to engineering and irrigation (FAO, 1984).

accurate or even up-to-date statistics describing the sector. Sometimes, as in Kenya, individual units have good documentation, but the overall effort is badly fragmented. More typically, as in Somalia, the necessary information for irrigation planning is simply not available and no realistic program for staff preparation exists. Of course, staffing weaknesses go hand-in-hand with an absence of sector planning. As a consequence, in most countries technical design and even field supervision depend on donor-financed, expatriate staff who leave when their contracts terminate. We have pointed out that this situation greatly reduces the possibility of organizational learning taking place within local agencies officially responsible for irrigation. Even after two decades of external assistance, many African countries have surprisingly little institutional capacity for planning and managing their irrigation subsectors.

3. Project Documentation

For African irrigation, the "literature" such as it is consists mostly of project documentation: preliminary reviews, appraisal reports, design specification documents, donors' performance audits, a sprinkling of trip reports, terminal reports and project evaluations. For most larger projects, several consultancy firms will have been involved. Their reports are user-commissioned. Sometimes individual authors rework their data for academic publication, but much more commonly the reports can only be found in the firm's headquarters or stacked against the back wall of some minor official's office in the recipient agency. Officials receiving this documentation have no incentive to integrate the information into a larger picture; and, indeed, the site and project-specific format makes synthesis difficult. If a report is utilized at all, it will generally be to provide some snippet of factual information which can be incorporated in a subsequent report on the same area or project. In many African countries, the only general collections of such technical materials occur in donor's offices, particularly within USAID and the World Bank.

This background accounts for the thinness of US documentation on African irrigation. The two principal exceptions are US theses based on

African field research and the World Bank's home office collections (to which access is usually restricted). For the bulk of materials on African irrigation, one must travel to company offices in England and on the continent or to library collections in Germany, Holland, London, Paris and Rome where the larger volume of donor-financed activity has originated. In particular, we suggest that there is a need for an inside review of documentation held in the United Kingdom, since British consulting firms have been especially active in Africa.

4. Vertisol Management

Vertisols -- what a lay person calls "black cotton clay soils" -- are found throughout the tropics, wherever soil formation occurs under circumstances of impeded drainage. Such soils constitute an important resource because of their moisture retaining capacity and their differential fertility, not only in Africa but also in India and Brazil (where they are also significant). In the review of technical aspects, it was pointed out that while these soils are difficult to work with light equipment, they are nonetheless the site for most flood basin irrigation of rice in Africa. Depending on the situation, they may be either acidic (highland swamps and coastal mangrove swamps) or alkaline (saline "pans" in closed drainages). The main point is that they react to moisture very differently from the sandy loams prized by plough farmers. With vertisols, canal lining may be unnecessary -- a significant advantage in Africa -- but water control structures must be specially constructed. Also, their high moisture retention may permit preirrigation and the growing of a subsequent, "ratoon" crop. For all these reasons, while vertisols constitute a key resource, they require distinctive engineering and agronomic management. Individual African countries are rarely in a position to tap the continent-wide experience with such soils. We suggest that donor support for exchange of managerial experience, coupled with further research to identify the most cost-effective crop and equipment combinations, would be something AID should consider. Any such exchanges of experience should also draw in irrigation engineers from Egypt, India and Brazil.

51

5. Weed Control

An unexpected finding has been that control of weeds -- terrestrial as well as aquatic -- is a major difficulty within African irrigation. Terrestrial weeds are, of course, usually treated as a farm-level problem, whereas aquatic weeds are seen as a threat to the water management system as a whole. Nonetheless, both types pose a high level of threat to irrigated production. Without repeating the technical arguments about "red rice" and other common weeds, we note simply that the partial completion of scheme works which often occurs provides ideal circumstances for rapid weed growth, just as do tropical canal systems for aquatic weeds. More attention to this aspect is imperative, since there are good reasons for suspecting that under typical conditions for smallholder production the degree of weed challenge may be far greater than is commonly acknowledged.

6. Maintenance

If, as earlier WMS II studies suggest, physical rehabilitation is in effect the provision of "deferred maintenance," then it seems plain that maintenance has been the weak link in many African irrigation schemes. The resulting deterioration is evidenced by inoperable equipment, by weed-choked canals, and by the erosion and failure of physical works. To the outsider, it seems poignant that such expensive irrigation works should be allowed to deteriorate so rapidly in such poor countries. Tractors and pumps which could have served for ten years may have an average working life of two to three years. Some schemes now require rehabilitation before their original loan financing is half repaid. Observations of this nature explain the nearly unanimous agreement that poor maintenance constitutes the single most important unresolved problem in African irrigation. Of course, it is linked to many other issues: recurrent cost constraints, the impact of currency and import restrictions, farmers' alienation or insecurity, improper design, seasonal bottlenecks in labor supply, etc. We reiterate, therefore, a plea made in last year's review of Sahelian irrigation: that this topic should receive top priority within any field research that donors might finance (Moris, Thom and Norman, 1984).

7. Irrigation Extension

As a rule, either irrigation "extension" is derivative from scheme requirements and confined to the project/scheme environment (as in Gezira, the Office du Niger, or Kenya's National Irrigation Board's schemes) or it is totally absent, leaving a void between the water supply section and the usual, rainfed farming orientation of the general extension service (as in Somalia). To irrigate successfully in Africa, farmers require a number of specialized skills: knowledge of how to level their fields, the signs of moisture stress in plants, when to stop watering, control of salinization, interactions between watering and fertilizer use, how to avoid waterlogging and unnecessary erosion, synchronizing irrigation activities with rainfed farming, how and when to do maintenance, the rotation system (if practiced), signs of nematode buildup, and how to recognize and control weed growth. This incomplete listing is sufficient to indicate that there is a fairly large element of skill and local experience needed.

Farmers who have grown up within an irrigated farming system (such as in Gezira or Madagascar) probably acquire most of the necessary skills informally. Elsewhere on the continent, to the contrary, adult farmers who in other respects know a great deal about plant husbandry may nonetheless lack these special skills. Where initial extension and training has been weak, farmers become entirely dependent on scheme management for advice, and they are likely to perform certain key operations (like field leveling) so poorly that yields are greatly depressed. This situation in turn reinforces stereotypes held by managers and staff about farmers' low motivation and interest, setting in motion the issuance of unexplained directview?? which further depress farmers' performance. The need for advance instruction is particularly great when irrigators are former pastoralists, whose traditional way of life differs at almost every point from what is required in irrigated farming.

Hardly anything is known about the actual content of "irrigation extension" as it occurs in Africa. There is an urgent need for comparative data of this nature, since the World Bank is wily-nily imposing its India derived "training and visit" system on most

African countries which accept its financial assistance in the irrigation sector.

8. Intra-Household Economics

Identification of household economics as a "gap" may strike African specialists as strange, since there is a huge literature on the continent's systems of production and exchange. There are even a number of detailed sources on the role of women in African peasant farming. The "gap" is not, therefore, a lack of basic sources, but refers instead to failure to integrate and apply this knowledge within analyses of irrigated farming. In part, there is a gap if we are interested in detailed economic analysis of the irrigated subcomponents within larger arable farming systems. However, there also appears to have been deliberate blindness towards likely production costs, since to have accepted realistic estimates would have wiped out the apparent benefits which were being claimed for irrigation projects. Incorporation of more realistic figures on likely yields, labor costs, time scheduling, etc. would have made it clear that most African irrigation projects have been problematic right from the start.

To understand future irrigation performance, donors must become willing to incorporate actual field data reflecting typical conditions into project appraisals and evaluation. In systems where households are only loosely integrated, allowance must be made for the possibility that returns within the household unit may be insufficient to guarantee the necessary commitment by women and other farm laborers. Analyses must also take into account the opportunity cost of farm labor during the peak bottlenecks so characteristic of African hoe cultivation. Planners must recognize women's strong commitment to achieving food security, and their limited access to credit which forces them to give priority to low input, rainfed cultivation even under conditions of high risk. In short, there are a bundle of agricultural economic issues which require knowledge of patterns of internal household organization within African farming systems. While many of these relate specifically to the woman's sphere, there are also other aspects of a more general nature requiring similar data. Estimation of farm investment potential, labor costs,

livestock economics, locational economics and intra-household distribution requires a type of applied household economics which is not yet available for most settings where irrigation might be considered.

9. US-Based Irrigation Expertise

The thinness of US documentation on African irrigation is matched by equivalent weakness in regard to irrigation expertise. There are only a handful of practitioners in the USA with professional interests in the various aspects of African irrigation. It was anticipated that there might be few US irrigation engineers interested in Africa, but in fact, irrigation economists are just as scarce. Yet, paradoxically, one finds numbers of younger scholars eager to work on applied aspects of irrigation development -- individuals with the necessary field acquaintance and language skills, but usually lacking technical training in irrigation or sufficient support to maintain an active involvement.

Given the lack of senior specialists, it is apparent that AID's future programs will depend upon expanding the numbers of younger professionals in irrigation-related fields. We strongly endorse the concept of "tag-along" assignments, whereby younger workers are funded to accompany the few senior experts on applied assignments in Africa. Another option might be to initiate an exchange program, wherein US graduate students lacking field experience might "fill in" at the host-country level for nationals who come to the USA under long-term training arrangements. Still another need is for establishment of two or three US centers where there is adequate documentation and staff background to provide relevant short and longer term training oriented towards African water management.

The difficulties we have encountered in assembling this report from (mainly) US sources will also apply when efforts are made to train African nationals within the USA. It is clear that US institutions have not paid much attention to African irrigation, and have relatively little to offer when it comes to an integrated, relevant perspective. To give adequate managerial training always requires having at hand a wealth of materials related to the problem: case studies, exercises, description of field constraints, etc. At present this context relevant

to African circumstances is missing within US technical training, which instead perpetuates a bias towards further specialization and "high technology" solutions.

AID Strategy

The message our review holds for AID/Washington may at first glance seem contradictory. African countries will be forced to rely more on irrigation in the future, and -- in view of the low levels of present performance -- have an urgent need to learn how to use irrigation technologies more cost-effectively. Nevertheless, because in most African countries USAID has become a minor donor, we cannot recommend any dramatic increases in AID's direct financial support to underwrite new irrigation projects. Existing African irrigation projects are simply too expensive to warrant receiving scarce investment funds from a small donor. This conclusion is strongly supported by the background papers prepared independently by Vincent, Humpal and Sparling (DATE). It also echoes the World Bank's "Berg Report" (1981:78), and Carruthers' OECD review (1983:15), both of which recommend an initial concentration of attention on improving output from present schemes rather than upon starting new ones.

Instead, the consensus among nearly all expert observers is that first priority within the irrigation subsector should be to strengthen its institutional capacities. As a general strategy, this has the advantage of providing a base for future project funding while also assisting countries to get higher returns from already committed projects. In a few instances where a country is heavily dependent on its irrigation sector (as in Sudan and Somalia), the U.S. Government may find it politically desirable to intervene at the production level, but even in these cases we recommend AID moves cautiously. At present, the USAID system in Africa, both at regional levels and within country missions, simply does not have enough qualified irrigation engineers to plan and supervise an expanded portfolio of irrigation projects. An immediate area for attention should be to expand US technical capabilities for dealing with irrigation and water management issues in African contexts. Thus, improvements in "institutionalization" are

needed in the USA itself as well as in recipient nations.

By "institutionalization," what is meant? Basically, "institutional measures are those which increase the capacity of national, regional and local systems to use irrigation more intelligently. More effective irrigation planning, based on actual field information and realistic premises, is one obvious requisite. Ways must be found to stimulate feedback from the farm and scheme levels. Decision-making procedures themselves need revision, so that once problems are identified they receive prompt and effective remedial attention. An organized capability to provide specialized assistance when individual schemes need help must be created. And, of course, projects must be institutionalized at the local level so that scheme users -- the farmers themselves -- understand what is required and participate to insure the success of their own irrigation.

In reviewing how AID might best render such assistance, we have kept two limitations in mind. First, over the past two decades USAID in Africa has paid little systematic attention to support for irrigation. Very little of value can be found in AID's Washington-based documentation service on African irrigation. When US firms have been active implementing irrigation-related activities (mostly in the Sahel), they have as likely as not employed French Canadians or European engineering staff on those aspects requiring detailed African experience. For East and Southern Africa, USAID has neither the engineers nor the documents required for an upgraded program of institutional support. We must therefore be realistic in assessing which are the areas of comparative US advantage, recognizing that on some desirable topics the US has little to offer. Second, except in a few countries, it is quite unlikely USAID will ever serve as the major donor assisting irrigation. Among other donors, the Dutch, Germans and Japanese are already far ahead and will likely remain so. This situation makes it desirable that AID coordinates its input to take into account what other donors are already doing within the continent. It also suggests we cannot rely upon "spin-off" benefits (participant training, etc.) from USAID's present projects to meet the main need for institutional strengthening. If this becomes AID's goal for the

irrigation subsector, it must be addressed directly.

Taking the above limitations into account, we propose . . . options as suitable areas for immediate AID support:

1. Cooperation with other donors:
2. Incorporation of Irrigation into FSR Projects
3. Scheme and Systemic Malfunctioning
4. RBAs and Irrigation Planning
5. Remote Sensing Applications
6. Women-in-Irrigation-Development
7. Deepening of US Capacity

1. Cooperation with Other Donors

In the short run, AID needs to incorporate the experience of other donors which have been active in assisting African irrigation. In saying this, we do not imply that these countries necessarily have better water management expertise than does the USA. The point is simply that documentation on irrigation consists largely of project reports of one kind or another: appraisal estimates, site surveys, trip reports, managerial audits and terminal evaluations. Such materials are usually commissioned, and rarely find their way into academic collections outside the country where they occur. In Africa, the main donors have been the World Bank, FAO, France and England; supplemented in recent years by the various development banks and funds and newer donors such as the Dutch and Germans. To consolidate Africa's present experience with irrigation, one must start with the agencies and donors who have been doing actual irrigation projects -- and that means going outside the USA (with the World Bank's Washington headquarters being the one notable exception). Our inability in this study to tap these other sources -- except for those in France, which were visited -- was a serious limitation, which probably reduces the general applicability and validity of our conclusions.

Beyond talking to those who have implemented irrigation in Africa, AID should reach a policy decision to participate vigorously in various low level, multilateral activities which are already under way. For

instance, FAO and the Dutch have strongly supported small-scale irrigation in Africa (Underhill, 1984), and FAO is taking the lead also in analyzing women's participation (Dey, 1984). Both kinds of activity merit additional support, and would constitute excellent starting points for a collaborative effort. AID should strengthen its representation at the various regional conferences on irrigation, which have become more important as the number of donors and potential recipient nations have increased. Assistance might also be given to ODI's irrigation network, which has reached a size where to remain effective it must have additional resources. None of these initiatives seem very glamorous, but they have the advantage of bringing US technical personnel into contact with those involved on a day-to-day basis in the planning and field implementation of African irrigation projects. Another source closer to home is the World Bank, which despite its policy pronouncements, remains closely tied to a number of large investments in African irrigation. While liaison between the Bank and AID in Washington has been smooth, for irrigation expertise the Bank has generally drawn on non-US sources. One way or another, AID and its associated contractors must develop direct access to an experiential base on African irrigation before other forms of institutional support become feasible.

2. Incorporation of Irrigation into FSR Projects

Currently AID has under way several farming systems research (FSR) projects in Africa (in Sudan, Tanzania, Malawi, Ruada, Burundi and Botswana, among others). The rationale for these projects has been the need to identify existing constraints and to describe the needs of various farming systems. Similarly, ILCA has sponsored several in-depth investigations of the role of livestock enterprises within the larger farming systems (with regional centers in Kenya and Mali as well as in Ethiopia itself). Then, under AID funding CIMMYT has its East and Southern Africa program, based in Nairobi, but conducting farm-level diagnostic surveys and seminars throughout the region.

Irrigated production exists as a significant option in many of the countries where FSR research is being done. The failure of researchers

to give it explicit consideration probably stems from the fact already noted that irrigated enterprises are often only a subcomponent within larger, non-irrigated systems. Also, early FSR research was preoccupied with rainfed, arable farming to the extent even of ignoring livestock enterprises which were also often present. We suggest that there is no defensible reason for arbitrarily excluding irrigation and livestock aspects from FSR, even in systems where these various enterprises are not tightly integrated.

Adding an irrigation component would thus complement existing FSR activities. From AID's standpoint, since these are already funded projects, some finance might already exist which could be tapped; or, alternatively, a minimal startup period would be needed if it were decided to broaden their objectives by additional funding for attention to irrigation and water management aspects. Several specific changes might be instituted along with such modifications: (a) incorporation of more attention to farm decision-making and intra-household aspects; (b) careful attention to competition between rainfed and irrigated enterprises; (c) analysis of the institutional risk which farmers incur when attempting irrigation; (d) analysis of on-farm labor costs and returns, between enterprises and throughout the season; and (e) estimation of returns from different potential innovations. The value of such information for understanding why irrigation has not been popular is obvious.

3. Scheme and Systemic Malfunctioning

A broad review such as this one, based mainly on a literature search, can only provide rough estimates of systemic performance. Numerous examples were given in earlier chapters to support the conclusion that Africa's irrigation performance is generally far below its design potential. Suggestions were also given why irrigation has been so problemmatic, but here the findings are of necessity more tentative. Only a handful of field visits were permitted; field practitioners were, with a few exceptions, not interviewed; and the engineering component is very poorly covered in the available US literature. It would seen essential, then for AID to further refine the

broad conclusions advanced within this report.

Three possibilities for doing so suggest themselves. First, better coverage of individual scheme experience would seem imperative. There are whole countries not covered in this report (e.g., Angola and Mozambique, as well as most of central Africa), just as there are many interesting schemes where the documentation is not available within the USA. Second, it might be fruitful to look at irrigation systems region by region -- a task fairly well in hand for the Sahel, but barely begun for Africa's other regions. There are pronouced regional differences which are bound to have direct policy implications; and, in any event, AID's own approach to project monitoring makes use of regional REDSO units. Third, it would be productive to look at particular technologies or situations (lakeside pumping; flood rice cultivation; swamp improvement, etc.) comparatively. (Since these constitute a very large agenda for potential action, we stress the need once again to avoid duplicating what other donors may have already begun.)

However obtained, more precise knowledge of the causes of scheme and systemic malfunctioning must be in hand before investments of the usual "institutional building" variety are launched. Public agencies have such an insatiable appetite for conferences, courses, training modules, publications, and the like that we cannot recommend the customary "shotgun" approach to deepening institutional capacity. First, let it become clear what the real reasons for poor performance have been, and <u>then</u> begin packaging remedial interventions.

Of course, gaining such information on schemes which are not USAID-funded will be difficult. Descriptions of main system management and present irrigation procedures are almost entirely missing, and must be created from scratch. In the process, it ought to be possible to learn why maintenance is so poor, necessary skills which farmers lack, and reasons for excluding them from meaningful participation. Informaton will also be required on the bureaucratic aspects of agency operation, and on the performance of necessary support institutions in the external environment.

4. RBAs and Irrigation Planning

As already noted in this chapter, AID could focus assistance for improving irrigation planning within the existing river basin authorities. Here the danger to avoid is to merely duplicate the present pre-investment planning which is already under way for the larger, multinational RBAs like the OMVS. Such projects simply substitute outside planners for local ones; they can become very expensive; and the large number of RBAs opens the door for a never-ending stream of requests. Instead, we recommend AID focus on improving existing methodologies and in-country capacities to do integrated water management planning. Topical attention (conveyed by means of short courses, regional workshops, etc.) might address needs such as development of rapid reconnaissance methods, better integration of soils information, exchanges of experience with regard to vertisols, identification of labor constraints and comparisons between technologies. RBAs might also benefit from manpower analysis and provision of externally assisted training to fill certain priority needs. They are strategically located to monitor environmental impacts, and might welcome assistance to facilitate this important function. In some countries where agricultural engineering has been established within higher level agricultural training, USAID might encourage linkages between training and river basin institutions. Another priority area would be to assist RBAs in evaluating and (where appropriate) organizing technology support to the irrigation subsector. Finally, RBAs should devise their own rating system for measuring scheme and project performance -- a development which might serve as a potent stimulus towards better performance.

In all instances, the goal should be to demonstrate an integrated, multidisciplinary approach in practice. Perhaps AID/Washington could select one or two river basins to serve as pilot areas for the application of more flexible, field oriented approaches -- maybe the Gambia and Juba basins? We assume further details about how such a program should be implemented will be forthcoming from AID's parallel review of four African river basins.

5. Remote Sensing Applications

Until recently, the USA has enjoyed a technological advantage in providing high quality LANDSAT imagery for African natural resource planning. Assuming that the non-military US remote sensing capability remains in the public sector, it offers substantial promise for estimation of rainfall coverage, and hence of irrigation demand. Weather satellite imagery has been drawn upon to provide relatively quick overall estimates of moisture and vegetative growth conditions. No other source can provide equivalent information for such large areas of the continent. We suggest such data should be integrated into a continent-wide "early warning" system, whose forecasts of impending drought would be shared with the countries concerned. In several key countries (from the perspective of US interests) this information, if provided promptly, could trigger a shift towards increased cereal food production in the irrigation sector, e.g., as happened in the Sudan this past year. There are undoubtedly other applications which also merit further refinement, carried out by collaborative teams of US scientisits and host country nationals. One suspects, for example, that spatial and trend analysis of the degree of environmental degradation taking place on the continent will continue to command policy-makers' attention. There is no reason why measurement of broad environmental trends cannot be combined with specific attention to hydrologic aspects. It would be a pity if at just the point where we are learning how to make these technologies genuinely useful, further financial assistance is withdrawn.

The above arguments constitute strong reasons why the US should maintain its present comparative advantage in applying remote sensing to the estimation and planning of natural resources. Of course, should Washington's proposals to "privatize" these publicly funded services be implemented, most LDCs will turn to other non-American sources which are already under development. If, for strategic reasons, the US government must fund such uses of remote sensing anyway, we consider it far preferable that this work is conducted in public where the countries being analyzed can participate and learn from the experience.

6. Women-in-Irrigation-Development

It seems that ultimately many issues in African irrigation revolve around gender-linked differences in farmers' commitment and access to resources. We note that the role of women in African farming is already an academic area where US researchers have a comparative advantage. One thinks immediately of Simmons, Fortmann, Staudt, Peters, Atherton, Jones and Spring (among others). Without recapitulating the points noted earlier in this chapter, we recommend that AID funds a modest "add-on" program targeted specifically at learning how African women participate in and benefit from irrigation. A topical focus on irrigation would give greater practical thrust to AID's present WID commitment, and might constitute justification for added support. The individual studies required would be mostly small-scale, to insure that intra-household aspects receive scrutiny. Perhaps the FAO office working on this topic or the two African REDSO units could provide an organizational base, to which researchers might be attached under a rotating, post-doctoral fellowship.

7. NGOs and the Private Sector

Another option for AID support would be to concentrate on helping the NGOs and PVOs active in African small-scale irrigation. For example, Kenya's small, PVO-assisted schemes reviewed by Kortenhorst have experienced many technical problems. Weber's background paper (1984) for this study cites numerous further examples from other parts of Africa. These suggest that small schemes can be just as problemmatic as large ones if designs are faulty or technologies inappropriate. Given that PVO staff are usually motivated and willing to experiment, helping them resolve technological and organizational problems might give AID access to a wide spectrum of African field experiences at comparatively low cost. There are individuals who have accumulated an in-depth understanding of particular aspects of irrigation development, but one usually finds they focus on only one or two elements of the larger process, and they are not free to advise beyond their own limited circle of projects. An outside organization (such as WMS II) could assist in pooling this valuable experience and making it more widely available.

70

In regards to private sector irrigation within African countries, there is an equivalent need to stimulate sharing of technological experience between large-scale, commercial operators and PVOs or public agencies working with smallholder farmers.

8. Deepening of US Capacity

The eagerness of US institutions for federal funds sometimes disguises the true situation vis-a-vis availability of manpower and resources to undertake requested technical tasks. This seems to be the case in regard to African development. While there are many American specialists with African experience, most are social scientists without in-depth understanding of the technical side of irrigation. Others lack the French or Arabic or Portuguese needed to undertake field assignments. And still others will find the deteriorating security and supply situation daunting. For all three reasons, we identified the thinness of US capacity as a major constraint limiting AID's scope of action in the short-run.

Remedial interventions should address both staffing and institutional resources. On the staffing side, we have suggested more use of "tag-alone" assignments to bring in young professionals who will acquire broadened field experience. This is particularly necessary in regard to the technical specialties (agronomy, irrigation engineering, hydrology, soil science, etc.) but it also applies to irrigation economics and settlement organization. (French and Arabic capability are also crucially important in certain countries, but many potential candidates already have the necessary languages from their initial field assignments.)

In regard to institutional resources, we propose greater use by Americans of London's ODI irrigation network rather than attempting to duplicate this listing of field practitioners. Access to field reports and theses on Africa needs to be improved at the major US institutions which AID intends to involve. Many of the needed resources do exist within the US, but are scattered within institutions which do not have an irrigation emphasis.

Bridging the Gap

This study has aimed to fill a gap in the literature by providing a continent-wide overview of African irrigation experience to date. Our contributors discovered the task sometimes exceeded the means within their reach. Not only is there a major gap between academic sources -- which generally can be located within the USA -- and the many user-commissioned project reports filed away overseas, there is also a chasm separating engineers who design and construct Africa's schemes from the agronomists and administrators who try to make them work. The first gap was expected, but the second one was not. We close this study, then, by identifying several areas where at present effective inter-communication often breaks down:

- Between civil engineers and agronomists (design versus operation);
- Between scheme managers and farmers;
- Between technology suppliers and technology users;
- Between plot-holders and field workers; and
- Between scheme members and surrounding communities.

The WMS II project originated because of concern that field programs would benefit from an integrated perspective, utilizing water management as a unifying device to highlight interconnections between sectors (and hence, between analytic disciplines). The "synthesis" element expressed AID's belief that field projects should not keep repeating each other's mistakes. This review makes it abundantly clear that both concerns are especially relevant within African irrigation. Present organizational structures virtually guarantee a fragmented approach to irrigation, leaving each set of actors in a position to blame others for the obvious faults which abound on every side. And, as a consequence, learning from past experience does not occur. We hope the views expressed in this report will constitute a first step towards a comprehensive understanding which will enable all of those involved to assume collective responsibility and, eventually, to devise more effective solutions.