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IRRIGATION MANAGEMENT NETWORK

ISSUES IN THE TURNOVER PROGRAMME IN INDONESIA:

HOW TO TURN OVER IRRIGATION SYSTEMS TO FARMERS? QUESTIONS AND DECISIONS IN INDONESIA

Bryan Bruns and Sudar Dwi Atmanto

FROM PRACTICE TO POLICY: AGENCY AND NGO IN INDONESIA'S PROGRAMME TO TURN OVER SMALL IRRIGATION SYSTEMS TO FARMERS

Bryan Bruns and Irchamni Soelaiman

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ISSUES IN THE TURNOVER PROGRAMME IN INDONESIA

The following two papers are combined in this publication as they address essentially linked issues of turnover in Indonesia. The first documents the process of turnover, while the second analyses the pivotal role a non-governmental organisation (NGO) has played in assisting the government to develop and implement this process.

HOW TO TURN OVER IRRIGATION SYSTEMS TO FARMERS? QUESTIONS AND DECISIONS IN INDONESIA

Bryan Bruns and Sudar Dwi Atmanto

Abstract: The Indonesian government has turned over more than 400 small irrigation systems to water users. Participatory design and construction of improvements prepare farmers and irrigation systems for turnover. Trained agency field staff facilitate local participation in preparation and implementation of turnover. Water users register their associations. The associations receive management authority *and* ownership rights, for the entire irrigation system including headworks. Questions remain over how to appropriately determine the role for government in assisting turned over systems.

FROM PRACTICE TO POLICY: AGENCY AND NGO IN INDONESIA'S PROGRAMME TO TURN OVER SMALL IRRIGATION SYSTEMS TO FARMERS

Bryan Bruns and Irchamni Soelaiman

Abstract: The Institute for Social and Economic Research, Education and Information (LP3ES) helped the Indonesian Department of Public Works (DPW) to develop and institutionalise methods for turning small irrigation systems over to water user associations. A series of earlier pilot studies had explored ways to improve local participation in design, construction and management of irrigation systems. For turnover, LP3ES trained irrigation staff who worked directly with farmers, trained trainers, provided consultants to assist provincial irrigation service officials in institutionalising new procedures and took part in national working groups which drafted regulations and manuals. Conditions for collaboration in institutional innovation included a willingness to compromise, funding linkages between the agency and NGO, building mutual trust and educated opportunism.

HOW TO TURN OVER IRRIGATION SYSTEMS TO FARMERS? QUESTIONS AND DECISIONS IN INDONESIA

Bryan Bruns[1] and Sudar Dwi Atmanto[2]

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HOW TO TURN OVER IRRIGATION SYSTEMS TO FARMERS? QUESTIONS AND DECISIONS IN INDONESIA

Bryan Bruns and Sudar Dwi Atmanto

1. INTRODUCTION

The continual growth of state intervention has been prominent in irrigation development around the world. Dissatisfaction with poor performance of government management, and abundant examples of irrigation systems managed well by farmers has encouraged increasing interest in turning over management to farmers (Vermillion, 1991).

Turnover to farmers allows restructuring of government activities in irrigation. By reducing expenditure on activities which farmers can carry out themselves, governments can focus their efforts on activities requiring greater financial capability, technical expertise or political authority. Government irrigation agencies can support and work in partnership with self-reliant local irrigation management.

This paper examines some key aspects of the turnover process as developed in Indonesia. It focuses on issues which were particularly difficult to resolve, and decisions which were crucial to shaping the turnover process.

By the middle of 1991 the Indonesian Department of Public Works (DPW) had transferred over four hundred small irrigation systems, covering more than 34,000 hectares, to water user associations (WUAs) in seven provinces. This is part of a long-term policy, developed in 1987, to gradually turn over all irrigation systems smaller than 500 hectares (small irrigation systems) to WUAs. This represents a major shift in previous patterns of government intervention in irrigation. Turnover converts government investments into locally-owned and managed common property.

Small government systems irrigate over 1.5 million hectares in Indonesia. Programmes have assisted these irrigation systems, particularly during the 1970s and early 1980s when Indonesia obtained abundant income from high oil prices. This was part of a relatively successful policy to improve welfare in rural areas and pursue national rice self-sufficiency.

Farmers originally built and managed most small irrigation systems. However, regulations decreed that irrigation systems with any government financial input, however small, become government irrigation systems. Reclassification as government systems could be made if they had received specific government assistance, because they were listed within officially defined government irrigation areas, or simply as part of policy to categorise all systems above a certain size as government irrigation systems. The area irrigated by government systems forms the basis for calculation of budgets for irrigation operation and maintenance (O&M), providing an incentive for agency officials to expand the area of 'government' irrigation systems.

Prior to the turnover programme, the DPW categorised irrigation systems not by size but by the extent of water control structures. Technical systems had, in theory, a full set of measurement and control structures, while semi-technical systems had only some measurement and control structures at the intake. Simple (*sederhana*) systems had no measurement and few control structures. Within this framework DPW treated small irrigation systems as if they were the same as tertiary areas of larger government-managed irrigation systems, ignoring the distinct hydrological and management characteristics of small systems with independent water sources.

Outside these three categories lay village or rural (*irigasi desa* or *irigasi pedesaan*) irrigation systems. These locally-managed systems still received government assistance, particularly from the village subsidy programme and its successors (Hafid and Hayami, 1979). Government intervention converted these systems into government systems, listed in the Inventory of Public Works Irrigation Areas.

During the 1980s, pilot projects demonstrated that community organisers could facilitate farmer participation in the design, construction and management of small and large irrigation systems. Researchers documented the widespread existence and continuing competence of traditional irrigation management institutions. Workshops brought researchers and government officials together to discuss the improved policies to support WUAs and use farmers' competence in irrigation management.

Some government officials and donors worried that the expanding government involvement in irrigation was creating dependency, with the state taking over tasks which farmers could manage. This caused tremendous burden on the budget and perhaps a decline in irrigation system performance. The drop in oil prices in the mid-1980s created a fiscal crisis and the Indonesian government became more receptive to revision of policies and discussion of alternatives.

In 1987 the Indonesian government declared a policy to gradually turn over all small systems to WUAs. This was supported by the World Bank funded Irrigation Sub-Sector Project (ISSP). Turnover of small systems and institution of an irrigation service fee in systems larger than 500 hectares were both intended to improve O&M through greater farmer participation in management and increased accountability to water users.

The turnover programme is managed by the Directorate of Irrigation I (DOI-I) of the Directorate General of Water Resources Development (DGWRD) of the DPW. The Provincial Irrigation Services (PRIS) implement turnover, testing and refining methods. Researchers from the International Irrigation Management Institute (IIMI), Andalas University and Padjadjaran University studied and helped formulate the turnover process. An Indonesian non-governmental organisation, the Institute for Social and Economic Research, Education and Information (abbreviated in Indonesian as LP3ES), helped train government officials and develop and institutionalise the participatory methods used to carry out turnover.

One way to carry out turnover would have been to simply turn irrigation systems over by decree, declaring that they were now the responsibility of farmers, not the agency. A working group, composed of representatives from DPW, IIMI, the Ford Foundation and LP3ES, believed that systematic preparation would make farmers more willing and better prepared to take over responsibility for the irrigation systems. This would strengthen WUAs and give farmers a greater sense of ownership. In most systems government assistance was also given in physical improvements such as building new division structures, flumes and canal lining.

DPW prepares for turnover through a linked sequence of activities: field inventory, preparation of a profile with social and technical information, design and construction of improvements. These activities also teach irrigation field staff about both technical and social conditions in the field, and a greater ability for participatory work with farmers.

2. INVENTORYING IRRIGATION SYSTEMS

Which irrigation systems are suitable candidates for turnover? What preparations are necessary before turnover? An inventory gathers basic information on irrigation system conditions and management, which government records usually do not contain. It was initially planned that farmer-managed systems, with little or no government involvement, but listed as government systems, would simply be reclassified as non-DPW irrigation systems. No improvements would be made or WUAs formalised.

However, as the project evolved, there were strong pressures from DPW to make all systems eligible for physical assistance and to register WUAs for all sites before turnover. Officials argued that it was unfair not to help all farmers, and that systems without previous government help were usually in worse condition. These arguments fit both good intentions towards farmers and DPW's self-interest in increasing construction budgets. DOI-I officials felt it would be confusing to have some systems turned over without any formal WUA in place. Once the DGWRD officially established policies on construction and WUA development, then almost all systems became eligible for improvements.

In many cases the Public Works Inventory of Irrigation Areas records several distinct systems with separate diversion structures as a single irrigation area (*daerah irigasi*). PRIS officials may have lumped systems together for administrative convenience and to increase the area used as a basis for O&M budgets, and so obtain more budget. The consequence is that the area covered by small irrigation systems is much larger than it initially appeared. According to 1985 records, such systems covered about 900,000 hectares. However, the provinces of Central and East Java have disaggregated irrigation areas and, based on their results, it seems likely that small government systems in Indonesia cover a total of more than 1.5 million hectares. The PRIS can desegregate systems as part of the inventory process.

Inventory enables categorisation of irrigation systems for eligibility for construction improvements (Figure 1). If systems are in good condition, have no government involvement in O&M, and contain no government built structures (Group A) PRIS can directly reclassify them as village irrigation systems after a WUA has been registered. However, the PRIS have included very few systems in this category and none have been turned over yet.

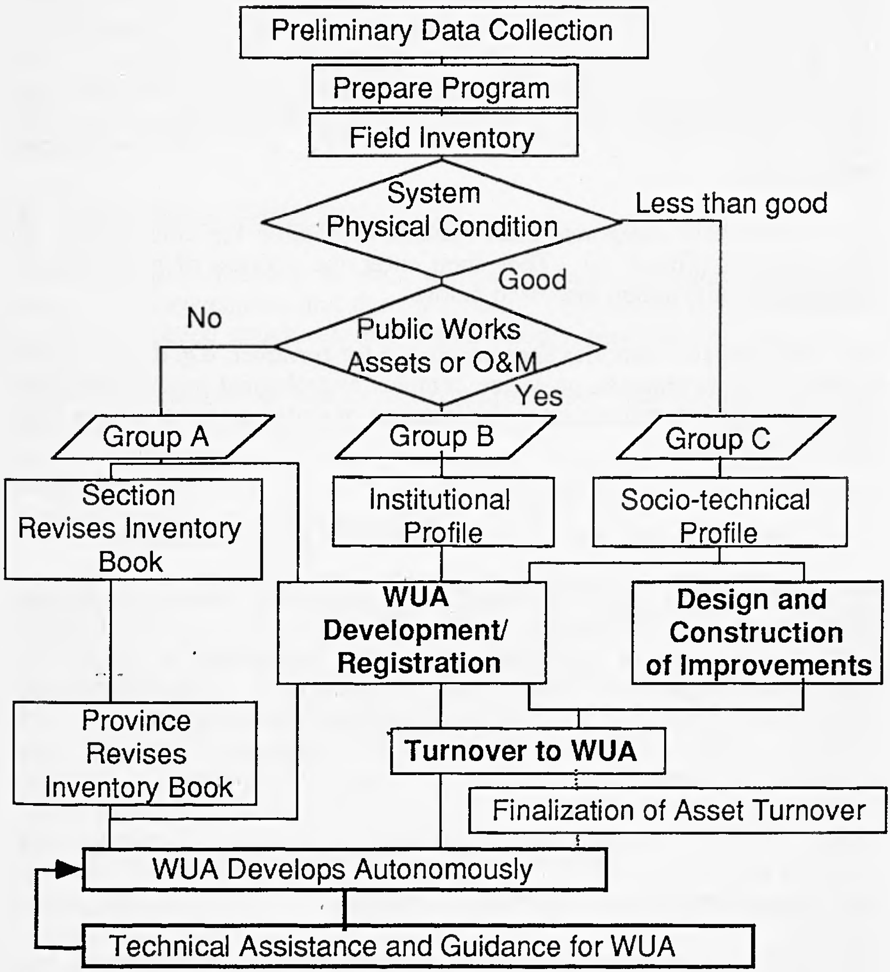

Figure 1: Sequence of Turnover Activities

Systems in good condition but with government-built structures or government involvement in O&M (Group B) require WUA development. Most systems in this category are sites improved by the Provincial Irrigation Projects in Java. However, more thorough consultation with farmers showed that farmers want further improvements before accepting turnover. Often designers did not consult farmers in planning earlier improvements, and improvements did not assist all parts of the systems equitably. Because of these issues, some provinces have obtained funds for additional improvements.

In fact the PRIS categorise most systems as eligible for construction of improvements (Group C). They then enter the process of participatory design and construction discussed below.

The inventory still identifies sites unsuitable for turnover, e.g. due to highly expensive improvements, or where complex hydrological interconnections between irrigation systems or multiple usage of water makes turnover to a WUA inappropriate.

3. AGENCY FIELD STAFF AS COMMUNITY ORGANISERS

The PRIS recruits irrigation inspectors to work with farmers as Farmer Water Manager Guides (abbreviated as TP4 in Indonesian). They learn to carry out the role of community organisers, functioning as mediators, catalysts and organisers. Public Works officials chose to use agency staff, rather than recruiting new community organisers. In earlier projects it had not been possible to provide funds to retain community organisers once special donor funding ended. The scale and rapid expansion of turnover would have made the recruitment of new staff difficult. If existing staff learn to work with farmers in a participatory way this should prepare them to better guide and assist WUA after turnover. These skills should also help in working with WUAs in government systems.

TP4s need special training in skills of communicating with farmers and developing WUAs because their previous work was primarily technical. Experience is that most TP4s work satisfactorily, given sufficient training and support (Helmi and Vermillion, 1990). Other factors, including travel distances, transport facilities and personal motivation, are more important in ability to perform well than educational background.

Some TP4s still take a top-down approach in working with farmers, so that supervisory visits are very important for strengthening their capacity for participatory work. Some TP4s also need support for specific activities such as organising meetings. Both section level turnover coordinators and subsection heads, the immediate supervisors of TP4s, can provide this support. Many TP4s state that the participatory approach is more enjoyable than their previous working style, which mostly involved keeping records.

4. FARMER DESIGN REQUESTS

To tailor improvements to farmers' wishes TP4s ask farmers about required irrigation improvements and their priorities. They sketch the location and form of proposed structures, and prepare design requests together.

Farmer representatives and design engineers then hold design integration meetings to discuss improvements, preferably at a site close to the irrigation system. PRIS officials held some meetings at subdistrict or irrigation section offices, but this did not facilitate communication because farmers felt inhibited in discussion at a government office.

Sometimes designers did not follow through on agreed improvements and changes made without explanation confused and upset farmers. Notifying farmers of changes and the reasons for them is a very effective way to prevent subsequent problems. The design requests and design integration meetings provide explicit mechanisms for giving farmers input into the design process, and should enable designers to base improvements on farmers' aspirations and experience.

5. DESIGN AND EXPENDITURE GUIDELINES

Small irrigation systems have specific characteristics which differ from larger systems. Structures are usually simpler; flows are highly variable, and they are often located in mountainous areas. DPW had no existing manual for design of small irrigation systems. It became clear that some consultants did not have the skills for designing relevant improvements. Many structures were larger or more expensive than necessary, sometimes inappropriate scaled down versions of large systems. As a result DOI-I, PRIS, LP3ES and consulting engineers formulated a manual for design of improvements to small irrigation systems. The manual also clarifies the sequence of activities through which farmers participate in preparing the design. It also supplements rather than replaces existing government design and construction guidelines for irrigation systems.

5.1 How Much to Spend?

Expenditure needs range from small amounts to complete rehabilitation or upgrading of the entire system. The World Bank Loan provided about US$ 100 per hectare for design and construction, as it wanted a clear and easily implemented limit to spending. This rate matched initial levels of funding for special maintenance of large irrigation systems, although the actual works in small schemes were significantly different.

Once implementation began the design requests usually exceeded the available budget, and agency officials argued that the per hectare level of funding was inadequate. Initially, some provinces allocated money evenly on a per hectare basis. It was suggested that PRIS should allocate according to need, giving more to sites in poorer condition.

The most expensive improvements are for headworks, especially building or improving concrete or gabion weirs, a frequent request. Farmers want to reduce time spent rebuilding after their temporary weirs are damaged by floods. Construction of permanent weirs is a familiar activity for agency officials, and one where their expertise is clearly relevant. However, their greater experience in relatively flat areas accustoms them to irrigation systems where diversion and division of irrigation water are the principal irrigation tasks. Many small systems lie in the upper watersheds, with relatively abundant supplies of water. Simple, cheap structures are often sufficient to divert water. The economic value of the time spent rebuilding the weir each year is low, compared to the cost of building a permanent structure. Unstable hilly environments with fluctuating river flows mean that seemingly permanent structures prove to be quite impermanent. Long-term sustainability comes not from permanent structures but from local capability to perform routine maintenance and periodic repair (Murray-Rust and Vermillion, 1989).

In such areas, the main problem is not diverting water into canals or dividing scarce flows but *conveying* water along steep and unstable slopes to reach paddy fields. Rather than new headworks, construction of canal lining, flumes, siphons and overflow structures to divert excess run-off away from canals may be more appropriate. The need for lining is itself difficult to assess accurately. At some sites lining is obviously essential to prevent erosion and reduce water losses. At others lining yields few real benefits, only simplifying maintenance and making the canal look prettier or more orderly.

Cost-benefit analyses of the small improvements built by the turnover project are difficult, especially in advance, and DPW engineers prefer to use technical criteria in deciding improvements. However, examples soon emerged of over-expensive improvements, and works which could not be justified by resulting benefits. This created a strong argument against increasing funding norms.

Many farmers stated that even with a lower level of funding per hectare they would still have accepted turnover. However, longer lists of requests could have been given with higher norms.

The earlier level of US$ 100 per hectare for design and construction costs has continued. Construction of new permanent headworks is outside the scope of the project, and sites needing expensive construction should be funded from other sources before entering the turnover project.

5.2 Contributions to Construction

Farmers' participation in construction strengthened their sense of ownership of the irrigation system. Options included the hiring of local labour for construction work, purchase of locally supplied materials and unpaid local labour contributions. As the project evolved, IIMI and the World Bank strongly recommended unpaid local labour contributions as a requirement, to complement government-funded improvements. These efforts to increase participation in construction, however, encountered several obstacles.

Construction by contractors or agency 'force account' (*swakelola*) began at turnover sites during the 1989/1990 fiscal year. In August 1989 the DGWRD declared a policy which forbade mixing government-funded improvements with those built through local self help. This policy did not forbid voluntary contributions, but required making them separately, to avoid problems concerning accountability and inspection. The policy also required paying labour and purchasing materials at full prices in government funded work.

This contrasted with a common practice where the WUA would provide labour and receive a percentage of the construction payments to fund its activities. Similarly WUAs sometimes supplied local materials or labour at a lower price to enable a greater volume to be purchased. These mechanisms could encourage local participation and increase productivity. However, DOI-I officials worried about the danger of misunderstanding and subsequent problems.

WUA leaders and TP4s tried to obtain a consensus on arrangements for WUA to receive a percentage of labour payments. However, it could not be ensured that everyone understood and agreed with the arrangements. This created the danger that later individuals could raise questions about not receiving full payment. There was also concern that incorporating local contributions could delay completion of construction. These concerns of administrative complications and problems were a major factor behind the decision forbidding WUA to mix voluntary contributions with government-funded improvements.

One suggestion was that government could provide materials only if farmers provided all the labour, thus reducing problems in accountability and inspection. However, DGWRD officials claimed that this approach was not feasible under existing regulations.

World Bank officials repeatedly suggested introducing a requirement for a specific percentage contribution from farmers, to help control costs by making farmers more aware of and responsible for costs. DPW officials strongly opposed this idea arguing that it could delay completion of the activities within a specific budget year. It would also have required much greater transparency of agency budgets and expenditure. A related issue was the degree to which contributions would be voluntary. Inclusion in the turnover programme was not voluntary, but rather the result of a government decision. Agency officials did not want to have to force farmers to follow through on commitments to contribute.

One alternative would have been to require farmer contributions towards any improvements, but allow farmers to choose to receive the system without improvements if they did not want to pay. DPW officials rejected this alternative as unfeasible. Farmers did contribute to construction, but to a value of usually less than 5% of government funding. Farmers in the Philippines, Thailand and Nepal contributed much higher levels in similar irrigation projects. Farmer labour contributions in turnover in Indonesia were mainly in earthworks, such as cleaning and straightening canals (normalisation), lining canals and building additional division structures.

The result of extensive discussions was that the Second Irrigation Sub-Sector Project (SISP-II) would in principle encourage contributions, but not require a specific percentage. During the first ISSP contractors or agency officials did make extensive use of local labour and locally purchased materials. However, the requirement to keep such self-help contributions physically separate from government-funded improvements greatly constrained the scope for additional voluntary contributions from farmers.

5.3 Redesign During Construction

One unanticipated development has been the extent to which farmers could make design adjustments during construction. In hindsight this is a clear consequence of farmer participation during earlier phases of design.

When construction began, farmers often felt the designs were not appropriate. Sometimes this reflected physical changes such as landslides and erosion since the design phase. At other times the final designs differed greatly from farmers requests and they insisted on the improvements they had asked for. Sometimes farmers' participation in design had been somewhat speculative. Once construction was certain, they requested additional changes, in part because more people became involved.

It was possible to incorporate many of the changes requested, as at most sites the construction budget was specified on a unit price basis. The contractor (or agency for force account) was responsible for providing the specified level of inputs, and the specified volume of works, leaving significant flexibility in the form these took. Mostly farmers asked for minor changes in location or shape of structures, although sometimes materials originally planned for structures were used for increased lining.

5.4 Contractors or Agency *Swakelola*

The PRIS can tender construction to contractors or build directly by *swakelola*. Officials responsible for the turnover project initially tended to use contractors. LP3ES staff and many farmers doubted whether contractors could work in a participatory way, and favoured the use *swakelola*.

Agency officials objected that *swakelola* was more complex to administer. This was particularly a problem for provinces outside Java with fewer and less qualified agency staff. Workers hired under 'force account' had to sign for every day worked. Many copies of forms had to be filled out and then checked and approved by several levels of officials. In addition, provincial officials usually handled contracting, but section level officials implemented *swakelola* construction. Thus, the potential benefits and burdens of the two methods differed for officials at different levels.

As implementation continued, it became clear that high levels of farmer participation were possible even with contractors. The level of supervision by agency officials was important, and the most crucial element was holding preparatory meetings between the contractor, WUA leaders and agency staff to discuss arrangements for hiring local labour and purchasing local materials. The final conclusion seems to be that local participation in construction can occur either through *swakelola* or contracting, but it is essential in either method to consult with farmers at the beginning of the construction process over use of local resources.

5.5 Improvement for O&M

The decision to make almost all systems eligible for improvement has increased the potential cost of turnover. This, combined with the dramatic increase in the area recognised as covered by systems under 500 hectares, means that at the rates planned for ISSP-II it would take over thirty years to complete turnover.

Also, there are many sites where farmers are not aware that their system had been classified as a government irrigation system. In these cases, technical and organisational changes before turnover have the potentially counterproductive effect of increasing government intervention and causing changes in existing farmer management.

The policy requiring separation of voluntary contributions from government-funded improvements discourages local contributions. Government-funded improvements have resulted in lined canals, and replacement of simple wood or bamboo division structures with permanent concrete structures. It is less clear how much impact these improvements have on reducing the burden of O&M or increasing agricultural production and farmer welfare.

Some sites clearly show increased production. At others, little seems changed, except that the system functions more smoothly and looks more orderly. The potential for increasing the impact of improvements seems to lie in focusing more clearly on improvement of not just overall irrigation system *condition*, but specifically on overcoming constraints to increased agricultural production (Murray-Rust and Vermillion, 1989). On the other hand it can be argued that the current process does improve conditions and, except in extreme cases of over-design or poor construction, does reduce the O&M burden transferred to farmers.

6. WATER USER ASSOCIATION DEVELOPMENT

Government policies concerning formal WUAs take place in the context of Indonesia's long heritage of diverse local irrigation institutions. There are still large gaps between existing local practices, often informal and episodic, and the framework for WUAs prescribed by national policy (Korten, 1987b; Bruns, 1990).

A 1984 Presidential Instruction gave guidelines concerning formation and responsibilities of WUAs, its officers and their duties. It allocates responsibility for WUA guidance among the Ministries of Home Affairs, Public Works and Agriculture, while a 1987 government regulation assigns responsibility for registration of WUA to district heads. Most provincial governors have issued decrees concerning WUA development and some provincial legislatures have passed laws concerning irrigation.

This gives the WUA some formal legal status so that it can receive management responsibility and government assets. However, the most important activity is strengthening WUAs through substantive involvement in the process of design, construction and preparation for turnover. The inventory and profile activities help the TP4 learn about existing irrigation management: who the leaders are, what irrigation tasks are done and how often, how activities are organised, and the history of efforts to develop formal WUAs in the area. The level of support and supervision TP4s receive strongly influences their frequency of visits, and whether they only concentrate on talking with existing local leaders and holding few meetings.

After the design meetings have established improvements, WUA leaders, village officials, the contractor (or agency official), and DPW staff meet to decide the roles for farmers in construction. WUA leaders coordinate the participation of members in construction and supply of materials. The TP4 then works with WUA leaders to help them plan the management of the irrigation system after turnover. Planning encompasses current management practices, the government tasks to be taken over by farmers and written guidelines on O&M. Farmers in water scarce areas tend to be more interested in improving irrigation management. In water abundant systems, farmers tend to continue current, less formal, management patterns.

The WUA must have a constitution and by-laws. The WUA must inform village and district heads when it has drafted these. Then the WUA submits them to the district head for formal registration. These should be based on existing customs and rules employed by farmers, to facilitate implementation by the WUA. However, there is a tendency to copy standard sample examples, with little or no adjustment for local conditions. In response to this problem DOI-I and LP3ES are preparing a flexible format for constitutions and by-laws which can be fitted to the existing conditions.

It is uncertain how long WUAs registered under the turnover project will persist. A study (Aziz et al, 1991) of WUAs formed ten years ago by the Sederhana Irrigation Systems Project showed that almost none had survived as formal organisations. Farmers continued to use traditional institutions to operate and maintain the irrigation systems. If the government provides little continuing field support and offers few advantages for registered WUAs, then prospects for their survival are poor.

The turnover programme can be analysed as attempting to synthesise two conflicting approaches to farmer organisation. One approach stresses that farmers already effectively organise themselves for irrigation management through informal or 'traditional' organisations. Thus turnover largely amounts to a process of recognising and legitimising existing farmer management. In Indonesia, high cropping intensities are perhaps the clearest physical indicator of the effective performance of many farmer-managed systems. As the turnover programme progressed it became clearer that dependence on government in irrigation O&M, if it existed at all, was only a problem in a very small number of systems. Even in systems with government gatekeepers, farmers still played the primary role in distributing water and maintaining canals.

The other approach is to assume that farmers need government assistance in improving irrigation management. This may be due to the need for an outside authority to enforce sanctions. Effective local institutions may have been weakened by commercialisation, disrupted by government intervention or undermined by other social changes. Growing competition for water may require more intensive management. Farmers may be able to benefit from exposure to new ideas concerning irrigation management. Government efforts might encourage more equitable distribution of the benefits of irrigation and counteract the attempts by local elites to gain an unfair share of benefits. Government may be able to facilitate local collective action which would otherwise be unlikely to occur. This approach stresses the need to train farmers and strengthen WUAs as part of the turnover process.

Indonesian government policy is framed in terms of the importance of state control and guidance. Written official policies and guidelines for turnover mostly reflect this paradigm, assuming that farmers need to be guided to behave in ways determined by the government, suggesting a highly interventionist approach to developing WUAs.

However, the rapid expansion of the project and the limited resources available for organisational efforts have meant that in practice the programme assumes farmers are already quite competent in managing irrigation. The principal thrust of the programme has been one of providing a modest amount of assistance for physical improvements to accompany the formal turnover of management authority and assets to farmers. If particular WUAs have problems, then they are supposed to receive extra attention. However, all systems go through the turnover process at roughly the same rate and are turned over according to the same schedule.

7. TURNOVER

WUA development, and participatory design and construction prepare for turnover. Decisions had to be made as to what and how to carry out turnover.

7.1 Headworks

Under Indonesian government policy farmers were already officially responsible for managing tertiary level activities. The government took responsibility for primary and secondary canals and the first fifty metres beyond the outlet.

Headworks are more complicated to operate than canal structures. However, in practice, farmers already operate many weirs as many sites do not have government caretakers. At other sites the DPW employees have informally given farmers the keys needed to operate gates. This is not just a matter of laziness or very low wages, it is also a practical issue of who can best operate the system, especially if heavy rains, perhaps during the night, require a rapid response and the irrigation staff do not live nearby.

If farmers did not receive responsibility for headworks, then turnover would mean relatively little change. Keeping headworks under government control could lead to assignment of staff to manage headworks at sites without caretakers. It would maintain substantial ambiguity in division of responsibility between government and farmers. It could leave the government responsible for headworks even in very small systems irrigating ten hectares or less.

The final decision was to turn the entire system, including headworks, over to farmers. DOI-I officials hoped that this would make WUA more fully responsible and avoid confusion and overlap. However, in systems over 150 hectares with more complicated headworks, staff responsible for headworks are being transferred in a phased manner. This is intended to give farmers time to develop their capacity to maintain and operate such larger weirs. Senior DGWRD officials in Jakarta have also been extremely hesitant about turning over systems between 150 and 500 hectares in size. For ISSP-II the emphasis will continue to be on turnover of systems under 150 hectares. However, during ISSP-I DPW turned over two larger pilot systems and will turn over more during ISSP-II.

7.2 Assets or Only Management Authority

Another question was whether to transfer ownership of the assets to farmers or only transfer authority to manage the system. If the assets continued to belong to the government then the irrigation officials would continue to be ultimately responsible for them and liable if problems occurred. Authority and responsibility would not match, and turnover would not represent a significant change from existing policies where farmers were already in theory responsible for operation and maintenance of tertiary areas.

DGWRD decided that existing laws provide WUAs with suitable status as legal bodies to receive ownership of irrigation system assets, if the WUA had first been registered with the district level government.

The Minister of Public Works has the authority to make such an ownership transfer with temporary status. Permanent change of status and deletion of the irrigation system from the inventory of government property requires approval by the Finance Minister. The intention is to eventually complete this process. However, DGWRD regards the current turnover process as adequate to give WUA full control of the systems and considers subsequent changes to be an internal matter within the government.

7.3 Ceremonies

For each province the DGWRD symbolically turned over irrigation systems in ceremonies attended by Provincial Governors, senior officials, WUA representatives and administrative representatives from each district. Some separate turnover ceremonies were also held at the district level. The ceremonies confirmed that turnover actually was occurring and publicised the project, but also required a substantial amount of time and money for preparation.

The choice of a site where an earlier project had already made a high level of investment showed willingness to turn relatively elaborate systems over to farmers, but may have also raised expectations about the level of government investment available, and what condition irrigation systems should be in before turnover. This may have been one factor which encouraged some provinces to request amounts of funding beyond that budgeted for turnover improvements.

8. GUIDANCE AND ASSISTANCE AFTER TURNOVER

The Ministerial Ordinance on Turnover outlines the government's role after turnover. The government retains authority over water resources, meaning it can determine how much water an irrigation system can divert. The government should provide guidance to WUAs and can provide physical and technical assistance for work beyond the capacity of farmers. Working these issues out in practice is much more complicated and is still under discussion.

In theory any diversion requires approval from the government. In practice provincial governments do not apply this process for agricultural water use. Where conflicts over water occur, officials deal with them on an *ad hoc* basis, often having little information about the number and history of irrigation systems in a watershed.

After turnover, systems have the same status as village irrigation systems. The government has a mandate to provide guidance to all irrigation systems, but in practice DPW has worked primarily with government systems. DPW officials are currently discussing the need for an irrigation extension position, whose duties might concern village irrigation systems as well as government-managed systems.

Monitoring the performance of turned-over schemes is important to identify what lessons can be learned and what government assistance is necessary. Under the ISSP-II, LP3ES will act as a consultant to the Department of Public Works to help develop methods for participatory monitoring of turnover. This will include methods for WUA self-assessment, monitoring of turned-over systems and participatory monitoring of training.

In principle the government should provide assistance for problems beyond the capacity of WUAs, for example, natural disaster damage. Government officials often lack clear guidelines about responding to local requests for help. There is a danger of encouraging unrealistic expectations from WUAs about government help, and discouraging initiative and self-reliance within the WUA.

Evaluation of farmer management after turnover may be complicated by the absence of economic evaluation in planning for improvements and lack of requirements for local cost-sharing. Once farmers are responsible for management they will probably allow unproductive and uneconomic structures to decay rather than waste time and money on repairing them (Ambler, personal communication).

In practice farmers will have to make urgent repairs themselves because the government cannot respond quickly enough. In the future it might be possible to enhance local resource mobilisation capacity by allowing WUAs to borrow money and repay it through collections from water users. The goal of turnover is not to abandon small irrigation systems but to make efficient use of scarce government resources and encourage local self-reliance.

9. STAFF READJUSTMENTS

Staff readjustments are being carried out, but the difficulties have slowed both the pace of implementation of turnover, and the spread of the project across a larger number of areas.

Staffing levels for irrigation O&M vary greatly between provinces. Irrigation inspectors and many system-level staff are responsible for several irrigation systems, and so can shift their attention to systems which have not been turned over. Some can transfer to nearby larger irrigation systems. Others may retire early. However, often they are local residents who cannot easily move, and who rely on other activities to supplement the low pay they receive. Sometimes the WUA is willing to pay them to continue working, but usually cannot afford to pay even current salaries.

Many system-level staff are daily workers without official right to permanent employment. However, there are moral commitments, and for DPW bureaucracy, reducing staff is threatening. In some areas, turnover implies that the PRIS may have to restructure subsection or even section offices. Even if irrigation inspectors continue in the same locations their duties will change dramatically.

The differences between provinces in staffing intensity and in area irrigated by small systems seem to be a major influence in levels of support or opposition to the policy of turnover. Provinces with a high proportion of small systems are more reluctant to carry out turnover. Provinces with fewer staff placed in, and lower areas of, small systems tend to favour turnover of small schemes and concentration on improved government O&M in larger systems.

It is not yet clear to what extent staff or other resources freed by turnover will shift to other activities, such as river basin management or improved O&M in larger irrigation systems. The government can focus its scarce resources where it has the strongest comparative advantage, particularly tasks requiring a high level of technical skill, funding or political authority. A tendency is for agency officials to suggest that irrigation inspectors and other staff above the system level should stay in the same area but provide more guidance and assistance to village irrigation systems.

10. CONCLUSIONS

The turnover programme shows that it is possible to shift responsibility for irrigation systems from government to farmers. In the Indonesian case factors which encouraged policy change were a fiscal crisis, encouragement from donors and a series of research and action projects showing farmer capacity in irrigation management.

For farmers the most immediate benefits from turnover are physical improvements to irrigation systems. Turnover legitimises water users' roles in managing irrigation systems, and it gives them more explicit authority over the irrigation system. Farmers may have to pay for O&M if they take over work from government staff, or if the WUA undertakes additional O&M activities. In most systems farmers already do most of the work of maintenance and distribution, so the additional expenses in time and money accompanying turnover should not create a great burden.

Nationally turnover offers the prospect of reducing government expenditures on O&M of small systems, and establishing a better division of labour between government and local communities. Turnover reverses the process of government takeover of farmer-managed irrigation systems, blocking one route for bureaucratic growth. Thus, unless there is strong backing from policy-makers and donors, it is unlikely that such a policy will be able to overcome bureaucratic interests in maintaining the status quo and seeking growth in budgets and staff.

By the middle of 1991 the government had transferred over four hundred irrigation systems covering more than 34,000 hectares to farmers. During the next four years the government plans to transfer systems covering another 150,000 hectares. If the government persists with the policy of improving almost all systems then, at current rates, turnover would take more than thirty years.

Indonesian experience suggests that turnover is most likely to succeed if begun by involving farmers in design and construction of irrigation system improvements. In countries where government involvement is relatively small it may be worth considering whether the government can simply turn systems over by administrative reclassification. However, if the irrigation bureaucracy is powerful, as in Indonesia, it may be more feasible to accept the principle of making some improvements to all systems. The priority would then be to match investment to needs and potential benefits, with only token amounts for systems already performing well compared to nearby systems.

The Indonesian experience is more ambiguous concerning the role of formal WUAs. Formation and official registration of such associations is clearly possible. However, as long as such formal organisations offer few practical benefits for farmers it is unclear to what extent they will actually improve on existing irrigation management institutions. If the government can legally transfer ownership and management authority to existing indigenous organisations, then this might be preferable. Policy should ensure that such organisations can take on additional responsibilities, if and as needed, for example to make contracts or borrow money (Korten, 1987b).

Compilation of specific procedures has enabled local participation. However, adequate support in terms of training, guidelines and procedures, coaching, backstopping from other staff, and logistic support (e.g. travel funds) is essential.

The turnover project shows that government intervention need not result in a loss of local control. Turnover can restructure the balance between government and local roles to restore a greater role for local ownership and management of resources.

FROM PRACTICE TO POLICY: AGENCY AND NGO IN INDONESIA'S PROGRAMME TO TURN OVER SMALL IRRIGATION SYSTEMS TO FARMERS[1]

Bryan Bruns and Irchamni Soelaiman[2]

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[1] A longer version of this paper was presented at the Asian Regional Workshop on NGOs, Natural Resources Management and Linkages with the Public Sector, 16-20 September 1991, Hyderabad, India, organised by the Overseas Development Institute, the Indian National Academy of Agricultural Research Management and the Administrative Staff College of India. A copy of the paper is available from Bryan Bruns.

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FROM PRACTICE TO POLICY: AGENCY AND NGO IN INDONESIA'S PROGRAMME TO TURN OVER SMALL IRRIGATION SYSTEMS TO FARMERS

Bryan Bruns and Irchamni Soelaiman

1. INTRODUCTION

Government agencies, donors and researchers are paying increasing attention to the potential contribution of non-government organisations (NGOs) in developing new agricultural technologies and supplementing government research and extension efforts (Wellard, Farrington and Davies, 1990; Farrington and Biggs, 1990). The Indonesian programme to turn over small irrigation systems to water user associations (WUAs) shows how an NGO can go beyond being an intermediary between government and farmers, and instead help a government agency change its standard operating procedures in order to recognise and enhance the role farmers can play in irrigation management.

An Indonesian NGO was involved in formulating and implementing turnover activities. The Institute for Social and Economic Research, Education and Information (LP3ES) was founded in 1971 by a group of activist Indonesian intellectuals. Their concerns were widespread poverty, lack of attention to basic rights and the dearth of institutions active in social and economic development. The birth of LP3ES coincided with the government's first five-year plan, which relied on a centralised, technocratic and top-down approach to development.

LP3ES' founders sought to promote the advancement of social science knowledge for development. They wanted to train young people to become key actors in development. They hoped to create an alternative model of development capable of mobilising popular participation. The Frederich Naumann Stiftung, a German NGO, provided financial and technical help for ten years to help LP3ES achieve these objectives.

In the 1970s LP3ES worked in development of religious schools, people's handicrafts and integrated community development. LP3ES carried out field research and distributed information through training, forums and publication in journals and books. Community development became a vehicle to try out models in a learning process together with the people. Government organisations could then disseminate new approaches in wider and more effective ways.

LP3ES is now a relatively large NGO in Indonesian terms, with a staff of over 100 people. It is an example of what David Korten (1987) refers to as a third generation NGO. LP3ES directs its efforts not simply at relief or local community development, but at working with and seeking to change government activities. Transferring management of small irrigation systems back to farmers contains elements of a fourth generation strategy to expand the role of people's organisations in development (Korten, 1990).

2. BUILDING NGO CAPABILITY

LP3ES had been involved in irrigation support and development in four programmes prior to the development of turnover activities.

(a) LP3ES acted as trainers and facilitators in a programme using community organisers (COs) to improve farmer involvement in the *Sederhana* schemes. These schemes were initially developed in unirrigated areas in the 1970s, but gradually the project included sites where farmer-built schemes already existed. LP3ES recruited, trained and monitored the organisers and facilitated workshops with government agencies. The Department of Agriculture, Department of Public Works (DPW) and Department of Home Affairs participated in the pilot project.

(b) During its first and second year plans, the government constructed the infrastructure of several large projects, expecting the farmers to build the tertiaries. However, few schemes developed local distribution systems, and the government invited three institutions to collaborate in a pilot programme of assistance 1981-86 funded by the Ford Foundation. Two universities researched hydrological and social issues, and LP3ES became trainer and monitor of the COs. The three met monthly, with the Directorate of Irrigation (DOI) as coordinator.

(c) Little information was available on indigenous irrigation systems and the implications of government intervention. Research was funded by the Ford Foundation at three provincial universities. LP3ES helped monitor the study and facilitate workshops at the provincial and national level. LP3ES also mediated between government officials and university researchers to help interpret sensitive research results, so that they would be accepted and would provide an agenda for change.

(d) In 1984, a policy was adopted to develop WUAs, but many government officials felt the need for refinements to guidelines. The Department of Home Affairs in collaboration with LP3ES conducted a study of the roles and functions of WUA from 1986-90 in five provinces. The National Planning Board, Provincial Planning Boards, Department of Agriculture and Department of Public Works also took part in the project. In this project LP3ES carried out a new role as facilitator for an inter-ministerial study and helped transmit results from the provinces back to the centre. The methods used by the project helped to build a consensus on the need to give WUAs stronger status, so they could enter into contracts, open bank accounts and take other legal action.

Thus, during the 1980s LP3ES built up experience and credibility in dealing with the institutional aspects of irrigation development (Tobing 1989, Dilts et al, 1988). LP3ES staff developed a network of contacts and shared experience with irrigation officials at the national and provincial levels and with university researchers. Action research, process documentation, working groups, policy dialogue and other techniques were refined as means for collaborating in the development of methods for involving farmers in the design, construction and management of irrigation systems.

3. THE TURNOVER PROGRAMME

Turnover was a new activity which required developing and refining new methods and training staff. The Ford Foundation provided funds for the Directorate of Irrigation I (DOI-I) to contract LP3ES as social and institutional consultants. Through 1989, the International Irrigation Management Institute (IIMI) conducted research and made recommendations concerning the turnover process. In 1990/1991 the Institute for Agrobusiness Development was responsible for research and documentation of turnover, using university staff who had worked in IIMI's research. Engineers from government-owned consulting companies assisted the Provincial Irrigation Services (PRIS) in the design and construction of improvements.

A working group formed in 1987 from staff of DOI-I, the Ford Foundation, IIMI and LP3ES to devise a framework for turnover. This drew heavily on the approaches developed in the pilot projects discussed above. The framework, discussed in the earlier paper by Bruns and Atmanto, uses a series of activities to prepare farmers and irrigation systems for turnover. PRIS staff (called TP4s) identify potential sites based on existing records and their own knowledge. Their role is similar to the institutional organisers and community organisers used in other irrigation projects in Asia. The TP4s attend a series of four training courses: inventory, profile and WUA development, design and construction, and preparation for turnover.

Field staff first inventory a system to collect basic information on physical condition, current management and past government construction assistance. TP4s then gather more detailed information profiling system conditions, management and problems. They begin to work with farmers to develop the WUA, if one already exists, or otherwise to form a new one.

The TP4 helps farmers prepare design requests, which are integrated with technical design considerations to produce final designs. The PRIS or contractors build the improvements in the following budget year. They hire local labour and purchase materials locally as much as possible. The TP4 works with farmers to prepare for farmer operation and maintenance of the system. The government then formally turns over system assets and authority for operation and maintenance to the WUA.

This process was elaborated and refined as the project continued. LP3ES played several roles in developing the process for turnover and strengthening the capability of the government to carry out turnover.

4. NGO ROLES

4.1. Training Government Staff to Work with Farmers

LP3ES acted as trainer in the turnover, though having an NGO responsible for training government officials was itself new and unusual. Agency officials accepted this role of TP4 training relatively easily, and it provided an entry into other activities. As trainer, LP3ES could directly contribute to changes which would enable local organisations to play a stronger role in development.

LP3ES had been training community change agents to work in urban and rural areas since the 1970s, and in the irrigation pilot projects, put particular emphasis on making trainees active, aware participants in learning.

LP3ES directly organised training of the TP4s during the first budget year of turnover. Then, during subsequent years, the PRIS had primary responsibility for training, with LP3ES acting as consultant. LP3ES provincial consultants remained heavily involved in planning and implementing training, especially in sessions dealing with social issues such as WUA development. In 1989, LP3ES wrote training materials and conducted courses to prepare provincial officials to carry out training.

Training provided an easily understood entry role for LP3ES. But even in the HPSIS project it had been clear that training alone was not sufficient. Implementing a participatory approach required new procedures, many of which could not be fully anticipated in advance and which often required decisions at senior levels. LP3ES faced a shift from direct implementation to the role of consultant providing support and preparing for eventual phasing out its role.

4.2. Consulting to Build Agency Capabilities

Turnover activities began in late 1987 with pilot efforts at about seventy sites, in two provinces. In 1988 the project expanded to two more provinces. Each province had a coordinator from LP3ES, supervised by a sociologist responsible for several provinces. The team leader and institutional advisor based in Jakarta took an active role in developing procedures.

Initially, coordinators frequently worked directly in the field in order to solve problems and show TP4s how to work with farmers. Almost all of the LP3ES staff had originally worked as community organisers in earlier projects, and some had become supervisors of community organisers. They were capable and comfortable working directly with farmers. However, this level of intensive consultant assistance was not sustainable given the rate of expansion the project faced nor consistent with the goal of strengthening *agency* capabilities, to work with farmers in a participatory process.

The TP4 Coordinators began to focus more attention at provincial and sectional level, with less work directly in the field. When DOI-I extended the contract with LP3ES in 1990, their title was changed from TP4 Coordinators to Provincial Social and Institutional Consultants with a broader scope of work. They helped plan programme implementation, helped plan and carry out training, participated in meetings at the provincial and sectional level, monitored the progress of implementation, and helped troubleshoot problems as they occurred. They and their co-workers tried to attend some key field activities such as meetings for design integration. The newness of the turnover activities made such support necessary, and formal training alone was clearly insufficient.

To maintain relations with agency staff the consultants had to give high priority to meeting targets, while still keeping longer term goals in mind. They had to make choices about where to direct the most effort. Some goals, such as participation in design, showed more progress and received more attention. For other goals, such as establishment of WUAs, the formal requirements were satisfied, but circumstances made progress slower in the local adaptation of organisations and use of thorough bottom-up approach.

DPW officials would have liked more help. LP3ES' consultants in Jakarta and the provinces lived with a continuing tension between the short run goals of meeting programme targets and the longer run goal of institutionalising a participatory process of irrigation development and turnover.

4.3. Collaboration in Drafting Procedures and Manuals

The third role LP3ES played was in devising the methods for turnover. This process took place not simply within a small pilot project but as part of the establishment of a large, and increasingly routine programme.

Working groups included representatives from DOI-I, IIMI, Ford Foundation and LP3ES, and sometimes provincial irrigation service officials. As the project evolved, working groups transformed and became much more linked to formulating specific guidelines for activities.

The first general guidelines for turnover were followed by more specific work on the inventory methods. The socio-technical profile underwent a similar process of pretesting and revision. However, by this time the project had already expanded beyond the initial pilot areas. For subsequent stages it was no longer possible to carefully pretest each stage.

A long series of meetings during 1989 eventually produced the Ministerial Ordinance on Implementing Guidelines for Turnover. The ordinance was formulated after field activities had allowed extensive testing, learning and refinement of many aspects of the turnover process.

DOI-I and PRIS officials and LP3ES staff, used the same collaborative approach to develop additional specific guidelines for turnover tasks, including manuals for preparing O&M guidelines for each system, design of irrigation system improvements and WUA formation and development.

Much time was spent in word by word revision of manuals and other documents, writing by committee. While seemingly inefficient, this process provided a forum for discussing many issues. The working group meetings maintained contact between those involved in the project. The process helped to build a sense of agency ownership. Materials were not simply produced by consultants and then ratified by the agency. Instead, agency staff played a major role in writing and extensively revising the manuals. The losses in short term efficiency were offset by advantages in terms of communication, cooperation and agency ownership of the results.

There was a genuine risk that much time would be spent compiling manuals which would never be read. However, agency officials strongly desired detailed guidelines on how to carry out turnover. Putting procedures into official manuals did constitute an important form of recognition of the importance placed on participation.

Changing how government agencies work is not simply a matter of high policy decisions (D Korten, 1980; F Korten, 1987a). LP3ES and the PRIS had to test and refine new procedures in the field and then discuss them with senior decision-makers. Government staff were not just carrying out orders from above, but acting as partners in creating something new which was enriched by their knowledge. Learning evolved in a cycle from policy to practice and back to policy. This collaborative process of learning institutionalised the new methods required for turnover.

5. CONDITIONS FOR COLLABORATION

Some pre-conditions made collaboration between an NGO and government agency possible, such as a political environment which was not actively hostile. LP3ES had experience with training and fielding community development workers on other projects, with goals of strengthening the role of people's organisations in the development process. Government officials believed that LP3ES had relevant skills and LP3ES saw a chance to pursue its own goals, so both were willing to try to work together.

5.1. Compromise and Reformism

First, and probably the most important condition for collaboration, is that the NGO accepts an incremental reformist approach to change, and the messy choices of reform. Working together with government officials requires trying to improve existing conditions. The prevalent political conditions will often limit the scope for alternative choices or more confrontational approaches.

Choosing to work collaboratively requires some sacrifices in terms of outspoken advocacy and criticism, particularly as an NGO may gain access to sensitive internal information about the agency. Creating a political scandal could easily poison cooperation with the agency. Relations with agency staff are likely to breakdown unless there is a basic agreement on the need to make compromises and take a patient, reformist approach.

There are fewer opportunities for the NGO for media attention, but perhaps more prospect of making substantive changes. Incentives for taking a reformist approach include the potential wide impact even small changes in government practices can have.

Prospects of success may be too dismal, or the compromises required too great and the better choice is not to cooperate. Even after cooperation has begun it may turn out to be infeasible.

5.2. Trust and Sensitivity

Creating and maintaining trust was an essential part of the process of working together. LP3ES staff had to assume that DPW would follow its commitments. DPW had to trust that LP3ES could make participation in irrigation development work. The long series of joint projects gradually built mutual trust.

Sensitive issues kept arising. If DPW was to listen to LP3ES' views then credibility was essential. Given ambiguities and incomplete information, it was easy to take things out of context or make different interpretations of the same facts. The need was to create an interpretation of events which DPW could agree with. This sometimes involved a process best described as negotiation. The issue was not to force the agency to agree with LP3ES, but to find an interpretation which fitted the available information while respecting the experience of DPW officials. Based on such an agreed interpretation of events, it might then be possible to draw conclusions and make changes.

Even internal written reports to the agency required a degree of self-censorship and sensitivity. Many topics could only be freely addressed verbally to seek solutions, making frequent NGO-agency interactions essential.

The need for sensitivity is linked to the sometimes huge gaps between policy and actual implementation. Working with an agency required recognising the diversity of practices in different areas, and looking for ways to use the creativity, flexibility and local initiative it represented. The pace of change was a subject for continual negotiation. LP3ES was one of many influences in the continuing process of restructuring how the agency worked with farmers.

5.3. Funding Linkages

The Ford Foundation chose to channel irrigation funding to LP3ES through the government. LP3ES' contracts with the government specified its responsibilities, though in practice both sides needed substantial flexibility to respond to project needs. In the case of turnover the Ford Foundation also gave a parallel grant directly to LP3ES to strengthen its ability to carry out work in irrigation.

Ford Foundation funding was relatively flexible, without a heavy administrative overhead. A series of grants were made, each for two or three years. The major grants were in the range of a few hundred thousand dollars, although smaller grants were given to support specific activities.

Over ten years, several million dollars was spent on the irrigation activities, much of which was channelled through government agencies.

Ford Foundation staff kept in contact with officials at many levels. They took part in preparing contracts, kept track of implementation and tried to ensure that financial and administrative problems did not impede progress. They attended field meetings and maintained informal contacts, especially before meetings to help encourage a consensus so that meetings would be fruitful. Agency-NGO collaboration took place in the context of a very activist role on the part of the donor.

Researchers studied improvement of the turnover process. In contrast with projects in the Philippines, Sri Lanka and Thailand, which paired a research institution with an irrigation agency, the work in Indonesia brought together the agency, research institutions and an NGO. Basing research and consultancy in separate institutions created some overlap and tensions, but it encouraged a broader range of ideas about the project. The research organisation's mandate included producing objective, publishable results, therefore researchers' views remained distinct from those of agency and NGO staff involved in implementation. However, the sensitivity of agency officials concerning written statements and formal presentations on issues hampered communication and often made it difficult to take full advantage of research data and analysis.

Funding linkages forced the agency and NGO to keep in contact. The funding structure clearly showed that the NGO must respond to government priorities. However, since the money came from an outside source, government officials also had some accountability to the NGO, if such grants were to continue. The NGO could appeal to the donor if problems occurred. This created a balance of interests which did not guarantee success, but established basic incentives to cooperate.

5.4. Coalition-Building

Bureaucracies are not monolithic. Diverse individuals, divisions, sections, branches and subgroups have varying experiences, interests and priorities. This creates an opportunity to find allies. Coalition building was one of the elements of the process through which Ford Foundation, DPW, universities and LP3ES worked together.

In the various projects, some agency staff worked intensively to create new approaches, while some took part in workshops and seminars. Donor, NGO and agency staff identified people interested in participatory approaches, who could be included in working groups and other activities. They talked, discussed and sought conclusions about how to make change feasible. The result was not unanimity on every issue, but the creation of a coalition, a set of people with shared goals about creating new approaches to irrigation development.

This process continued throughout the turnover project. Some people felt strong personal commitments. Others contributed because the project was part of their job. However, they were able to work together. Funding linkages and contracts were reinforced by a network of personal relationships.

This network has survived a near total changeover in the actual people working on the project. New people need time to learn about project activities but a coalition seems able to persist, which is not simply dependent on one or two specific individuals. It does, however, depend on having a group of people willing and able to invest sufficient energy in the project.

5.5. Educated Opportunism

Turnover involved a range of issues. It had a broad goal of reversing government takeover of small irrigation systems. It had a fundamental concern that government recognise the special characteristics of small, locally-managed irrigation systems, and develop appropriate policies. The programme sought to institutionalise a participatory process of design and construction. It intended to strengthen WUAs. Given this multiplicity of goals, priorities had to be set and adjusted over time. In hindsight it would be easy to miss these choices, or to act as if the particular outcome which actually occurred was the only choice. For example, the questions of whether to turn over assets or only management authority, whether to turn over the entire irrigation system or only the headworks, were the subject of discussion in early phases of the project.

Given the range of issues, NGO and donor staff and agency officials had to make choices about where the greatest potential existed for improving the role of local people in irrigation development. Project staff made these decisions in the context of limited information and much ambiguity. Poor decisions could result in wasting much effort for little gain.

Compromise, trust, coalition building and educated opportunism are particularly important in a political culture such as Indonesia's which stresses consensus in making decisions, rather than confrontational, adversarial processes. Nevertheless, if the goal is joint action by an NGO and government then these issues will probably be relevant in any country, to avoid the dangers of becoming trapped in sterile debates and mutual hostility, and to establish a context for productive cooperation.

6. CONCLUSIONS

The turnover programme is an example of how an NGO can play a role in changing the ways a bureaucracy works with farmers, through training agency staff, developing concepts and institutionalising new methods. This demonstrates that NGOs are capable of working at multiple levels from farming communities to national policy formulation.

The turnover programme linked the NGO's concern with local organisations and social aspects of development with the delivery of government technical and financial assistance. A series of projects evolved methods and demonstrated the feasibility of more participatory approaches. The programme of technical assistance embodied methods for enabling participation and empowerment, improving government capacity to work with farmers. A fundamental restructuring of government relations with local organisations was implemented.

NGOs have the advantages of flexibility, creativity, local knowledge and understanding of institutional issues. This suits them for a role as innovators collaborating to develop new approaches and consultants helping institutionalise capabilities within agencies. LP3ES' work in the project to turn over small irrigation systems to farmers is an illustration of how an NGO can accelerate research and development of institutional innovations in the ways government works with local organisations.

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IRRIGATION MANAGEMENT NETWORK

VARIATION IN INTERVENTIONS, VARIATION IN RESULTS: ASSISTANCE TO FMIS IN NEPAL

Ganesh Shivakoti

Network Paper 11

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VARIATION IN INTERVENTIONS, VARIATION IN RESULTS: ASSISTANCE TO FMIS IN NEPAL[1]

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VARIATION IN INTERVENTIONS, VARIATION IN RESULTS: ASSISTANCE TO FMIS IN NEPAL

Ganesh Shivakoti

1. INTRODUCTION

1.1 Statement of the Problem

The recent efforts of the Nepalese government (HMG/N) to assist User Controlled or Farmer Managed Irrigation Systems (FMIS) have not been uniformly successful. It is recognised that many FMIS in Nepal would greatly benefit from financial assistance to construct permanent diversion structure works, to line key parts of canals, and to undertake other capital intensive work that would improve the technical efficiency of their systems. Government interventions in this area have been of varying types, ranging from no user participation at all to full participation of farmers in the improvement of their systems.

While some interventions have decreased maintenance costs to users and increased the overall efficiency of their irrigation systems, other interventions have had just the opposite effect. The organisational effectiveness of some local irrigation institutions has declined. Farmers who used to maintain their systems regularly, no longer do so. Disputes over water rights have increased. In some instances the total land area irrigated or the crop yields have decreased following interventions that were intended to increase these outputs. Thus, the impact of the different types of intervention in FMIS has become a topic of central interest, and a need was felt to systematically analyse the issue. Such a study should help to understand how the intervention approach used changes the incentive of participants, and influences the consequent activities of the farmers, local contractors and local politicians. This study is designed to analyse how and why some ways of helping FMIS have had positive results and others have had no, or negative effects.

Three forms of irrigation management can be found in Nepal. The first is non-user or Agency Managed Irrigation Systems (AMIS), the second is user (farmer) controlled and managed (FMIS), and the third, joint user and agency managed with varying levels of control exercised by each party. The public agency primarily involved in the development of irrigation in Nepal since 1988 is the Department of Irrigation (DOI) in the Ministry of Water Resources.

The total irrigated area in Nepal is estimated at 1,058,000 ha, 33% of the cultivable area, of which only one-third has perennial irrigation. Out of the total irrigated area, 350,000 ha are AMIS, whereas 608,000 ha are FMIS. The Agricultural Development Bank of Nepal (ADB/N) has supported the development of an additional 106,000 ha, which are also mainly FMIS. There are 1,700 and 15,000 FMIS in *terai* (plains) and hills respectively (Pradhan, 1989).

Nepal's irrigation potential has been estimated at 1.9 million ha for the terai and 0.3 million ha for the hills (NPC, 1985). In order to meet the objectives of the government's Basic Needs Programme, DOI has set the goal of developing irrigation facilities for 464,000 more ha of which 99,000 of existing FMIS will receive improvements. The ADB/N is assigned the responsibility of developing 227,000 ha, and the remaining 138,000 ha will be developed by the DOI (Pradhan, 1989).

Studies report that some FMIS are functioning better than AMIS (Laitos et al, 1986; Pradhan, 1988; Tang, 1989; Yoder, 1986). In AMIS and user/agency jointly managed systems there is mixed experience; some systems are effectively maintained while others are not despite having ample resources and technical backing (IMC, 1989; Ostrom, 1988).

Considering the relatively large numbers of well-managed FMIS, increasing involvement of users in AMIS may improve performance. This could be achieved through decentralisation of the systems, making the users accountable for management and operation and maintenance (O&M). However, by only defining duties of O&M and local control there is no guarantee that user participation will yield the desired equity in distributing water to the individual farmers' fields. Therefore, the comparative intervention strategies adopted by different agencies in FMIS are documented and analysed in this study.

The broad hypotheses to be tested in this study of twelve FMIS, receiving different forms of intervention, are as follows:

- "Direct intervention in physical system improvement by the public agencies without farmer participation renders the system to be less productive."

- "Increased participation of the farmers in system improvement, increases productivity of the system."

1.2 Objectives of the Study

This study attempts to answer the following questions:

(a) What agencies have attempted to assist FMIS during the last two decades?

(b) What processes were used to select particular farmer-managed institutions for assistance?

(c) What are the objectives of each of the programmes that are assisting FMIS?

(d) What are the costs of rehabilitation or expansion of the systems? What criteria are used for cost sharing?

(e) What is the method of resource mobilisation for O&M of the systems? Are there any organisational changes over the period of time?

(f) What changes in agricultural performance are due to intervention?

1.3 Selection of Research Sites

Twelve irrigation systems, assisted by different agencies at varying levels of intervention, were selected for study. Ten systems were in the mid-hill districts of Gorkha, Kaski, Lamjung and Tanahu in the Western Development Region. Two systems were in Makwanpur district, in the Central Development Region, as FIWUD and CARE/ADB/N had not intervened in the mid-western hills. Further criteria for the selection of these twelve systems were: availability of secondary information (rapid appraisals, Irrigation Management Center [IMC] applied studies, baseline studies); accessibility of sites from the IMC office at Pokhara; and the principal researcher's dissertation research sites selection criteria. Table 1 summarises details of the twelve systems.

Table 1: Basic Information on Selected Irrigation Systems

	Name of System	*District*	*Command Area (ha)*	*No of Household*	*Intervening Agency*	*Initiated by:*	*Controlled by:*
1.	Manechhango & Pangduri	Gorkha	32	68	ADB/N; MPLD	A/F	F
2.	Rangdi Khola*	Gorkha	20	55	HFPP-Hill Food Production Program	A/F	F
3.	Hyangja	Kaski	300	545	DIHM, Hill Irrigation Dev Program - ADB	A	A
4.	Chaurasi	Kaski	100	285	Dept of Canals/Minor Irrigation Program	F	F
5.	Thuli Besi	Kaski	20	52	CARE/Nepal; MPLD	A/F	F
6.	Ghachchowk	Kaski	200	650	ILC/DOI/ISP	A/F	F
7.	Lahachowk	Kaski	100	410	ILO/DIHM; DOI MPLD	A/F	A
8.	Bhorletar	Lamjung	220	194	ILO/DIHM; DOI	A/F	A
9.	Handetar	Lamjung	260	513	DIHM; IMP/DOI	A	A
10.	Malebagar	Tanahu	22	59	IMC/DOI	A	F
11.	Rapti-Nawalpur	Makwanpur	175	208	FIWUD/MPLD	A/F	F
12.	Bhalu Tar	Makwanpur	31	64	CARE/ADB/N	A/F	F

F = farmer; A = agency; A/F = joint agency/farmer; * = Rangdi Khola is a 'model' system under HFPP

Data source: Different reports and field survey

1.4 Data Collection

The study team was comprised of a social scientist and an agricultural/irrigation management engineer working at IMC. Secondary data and description of the systems by the Western Regional Directorate served as background information. Interviews were conducted with personnel working in relevant agencies. The two field researchers visited the twelve systems spending one to two days, depending on size, walking from the water source to the tail end of the system with key informants. User committee members, site staff and farmers at different locations in the system were also consulted. Thus, the information collected was through a rapid appraisal method.

2. PUBLIC AGENCIES INVOLVED IN IRRIGATION DEVELOPMENT IN NEPAL AND THEIR APPROACHES

2.1 The Agencies Involved

Before 1988, the major government agencies involved in irrigation development were: the Department of Irrigation, Hydrology and Meteorology (DIHM), the Farm Irrigation and Water Utilisation Division (FIWUD) of Department of Agriculture, the then Ministry of Panchayat and Local Development (MPLD) and the Agricultural Development Bank (ADB/N). The major difference in mandate between these agencies was the size of system dealt with. DIHM undertook projects with command areas larger than 500 ha in the terai and larger than 50 ha in the hills.

DIHM has also coordinated irrigation construction activities with the International Labour Organisation (ILO), World Bank, Asian Development Bank, USAID and other donor agencies. Some of the larger projects are carried out through semi-autonomous organisations called 'project boards'. Management under this system gives autonomy in personnel recruitment and financial flexibility (Shrestha, 1987). Also, the Department of Agriculture has launched integrated programmes such as the Hill Food Production Program, where the project maintains its own cadre of irrigation technicians for the project period.

Agencies involved in irrigation works initially each followed independent policy leading to inconsistency in cost sharing and government subsidy.

Consequently, all irrigation activities were grouped under one umbrella of a new Department of Irrigation (DOI) in 1988 to unify approach and policy.

To achieve the new targets of irrigation development, the main principles considered as the foundation stones of the new working policy are:

- Beneficiaries' participation and consent is compulsory in project identification, selection, design, construction, operation and maintenance;

- Whoever the executing agency, the government contribution or share for each type of project is to be fixed, and ADB/N is to provide loans to the beneficiaries based on a fixed formula (HMG/N, 1988).

The present working policy recommends DOI financing only of projects which are constructed or rehabilitated by the farmers themselves, mobilising their own resources. Other projects are to be financed from HMG/N development budget (full cost or partial grant), aid or loan from international financing agents (for example HMG/N's Irrigation Sector programme, through the World Bank financed Irrigation Line of Credit), equity contribution by the beneficiaries, and investment from ADB/N or other commercial banks (HMG/N, 1988).

2.2 The Process of Intervention

Public agency intervention in FMIS has been of two broad categories during the last two decades. Firstly, those initiated by the users themselves approaching the intervening agency. MPLD financed projects, FIWUD supported systems, ADB/N, CARE, Hill Food Production Program (HFPP), and to a certain extent, World Bank-financed Irrigation Line of Credit (ILC), classify as user-initiated projects. In the second category, agency initiated cases, it is not necessary that the users approach the agency before the decision is taken to implement the project. Projects implemented by DIHM, ILO and the Hill Irrigation Project fall under this category.

The focus of each of the intervention programmes available to assist FMIS in Nepal, is outlined below. The programmes are not mutually exclusive. One system may receive assistance under more than one category:

- Grants made for the construction of large scale permanent diversion works and to line main or branch canals and expansion of systems: DIHM, ILO, Hill Irrigation Project, ILC and FIWUD are the responsible agencies for such type of intervention. Hyangja, Ghachchowk, Lahachowk, Bhorletar, Handetar and Rapti-Nawalpur systems fall under this category.

- Grants and/or loans made at low interest rates to enable farmers to make major capital investments in their facilities: CARE/ADB/N, ADB/N, ILC and HFPP are the responsible agencies for such types of intervention. Manechhango and Pangduri, Ghachchowk, Rangdi Khola/Kalleri Phant and Bhalu Tar systems fall under this category.

- Grants made for flood control or other disasters that exceed farmers' capacity to respond, either as a watershed development strategy or emergency funds: CARE and MPLD are the agencies providing help on this basis. Thuli Besi and Chaurasi systems have received assistance on these grounds.

- Efforts to train farmers in irrigation system management, organisational skills or in improved agricultural practices and also efforts to turn once-intervened systems back to farmers for O&M: IMC and IMP are the agencies responsible for these functions. Handetar and Malebagar systems are recent efforts of DOI on these endeavors.

Although the ultimate objectives of user initiated and agency initiated systems are the same, the different processes of intervention have resulted in varied performance. A single intervening agency may use different implementation patterns, according to the external funding agencies' terms and conditions. Each of the agencies' approaches to intervention is discussed below.

Department of Irrigation, Hydrology and Meteorology (DIHM)

The intervention of DIHM in FMIS has started with either constructing new irrigation systems or construction of diversion works and lining parts of the existing canals. The projects are conceptualised to increase water availability in the project area, either by expanding the system or increasing the quantity of water in the command area on the basis of financial resources available. Users are not usually consulted in identification of systems for a feasibility study, which is done by consultants or DIHM technicians. Feasibility studies contain limited information on socio-economic, agricultural and water management aspects. Systems are usually constructed by contractors with no attempt made to form a users' committee.

DIHM projects concentrated on extension of basic irrigation infrastructure without focusing on water management aspects. On completion of construction works O&M remained a full function of the department and beneficiaries were expected to pay water fees to meet part of O&M costs. However, there was no clear policy for fixing and collecting water charges. Consequently, DIHM is the only agency in the study to decide project priorities and bear all the costs of construction, rehabilitation and O&M.

International Labour Organisation (ILO)

Selection criteria for irrigation systems undertaken by DIHM with ILO Technical Assistance have been influenced by political lobbying. Both systems in this study, Bhorletar and Lahachowk, were incorporated under the departmental plan by a group of users with political influence. However, during construction and operation, locally available materials and labour were used according to ILO's working principle. The systems were constructed using committees with representation of both users and DIHM technicians. Smaller block committees under petty contracts were supervised by a main construction committee.

After reorganisation of the irrigation sector under DOI, all the DIHM systems under study formed water users committees and/or construction committees which get financial assistance from District Irrigation Offices, mainly for lining sections of the main canal. The users also contribute labour. There remains an uncertainty about paying the water fees, and take over of responsibility for O&M by the users.

Irrigation Line of Credit

The Irrigation Line of Credit (ILC) is financed by the World Bank under HMG/N's Irrigation Sector Program (ISP) in the Western Development Region. It uses water exclusively from rivers and streams forming the Narayani river basin. On receiving a majority of farmers' genuine demand for the project, the technicians conduct a feasibility survey. If the project is feasible, the farmers have to organise themselves into a Water Users' Association (WUA). The WUA must agree with the terms and conditions of the assistance, including users' contribution towards capital cost, and their responsibilities in planning, construction, operation and maintenance of the sub-project. Farmers have to deposit between 1-5% cash and contribute between 6-20% labour-equivalent of the total scheme cost.

Farm Irrigation and Water Utilisation Division (FIWUD)

FIWUD was established in 1973 under the Department of Agriculture. Its aim was to bridge the gap between the engineering services of DIHM and the extension services of Department of Agriculture in both AMIS and FMIS. FIWUD's mandate was to:

(a) Provide irrigation and drainage facilities at field level to ensure the optimum amount of water;

(b) Assist in operating tertiary irrigation systems in large and medium scale projects;

(c) Organise water users groups and guide and monitor their activities;

(d) Provide training to water users in tertiary system O&M and on-farm water management;

(e) Develop ways of increasing cropping intensity through coordination with agricultural research and extension services and the introduction of new irrigation technology (Shrestha, 1987).

Under its Farm Irrigation or Small Irrigation Program, FIWUD helped farmers construct, improve and maintain their own irrigation systems and make optimum use of the available water for increasing production.

FIWUD identifies its projects based on collective decisions and requests made by users and channelled through the village assembly, or by special directives from politicians. Potential beneficiaries serve as a primary source of information. A site survey team walks along the proposed canal alignment with the beneficiaries, and recommends whether FIWUD technicians should conduct a detailed survey, design and estimates. If the site meets criteria a project approval notice is issued. Farmers from the construction committee deposit 5% of the estimated cost in the bank, in the name of the scheme, and commit another 20% of the estimated cost in the form of labour contribution. Construction works are implemented by the construction committee under the supervision of FIWUD technicians. When the construction is completed, the users' committee is formed and they take over the system of O&M.

Ministry of Panchayat and Local Development (MPLD)

The former Ministry of Panchayat and Local Development (MPLD), now the Ministry of Local Development (MLD), activities concentrate on low cost technologies for improvement of systems with less than 50 ha command area. A policy of people's participation is followed, although the degree of participation was not fixed. Construction contracts were given to the beneficiaries' groups, who also had to undertake O&M responsibilities. The basis for the selection of projects was mainly political.

MPLD's central treasury allocated budgets for local development activities at district level, and the then District Panchayat allocated funds for village level projects. After identification of projects, villages requested approval from the District Panchayat. The district office approved the project only after the District Technical Office submitted design and cost estimates. Once the project was approved, the villagers formed a construction committee and a formal contract was signed between this committee and the district administration. With the initial 50% of the estimated cost released, construction work started under the supervision of the District Technical Office. Additional funds were released on the basis of construction progress, as certified by the technicians. When the project was completed, the construction committee was dissolved and a users' committee formed.

Although the District Technical Office submitted detailed design and cost estimates, it is common for projects to be under-funded as compared to cost estimates, due to low budget allocations. Manechhango, Chaurasi, Thuli Besi, Lahachowk, Bhorletar, Handetar, Malebagar and Rapti-Nawalpur irrigation systems have received MPLD assistance once or more during the last two decades. Moreover, MPLD grants to these systems have worked as the qualifier for other intervening agencies. The range of assistance varies from solely materials like gabon wire, cement and even skilled labour, to cash and technical advice.

Agricultural Development Bank of Nepal (ADB/N)

The Agricultural Development Bank in Nepal (ADB/N) has played an active role in providing irrigation facilities to farmers, as it was responsible for providing credit to farmers for agricultural activities. ADB/N granted loans for FIWUD's irrigation schemes, pump irrigation and gravity irrigation systems. ADB/N has also collaborated with CARE/Nepal to finance a few gravity-flow systems. ADB/N has supported irrigation development of about 106,000 ha (Pradhan, 1989), the majority of which are FMIS.

ADB/N has recently started identifying projects through a Small Farmer Development Programme baseline survey. Perceived needs of the farmers are prioritised and usually irrigation is top priority, provided water sources are available. ADB/N conducts a survey, and if irrigation projects are feasible, an irrigation group is formed. The group contributes 10% of total cost as labour, 60% comes as a government grant and ADB/N provides 30% as a loan to the group. Technical assistance is provided by ADB/N and construction works are usually done by the farmers: where there is no local expertise, petty contractors are usually used. On completion, ADB/N hands the system over to the irrigation group, and technical service, if needed, continues to be provided by ADB/N.

CARE/Nepal (CARE)

CARE/Nepal agreed with farmer groups on its level of involvement in canal construction, especially through the Small Farmer Development Programme of ADB/N. In the Western Hill region, CARE has adopted an integrated watershed development approach. The main purpose is to improve the quality of life of people in the area through maximum local participation, without disturbing the ecological balance. CARE technical field staff, together with farmers, identify feasible projects. The request for inclusion of the programme is channelled through the District Local Development Office to the Ministry of Local Development. Once HMG/N approves the scheme there is a direct working relationship between the users and the CARE field technicians. Community contribution is in terms of labour, and CARE purchases the required materials directly. Thus, the users are provided with materials, skilled labour and technical expertise. Users have to bear 30% of the total project costs, mainly as a labour contribution and the rest is borne by CARE.

CARE/Nepal with Agricultural Development Bank of Nepal

The process of CARE/ADB/N joint intervention starts with farmers, after a group decision, approaching a Small Farmer Development Programme office. The Group Organiser helps farmers to make an application for assistance to the CARE/Nepal central office. Approval of the project is the joint responsibility of CARE officials and ADB/N management, based on the feasibility survey by CARE technicians. The approval notice is sent to the Small Farmer Development Programme office, design estimates are made by CARE technicians and the expense details are made known to the farmers. CARE provides 50% of the total costs, mainly construction materials such as cement, gabon and rods, 30% comes as loan from ADB/N, and the remaining 20% is to be borne by the farmers, mainly as labour contribution. The construction is the responsibility of the construction committee which is composed of beneficiary members. When construction is complete, the system is handed over to the farmers by forming a WUA for the operation and maintenance of the system.

Hill Food Production Program (HFPP)

The HFPP is a special programme launched by the Department of Agriculture and financed by the World Bank. It aims to increase crop production in the hills by providing required inputs such as irrigation, fertilisers, pesticides and insecticides, improved seeds and plants, through effective extension programmes. HFPP maintains its own cadre of technicians to implement the project. The irrigation schemes are identified on the collective request of the users, and the process for approval and implementation of the schemes is the same as that of FIWUD, but under the technical supervision of HFPP technicians. Usually assistance is provided for head works, lining the main canal and the retaining wall of the existing FMIS.

Irrigation Management Project (IMP)

The IMP is jointly funded by HMG/N and USAID, and has been executed by the Department of Irrigation since 1985. Its objective is developing and strehgthening the capability of WUAs to assume greater responsibility and authority for the O&M of irrigation systems and improving irrigation management practices of Nepali farmers. An important objective of IMP, is to create an awareness among government entities that management is the crucial link between construction of irrigation canals and increased crop production, that presently limits the benefits realised from government-operated projects.

The joint effort has created two institutions, the System Management Division (SMD) and the Irrigation Management Center (IMC). The primary objectives of SMD are to implement systematic operation and maintenance procedures, to facilitate the organisation of WUAs and initiate monitoring, evaluation and feed back procedures. IMC has two primary objectives of conducting training for agency personnel and farmers, and carrying out short and long-term studies of Nepal's irrigated agricultural systems.

2.3 Cost Sharing on Construction and Rehabilitation of the System

Hyangja incurred the highest total cost, due to the construction of a completely new and fully-lined system (Table 2). The Hill Food Production Program at Rangdi Khola was constructed as a model and also had a high cost per hectare. High costs incurred reflect the high quality of work resulting in these systems being technically more sound. The systems based on low cost technologies are also smaller in size, and per hectare costs are relatively lower as detailed in Table 2.

The cost sharing criteria of each of the intervening agencies are different. Farmers have contributed between 66% and none of the total cost. The DIHM systems have required no contribution from the farmers. Cost sharing in all systems is mainly in terms of labour contribution. Recently DOI requires between 1-5% of total costs to be deposited in the bank by the users, the percentage depending on the total costs estimates. The cash provided through bank loans is as high as 32% of the total cost. The repayment schedule of the ADB/N loan is usually three and five years, two additional years' grace period being given without interest for systems suffering major damage during the construction period. Table 2 gives a breakdown of the farmers' contribution towards construction and rehabilitation costs.

ILO and CARE/ADB/N schemes have the highest per hectare cost for construction and rehabilitation. This might be accounted for by direct purchase policies for materials by these agencies (buying quality standard materials with high prices). CARE's position is that delegating requisition of inputs decreases quality due to over-invoiced shoddy materials and also decreases quantity because of misappropriation, leaving the farmers with a poor, inadequate supply of materials.

Table 2: Farmers' Contribution Towards Rehabilitation/Construction Cost

	Name of System	*Intervening Agency*	*Intervention Year*	*Farmers' Contribution % of Total Cost*	*Cash (%)*	*Labour (%)*	*Other (%)*	*Total Cost (NRs/ha)*
1.	Manechhango@	MPLD	1961-62	50	0	50	-	750.00
	& Pangduri	ADB	1987-88	40	30*	10	-	7099.35
2.	Rangdi Khola	HFPP	1986-87	25	5	25	-	31018.23
3.	Hyangja@	DIHM/ADB	1982-86	0	0	0	-	47095.88
4.	Chaurasi	MOA/MPLD	1961-64	0	0	0	-	680.00
		MPLD	1967-68	66	0	66	-	450.00
		MPLD	1974-75	66	0	66	-	4500.00
5.	Thuli Besi	MPLD	1985-86	66	0	66		600.00
		CARE	1988-89	28	0	28	23**	2341.75
6.	Ghachchowk	ILC/DOI	1989-90	15	2.5	12.5	-	19523.12
7.	Lahachowk	ILO@	1979-80	0	0	0	7.5***	12000.00
		-DOI	1989-90	20.5	4.5	15	-	3200.00
8.	Bhorletar	MPLD	1962-63	50	0	50	-	544.00
		ILO@	1979-82	0	0	0	8.65***	35836.36
		DOI	1988-89	15	0	15	-	10250.00
9.	Handetar	MOA/Irrig Div	1962-63	66	0	66	-	420.00
		DIHM@	1970-74	0	0	0	-	10230.77
10.	Malebagar	IMC	1988-90	0	0	0	-	5756.25
11.	Rapti-Nawalpur	MPLD	1977-78	49	49****	0	-	1720.00
		FIWUD	1987-88	25	5	20	?	3696.84
12.	Bhalu Tar	CARE/ADB/N	1984-87	52	0.5 32.0*	19.5	48**	34476.00

* = loan from ADB/N; ** = materials directly purchased by CARE; *** = local resources directly purchased by ILO; **** = Hetauda City Council's direct labour contract to the farmers; @ = new construction.
Data source: Documents (listed in the references) and farmers' interviews.

3. CHARACTERISTICS AND PERFORMANCE OF IRRIGATION INSTITUTIONS

3.1 Farmer Organisation

During the intervention process the farmers have to organise themselves to meet required commitments. Some FMIS have formal and some informal organisations, formal organisation being defined here as existence of a users' committee with written minutes of meetings. Organisation is termed informal when there is mass gathering of users, as and when needed, and resolutions are passed without written records. Many public agencies require organisation, such as formation of a *construction committee* or WUA, as a qualifier for intervention. Thus, many informal organisations have formalised themselves. In large systems, with 200 ha or more to be irrigated, there are sometimes two tiers of organisational structure, at the system level and the branch canal level.

The functionaries in the organisation of FMIS are usually selected from among the construction committee members. In AMIS these functionaries were the members of village council or class organisations, in the old Panchayat political system. The smaller systems, with a command area of 20-30 ha, have mostly non-political functionaries whereas, except for FIWUD intervention, all other systems have village council members (political representation) as members of the WUA. This arrangement is influenced by the Decentralisation Act. This required elected Panchayat officials to represent every users' group formed in the village. To make room for many elected officials, the number of committee members is higher post-intervention. The changes in organisational structure following intervention are presented in Table 3.

3.2 Resource Mobilisation

Farmers' contribution to annual maintenance of the system is mainly provided in the form of labour. The labour contribution on a per hectare basis has fallen significantly since intervention. The smaller systems which mobilised a one day equivalent of labour per household for repair and maintenance before intervention, contribute only half a day of labour after intervention (Table 4).

Table 3: Change in Organisational Structure of Irrigation Systems

	Name of System	Type of Organisation		No of Committee Members		Chairman/members of WUG Selection Procedure	
		Before Inter-vention	After Inter-vention	Before Inter vention	After Inter-vention	Before Inter-vention	After Inter-vention
1.	Manechhango & Pangduri	IN (1)	FO (1)	3	7	SEL	SEL/ELE
2.	Rangdi Khola	IN (1)	FO (1)	3-5	6	JIM/SEL	SEL/ELE
3.	Hyangja	-	FO (2)	-	9 25*	- -	VPC Members SEL/ELE
4.	Chaurasi	FO (1)	FO (2)	11	11 30*	VPC Members -	VC Members SEL/ELE
5.	Thuli Besi	IN (1)	F0 (1)	5	9	JIM/SEL	SEL/ELE
6.	Ghachchowk	IN (1)	FO (1)	3-5	7	JIM/SEL	SEL/ELE
7.	Lahachowk	IN (1)	FO (1)	11	9	VPC Members	VC Members
8.	Bhorletar	IN (1)	FO (2)	5	9 32*	VPC Members	VC Members SEL/ELE
9.	Handetar	IN (1)	FO (2)	5-7	10 53*	JIM/SEL -	VC Members SEL/ELE
10.	Malebagar	IN (1)	F0 (1)	3-5	7	SEL	SEL/ELE
11.	Rapti-Nawalpur	IN (1)	FO (2)	3-5	11 70*	SEL -	SEL/ELE SEL/ELE
12.	Bhalu Tar	-	FO (1)	-	11	-	SEL/ELE

Note: Figures in the parentheses ( ) indicate number of tiers in the organisation. IN = informal; FO = formal; VPC = Village Panchayat Council; VC = Village Council; SEL = selected; ELE = elected; JIM = Jimwala (land revenue collector at the village level); * = branch canal committee members.

Data source: Field survey

Table 4: **Resource Mobilisation for Annual Maintenance**

Name of System	Before Intervention Cash (Rs/yr)	Before Intervention Labour (man days/yr)	After Intervention Cash (Rs/yr)	After Intervention Labour (man days/yr)
1. Manechhango & Pangduri	156/ha	1/household (4/ha)	-	0.5/household (2/ha)
2. Rangdi Khola	-	14/ha	-	2/ha
3. Hyangja	373/ha	2/household (3/ha)	-	-
4. Chaurasi*	373/ha	2/household (3/ha)	746/ha	3/household (9/ha)
5. Thuli Besi	-	1/household (2.6/ha)	-	0.5/household (1.3/ha)
6. Ghachchowk	-	1/household (2.25/ha)	-	1.5/ha
7. Lahachowk	-	3/household (3/ha)	18/ha	1/household (1/ha)
8. Bhorletar	-	7/ha		--
9. Handetar	-	1/household	-	-
10. Malebagar	-	0.5/household (1/ha)	-	0.25/household (0.5/ha)
11. Rapti-Nawalpur	-	1/household (2/ha)	270/ha	-
12. Bhalu Tar	-	1/household (2/ha)	-	1/household (2/ha)

Note: Figures in the parentheses ( ) are the labour equivalent to per hectare of land. * In Chaurasi system both the number of households and the area under the scheme decreased after intervention.

Data source: Field survey

Only in the case of Chaurasi system has the contribution of cash almost doubled and three times more labour is mobilised after intervention. The main reason for this increase is the division of the system by DIHM to create the Hyangja system. The same resources need to be mobilised for work in the source, but the number of beneficiaries contributing labour is halved. Almost all the systems which mobilise labour resources for annual maintenance still contribute on a per household basis. Labour mobilisation for emergency repairs in all the systems is based on total land area irrigated. Chaurasi excepted, none of the systems have major emergency labour mobilisation problems, as the sources are either perennial or the intake diversion structures are permanent.

The DOI constructed systems are still receiving contributions towards annual repair and maintenance. Thus, the farmers in the lower Hyangja, Bhorletar and Handetar systems do not contribute any cash or labour for the repair and maintenance. Lahachowk, on the other hand, although agency managed, still mobilises labour for desilting and cleaning the canal. This is mainly due to a smaller budget allocation by the district irrigation office.

In the Rapti-Nawalpur system, the rate of payment is dependent on land location in the system. On average Rs 270 per ha is collected from the beneficiaries. The rate ranges from Rs 180 per ha for head farmers to Rs 380 per ha for the tail enders. This payment includes the water monitor's (*pani pale*) salary for four months during the monsoon rice growing season.

3.3 Water Allocation and Distribution

The smaller irrigation systems with 20-30 ha command area do not have water allocation problems except during the dry season. Then, water is allocated on a rotational basis, usually the head farmers irrigating first followed by tail enders. Thus, there is harmony among the users and less conflict on water use in these systems.

In systems with more than two branch canals conflicts over water allocation between beneficiaries from different branches are frequently recorded. Hyangja, Handetar, Bhorletar and Lahachowk systems have experienced many conflicts. Although in these systems water allocation criteria are set, they are not enforced.

Almost all the systems have continuous water supply during the monsoon season, and in winter and spring a rotational distribution of water is practised. Water distribution in the individual fields is the responsibility of the *pani pale* in the smaller systems, whereas in larger systems with users control, village council messengers are employed for water distribution. In DOI managed systems, the water is allocated in branch canals by the *pani pale*, thereafter distribution is the individual farmers' responsibility. In Bhorletar, the WUA has employed one person to distribute water at the field level, whereas in Hyangja, Handetar and Lahchowk no rules exist and farmers often have conflicts. Although WUAs have been formed in these systems, they are non-functional so far.

4. AGRICULTURAL PERFORMANCE

The discussion on agricultural performance includes changes in the net command area, cropping pattern, cropping intensity and yields due to intervention. These indicators are influenced by other variables such as availability of markets, modern inputs and technology, which all usually follow availability of irrigation facilities. Table 5 shows a significant change in area irrigated, especially in agency constructed systems with larger command areas. The smaller systems have not significantly increased the irrigated area, mainly due to small terraces being cultivated to full potential earlier.

Substantial increase in spring paddy area and, to some extent, wheat area, is shown in Table 5 following availability of irrigation during the dry season. There are also increases in cropping intensities: these are highest in systems where support agricultural services are available. Rangdi Khola and Bhorletar systems have support services from the Hill Food Production Program, and Thuli Besi and Bhalutar systems are supported by CARE's agricultural development programmes. The most significant increase in cropping intensity has taken place in Rapti-Nawalpur due to changes in cropping patterns with availability of water throughout the year.

Table 6 shows changes in average yields of major crops following intervention. Significant yield gains have been achieved in paddy, maize and wheat in systems where there was also a significant increase in cropping intensity. All the systems recording higher productivity are smaller systems, except Rapti-Nawalpur and Bhorletar, which are also operated and managed by the users themselves.

Table 5: Change in the Command Area Following Intervention

	Name of System	Change in Area (ha)							
		Rainfed	Irrigated	Paddy Spring	Paddy Monsoon	Maize	Wheat	Other	Change in CI
1.	Manechhango & Pangduri	-12	+12	0	0	0	+12	+2	+44
2.	Rangdi Khola	-4	+4	+8	+4	+4	+6	+1	+75
3.	Hyangja	-200	+200	+75	+120	+50	+75	-5	+72
4.	Chaurasi*	0	-100	-15	-100	-15	0	-5	+45
5.	Thuli Besi	0	0	+5	0	-2	+4	+1	+40
6.	Ghachchowk	-30	+30	+30	+30	+5	+35	-16	+37
7.	Lahachowk	-20	+20	+10	+15	-4	+23	-3	+41
8.	Bhorletar	-110	+110	+110	+110	+108	+25	-25	+51
9.	Handetar	-130	+130	+26	+130	+108	+3	-9	+16
10.	Malebagar	0	0	+3	0	+0.1	+0.9	-1.5	+11
11.	Rapti-Nawalpur	-75	+75	+38	+75	+10	+107	-22	+119
12.	Bhalutar	-16	+16	0	+6	+4	+5	-6	+29

Note: CI = cropping intensity. * decrease in area cropped is due to loss of land when the original Chaurasi system was divided into two to create the lower Hyangja system.

Data source: Field survey and IMC Reports and Rapid Appraisal Reports.

Table 6: Change in Average Yield of Major Crops Following Intervention

	Name of System	*Pre-Intervention Reference Year*	*Change in Production (MT/ha)*		
			Paddy	*Maize*	*Wheat*
1.	Manechhango & Pangduri	1987	+0.55	+0.40	+0.28
2.	Rangdi Khola	1985	+1.2	+0.74	+0.49
3.	Hyangja	1985	+0.75	+0.15	+0.50
4.	Chaurasi	1984*	+0.25	+0.15	+0.50
5.	Thuli Besi	1988	+0.60	0.17	+0.85
6.	Ghachchowk	1988	+0.18	+0.10	+0.40
7.	Lahchowk	1980	+0.25	+0.15	+0.50
8.	Bhorletar	1978	+1.23	+0.45	+0.95
9.	Handetar	1988**	+0.72	+0.36	+0.45
10.	Malebagar	1987	+0.10	+0.14	0
11.	Rapti-Nawalpur	1986	+0.89	+0.46	+0.30
12.	Bhalutar	1985	+1.29	-0.18	+0.06

Note: * = prior to construction of Hyangja by DIHM; ** = prior to IMP intervention.

Data source: Key informants' interview and Rapid appraisal and other related documents

5. CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1 Conclusions

The following conclusions can be drawn from this study of public intervention in FMIS:

1. The process of public intervention in FMIS can be broadly categorised into two types. In the first category the process is initiated by the users themselves; in the second, the agency prompts the project. MPLD financed projects, FIWUD supported systems, ADB/N, CARE/N, HFPP and, to a certain extent, World Bank financed ILC, fall under the user-initiated category. Projects implemented by DIHM, ILO, and the Hill Irrigation Projects are agency-initiated projects.

2. Higher per hectare rehabilitation/construction costs are incurred in systems with higher quality irrigation works. Systems based on low cost technologies are smaller in size and the per hectare costs are relatively low.

3. The cost sharing criteria of each of the intervening agencies are different. Farmers have contributed up to 66% of the total costs down to no cost at all. Cost sharing in all systems is mainly in terms of labour. Cash has been provided through bank loans up to a maximum 32% of the total costs.

4. Many public agencies have required farmer organisation as a qualifier for intervention. Thus, many informal local organisations have formalised themselves. In systems with 200 ha or more to be irrigated there are sometimes two tiers of organisational structure, at the system level and the branch canal level.

5. Resource mobilisation for annual maintenance of the system is mainly in terms of labour contribution. Labour contribution on a per hectare basis has been reduced significantly following intervention. The smaller systems which mobilised a one day equivalent of labour for repair and maintenance before intervention now contribute only half a day of labour. In DOI/DIHM constructed systems the agency is still contributing financially towards annual repair and maintenance.

6. Water allocation criteria are more easily implemented in the smaller irrigation systems with 20-30 ha command area. In systems with more than two branch canals, conflicts over water allocation between beneficiaries from different branches are frequently recorded. In these larger systems, there is often a lack of clear allocation criteria. When criteria are fixed they are not enforced.

7. There has been a significant increase in area irrigated, especially in agency constructed systems with larger command areas. The smaller systems have not increased irrigated area significantly, mainly due to small terraces being cultivated to full capacity earlier.

8. There is substantial increase in the area of spring paddy and winter wheat cultivation, and corresponding increase in cropping intensities. These changes are relatively higher in those systems where agricultural support services are available. Significant yield gains have been achieved in paddy, maize and wheat in systems where there are also significant changes in cropping intensities.

5.2 Policy Implications and Recommendations

The following policy implications and recommendations can be drawn from the literature review and study:

1. Attention must be given to ecological sustainability in smaller systems. Grants must be made available for environmental protection in these systems. The watershed development strategy of CARE can be a useful experience in this direction.

2. Mobilisation of local materials, expertise and contractual arrangements should be maximised. Where local expertise is not available, the outside contractors must be made accountable to the users.

3. In systems where intervention was initiated without consultation with the users, realignment of canals through discussions with the users should be considered. The Hyangja and Chaurasi systems, if possible, should be re-combined into one system as it was previously.

4. The practice of unnecessary designs simply to make systems look impressive should be stopped. This creates additional and unnecessary financial and resource burdens on the farmers.

5. The act of decentralisation, making the local politicians responsible for O&M of the system, should be reconsidered. Those systems with independent organisational structures are functioning better than those attached to political entities.

6. The *pani pales* are more effective in water allocation and distribution than the village council messengers. The *pani pales* should be considered as a viable alternative, with accountability to the WUA.

7. Farmers must be involved in the management of systems from the very beginning of the intervention process. Contribution of farmers' resources must be managed to create a feeling of ownership of the system. This requires considerable effort and commitment on the part of the concerned irrigation agency. The experiences of FIWUD, CARE/ADB/N and ILC should form a basis for intervention.

8. When the WUA takes over the O&M responsibility, the members should be made responsible for deciding the amount, collection method and utilisation of resources to make the system more sustainable. Technical help, emergency repair and maintenance beyond the capacity of farmers should be considered by the concerned agency.

9. Once the systems are handed over to the users, there should be a clear understanding of what the users must do themselves, and of what agency assistance they can expect for problems beyond their capacity. Once agreed, agency assistance must be made available immediately when there is an emergency. The case of Manechhango and Pangduri are the examples of these arrangements.

10. Training farmers in irrigation system management and development of their organisational skills is an iterative process. Farmers' experiences combined with technical back-stopping should form the basis of IMC and IMP intervention. Farmer to farmer training and visits to successful systems by the WUA members are possible additions to current training programmes. The role of IMC and IMP should be facilitative.

11. Agricultural performance in the systems is largely dependent upon the institutional support provided by the intervening agencies. Providing water without improved packages of practices does not substantially increase yield. The intervention strategy should incorporate agricultural support services in FMIS. The experiences of CARE/ADB/N, CARE and HFPP provide guiding principles on designing future programmes.

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IRRIGATION MANAGEMENT NETWORK

THE EQUITY IMPACT OF DEEP TUBEWELLS: EVIDENCE FROM THE IDA DEEP TUBEWELL II PROJECT

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THE EQUITY IMPACT OF DEEP TUBEWELLS: EVIDENCE FROM THE IDA DEEP TUBEWELL II PROJECT

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THE EQUITY IMPACT OF DEEP TUBEWELLS: EVIDENCE FROM THE IDA DEEP TUBEWELL II PROJECT

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1. INTRODUCTION

The development of minor irrigation, particularly through groundwater extraction, has played an important role in agricultural incomes and livelihoods. In the Fourth Five Year Plan continued reliance is to be placed on this sub-sector.

Of the technologies for groundwater extraction, shallow tubewells (STWs) give superior economic returns to deep tubewells (DTWs) due to their much lower capital costs per unit of water delivered, but are technically precluded from operating where static water levels are deeper than 20-25 feet. In addition to their high overhead costs, DTWs are also often criticised for their adverse impact on equity. It is argued that large farmers use their power to dominate irrigation decisions, take more than their share of water and divert any surplus from equipment operation to their own use.

This paper summarises the results of a study which estimated *quantitatively* the impact of DTWs on income of different farm size groups from crop production, wage employment and DTW 'ownership'. Data to estimate income flows from input supply of fertiliser and mechanical services are not available; accordingly, only the village level equity implications are considered.

The major conclusions are that large farmers ensure that a greater proportion of their land within the potential command area (PCA) receives water, but small farmers still do relatively better from the DTW because a higher proportion of their land is in the PCA and they use high yielding varieties (HYV) more. Production benefits considerably outweigh the surplus from equipment 'ownership', even when loans are not repaid.

Calculations were also made of increase in the demand for wage labour and, assuming wage increases similar to those reported elsewhere, on total wage income. Incremental wage income - going primarily to small (non-irrigating) farmers and the landless - was around 20-25% of the total benefits, more than the percentage accruing to large farmers.

2. DATA SOURCES

For this study, data from a number of sources have been used. Some use is made of the published literature; where so, references are cited. But most of the data has been generated by the DTW II Project either directly, using resources available to the project, or indirectly, through commissioned studies.

The Annual Evaluation Survey (AES)[1], despite its name, gathered data for only two years: 1986 and 1988. In 1988, six separate studies reported on work conducted in ninety villages, drawn from across the Project area, which covers thirteen districts around Dhaka and to its north. The villages were divided into three categories: 'old' villages, which had been covered by the 1986 studies; 'new' villages, where wells had become operational since 1986; and 'non-operational' villages, where loan approval had been given but the wells had not operated. Two reports - one covering 40 'old' villages, one 40 'new' - looked at well operation and KSS[2] performance; three reports, each covering 10 villages from one of the three categories, gave the findings of an intensive agro-economic survey of irrigating and non-irrigating farmers; one report, on the 30 villages where the ago-economic surveys were conducted, covered land tenure.

The AES of 1988 was the principal source of data for this study. Some use was made of data from the land tenure survey[3] and the Agro-Economic Survey of 10 'new' villages[4]; but the main source was the Agro-Economic Survey of 10 'old' villages[5].

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[1] Conducted for the BADC DTW II Project by Engineering Planning Consultants (EPC) Ltd.

[2] Bangladesh farmers' cooperative.

[3] EPC (1989a).

[4] EPC (1989b).

[5] EPC (1989c).

The survey was of eight villages chosen from the Brahmaputra-Jamuna flood-plain and two from the Madhupur tract, and elevated terrace with more weathered soils.

The Annual Monitoring Survey (AMS) has been conducted every year since 1987. The most recent completed report relates to the season 1988-89[6]. From the list of the 1812 Project wells reporting irrigation in the April 1989, every seventh scheme was chosen. Two separate questionnaires were used: one relating to KSS and well performance, the other to farmers costs and returns on crops irrigated by the DTW. Field level government staff acted as enumerators.

The results from the KSS questionnaire are used here to derive operational costs and revenues of tubewells and to calculate operational surpluses before loan repayment.

The Socio-Economic Impact Study (SIS) was an *ad hoc* study undertaken by an independent consultant with assistance from the DTW II Project. It was undertaken in April-May 1990 and covered six villages. Four of these had been covered in the Agro-Economic Survey (AES) of 10 'old' villages. A total of 114 irrigating farmers responded to a coded questionnaire and the results were entered in a database. The data collected have been used to supplement the AES data.

3. <u>METHODOLOGY</u>

Information on the distribution, between farm size categories of land and its irrigation source, if any, was given in AES (EPC, 1989) based on a census of ten villages where Project DTWs had been operating for more than three years. The farm size categories, used for this study, based on land *operated*[7], were as follows: small farmers - 2.5 acres or less; medium farmers - 2.5 to 5.5 acres; large farmers - more than 5.5 acres.

The crop production impact on farmers with different sizes of holding is measured by the difference between their situation 'with' and 'without' an IDA DTW. The 'with' situation was derived directly from AES data. Since

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6 DTW II Working Paper 52.

7 The AES report classification of households is by land operated, rather than land owned.

there was no baseline survey, the 'without' situation was calculated by assuming that the area irrigated by the Project DTW would otherwise have remained unirrigated.

It is recognised that in areas where STWs can operate this assumption would overstate DTW benefits. But the concern here is with the expected situation under the forthcoming National Minor Irrigation Development Project (NMIDP), where STWs and DTWs would rarely compete.

Land use in the 'typical' village was defined by assuming a DTW command area of 57 acres, the average acreage for the 1988-89 irrigation season. The area of land irrigated by other means and unirrigated land was calculated by assuming the ratio of such land to the DTW command area was similar to that reported in the villages covered by the AES.

AES data was then used to derive the 'with' and 'without' cropping patterns for different farm size categories. These were then used with the appropriate input-output and gross margin data to derive incremental impact on production, labour use and net income (full cost and cash cost) for each farm size category. Some fairly bold assumptions have been made in constructing these models and these are discussed in Appendices 1 and 2.

Farmers income was then adjusted to account for flows of income due to tenancy and for the rise in wage rates that are associated with the expansion of irrigation[8] (see Appendix 1). The corollaries of these were the flows of income to landlords (large farmers and absentees) and a calculation of the increase in wage income (accounting for price and quantity effects) going to small farmers and the landless.

Finally, a calculation was made of KSS income using AMS data (see Appendix 1). A weighted average of costs, income and loan repayments was taken. It was assumed that the whole surplus was divided among the large farmers.

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[8] See Hossain, M. (1989) Green Revolution in Bangladesh, pp 102 and 105.

4. RESULTS

AES data[9] were used to derive: the cropping intensity (CI) on DTW land (156%), on other irrigated land (177%), and on unirrigated land for irrigators (182%), and on non-irrigators (170%); and the ratio of irrigated to unirrigated crops in the cropping patterns on irrigated land. Gross cropped acreage was then estimated for irrigated and unirrigated crops (see Table 3).

It will be noted that the introduction of the DTW results in a slight overall increase in CI, despite the CI being lowest on DTW land. This is because the CI of the unirrigated land of irrigators is higher than that of non-irrigators and, according to the assumptions of the model, many farmers who change category after the DTW is installed change cropping patterns and intensities correspondingly.

The cropping patterns for irrigators and non-irrigators in each size category were used, together with the corresponding output data, to calculate the impact on production. The outcome for the principal crops, taking all size categories together, is summarised in Table 1.

Overall the trade-off between rice and other crops is remarkably benign. This is because the substitution in the cropping pattern is not principally between rice and other crops, but between rice crops: B Aus, yielding 14 maunds/acre, for HYV boro, yielding 49 maunds/acre. Gains also come from the adoption of higher yielding T Aman crops.

Considering the distributional implications, most notable is the much greater degree by which small farmers increase their rice production. Partly this reflects the more dramatic jump in their area irrigated. But small farmers also show a greater preference for HYV over local variety (LV) or local improved variety (LIV) boro. Also notable from the AES data is that, contrary to the findings of other studies, the yields per acre for each crop are marginally lower for small farmers than for large. This may be attributable to lower recorded rates of fertiliser application[10] or an unquantified, but widely cited, tendency of large farmers to ensure that their land has priority in irrigation.

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9 Based on EPC (1989c) Table 11.1, pp 134-7, and Table 11.2, pp 138-9.

10 See EPC (1989c), Table 15.535, p 159.

Table 1: Change in Production of Major Crops 'With Project'

	Small maunds	%	Medium maunds	%	Large maunds	%	All maunds	%
rice	1314	40.1	558	19.4	174	18.5	2046	28.8
wheat	-42	129.3	12	8.3	-4	-9.6	-3	-10.2
pulses	-6	-3.2	-31	-22.3	-14	-34.7	-52	-13.8
oilseeds	-17	-13.4	0	0	-2	-10.5	-19	-8.6
jute	-47	-19.0	-25	-14.8	-4	-5.5	-76	-15.6

Source: DTW II

Tables 2 and 3 below give the overall income flows using cash cost and full cost gross margins for crop production, respectively. It is argued that, of these two measures, the former is more appropriate for the purposes of a distributional analysis (see Appendix 2). It is true that small farmers, together with the landless, supply the vast majority of agricultural wage labour. So the additional labour demands from their newly irrigated plots will require them to forego wage-earning opportunities. But their withdrawal from the labour market correspondingly increases the employment available for the remaining wage labourers who come from a similar class, resulting in an intra-class income flow. Accordingly, the focus of the discussion below is on the results based on the cash cost gross margins.

Incremental crop production income dominates all other income flows. Income from tenancy to landlords represent the smallest flow, at 2.9%. Significantly, the 'returns' to KSS domination, even when calculated under relatively extreme assumptions, are only a small part (12.2%) of the total picture and are substantially less than the incremental returns to wage labour (21.3%).

Small farmers obtain nearly half of the incremental benefits from the DTW; medium farmers have second largest absolute share (16.3%). This is only fractionally larger than the share going to the landless (16.2%). Large farmers have come only third in absolute terms, with 15.8%. Absentee landlords come last, with only 2.2%.

Table 2: Incremental Income from DTW (Tk) - Cash Cost Gross Margin

	Crop Income	*Tenancy*	*Wages*	*KSS*	*Total*	*Total %*
landless	-	-	52968	-	52968	1.62
small farmers	145503	-	16752	-	162255	49.5
medium farmers	53388	-	-	-	53388	16.3
large farmers	9414	2416	-	40000	51830	15.8
absentee landlords	-	7250	-	-	7250	2.2
Total	**208305**	**9666**	**69720**	**40000**	**262181**	**100**
Total %	**54.5%**	**3.7%**	**26.6%**	**15.3%**	**100%**	

Source: DTW II

Table 3: Incremental Income from DTW (Tk) - Full Cost Gross Margins

	Crop Income	*Tenancy*	*Wages*	*KSS*	*Total*	*Total %*
landless	-	-	52968	-	52968	20.2
small farmers	103194	-	16752	-	119946	45.8
medium farmers	33940	-	-	-	33940	12.9
large farmers	5661	2416	-	40000	48077	18.4
absentee landlords	-	7250	-	-	7250	2.7
Total	**142795**	**9666**	**69720**	**40000**	**262181**	**100**
Total %	**54.5 3.7**		**26.6**	**15.3**	**100**	

Source: DTW II

These incremental income flows present a picture that is in sharp contrast to the widely held belief that large farmers, through their domination of KSS, are able to secure the bulk of the benefits from DTW irrigation. Large farmers still do well per acre irrigated but not as well as is often implied. It is valid to question the reasons behind this result.

4.1 Reasons for Relative Success of Small Farmers

Small farmers do well for two reasons: firstly, irrigating small farmers gain disproportionately from increased crop production; and secondly, the gains of small non-irrigators able to take advantage of increased wages and work opportunities in the Rabi season offset reductions in gross margins experienced by small farmers hiring labour. Their disproportionate gain from crop production deserves further mention. In part it reflected their greater disposition to grow HYV rather than LIV or LV boro and their considerably higher cash gross margins; these factors were fairly predictable. But it also reflected the fact that they benefit to a greater extent (compared to their total land holdings) from the DTW. This is surprising and contrary to the weight of anecdotal evidence that large farmers often bias DTW siting to their own land and then dominate management of the well to ensure that all their other land within the PCA receives irrigation.

The explanation of this 'perverse' result is to be found in the dispersion of landholdings in the utilised command area (UCA) and inside and outside the PCA (see Table 4). Large farmers do manage to obtain irrigation for a larger proportion of their land within the PCA[11]: the UCA/PCA ratio is 0.83, compared to 0.71 for small farmers. This is in accordance with the anecdotal evidence. But more than compensating for this bias, they hold a smaller percentage of their land in the PCA: 25.5% compared to 41.9% for small farmers. Consequently, they irrigated a smaller percentage of their total land.

Why large farmers should hold a smaller percentage of their total land in the PCA is not certain. It could be a statistical anomaly, but the AES study of 10 'new operational' DTW KSS villages reflected the same pattern[12]. One explanatory hypothesis is that with highly fragmented and dispersed holdings, farmers forced to sell land will *ceteris paribus* dispose of plots farthest from their homestead. Small farmers would thus dominate the land adjacent to settlements - which is where DTWs are often sited for security reasons.

Medium farmers do poorly, relative to their numbers and land holding, because: the impact on their irrigated holdings is less dramatic; they employ considerably more labour than small farmers and have lower cash gross

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11 Derived from EPC, op cit, Table 7.1, p 123.

12 See EPC (1989), Land Tenure Survey of IDA DTW KSS Villages, Table 7, p 31.

margins; and, according to the assumptions made, they do not share in the benefits from KSS domination.

Table 4: Total Land (%) Distribution Relative to Command Area

Farm Category	*UCA % **	*Inside PCA %*	*Outside PCA %*	*UCA/FCA Ratio*
small irrigators	29.8	41.9	58.1	0.71
medium irrigators	20.2	28.0	72.0	0.72
large irrigators	21.2	25.5	67.2	0.72
Total	**25.0**	**34.7**	**65.3**	**0.72**

* UCA is a sub-set of PCA.
All percentages are of total landholdings.

Source: Based on EPC, op cit, Table 7.1, p 26 and Table 1 above.

Large farmers do less well than expected for a number of reasons: first, though they are able to ensure that more of their land in the PCA is irrigated than that of other farmers, they hold a smaller proportion of their land there, and so the DTW irrigates a smaller proportion of their total land. Second, they are more inclined to grow LV or LIV boro, which has much lower yields than HYV. Third, they hire considerably more labour than smaller farmers and so have lower cash gross margins and suffer more than other groups from any increase in wages resulting from the DTW. Per acre irrigated, the 'returns' to KSS domination compensate for this; but since these returns are so much lower than the benefits accruing from crop production, not sufficiently to allow large farmers dominate incremental income flows.

5. CONCLUSIONS

There is clear evidence from the relative percentages of land within the PCA receiving irrigation, that large farmers are able to secure for themselves a disproportionate share of irrigation water (see Table 3). This confirms many verbal reports and some field case studies[13]. There is also an overwhelming weight of anecdotal evidence that many large farmers are happy to treat any surplus KSS funds as their own and feel no strong inclination to reduce that surplus by making repayments on the DTW loan.

These are sources of concern for both government and donors, but the problem should be placed in the context of both the distribution of other income flows arising from the DTW and the other potential forms of government supported investment in rural areas.

An assessment of specific alternatives to DTWs has no place in this paper, but a number of studies[14] have indicated the ease and ruthlessness with which local elites may capture the benefits of government sponsored schemes intended for other groups. Thanks to land fragmentation, this is harder to achieve with a DTW, where the largest category of benefit - from crop production - must be shared by all land owners within the UCA.

Improvements can be made in the distributional impact of DTWs through increases in: command areas, to encompass land (usually belonging to small farmers) in the PCA that remains unirrigated; KSS membership and their influence over the disposal of KSS funds; and loan repayment rates. But, the overall impact on equity of DTWs is considerably more positive than is recognised by many commentators. And, where STWs are unable to properly exploit groundwater resources, perhaps superior in both economic and distributional terms to many alternative forms of government intervention in rural Bangladesh.

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13 For instance, Jansen (1989), Rural Bangladesh: Competition for Scarce Resources, p 152.

14 See Hartmann and Boyce (1979) Needless Hunger: Voices from a Bangladesh Village, and Jenkins, et al (1980) The Net: Power Structure in Ten Villages.

APPENDIX 1

Other Sources of Income

1.1 Landlords Income from Tenancy

The AES collected a considerable amount of data on tenancy relations in the 10 villages. Land share-cropped, leased or mortgaged in and out by each stratum is detailed, revealing a complex set of relations[15], similar to those found by Jansen (1987). The conditions attached to these tenancy contracts also varies, even quite locally. For instance, in Glaser's study[16] in six villages found eight named types of tenancy, with conditions varying over lease cost, duration, cost sharing, conditions for the return of land, etc.

To quantify the implications of tenancy on income flows it was necessary to abstract from many of these complexities. In the calculations, only the *net* tenancy position of each size group was considered: the tenancies of medium farmers balanced; small farmers as a group were net tenants, on around 9% of their land[17]; the net landlords were large farmers (25%), and absentee landowners (75%). Mortgages were less frequent and subject to widely varying conditions, so it was assumed that all tenancies were share cropping. Tenancy was taken to be for the full year, with gross returns from all crops being divided equally. Cash costs of cultivation were ascribed to the tenant, except for boro rice. For boro, where the landlord may bear up to half the costs[18], 75% of costs were ascribed to the tenant. Income was recalculated for small farmers assuming that 9% of their land was subject to these conditions. This was divided among the landowners *pro rata* to their net tenancy position.

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15 See EPC (1989c) Table 6, p 122.

16 See Glaser, Socio-Economic Impact Study.

17 Net figures are used because the overall effect on the group is the focus of the study.

18 See Glaser, ibid.

1.2 Impact on Water Income

With the introduction of the DTW, both the quantity of labour demanded and wage rates increase.

To calculate the change in the quantity of hired labour demanded, the cropping pattern model was used, together with data on hired labour use for each crop by irrigators and non-irrigators in each size category. Predictably, there is a seasonal shift from early to late Kharif, and Rabi.

Those irrigating from other sources are assumed to have the same input coefficients for hired labour use in both the 'with' and 'without' DTW situations. But Hossain has noted that, with greater prosperity from irrigation, farmers tend to substitute wage labour for their own labour in farm operations[19]. Irrigating farmers would therefore be expected to use a lower proportion of hired labour in the 'without' situation. The assumption of fixed coefficients for hired labour thus probably results in an under-estimate of the increase in demand for hired labour.

To include the effect of changes in wage rates in the calculations, two symmetrical effects must be introduced: an increase in income going to wage labour, and a decrease in incremental gross margins for farmers employing wage labour.

Hossain found that a comparison of developed and under-developed villages suggested that technological progress has a positive effect on the wage rate. For male workers, the agricultural wage rate in developed villages was 19% higher than in under-developed villages[20]. The AES also reported an increase in wages for casual labour for the peak operations in the boro season[21]. The survey conducted for SIS indicated increases in real wages of the order of 50% following the introduction of the DTW, but wage rates quoted varied and the quantity of labour employed was not recorded, so it was not possible to calculate a weighted average. Accordingly, a wage increase of 20% (in line with Hossain) has been assumed.

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[19] See Hossain (1989), p 102 and Table 56, p 105.

[20] See Hossain (1989), p 99.

[21] See EPC (1989c).

1.3 KSS 'Income'

Though tubewells are owned by their cooperatives, there are a number of avenues for personal enrichment, ranging from misunderstandings by the KSS membership of their rights to straightforward theft. Examples include: refusal to pay dues; the division of any operational surplus among a select clique (often those contributing to the downpayment on the loan); and misappropriation of the monies designated for loan repayment.

These *ultra vires* income flows are of particular relevance to any discussion of the equity impact of tubewells because it is predominantly the powerful who exploit such opportunities with impunity. The issue of KSS domination by local elites has received much attention in the literature and its variations and mechanics will not be further elaborated here. But to gain a sense of its proportion to the other income effects of the tubewell, these flows need to be quantified.

Costs vary with power source - diesel or electricity - and average Tk 48,885. DTW operational revenues are dependent on the area irrigated, the water charges levied and the rate of repayment. As before, a command area of 57 acres is assumed. Water charges vary according to method of collection of loan repayment contributions and water charge payment method. Where payments are made in cash, water charges for irrigated (non-beel) boro rice averaged Tk 975 per acre (excluding loan repayment contributions), and Tk 1,420 per acre (including loan repayment contributions)[22]. Where crop-share is used, the near universal norm is for 25% of the crop to be taken. With a yield of 48 maund/acre and a price of Tk 203/maund, this gives a cash equivalent water charge of just under Tk 2,440 per acre. The ratio of crop share to cash schemes is 30:70. If the higher cash water charge is taken, this gives a weighted average water charge of Tk 1,726 per acre and a projected revenue for the 'average' scheme of Tk 98,380. Not all of this will be collected by scheme management. Though the repayment rate on crop share schemes was good, for schemes collecting their water charges in cash, 42% of irrigators had not repaid their water charges in full by the end of September[23]. However, because it may often be the larger farmers who do not pay, non-payment of water charges will be ignored here in the calculation of operational surplus.

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[22] DTW II Working Paper 52, Table 2.7, p 14.

[23] DTW II Working Paper 52, Table 2.9, p 15.

This would give an initial surplus of Tk 50,000. An average scheme will make some repayment to the bank - 35% of instalments due were reported as repaid in AMS89[24]. This would represent a payment of Tk 9,240 on the weighted average instalment of Tk 26,396[25]. This leaves Tk 40,000 available for non-accountable distribution.

For obvious reasons, no hard information is available as to how mis-appropriated funds are divided among irrigators belong to the different farm size groups. However, there are reasons to believe that the rewards are spread. For crop share schemes, the financiers of the DTW's seasonal variable costs expect to share any operational surplus. The average number of financiers reported in AMS89 was 15[26]. Those who contribute to the initial downpayment are also seen as being entitled to a share. The obligations that exist between members of the same *gusti* would also indicate that large farmers, however much they might dominate KSS decisions, would feel obliged to share the operational surplus from well operation with other households. ***Nevertheless, in the calculations, it is assumed that the entire operational surplus of Tk 40,000 is divided among the large farmers.***

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24 DTW II Working Paper 52, Table 2.15, p 21.

25 DTW II Working Paper 52, Table 2.14, p 20.

26 DTW II Working Paper 52, Table 2.5, p 11.

APPENDIX 2

Reasons for Using Cash Costs

AES provided data on cash cost and full cost gross margins. (The latter adjust cash costs to attribute the market value to inputs - mainly labour - supplied free by the farmers own household.) The difference is important, particularly for the small farmers, who hire little labour.

Cash rather than full cost gross margins were used for two reasons: first, because the latter are highly misleading when there are, for much of each season, high levels of underemployment at prevailing wage rates; and second, and more importantly, because of the distributional focus of the study. It is true that small farmers, together with the landless, supply the vast majority of agricultural wage labour. So the additional labour demands from their own irrigated plots will require them to forego wage earning opportunities. But the withdrawal of their labour from that market represents as much a gain for others (of a similar class) as a loss for themselves. Since the focus of this study is the accrual of benefits to size classes rather than to individuals, the loss of wage income by some small farmers is taken as an intra-size class redistribution, and therefore ignored.

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GROUP INNOVATION IN UTILISING LAND AND WATER RESOURCES IN RWANDAN VALLEYS[1]

Michael E Loevinsohn[2], Johnson Mugarura[3], Augustin Nkusi
Project Rizicole de Butare, BP 76, Butare, Rwanda

1. INTRODUCTION

A variety of methods have emerged in recent years that seek to draw upon farmers' knowledge, insights and innovative capacity in the identification and selection of agricultural technologies. However, the focus of research has generally been on innovations that are feasible for individuals acting alone. Few accounts describe the development of alternatives where potential benefits depend critically on the area over which they are practised or on the number of farmers adopting them. Exceptions can be found in the domains of irrigation management (Korten, 1982) and wide-area pest management (Loevinsohn et al, in press), but in these cases farmer groups have most often been involved in the planning and implementation of pilot projects at a production scale, rather than in selecting among and testing technical options.

This paper describes the process and results of research, with groups of small-scale farmers, on sustainable irrigated agricultural alternatives for highland valleys in Rwanda.

1 Excerpt from a paper presented at the 11th Annual Symposium of the Association for Farming Systems Research and Extension, Michigan State University, October 1991.

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2. THE CONTEXT OF VALLEY FARMING

The Central Plateau of Rwanda is a region of rolling hills and generally well-watered valleys between 1500 and 1800 metres in altitude. The population density is among the highest in Africa, with typical holdings in the order of 0.5 - 1.0 hectares (ha) (Ministère de l'Agriculture, 1984). Phaseolus beans, sorghum, sweet potato and banana form the basis of small farmer agriculture, which until relatively recently was restricted to the tops and flanks of hills. Over the last few decades, however, demographic pressure and the resolution of a centuries-old conflict between herders and farmers have opened the valley bottoms to cultivation. Though representing less than a tenth of the cultivable area, highland valleys are responsible for some 18% of food energy and 22% of protein production (Jones and Egli, 1984). With more assured access to water and less degraded soils, the valleys are widely thought capable of greater intensification than the hillsides (Ministère de l'Agriculture, 1987). Rainfall is approximately 1200 mm, distributed between two wet seasons.

Farmers exploiting the valleys almost invariably farm a substantially greater area on the hills. The valleys are most intensively used during the long dry season (June-August) under irrigation: a second or third crop may be possible where the risk of flooding is low. Crops are grown on raised beds separated by ditches whose spacing and dimensions represent a finely-calculated balance between the need to drain or irrigate (Steenhuis, 1987), a practice that has evolved over the 20-60 years the valleys have been cultivated. Maize, sorghum beans and vegetables are widely grown in the valleys, but sweet potato dominates. Though its yields are lower than on the hills, dry season cultivation in the valleys ensures a continuous supply of planting material which has permitted a marked expansion of sweet potato on the hills (Jones and Egli, 1984).

Land in the valleys is public property and individuals enjoy only usufruct rights there. 'Coopératives', formalised groupings expected to cultivate collectively, are favoured by government policy, and may be granted land that is unoccupied, or, more often, already cultivated by independent farmers. Land may also be accorded to state or parastatal enterprises which then organise small farmers around cash crop production, specifying techniques and ensuring inputs and marketing.

The Projet Rizicole de Butare (PRB) manages some 750 ha of paddies at around 1400 m on the eastern edge of the Plateau, where rice has been grown since the late 1960s. High production costs in these 'perimètres' due to low marketed volumes (yields in the two annual harvests average 2.5-3.5 t/ha), inefficient use of chemical inputs, expensive hydraulic infrastructure and high staffing levels have threatened the project's objective of reducing national dependence on imported rice. It was with a view to exploring the agronomic, social and economic feasibility of farmer-managed, low input rice production in higher altitude valleys, that the project supported the research described here. The scarcity of resources (3 person days/week of both researcher and technician time) and the diversity of conditions in highland valleys helped convince senior PRB officers of the utility of participatory techniques.

3. METHODS

We began by conducting rapid appraisals of valley agriculture in several communes of Butare Prefecture in the heart of the Central Plateau. We spoke to researchers, extension officers and, particularly, farmers whom we approached in their valley fields. Using an open format, we asked about current agricultural practices and how they had evolved, the extent of cooperation within and among households and the links between hill and valley cultivation. Where farmers' interest in collaboration appeared real, we asked if it was possible to organise a meeting of those cultivating contiguously in a part of the valley.

These larger meetings, attracting 30 or more farmers and local authorities, focused on the problems people were encountering in the valleys and the options they saw for dealing with them. Most frequently cited among the constraints were the extreme shortage of land and insecurity of tenure, declining soil fertility and difficulties in drainage or irrigation. The solutions envisaged for the most part involved intensifying what was already being done, for example, renting more land (though cash was scarce) and using more compost or manure (though supply was limited and employed preferentially on hillside fields). We were asked how we could help and offered some ideas. For example, more land could be found in the uncultivated drains between their raised beds. Rice might be grown there, as we had observed a farmer trying with a handful of seed in one valley, and as Javanese farmers do in a system known as *'sorjan'* (Suryatna et al, 1979). Would they like to try? We emphasised the range of options, for example, in time of planting and the possibility of creating paddies, as well as the risks we foresaw (primarily cold sterility and disease). The choice of option, and its risks would be theirs; we undertook to provide seeds and advice, but could only work with groups. We made no stipulations, however, about their size or form.

Other ideas were introduced in a similar manner. These included growing two indigenous species of *Sesbania* for green manure, constructing peripheral canals to improve irrigation, and integrating fish culture into their systems.

Four groups agreed to work with us on these terms. Though situated within a radius of only 6 km, they differed markedly in their organisation, economic orientation and cropping pattern. The valleys they farmed also varied in soil type, topography and hydrology. The 'coopératives' manage their land collectively, whereas farmers in the informal associations cooperate as and when their members see fit.

We encouraged innovation by several means:

(a) During weekly visits to the valleys, we met groups or individuals who wished to consult us, examined the progress of their experiments and discussed further trials;

(b) A 'travelling seminar' was held each season, in which groups visited each other and discussed the experiments they were conducting;

(c) In 1989, representatives of the groups were brought to the 'perimètres' to observe farmers' fields and researcher-managed experiments which focused on themes the farmers were themselves pursuing.

4. RESULTS

Integration of Rice

Adoption of rice by each of the groups has been rapid, though no more than a handful of farmers had previously had direct experience of the crop. Marked improvements in irrigation, land preparation, transplanting and crop protection have been evident and are, in large, responsible for the increase in mean yields from 2 t/ha in the first season to 3-4 t/ha subsequently. This production has been obtained without external inputs and thus far with little reliance on biological fertilisation. As in the lower altitude 'perimètres', yields are constrained during the long rainy season (March-May) by diseases, primarily blast (*Pyricularia oryzae*) and sheath rot (mostly *Sarocladium* spp).

Farmers are impressed by the productivity of rice, comparing it favourably to previous crops they have grown in the valleys, despite the greater labour requirements. A survey of neighbouring farms in February 1991 indicated that gross economic returns to rice were greater than for any other crop harvested at that time.

While there has been experimentation with the *sorjan* idea in each of the groups, paddies have been, from the first, the preferred approach to growing rice. The reasons farmers give are consistent: the space available between their raised beds does not justify digging a canal, building a dam and sowing a seedbed, all of which could equally serve a larger area. However, in the last two seasons, two of the groups have employed the *sorjan* alongside or after paddies, thus benefitting from the infrastructure already created. While widespread use of the *sorjan* would permit even greater landuse intensity, the introduction of paddies has reduced the uncultivated area to 11% of bottom land from 32% when raised beds are employed.

Though both appear committed to rice, the associations and 'coopératives' diverge in the land-use strategies they are developing. The former have almost doubled the per capita area devoted to rice cultivation to effectively 100% of the land available on a seasonal basis. In contrast, the two 'coopératives' have maintained the area planted to rice roughly constant, at between 25% and 40% of their holdings. Their cropping patterns conserve greater diversity: rice is present in all seasons, but is generally rotated between fields. This involves building and then dismantling raised beds, a highly labour-intensive procedure.

The cropping patterns emerging in the four groups (Figure 1) represent modifications of patterns that existed before the advent of rice. Some of the variation is explained by difference in hydrological conditions, other key factors are farmers' orientation to market or subsistence production, and the scale of management. In Gatovu, for example, a single-season monoculture of sweet potato has given way to uniform double-cropping of rice. In part, the variation in cropping pattern appears to be a response to physical and hydrological constraints. Gatovu farmers explain that nothing survives the flooding they experience during the long rains, except rice, and previously their land lay fallow. Two kilometres downstream in Cyamuginga, the valley broadens and the risk of flooding is less, hence sweet potato and eggplant can be planted on rebuilt, raised beds, reserving rice for the next season when it generally yields best. Conditions in Rujangari are more moderate, permitting greater crop diversity, but the collective use of the land also creates possibilities, such as fish ponds, not available to individuals farming only a few ares (.01 hectare). The option for an independent farmer of maintaining a raised bed, with one or more crops, beside a paddy encounters the same 'economies of scale' argument as the *sorjan*: a large investment of labour is required for a small area of rice. Other considerations encouraging wide and uniform rice cultivation are the difficulties intervening raised beds create for irrigation and the refuge they provide for grain-eating birds.

The maintenance of diversity has been a recurring theme of discussion within and among the groups. Some farmers in Gatovu and Cyamuginga have suggested that the associations divide into contiguous rice and raised bed areas, rotating seasonally as in Rujangari, in order to spread risks, ensure a source of sweet potato cuttings for the hills and pursue speculative ventures (such as highly profitable out-of-season maize), while facilitating irrigation management and crop protection. The idea has not received general support as most farmers see rice as the 'best bet' and are unwilling to accept the second best 'for the good of the group'. Our arguments that double-cropping risks aggravating disease and fertility problems have not proved persuasive, at least in Gatovu. Farmers are not convinced of the imminence of these threats and point to the double-cropping long practised in PRBs 'perimètres'.

Organisational Innovation

By the end of the first season, all four groups had constructed peripheral canals, up to a kilometre in length, that feed their fields directly. For the most part, these have been efficiently managed. However, the maintenance of irrigation infrastructure has at times been compromised by 'free-riders', people who do not participate in cooperative work knowing others will complete it. The phenomenon was most apparent in Cyamuginga, where large stream volumes during the long rains in 1990 necessitated frequent repairs to the simple sandbag-reinforced dam. The group has since largely avoided the problem by cultivating rice during the short rains, a strategy that was also favoured for agronomic and economic reasons. By the third year, both associations had elected coordinators, two or three per group, responsible for mobilising members for common tasks and enforcing cash or labour penalties. Such sanctions already existed in the 'coopératives' when we arrived.

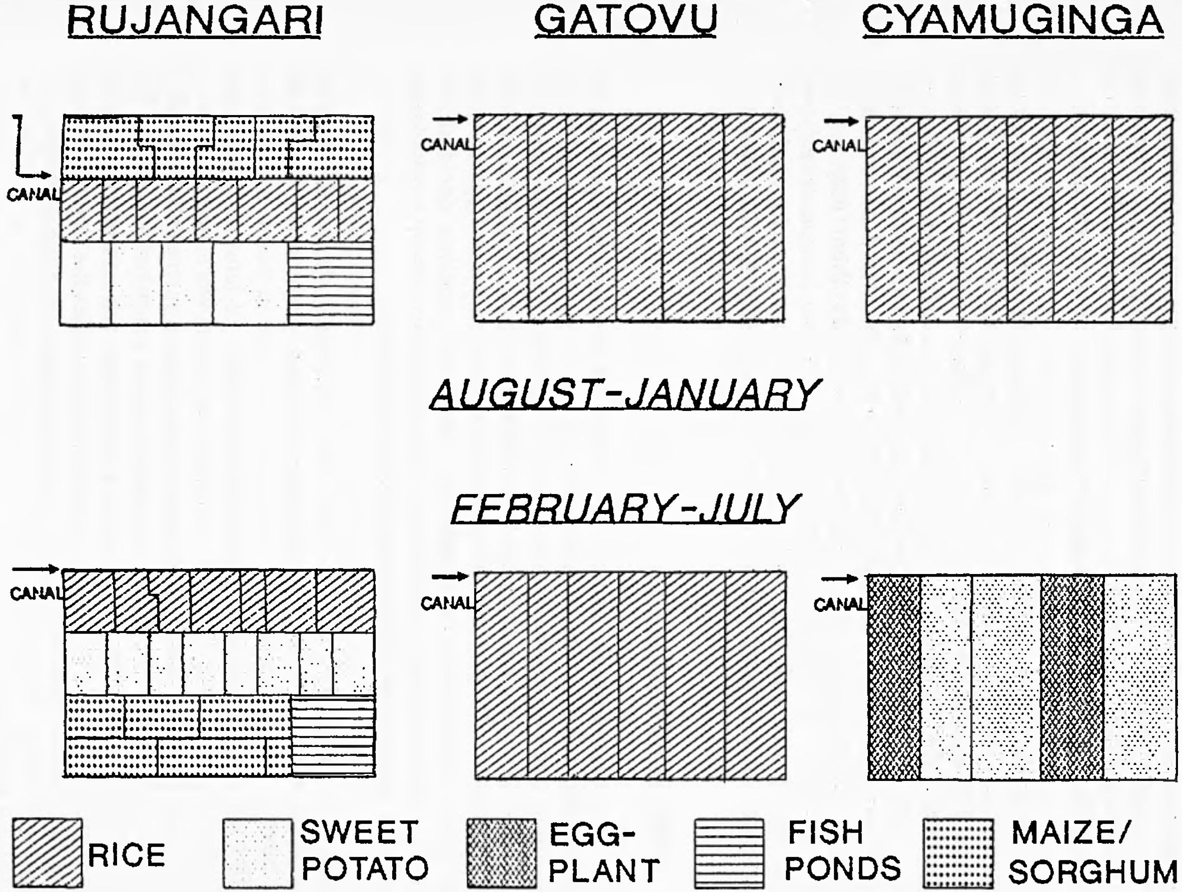

Figure 1: New Seasonal Land-Use Strategies Evolving in the Different Farming Groups

Whereas irrigation maintenance usually involves all members of the associations, other tasks are accomplished by smaller groups, reflecting their specific scale economies. In both Gatovu and Cyamuginga, rice nurseries are now maintained by groups of ten to fifteen, which appear able to avoid the inequitable sharing of seedlings that occurred with a single nursery.

The associations have resisted calls from local officials to form 'coopératives', in large measure because they wish to avoid the closed structure, formal statues and full panoply of officers, though they do seek recognition of their rights to the valley land. The 'coopératives' themselves, however, do not always work collectively, as officially expected. While the most labour-intensive aspects of rice cultivation are carried out together, sweet potato beds and the *sorjan* rice plots beside them may be the responsibility of individual women. One of the 'coopératives' has experimented with assigning smaller rice fields to members for their own subsistence, while larger fields are collectively cultivated for the market.

5. DISCUSSION

The diverse ways in which farmers have integrated rice into their production systems reflect the diversity of their physical and socio-economic conditions, underlining once again the importance of ensuring that a wide range of technological options are available for on-farm research. Our methodology also reduced the danger of conflict between rice and upland systems, for example in competition for labour, as farmers themselves decided the intensity and timing of rice cultivation. None of the farmers we worked with mentioned that rice had aggravated labour bottlenecks.

In collaborating with farmer groups from the earliest stages, the project avoided costly investments in seemingly appropriate techniques that would later have proven unacceptable. The *sorjan* is a case in point: it appeared to offer a low-risk means of increasing the intensity of land and water use while maintaining crop diversity. Farmers, however, were prepared for a much larger step; many, including some of the poorest, turned all their valley land into paddies to accommodate a crop they had never before grown. We doubt whether, even with substantially greater research resources, it would have been possible to predict this response, which belies the common image of the risk-averse small farmer. On the other hand, had we attempted to design technology in isolation before taking it on-farm, it is unlikely we would have considered the method employed in each of the groups to rotate rice and other crops. Building and then destroying raised beds is prodigiously demanding of labour when considered on a hectare basis, but appears to be acceptable to farmers who manage only a few ares.

The integration of rice into these highland valleys has required innovation in organisation, particularly on the part of those farmers who previously farmed entirely independently. Together farmers have been able to realise what an individual could not do alone. In irrigation terms, this has involved building and maintaining simple sandbag-reinforced dams and peripheral canals. Success in cooperation is largely attributable to the significant benefits farmers derive from cultivating rice and the relative evenness with which these benefits are distributed within the groups, two factors that Wade (1987) identifies as crucial in determining the likelihood of sustained cooperative action. The associations were able to effectively realise economies of scale in water management and rice production, lack of attention to which may explain the failure of earlier, scattered attempts to introduce the crop in the Central Plateau.

Though based on a small sample of groups, the findings suggest that the quality as well as the scale of cooperation may be important in the innovations that can be developed. Collective ownership appears to make possible a degree of crop diversity that escapes farmers in the associations. The minute size of holdings in the valleys severely limits the choices open to individuals but their situation is not unusual. Larger Asian rice farmers find themselves similarly constrained, particularly by irrigation-related factors, in diverging from the prevailing cropping pattern (Schuh and Barghouti, 1987). If our analysis is correct, that the intensity of the relationship among members is key, one will find that existing groups with demonstrated cohesion and regular contact, possibly for reasons other than joint cultivation, make more dynamic research and management partners than those whose members are selected by scientists (Norman et al, 1988).

Discussions are currently underway among local institutions over how to build on these results in a larger extension programme in the Central Plateau. A major challenge will be to maintain the flexibility in presenting technological options, where extension workers have generally been expected to transmit simple messages in a large number of domains. The utilisation of these findings will also be affected by the outcome of current debate concerning agrarian reform in Rwanda.

The Commission Nationale d'Agriculture (1990) contends that the minuscule size of valley holdings precludes significant technological advance and efficient use of land and irrigation resources. It proposes that most valleys be cultivated by large, commercially-oriented groups of farmers who will have surrendered their hillside fields. Our work suggests that even the smallest of farmers have a capacity for innovation that includes a willingness to associate so as to realise economies of scale. Except in bringing the valleys under cultivation, agriculture as commonly practised has not placed much demand on that capacity. An alternative to the Commission's proposal would involve first presenting farmers with new options for land and water management that make cooperation worthwhile, then giving them the time to adapt the technology to local conditions and their organisation to the new possibilities.

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WETLAND DEVELOPMENT AND MANAGEMENT IN MALAWI[1]

C P Mzembe[2]

1. INTRODUCTION

Wetlands in Malawi, characterised by hydromorphic soils, and grass and sedge growth throughout the year are called *dambos*. Topographically *dambos* are usually broad, gentle sloping valleys occurring in the catchment area of Malawi's main rivers. *Dambo* soils are waterlogged at or near the surface for a large part of the year. These hydromorphic soils have a high watertable and are poorly drained resulting in poor aeration. They vary from coarse sands to heavy clays with a soil reaction ranging from acid to alkaline. Large variations also occur in the nutrient status and the structural stability of *dambo* soils. Vegetation, grass and sedge, sometimes shrubs or trees, grow even during the driest months of the year.

The World Bank (1987) estimates that *dambos* form about 12% (259,000 hectares) of the total land area available for cultivation in Malawi. The *dambo* area comprises about 31,000 hectares (ha) used for grazing (Arup-Atkins International Ltd, 1988), 50,000 ha under rice production (Calbro, 1989), 700 small dams (Hunting Technical Services, 1986), and an unknown area used for vegetable growing. Most of the wetland area is uncultivated (approximately 178,000 ha) and possibly surplus land. These areas are too wet to grow crops or graze, and as a result are left to natural vegetation. However, with proper drainage and flood control facilities, wetlands could contribute positively towards national crop and livestock production goals.

1 Malawi Country Paper, The Technical Cooperation Network Workshop, Banjul, The Gambia, 2-6 April 1990.

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Some of the 'surplus' *dambo* land is already used for scattered smallholder vegetable gardens, and the 700 small dams, mainly constructed for watering tobacco nurseries. However, a large proportion of this unaccounted land appears to remain unutilised. Land use data seem to indicate that *dambos* are grossly under-utilised. Moore et al (1987) estimated irrigation potential in Malawi at 290,000 ha in total, while presently only 16,000 ha are under modern irrigation.

There are three types of land tenure in the *dambos*:

(a) **Public Land Tenure,** where land belongs to the government. The 3200 ha of rice irrigation schemes established by the government in the *dambos* are under this tenurial arrangement;

(b) **Traditional Land Tenure,** under the rice self-help irrigation schemes;

(c) **Traditional Land Tenure - under communal grazing,** most of the land is under this tenurial arrangement both at intra-village and inter-village levels, owned and used communally. A range of uses is made of this land, including livestock grazing, crop production (e.g. vegetables), tobacco nurseries, domestic and livestock water supplies, forage for stall-fed cattle, and the provision of materials such as clay for pots, building sand and thatching grass.

The traditional customary ownership of wetlands causes problems where animals (cattle, goats and sheep) are raised. Immediately after harvest of crops (May to August), crop residues are left for communal grazing by livestock, supplemented by *dambo* grazing as the dry season advances. *Dambo* grazing becomes extremely important from September to November, when almost all the crop residues are depleted. Erosion problems have occurred in some cases due to the uncontrolled, high stocking densities. The customary land ownership and livestock systems do not encourage development of improved pastures on the *dambos*, and facilitate fast spread of animal diseases.

Any changes in management of these wetlands (e.g. fencing, fertilising, pasture seeding, development of irrigation schemes, etc), could result in an upheaval in traditional systems of *dambo* utilisation. It is therefore important that any management changes must be agreed upon by the community using the wetland.

2. DEVELOPMENT OF IRRIGATION SCHEMES AND FARMER PARTICIPATION

The development of irrigation schemes in *dambos* can be categorised under two types:

- Government-supported irrigation schemes on public tenure;
- Self-help irrigation schemes on customary traditional tenure.

Most schemes are located on the shores of Lake Malawi, Lake Chirwa area, the Phalombe plain, and the Shire Valley. They are almost exclusively rice schemes, although farmers in self-help schemes occasionally grow either vegetables or winter maize, plus pulses or sweet potatoes.

Presently there are sixteen government-run smallholder irrigation schemes commanding an area of 3200 ha. They were developed between 1968 and 1976, the land being turned under public tenure. The main objectives of the government schemes were to settle farmers and to increase rice production for domestic and export markets. The government schemes are managed, operated, maintained and rehabilitated by the Ministry of Agriculture (Departments of Agriculture and Irrigation). The development cost of these schemes ranged from MK (Malawi Kwacha) 15,000 to MK 20,000[3] per ha, and the annual maintenance cost is about MK 300 per ha.

In areas where irrigation schemes have been developed and land is public, farmers were not allowed to participate in planning, design and construction. Therefore, they are reluctant to participate in the operation and maintenance of the irrigation schemes. Farmers feel that production is insecure on this public land and are not prepared to participate in the scheme's activities.

Realising that this public land, top-down approach is a non-starter, the government is now encouraging the development of self-help irrigation schemes, utilising a participatory approach which involves beneficiaries. Land is left under the traditional customary tenure system so farmers do not face the insecurity and threat of eviction. Farmers participate in the designing, construction, operation and maintenance of the irrigation schemes. The public-land approach has proved expensive both in terms of capital and recurrent expenditure. The development of self-help irrigation

[3] Present exchange rate: 2.79 Malawi Kwacha = US$ 1

schemes, which require farmer participation as a prerequisite, needs less material and administrative support from the government. Participation of farmers in the construction of the self-help irrigation schemes reduces the capital investment to MK 3000 ha on the part of the government; farmers excavate the canals and drains, provide labour to build structures, and provide stones, sand and mould bricks. They do not make any cash contribution. Recurrent costs borne by the government are reduced to almost zero.

Under this system land is rarely withdrawn, only in cases of serious neglect or misbehaviour. It appears that even though the farmers do not have legal ownership of the land, they consider it as their own, because of the social stability of the system. Table 1 compares the relative advantages and disadvantages of self-help and government-supported irrigation schemes.

3. LABOUR

Labour issues are more relevant to the irrigation schemes, where land has been allocated to individuals than to the communally grazed wetlands. Many farmers face labour problems in the wet season due to the high labour demand of rice production. Their labour has to be divided between the rice schemes in wetlands and their upland gardens. This problem is aggravated by the fact that farmers rely on the use of the simple hoe for land preparation. Work oxen are not extensively used for any cultivation operations. Labour conflicts do not exist in the dry season because crops are not grown in upland areas at this time.

4. MARKETING

The Agricultural Development and Marketing Corporation (ADMARC) is the main channel for smallholder produce in Malawi. The Corporation is charged with the responsibility of purchasing all the smallholder produce as a residual buyer. However, government liberalisation of the market in 1987 means that now private traders play a leading role in buying farmers' produce in rural areas. Farmers prefer to sell to private traders, who offer better prices. In 1989/90, farmers sold paddy rice at 30 tambala/kg (US$ 0.12 kg) and 45 tambala/kg (US$ 0.18 kg) to ADMARC and private traders respectively (Calbro, 1989). Farmers obtain a premium price if they process the rice.

Table 1: Comparison of Self-Help and Government-Supported Irrigation Schemes

	Parameter	*Government*	*Self-Help*
1.	cost of development to be borne by government	high	low
2.	cost of operation and maintenance to be borne by government	high	low - zero
3.	training required for farmers in maintenance and operation	low	high
4.	training required for staff in maintenance and operation	high	low
5.	land tenure problems	high	low
6.	support for the scheme by local farmers	low	high
7.	present and future donor support	low	high
8.	ownership of the scheme by farmers	none	wholly owned by farmers
9.	distribution of the schemes nation-wide	low	high
10.	vulnerability	low	high

Source: C P Mzembe (1990)

However, due to lack of finance and the scale private traders are able to operate on, they fail to compete effectively with ADMARC throughout the marketing season. As a result, most paddy is finally bought by ADMARC at the government's bottom set price. Support to private traders as loans, is required if competition with ADMARC is to be effective, increasing paddy prices to the farmer and encouraging increased production.

Another problem related to marketing is transport. Farmers do not use oxen and ox-carts extensively and do not have transport to carry their produce from the field to the house, and then to the market place. The Smallholder Agricultural Credit Administration (SACA) offers medium term loan facilities to encourage use of ox-carts for product transportation.

5. PROBLEMS TO BE ADDRESSED IN SELF-HELP IRRIGATION SCHEMES

The biggest problem to be addressed in self-help schemes is the operation and maintenance of the schemes after construction is completed. For a sustainable development programme, it is therefore important to:

(a) Provide the beneficiaries with good quality and sufficient training in the operation and maintenance of irrigation schemes;

(b) Create a fund, through user contributions, for purchase of maintenance materials such as bricks and cement. To achieve this each self-help irrigation scheme should develop its own by-laws, specific to the scheme to address its particular problems. A fund contribution clause must be included. Extension and irrigation staff should help and advise on the development of such by-laws.

(c) Provide support for emergency needs, e.g. if the scheme has been washed away. In such a case, both government and farmers should be involved in the planning and rehabilitation of the scheme.

The government intends to develop 1000 ha of self-help irrigation schemes per year in the wetlands from 1991. It is expected that 5000 ha will have been developed by the end of 1996. To achieve this target the government has decentralised its irrigation services into eight Agricultural Development Divisions (ADDs), roughly representing eight ecological areas. The staffing structure and staff training provisions of the Irrigation Department are now under review by the government. Presently staff training is given in irrigation engineering, irrigation agronomy, irrigation extension, sociology, agro-meteorology, mechanical engineering, surveying and draughtsmanship.

Self-help irrigation goals require the mobilisation of smallholders in development; this cannot be achieved by a top-down bureaucracy. The government have to create a local level political infrastructure and institutions. The principal mobilisers of farmers towards the development of self-help irrigation schemes are party officials, village headmen, chiefs and local-level government personnel, such as the community development assistance and agricultural extension workers.

6. INSTITUTIONAL SUPPORT TO WETLAND DEVELOPMENT

The government's agencies involved in wetland development are the Department of Irrigation, Agriculture (Extension), Animal Health and Industry, Smallholder Agricultural Credit Administration, and Fisheries. At the intra-ministerial level, the following institutions are important; Water Department, Economic Planning and Development Division, Health, Community Services, and Personnel Management and Training.

The government's role is to formulate development policies in line with both the local and international environment. Non-governmental organisations (NGOs) are not involved in the development of wetlands.

The role of donors is to support the projects with funds and technical assistance. Donors have been receptive to the self-help approach in the development of irrigation schemes. The funds provided are used for the procurement of materials, such as cement, construction of flood protection bunds, and services such as training. The farmers provide local materials (big stones, bricks, sand) and labour for canal and drain excavation.

7. NATIONAL PRIORITIES AND FUTURE PROSPECTS FOR WETLAND DEVELOPMENT

There appear to be unutilised areas in *dambos* suitable for irrigation, fisheries or pasture development. The decision on the type of development should be made by the beneficiaries themselves, with government officials acting as trainers and advisers. The national policy on wetland development is to encourage irrigation schemes on a self-help basis where beneficiary farmers participate in the planning, development, operation and maintenance of the schemes. This will, hopefully, avoid potential conflict between any current unknown or under-estimated land uses, and new developments. It is hoped that donors will assist the establishment of self-help projects, including training.

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AQUATIC WEEDS IN SUDAN'S GRAVITY IRRIGATION SYSTEMS: PROBLEMS, RESOLUTIONS AND FINANCIAL AND POLICY IMPLICATIONS

Taha Eltayeb Ahmed[1] and Seif E Hamad Abdalla[2]

1. THE PROBLEM

A major water management problem encountered by the Sudan Ministry of Irrigation is that of aquatic weeds. The authors interviewed senior hydraulic engineers and collected secondary data in Ministry of Irrigation (MOI) records to investigate the issue.

The presence of aquatic weeds was reported in the Gezira Canals in 1929, only four years after the irrigation system started to operate. The infestation gradually increased, and with the present intensification policy, weeds now constitute a major constraint to the irrigation system. The problem is particularly acute in the minor canals, Abu XXs[3] and drains.

Aquatic weeds can be classified into four groups:

(a) **Emerged plants** anchored into the soil with most of their stem and leaf tissues above the water surface. Their height does not change with the water level;

(b) **Submerged plants** with most or all of their vegetative tissues below the water surface. They are often rooted or anchored;

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[3] Abu XX is a water stream irrigating nine fields of ten feddans each. Each Abu XX supplies nine Abu IVs which carry water into the fields.

(c) **Floating plants** free floating or anchored with most of their stem and leaf tissues at or above the water surface. They move up and down with the water level;

(d) **Algae or unicellular**

All aquatic weeds contribute to decreased efficiency of waterways. Their presence decreases water velocity and consequently the conveyance capacity of canals. The ultimate effect is a shortfall in delivery of optimal crop water requirements. In drainage ditches the growth of weeds increases the danger of flooding cultivated lands, resulting in crop damage or hindering land preparation. In lakes and irrigation headworks high evaporation rates of water is also a concern.

A survey of aquatic weeds by the Hydraulic Research Station in minor canals has revealed the presence of the first three categories of weeds. Potamogeton spp. and Echinochloa stagnima are the most common species and are responsible for most of the damage. Of the 52 canals surveyed, 60% were almost free of weeds, due to a recent manual/mechanical control operation; 15% were moderately infested while the remainder were heavily colonised. The tail sections of canals usually suffered most from blockage by weeds, because water there is almost stagnant. Weed presence in all canals was not uniform, indicating that clearance operations are selective and not made throughout the length of the whole canal in one operation. Hydraulic engineers believe that the practice of selective weed clearance is undesirable, as it allows for a faster re-growth of weeds.

Recolonisation of clean minors begins with emerged weed species, such as E. stagnima, I. aquatica and P. nodiflora. These species spread from the banks to the water, possibly as a result of poor mechanical desilting, manual pulling or raking of weed species rooted at the banks. The growth of emerged weeds decreases the flow velocity and provides favourable conditions for re-infestation by submerged weeds such as Potamogeton spp. N. pectinata and Ottelia spp.

Most of the drainage ditches are heavily infested, as a result of the insufficient machinery usually being employed for canal clearance which has priority.

2. WEED CONTROL METHODS

To combat weed problems and maintain the efficiency of irrigation canals MOI has adopted the following control methods:

(a) Manual Control

MOI employs teams of permanent workers to control weeds manually in heavily infested minor canals. The job is done by pulling, cutting, raking, chaining and harvesting weeds at intervals of 2-3 weeks. The method used to be effective and feasible. However, with the existing extensive canal and drainage system, the shortage in labour supply and reluctance of recruits to work under hazardous conditions, manual control has become expensive and less effective than it used to be.

(b) Mechanical Control

This entails the continuous desilting of minor canals using mechanical grabbers. Weeds are uprooted and placed on the banks. This method has the advantage of serving the dual purposes of desilting and weed control. The small number of available machines and shortages in spare parts means the operation cannot be repeated in the same year in any one area.

Agricultural engineers at the Gezira Scheme have developed a mechanical device to do the job more effectively. It is a steel bar with long hooks which extend into the bottom of the canal. When the device is pulled by two tractors, one on each bank, submerged as well as emerged weeds are cut and shredded. However, plant material needs to be manually removed. The trial has shown considerable promise in controlling weeds. In addition, a selection of machines have been ordered from the Netherlands, but their efficiency and effectiveness remains to be tested.

(c) Chemical Control

Herbicides are used to eliminate the growth of weeds. In Sudan both Roundup and Pasta herbicides are used, although the effectiveness has not been evaluated. A major concern is environmental pollution and the cost involved. Opponents to the use of chemicals have campaigned to influence policy, claiming a number of drawbacks to chemical control:

(a) Chemicals effect only submerged weeds, at only a specific stage of plant development. If chemicals are not applied at that stage control is not achieved;

(b) Even effective chemical control needs to be supplemented by a manual or mechanical operation to remove the dead plant material. This implies both additional cost and an environmental hazard facing follow-up workers;

(c) It has been technically established that chemicals are most effective when the canals are dry or the water is stagnant. However, weeds grow and hinder irrigation mid-season when canals are full of water;

(d) There is a risk that operating chemical companies will use an over-dose to produce short-term results on submerged weeds in order to promote their chemicals' performance. This practice has been encouraged by the evaluation method MOI uses for chemical companies, whereby irrigation engineers assess chemical effectiveness by the results as seen immediately after operations. The risk are excessive costs, long term failure and environmental hazard;

(e) Management of the chemicals is often not optimum. Chemicals are stocked for long periods at the risk of spoilage and loss of effectiveness;

(f) Chemicals pose an environmental hazard to farmers and their families, agricultural workers and the operations' staff of the chemical companies.

3. <u>FINANCIAL IMPLICATIONS</u>

Currently, there is no reliable economic data to compare relative costs and impacts of different weed control methods. Some data from the commercial chemical companies is available from the author on request. However, this type of information is often biassed in the direction of promoting the company's product. MOI keeps budget records on all three control methods in their campaign to fight aquatic weeds. However, interpretation and usefulness of these records is limited as discussed here. Expenditure for each method for the period 1985/86 to 1990/91, in comparison to the total irrigation expenditure, was very variable. In this period, on average, about

60% of total MOI expenditure (operation and maintenance, and minor development) was for weed control, with a range of 40% to 87%. However, the records of MOI annual expenditure do not give an accurate reflection of the true cost of each control method. Some of the apparent variation in expenditure between years may be explained as follows:

(a) In MOI accounts there is no stock-taking procedure to account for opening and closing chemical stocks for each year. The chemical purchases in any one year are recorded as if wholly consumed in that year;

(b) A major increase of the budget item 'mechanical works' took place from 1989/90, due to a huge programme of earth-moving operations fighting both siltation and weed problems. Expenditure on this programme will give benefits in years to come, although accounts attribute the expenses only to the year of operation.

Consequently, expenditure on manual control appears not to have a wide variation (ranging from 9-18% of total expenditure); whereas annual percentage expenditure for mechanical (35-79% of total), and chemical (3-51% of total) methods of control appear to have varied noticeably.

An exceptional decrease in the percentage expenditure on chemical control from 1989 to 1991 was due to the decrease in foreign support in the form of grants and soft loans. This raises a further issue of the sustainability of chemical control in terms of supply and high recurrent budgets required for purchase.

It is not just the total annual expenditure on weed control, or the percentage of total expenditure which is important, but the cost-effectiveness of each method. Cost-effectiveness calculations must take the following factors into consideration:

(a) How long does a treatment under each method last and, therefore, over what period is the expense borne? It is scientifically proven that methods vary in this respect;

(b) The mechanical and chemical methods need to be supplemented by a further manual operation to remove dead weeds which otherwise block the waterways;

(c) Mechanical control removes both weeds and silt in one operation, so rendering a valuable side service. Although, on average, the percentage expenditure for the total study period was recorded as highest for mechanical weed control, this was not necessarily the dominant method. Some of the costs should be attributed to desilting benefits.

4. POLICY IMPLICATIONS AND FUTURE RESEARCH

Government policy on aquatic weed control in Sudan's gravity irrigation systems has emphasised the use of chemicals as a replacement for manual and mechanical methods. However, experience is showing that use of chemicals also has disadvantages, especially in environmental terms. There is no concrete evidence in Sudan to show that chemical control is superior to mechanical or manual, either theoretically, economically or environmentally. Little objective data is available to show that the real economic cost (e.g. including the cost of removal of dead weeds) for effective weed control is lower for chemical than other methods. It is clear that the subject needs further research, with accurate financial recording, including cost-benefit analysis of the different control methods and environmental investigation of the hazards of chemical use for humans, livestock and wildlife.

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Network Paper 14

PLANNING FOR HOUSING IN IRRIGATION SETTLEMENT SCHEMES IN KENYA: AHERO AND WEST KANO SCHEMES

Joyce Malombe

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PLANNING FOR HOUSING IN IRRIGATION SETTLEMENT SCHEMES IN KENYA: AHERO AND WEST KANO SCHEMES

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PLANNING FOR HOUSING IN IRRIGATION SETTLEMENT SCHEMES IN KENYA: AHERO AND WEST KANO SCHEMES

Joyce Malombe

1. INTRODUCTION

Only one third of Kenya's total land area is fertile, arable land, with consequent high concentration of population in these areas. In the remaining land area, water is the main limiting factor in food production and rural development. Increasing efforts are being made to supplement rainfall with irrigation schemes, to ease the existing pressure on arable land and also reverse the rural-urban migration. It is further anticipated that irrigation schemes will alleviate food production problems, especially rice production, decreasing the present volumes imported to meet demand. Therefore, irrigation schemes have been encouraged by the government in different parts of the country.

Eighty five percent of Kenya's population live in rural areas and are engaged in agriculture. There is a need to improve the quality of life in rural areas, and the government sees development of irrigation schemes as one way of doing this.

1.1 History of Irrigation Schemes

The history of settlement irrigation schemes dates back to 1954 when Mwea Irrigation Scheme was established to settle detainees. After independence the policy changed from that of rehabilitating detainees to that of resettling landless and jobless families in an effort to improve their quality of life. Irrigation schemes are part of the nationwide resettlement programme in rural Kenya, seen as a way of initiating rural development. They have mainly involved land consolidation and villagisation. Other schemes developed are Tana River (Hola), Perkerra, Bunyala, Ahero, West Kano and Bura.

This study covers Ahero and West Kano irrigation schemes in the Kano plains, Kisumu District. Housing conditions before and after the inception of the schemes are discussed, identifying the major problems in housing development in such schemes. Issues like household characteristics, construction of houses, use of building materials are given special attention. The planning process in both traditional and National Irrigation Board (NIB) housing is also analysed. Finally, conclusions are drawn and recommendations made for planning and improvement of housing. Data sources include surveys conducted in the two settlements in 1984. Some of the data was updated in 1991.

The history of Ahero Irrigation Scheme dates back to 1952 when a survey of the Nile Basin within Kenya was first suggested by the colonial government. Surveys done between 1954 and 1962 revealed that the Nile Basin area in Kenya contained an irrigable area of 54,694 hectares (ha) of which 12,633 hectares lay within the Kano Plains. The total area set aside for this project is approximately 1540 hectares and 840 ha are under cultivation, with initially 1.6 ha allocated per licensed plot holder. There was initially a total of 519 plots and the original population within the scheme included 1,012 families.

The West Kano Irrigation Scheme was intended to have equal areas of both rice and sugarcane, as experience in Ahero revealed a very high potential of sugarcane under irrigation. Survey and compensation exercises commenced in 1971 and construction work was completed in 1978. The scheme has a total area of approximately 1320 ha with a net crop area of 883 ha. A total 553 tenants were each allocated 0.82 ha of rice and 0.82 ha of sugarcane. Tenant and land use specifications were similar to those in Ahero.

In both schemes NIB management supplies all technical staff and supervision, controls water, cultivates the fields and receives the crop which is weighed, rice after drying, and then marketed on behalf of the tenants.

Selection criteria for tenants on both these projects included the following:

(1) Landlessness
(2) Unemployment
(3) Must have a wife and a family (This excluded single persons or female headed households. This is mainly because culturally it was not a common practice for women to remain unmarried. This is still the

case in rural areas, and it is common in this area to be married as a second wife. The project implementors therefore assume that men will be the household heads. Women were not expected to be the sole owners of any households traditionally and were thus not catered for by the project. Custom in the area also insists on widows re-marrying the brother of the dead husband. Women also do not traditionally own land.)

(4) Healthy and of sound mind
(5) Not a criminal
(6) Must be able to undertake at least 50% of the labouring and able to hire the rest of the required labour

2. HOUSING CONDITIONS BEFORE THE INCEPTION OF THE SCHEME

Housing before the coming of these schemes was of a traditional nature, built by people themselves according to defined customs. Families lived on their own homesteads, the household comprising of a man's wife or wives, his children and other relatives.

Traditional settlements in Kisumu District are characterised by a concentration of scattered homesteads. In the Kano plains these settlements are sited on high spots and ridges as a result of historical developments based on socio-cultural rules, and also efforts to avoid flooding and destruction of the homestead and crops. These homesteads differ in size and composition according to the characteristics of the household and the quantity of land available. The homestead contains separate dwelling units for the man and his wife, and in cases of polygamous households, each of the wives and her children. These arrangements are still adhered to in the settlements in this area today.

The various residential structures have a fixed location in the homestead layout according to cultural practices. The first wife's house is built facing the gate. The second wife's house is built on the left hand side of the first wife. If there is a third wife, the house will be on the right side of the first wife's house. If there are more wives the houses are built in the same manner. The houses of the married sons are constructed near the entrance.

2.1 Household Characteristics and Housing Construction

Before the inception of the scheme, respondents had, on average, 1.5 wives; 35% of the respondents had two wives, while 10% had three wives. All the households had children; 44% of the respondents had more than five children, while 18% had more than ten children. Children traditionally are not supposed to stay in the same house as the parents unless they are very small. The boys would be helped by their father to construct a hut, while the girls slept at the grandmother's house or in the kitchen. The whole family were, however, all housed in the same compound.

2.2 Construction Method and Building Materials

Traditional housing is constructed using local skills; people construct their own houses, with the help of family and friends. All houses are constructed with local building materials. A total of 42% of the respondents had bought some of the materials used. Following is a breakdown of the materials used:

Table 1: Materials Used

Materials	*% Bought*	*% Not paid for*
Wall		
soil	28	72
poles	35	65
Roof		
grass	33	67

Source: 1984 Field Survey

3. NATIONAL IRRIGATION BOARD (NIB) HOUSING

The NIB in Ahero pilot scheme and West Kano rice and sugar irrigation scheme provided housing for all plot holders. The farmers were to reside in planned villages dispersed within the scheme. Ahero had five villages namely, Nairobi, Mombasa, Nakuru, Kericho and Kobura. West Kano also had five villages referred to as villages 1-5. Houses of different size were planned by the NIB and other consultants. NIB set regulations, some shown below, which governed this housing.

Specific regulations on housing:

1. The Manager may allocate a licensee a house to be occupied by him within the scheme, or may permit a licensee to erect his own house.

2. In either event it shall be the duty of the licensee to maintain his house and its precincts to the satisfaction of the manager. If the manager is dissatisfied with the condition of the house or its precincts he may give written notice to the licensee to do the repairs which he considers necessary and specify a reasonable time with which they must be completed.

3. If the licensee fails to complete such repairs within the time specified and to the satisfaction of the manager, the manager may arrange for such repairs to be carried out and may recover the cost thereof from the licensee.

4. The licensee may not occupy any house other than that allocated to him without prior permission in writing from the manager.

5. A licensee shall not construct buildings or other works of any kind on his holding or elsewhere in the scheme without the prior consent of the manager in writing. In the event of his having erected a structure, it shall be removed and the land returned to its original state. If the licensee fails to comply with this directive within one month, the manager may enter the building or structure for the purpose of demolition. Any expenses incurred by the manager for the removal of the building or structure may be recovered from the licensee[2].

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[2] The Irrigation Act (Cap 34) Kenya subsidiary legislation, 1977.

3.1 Planning of the Schemes

The Ahero scheme was planned by a Dutch company in conjunction with the NIB. The houses were built by private contractors without consultation with the local residents. The design did not take into account any cultural aspects, but was made with the feeling that better housing was being provided for these people who had lived in houses built with local materials. To the planning body, this was development and the approach was that they knew what these people needed. As it turned out, this was not true.

Lessons learned from Ahero scheme led to a modified approach in West Kano scheme, which was planned by NIB with the assistance of expatriates who knew the local situation much better. The areas around the scheme were surveyed to see what kind of houses people had. The surveying team decided that three rooms and a kitchen would be sufficient. A decision on the size of the compound was also based on the survey, one house to be built which the Board regarded as the main house. The rest of the houses would be built by the owner when he needed them. This second scheme shows a move in the right direction, but villagers could have been more involved in planning.

3.2 Household Characteristics and Housing Development in Ahero

Thirty seven percent of households surveyed in the scheme had one wife, 48% had two wives, while 14% had more than two wives. The average number of wives has increased from 1.5 to 1.8 following the scheme. The percentage of men with two wives increased from 35% to 48%, while those with more than three wives increased by 3%.

The average number of children per household increased from five pre-scheme, to six post-scheme. The percentage of households with five or more children increased from 44% pre-scheme to 73% post-scheme. The percentage of those with ten or more children trebled. These changes indicate the need for more housing units to accommodate the increased number of people. This is especially important given that grown-up children are not supposed to live in the same house as their parents.

The increases were explained as a sign of prosperity. The men were marrying mainly to show a change in status as a result of moving to the irrigation project. The increased number of wives led to increased children per family. In addition, some of the younger couples had not started families before moving to the scheme.

Housing

Four hundred and nineteen houses were constructed by a private contractor on arrangement with the NIB. They were rectangular, made of cement blocks, with a corrugated iron roof. Two sizes were built: 35 m^2 (7 x 5), and 45 m^2 (9 x 5). Each house had two rooms and a latrine. Houses were built in straight lines, on one quarter acre plots. No other services were provided for the tenants. The original price for these houses was KShs (Kenyan Shillings) 3200, to be repaid in instalments of KShs 100 every season, totalling KShs 200 per year. This payment was too much in seasons when the household did not get any income from their harvest, which was said to be a common occurrence. In spite of this they had to pay, which was an added burden to trying to buy food. Timing of payments should have been more flexible.

Sixty five percent of the original houses constructed in Ahero had collapsed by the time of the survey, mainly because local soil conditions (black cotton soil) had not been considered during construction. The few houses remaining in the whole scheme had very bad cracks. The bad housing conditions, among other factors, made many people leave the village and live outside the scheme which was against the regulations. The proportion of villagers living outside the scheme is hard to determine, because households split as there wasn't enough room for all the family members in the settlement. Other factors included lack of space for keeping livestock, no provision for burial grounds, and lack of income from the rice harvest.

Those who remained have tried to solve their own housing problems using local skills and materials as they had done before the scheme. Some tenants bought their neighbour's plots and built more houses. Table 2 indicates the number of local material houses each household had at the time of the survey. Fifty five percent of households had used corrugated iron sheets for roofing from NIB houses which had collapsed, while the remainder had used grass. The construction of these houses violated the NIB regulations, but people were able to meet their basic housing needs.

Table 2: Number of Local Material Houses per Household in the Scheme

No of Houses	*Percentage of Respondents*
1	32.5
2	25
3	17.5
4+	12.5
No response	12.5

Source: 1984 Field Survey

Services

Only pit latrines were provided, although almost all had collapsed by the survey. People had created for themselves some of the other services lacking, including five nursery schools and two secondary schools. No space had been provided for development of such services in the scheme. Drinking water was not provided and tenants used canal water for drinking and all other purposes, also used by livestock. Water ranked highest in villagers' priority list, followed by a clinic because of the frequent malaria attacks and periodic cholera outbreaks. The Board is not responsible for tenants' children above the age of 18 years, and even for the younger ones they only provide malaria drugs. Schools ranked third in their priority. Lack of services or planned spaces to develop them was a major shortcoming of this project.

3.3 Housing Characteristics in West Kano Rice/Sugar Scheme

Some deficiencies in the earlier Ahero pilot scheme were addressed in this scheme. No significant differences in household characteristics were observed in the West Kano project.

Housing

A total of 553 four-roomed houses with a latrine were constructed as a major component of the West Kano scheme before the villagers moved in. The building materials and skilled labour were provided by NIB, but the farmers and their households participated in construction. The NIB's craftsmen assisted with roof, door and window construction, while the residents and friends did the rest of the work. The craftsmen were paid by NIB and the building materials were charged to the tenants on hire purchase terms.

The houses have a framework of poles. Mud and wattle walls are plastered with clay or cowdung. The floors are earthen. The roofs are made of corrugated iron (GCI) sheets. The four-roomed houses are built to a standard floor plan of 40 m^2. They do not have a separate kitchen; one of the rooms is supposed to be used as a kitchen. Eighty three percent of the houses were in good condition at the time of the survey.

The major complaint was that the rooms are very small. The average number of houses per household decreased from 3 before moving into the scheme to 1.6 after moving into the scheme. Thirty seven percent of households had one house, 40.7% had two houses, while the remaining 15% had three or more houses. Households with four houses or more decreased from 20% to 1.9%. This shows a very drastic decrease in the number of houses per household, in spite of the increase in the number of children and wives. Schemes developed subsequently have allowed families to stay in their own houses, so planning for room size and house number have become unnecessary.

Services

Again apart from pit latrines, most of which had collapsed, no other services were provided. Plans only extended to allocation of space for schools and playgounds; facilities themselves were not provided. Provision of these services was left to the initiative of the tenants, such self-help projects being common practice in Kenya. The tenants were also expected to utilise the services near the scheme. They had, through their own initiative, constructed two nursery schools and two primary schools. The other required services were a clinic, clean drinking water and schools. The clinic was especially critical because the nearest one was in Ahero, 30 kilometres away, and malaria and cholera outbreaks were frequent. There was no adequate transport to the clinic in Ahero and this road was impassable during the rainy season.

On the whole, the housing in the West Kano scheme was better than the Ahero scheme. The houses had more rooms and greater building space was provided. The use of local building materials meant that tenants could be involved in the construction of the houses. The only serious problem was in village 4 where most of the houses had collapsed because of flooding. Since the houses were similar to the ones tenants had outside the scheme, and the local materials were easy to replace, they were able to maintain them well.

4. EVALUATION OF SCHEMES

4.1 General Problems

The implementing agencies did not consider existing social customs and how these would affect the resident populations. Most families could not live in the same compound in the schemes because of the lack of space, and many residents hated the idea of planned villages. They did not choose their neighbours and some were allocated houses next to people they did not get on with. Many expressed the feeling that they had lost their identity and were frustrated because they were not in a position to control their home lives. The scheme regulations affected other customs too. In Ahero one burial ground was provided in the entire scheme. The idea of burying your children or relatives so far away from the home was resisted and some people buried family in their household plots within the scheme. In Tanzania village, which had very little land, this issue of burial was so central that some tenants simply left and went outside the scheme because they needed a place to bury their dead. Other problems are as follows:

(a) *Lack of adequate food*

Pre-scheme, subsistence farming was a main occupation. Farmers kept livestock, grew maize, beans, millet and pigeon pea, and also fished on Lake Victoria. They had not grown rice before, and this is not a traditional staple food in rural areas. The household plots on the scheme were so small that tenants could not grow adequate food. Most food had to be bought, although households could not afford this. Coupled with this, delays in payment demoralised the farmers, many of whom could not even pay school fees for their children.

(b) ***Communication***

There was a serious communication problem between the tenants and the NIB management. The tenants did not seem to have understood or been informed of the planning and operation of the scheme. Like most government development projects, they expected the government to do most things for them. In some instances, it was commented "since it is a government project, they should give us food". Provision of services was not in the initial project agreement. The households were thus not in a position to lobby. They, however, said that they had discussed these issues with the management but argued that the management never listened to them. People expected the management to provide these services and so did not understand the lack of response. They interpreted the silence to mean that the management was ignoring them. It seems as if no effort was made to explain to the tenants what the scheme would provide. They expected betterment of their lives through involvement in the scheme: one way of achieving this was by provision of services, which apparently was not in the package. The people did not seem to see it as their project, made worse by the fact that they were tenants. The study suggests that farmers did not understand the implications of being involved in this project. Expectations which could not be fulfilled were raised, and this led to serious frustrations which has affected people's attitudes towards the schemes.

It seems that most problems stem from lack of adequate communication. Given that most tenants are illiterate, clear cut channels of communication are a necessity to facilitate understanding between the management and the farmers. Tenants were given a copy of the regulations, but do not seem to have understood, perhaps because they cannot read them! These attitudes have been made worse by other calamities like crop failures and additional expenses.

(c) ***Marketing***

In West Kano rice and sugar irrigation scheme the marketing facilities for sugarcane are a problem. The factory is not able to cope with the amount of sugar-cane produced. This means that even if the sugarcane is delivered to the factory it might not be processed quickly. This has been a great frustration and discouragement to the farmers. Small scale sugar cane growing takes place traditionally, but not for marketing. Sugar factories were too far for farmers and the cost of transportation would have been prohibitive.

4.2 Housing Problems in Ahero Irrigation Scheme

The housing provided by the NIB fell far short of people's expectations. Culturally these houses were not acceptable, designed and constructed by people who did not consider the culture of the inhabitants of the Kano Plains. The farmers were not consulted and two roomed houses were constructed, without consideration of the family sizes and composition. This was a serious problem because most families were polygamous with two or more wives. According to custom each wife has to have her own house in the Lou community. In addition, many families were fairly large.

This has had adverse effects on families; the man now often cannot live with his whole family in the same compound. Many tenants have resorted to buying land elsewhere for their sons and their other wives. Only those who have the financial means can do this, others are crowded in a very small plot, and in a few instances the wives had left their husbands. The housing situation disrupts the family unit which now often has to live in two separate locations. It also means that the household head has to support two families, causing financial strain especially when the major source of income is rice.

Another social problem is the issue of living in a village on very small home plots. This deprives people of personal privacy and has been a cause for many conflicts and quarrels. This has affected the community's cohesiveness and it is alleged that it is difficult to get people to participate in community activities as a result of this. There is therefore friction among the tenants.

4.3 Lack of infrastructural services and facilities

When these houses were constructed, the only additional facility provided was pit latrines and these, like the houses, collapsed within a very short time. Roads leading to different villages were constructed, although most of these are not passable during the rainy season. Other than these no services or facilities were provided or even planned for. Primary and nursery schools, and clean drinking water should have been provided.

4.4 Housing Problems in West Kano Scheme

The housing provided in West Kano was much better than in Ahero scheme. At the planning stage the officers tried to find out facts about traditional housing, although many of these were not actually incorporated into the project. In spite of these improvements, the houses still had some basic shortcomings, still not being big enough and the whole family unable to live together. The idea of the family living in different locations defeated the function of socialising the children, who mainly ate meals with the family then had to walk, sometimes long distances, to their sleeping place.

The major complaints were about construction and the building materials used. Only four cedar poles had been used for the walls. The rest of the poles were immature, untreated eucalyptus, which rotted within a very short time. This meant that although tenants were still paying off the NIB housing loan, they had to buy better poles in addition which made it an expensive exercise. Had good quality poles been used initially there would have been savings both in terms of money and time. In addition to this, the black cotton soil used for the walls was washed away within a short time and tenants had to buy better soil from other parts of the district. Those who could not afford to buy better soil had to keep making the walls over and over again. The use of GCI sheets made the houses very hot, especially during the dry season. The roofs were leaking due to poor construction, and in most cases had to be re-fitted.

4.5 Benefits of the Scheme

Aside from housing problems, the scheme has benefited farmers. Before the irrigation schemes the people living here were greatly harassed by floods and droughts. The schemes have stabilised farmers' livelihoods, with the ability to control the floods to some degree, and to use irrigation water during the dry season. Incomes have, on the whole, been raised, but fluctuate a lot depending on factors within the scheme, natural disasters or general management. Some farmers have been able to buy expensive land outside the scheme for their sons and second wives, and also land for their livestock from their incomes. Others had built good houses with the money they had earmed from rice sales; income which also helped them maintain the NIB houses. Tenants also have more wives now, a sign of prosperity in this part of the country. Recognition of financial benefits was possibly distorted by the negative attitudes towards the settlement.

The schemes also provided employment opportunities for the local people from surrounding villages. Some are employed on a permanent basis, while many work as casual labourers. The tenants had no spare time to work on other people's fields, as their own rice production was labour intensive.

5. CONCLUSIONS AND RECOMMENDATIONS

Housing in the irrigation settlement schemes is a major problem. Housing is not an independent variable, but is embodied in people's way of life. It not only provides a structure to live in, but is designed and built to meet certain socio-cultural needs: to be accepted and to perform its function, certain aspects have to be considered in design. Social change takes time, especially among rural communities, and abrupt change is likely to be resisted as is evident in both schemes. It is necessary for the implementing agency to understand a people's way of life and incorporate it into the scheme plans. The design and feasibility studies for scheme housing were made by a foreign consultant who had no regard for or understanding of people's customs. Also, poor construction methods led to the collapse of the houses within one year in Ahero. Ignoring people's culture was very costly in all ways. First, many houses were abandoned, wasting limited, valuable resources and tenants did not benefit from the housing as they should have. This has frustrated residents and developed a negative attitude towards the schemes. Lack of proper housing also affected production, because as families were not living together, it was difficult to mobilise them for rice cultivation.

Services and facilities which enhance the living environment were not provided. No plans for these seem to have been made. The environment in the villages is very urban, with small plots and no extra land for other uses. The pit latrines provided collapsed, causing a health hazard. No piped water was provided, leaving people to use the running canal water which they shared with their livestock and also washed their clothes in. No garbage collection facilities were provided or planned for, despite people living very closely together. Schools were not even planned for, tenants have, however, built some schools on their own initiative. A major problem was availability of land to build schools. Health facilities are yet another problem, especially in West Kano where the farmers have to travel 30 kilometres for treatment.

Another aspect that should have been considered at the planning stage is subsistence plots. Rice alone cannot feed people: the four bags of rice allowed per season were inadequate for big families and they had nowhere to grow anything else, especially in Ahero. This has brought about continual shortage of food and malnutrition of children in the schemes as families could not afford to buy adequate food. The absence of subsistence plots was a serious mistake because instead of people investing money on other development activities, most of it was spent on food. Many farmers could not feed their families adequately. This problem could have been avoided if tenants had been provided with subsistence plots to grow their own food.

If people had been more involved in both planning and construction of housing areas, it is likely that more suitable housing would have resulted and expenditure could also have been reduced. Local people have always built their own houses and they know how to maintain these. It gives them a sense of ownership, and they are able to do it according to their requirements.

5.1 Recommendations

To get the maximum benefit from irrigation schemes, proper planning for housing and social requirements is essential. One cannot look at the schemes as merely increasing food production, and ignore the farmers' social environment: they are the ones who make this increase in food production feasible. Rural communities tend to be conservative: their lives must not be considered in fragments but as a whole because each aspect is important and cannot be ignored. Traditions play an important role in people's well-being and greatly influence their productivity. Consequently the planning of these schemes and their housing should be taken very seriously. Planned settlements cannot avoid some changes, but the basic social and economic needs of farmers must be taken care of if these projects are to survive. One such basic need is housing, which not only provides shelter but plays a significant role in passing on cultural traditions which are performed and taught here. It is clear from this study that for effective housing planning, the following aspects should be considered seriously. The study recommends:

- comprehensive feasibility studies and integrated planning
- involvement of the people in all the stages of development
- avoidance of unnecessary disruption of people's way of life
- exploitation of local skills in housing development

- leaving people in their existing villages
- giving a longer period of tenancy
- increasing the house plot sizes and providing subsistence plots
- payment to the farmers in good time for their produce
- improvement of the communication network between the management and the farmers

Some of these recommendations have already been implemented in projects that were developed after this study and report. The main recommendation implemented has been leaving people to live in their original villages and, therefore, not selecting their neighbours for them. If displacement, due to flooding, occurs then the project has to compensate the household that has been displaced. The officer-in-charge said this was hardly ever necessary, because no one builds their houses in low-lying areas for fear of being flooded. Local houses are generally built on high land points, while lowlands are used for irrigation. No transportation is required to the scheme fields because the original settlements are within walking distance.

Farmers have also been more involved in all the stages of development in recent schemes. The management has held discussions with the tenants before doing anything in the settlements. They even asked them what crops they wanted to grow and did not limit them to growing rice. The final decisions in planning are made by the people with the assistance of the management.

These changes are said to have made a substantial difference in the newer projects. Families have not had to spend money on new housing; they are able to continue subsistence farming, in addition to rice cultivation, and thus provide food for themselves without the need for cash. They have an option of whether or not to be involved with the scheme. This has resulted in positive attitudes towards the more recently developed projects, and a willingness of farmers to participate and cooperate. If the other recommendations are also implemented, these projects will go a long way in meeting their basic objectives, and increasing productivity as a result of more satisfactory household economics and social environment.

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IRRIGATION MANAGEMENT NETWORK
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Network Paper 15

CONTRACT FARMING AND FEMALE RICE GROWERS IN THE GAMBIA

Judith A Carney

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CONTRACT FARMING AND FEMALE RICE GROWERS IN THE GAMBIA[1]

Judith A Carney[2]

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CONTRACT FARMING AND FEMALE RICE GROWERS IN THE GAMBIA

Judith A Carney

1. INTRODUCTION

The government of The Gambia initiated an ambitious plan to develop the Gambia River Basin, with the implementation of the Jahaly-Pacharr irrigated rice scheme in 1984. Irrigation is the key strategy formulated by the Gambian government to solve its agrarian crisis, and meet national food security objectives. Dependence is on a single export crop, groundnuts, to finance milled rice imports that currently satisfy half of the nation's annual consumption needs.

Jahaly-Pacharr is not the government's first attempt to increase rice production through import substitution. Nor is it The Gambia's first irrigated rice scheme. The significance of Jahaly-Pacharr is as the first irrigated rice scheme based on contract farming, a blueprint for future irrigation schemes following the proposed dam construction along The Gambia river. Contract farming is planned as the instrument by which the government can raise rice productivities. It, however, imposes production schedules that demand strict timing of work routines. This analysis of the Jahaly-Pacharr project, now in its sixth year of operation, examines the changes that have occurred in household-based production dynamics with contract farming a food crop.

2. CONTRACT FARMING AND AFRICAN AGRARIAN TRANSFORMATION

During the past decade contract farming has emerged as a promising strategy for modernising smallholder production. Contract farming, it is often argued, can facilitate technology transfer to the rural poor and thereby create a class of yeoman farmers capable of transforming agriculture from a stagnant to a dynamic sector (Morrissy, 1974; Glover, 1983, 1987). Initially developed for export commodities like sugar, tea and vegetables, contract farming has more recently been extended to food staple production. Despite the lack of research on contracting food crops, its viability for cereal production is controversial (Binswanger and Rosenzweig, 1986: 528). In this controversy, insufficient attention is being directed to the impact on the peasant labour process (Buch-Hansen and Marcussen, 1982). Yet the changes caused by contract farming on household-based production systems are central to understanding its potential for improving food availability.

Gambia's Jahaly-Pacharr scheme is one of the first projects in sub-Saharan Africa to implement contract farming for cereal production. Contract farming refers to a district social organisation of labour which links peasant producers to the state through the supply of agricultural commodities specified in advance by a written or oral contract (Watts et al, 1988). Contract farming, however, induces significant changes in the social organisation of household production relations which affect cash and food crop cultivation, the gender division of labour, access to productive resources and property ownership. The intensified farm work burden moreover results in overlapping claims on the labour of family members. In the Jahaly-Pacharr area, small farmer households have restructured customary land and labour patterns, in response to the state's production strategy, through intra-household struggles between men and women over access to and control of female labour.

This discussion begins with a description of the production contract implemented in Jahaly-Pacharr. Attention next focuses on the labour process and specifically, the changing land and crop rights induced by contract farming. In the concluding section, the analysis shifts to intra-household dynamics and the gender effects of contract farming among the four ethnic groups involved in the Jahaly-Pacharr project.

3. CONTRACT FARMING IN JAHALY-PACHARR

The Jahaly-Pacharr irrigated rice project is located 280 kilometres upstream on the south bank of The Gambia River. Production started in 1984 with multilateral funding under the direction of the principal donor, the International Fund for Agricultural Development (IFAD). The Jahaly-Pacharr project involves over 2000 rural households from nearly 50 villages, and includes the Mandinka, Serrahuli, Wolof and Fulani ethnic groups. Approximately 1500 hectares are developed in the project, of which 560 hectares are pump-irrigated for double cropping, with the remainder used for improved rainfed and tidal rice cultivation during the wet season.

The project is managed by the Gambian government with Dutch technical assistance. The management provides water, mechanical ploughing services, and a green revolution biochemical package based on short duration (120 days), high yielding rice varieties, fertilisers and pesticides. Smallholders perform all farm operations on the 0.5 hectare irrigated plots and return a portion of their harvest for the costs of land preparation, water and inputs. Growers must belong to cooperatives to receive production inputs and to ensure loan repayment. The cultivation schedule is determined by the project management, which establishes the dates for planting, plot irrigation, weeding, transplanting, and harvesting. Smallholders are informed of these decisions through nine extension agents (one for about every 300 households), and contact farmers who are selected for each ten hectare block. Two land allocation committees serve as conduits for smallholder-project management interactions, but there are no farmer-directed growers' organisations.

Jahaly-Pacharr operates with a twenty one year renewable lease which the government negotiated with district authorities and village headmen. Continued household participation in the project ultimately rests on repayment of the seasonal production credit, the cost of inputs, plus 15% interest; failure to comply with loan repayment schedules can lead to eviction. The threat of usufruct loss, is the key mechanism by which the project management exerts labour discipline among growers. This emerged as a problem in summer 1990, when low yields caused 10% of the farmers to fall into arrears on loan repayment. Their plots were seized by the project management and opened up for others to cultivate with the proviso that the outstanding loan be repaid. But the project management agreed to forestall permanent expulsion by permitting plot 'owners' to reclaim their land if the debt was repaid the following season. The compromise diffused peasant resistance over potential land dispossession.

The actual contract mediating production and labour regimes in Jahaly-Pacharr is based on an anticipated average yield (7 tons/ha), and 'paid' in paddy rather than cash. This system has two advantages: (1) it enables the government cooperatives to collect large amounts of paddy for later marketing and mitigates the problem of illegal cross border sales with Senegal where the producer price is higher; and (2) the collection of paddy by the cooperatives is more inflation-proof than payment in cash since the Gambian currency (the *dalasi*) experiences continuing devaluation.

The scheme's overall objective is to ensure double cropping and surplus rice production without a reduction in upland groundnut cash cropping. But irrigated rice development in The Gambia has long experienced labour conflicts during the wet season between groundnut cultivation and irrigated rice. A brief overview of the farming system clarifies the problem. Gambian farmers utilise two broad environmental zones for agricultural production: lowland swamps and upland sandy soils. The lowland zone, which actually embraces a range of micro-environments not strictly dependent on rainfall (such as tidal flats and hydromorphic soils) is planted to rice. Agricultural production on the uplands, however, is completely dependent on a five month rainy season. This geographic area is planted to millet, sorghum and groundnuts, the principal cash crop. The spatial division of farming also reflects distinct gender divisions of labour. Women predominate in lowland swamp rice cultivation, but their access to upland fields and thus, groundnut plots for cash cropping, varies by ethnic group. Fulani, Serrahuli and Wolof women are also involved in groundnut cultivation. However, among the Mandinka, Gambia's dominant ethnic group and pre-eminent rice growers, men plant the uplands while women customarily work in lowland rice. Mandinka women consequently rely on rice for subsistence as well as cash needs, even though the crop is less remunerative than groundnuts.

The initial phase of Gambian irrigated rice development (1966-80) perturbed the spatial and gender division of labour among the Mandinka. World Bank and Chinese funded irrigation schemes introduced the 'green revolution' package to male household heads, thus placing the rice land under male control. This resulted in the irrigation schemes being under-utilised during the rainy season when men turned to their more remunerative groundnut crop. Mandinka women, denied control over the benefits realised by technological change in rice cultivation, continued its production in adjacent swamps not converted to pump irrigation. While this arrangement minimised intra-household conflicts between men and women over the latter's denied access to technologically-improved rice, the restriction of irrigation to dry season production crippled the surplus-generating potential of the schemes.

The Jahaly-Pacharr project sought to avoid such problems by the mechanism of contract farming. This would ensure double cropping and thus greater control over household (male and female) labour processes, while revolutionising rice productivity. The production constraints of previous irrigation schemes were specifically addressed:

(1) Through removing control of irrigation projects from local communities, and making access to project land dependent on compliance with loan repayment;

(2) By registering the plots in women's names and thereby securing their labour for year-round production;

(3) By minimising potential labour bottlenecks by scheduling the irrigated rice cycles to complement groundnut cultivation.

Consequently, the project's dry season planting cycle commences after the groundnut harvest in January, and begins anew in July once the groundnut fields are sown. To facilitate the irrigated rice schedules, the management mechanically prepares the fields in the interval between planting seasons. Once the irrigation cycle gets underway, the remaining field operations are performed manually with rudimentary hand tools. This rigid cropping schedule demands strict adherence since the labour bottlenecks posed by planting delays could: (i) diminish productivities in both crops; (ii) reduce foreign exchange earnings from groundnuts; and (iii) threaten project smallholders with eviction for failure to repay their seasonal credit.

Jahaly-Pacharr was additionally conceptualised to address specific welfare objectives. The first of these aimed to extend irrigated rice development to those rural poor bypassed in previous schemes which favoured smallholders with the resources to purchase the green revolution inputs. The Jahaly-Pacharr scheme reached a broader spectrum of small farmers by making inputs available on credit through the project's cooperatives. Anticipated productivities of 7 tons/ha, well in excess of household subsistence needs, also promised a significant increase in rural incomes. This may seem high, but in the first years project farmers recorded harvests frequently in excess of 7 tonnes/ha.

A second welfare objective stemmed from Dey's (1980, 1981, 1982) research on the deleterious gender effects of earlier Gambian irrigation schemes, which received widespread attention in development circles. Her work combined with the vigorous 'women in development' lobby to pressure international development agencies for projects sensitive to gender issues. The European donors of the Jahaly-Pacharr scheme aimed to target women "who traditionally have been the major rice growers under arduous swamp conditions" (IFAD, 1981).

4. LAND, CROP RIGHTS AND A NEW LABOUR PROCESS

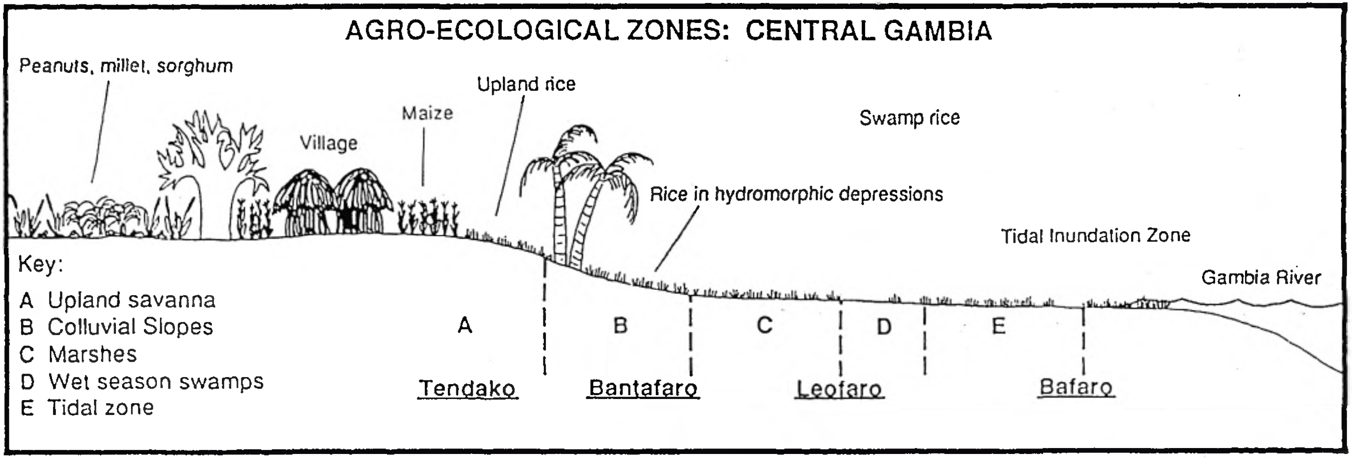
The retention of plot access in Jahaly-Pacharr depends on firm adherence to stipulated cultivation practices, cropping calendars, production targets and loan repayment schedules. Yet, by imposing new and demanding work claims on household labour, this production strategy strikes to the core of family relations. Households are not only under considerable pressure to follow regimented cropping schedules, but also to extend agricultural work to year-round cultivation. This form of agricultural intensification is illuminated in Figure 1, which contrasts cultivation calendars and labour requirements for groundnuts and traditional swamp rice with the project's pumped plots. Even with the use of labour-saving machines for ploughing, pump-irrigated rice production within Jahaly-Pacharr requires an average of 60% more labour per unit of land than traditional rice (von Braun and Johm, 1987: 15-16).

Household heads, as well as the project management, fully expected women to absorb much of this intensified labour burden. Women's pre-eminent role in rice cultivation, particularly their expertise in transplanting and weeding, was critical to easing wet season labour bottlenecks with groundnut cultivation. By making women the principal project beneficiaries through granting them pumped plots, the donors hoped to mobilise female labour for production schedules and improve women's incomes. But the initial land distribution proved the importance of the project and female labour control for household income generation. Male household heads were registered as plot 'owners' in all but 10% of the pump-irrigated plots.

Male plot control in the scheme prompted IFAD, the lead donor, to send a mission to reverse the allocation and redistribute the plots to women (Alterelli-Herzog, 1984). But the project's Gambian management brokered the re-registration process. They overcame male resistance to female plot control by agreeing that the household, not individual women, possessed ultimate control over the plot. IFAD, however, did successfully manage to place women on the two land allocation committees, which mediate management-grower interactions and project disputes.

Assured by the project management that women's rights in the scheme would be upheld, IFAD ceased direct intervention in monitoring gender issues. The Gambian management's decision in the land reallocation, however, cleared the way for male household heads to obtain *de facto* control by declaring the plots household fields.

Figure 1



Source: Carney 1986

5. LAND OWNERSHIP SYSTEMS

Gambian household-based production systems operate with both communal and individual property rights. The fundamental principle conferring ownership is the clearing of uncultivated, unclaimed land. If family members undertake the clearing jointly, the land is designated household land (Mandinka: *maruo*). Individual men and women, however, may establish land ownership rights by clearance with their own labour (Mandinka: *kamanyango*). Although a smaller proportion of total land ownership, *kamanyango* fields are important, especially for women, for they represent partial autonomy from the patriarchal structure of family property control and give women the opportunity to transfer land to their daughters. Most individually owned land in The Gambia has been cleared from lowland swamps for rice production.

The terms designating land ownership simultaneously refer to labour relations and crop rights on the land claimed. The Mandinka distinguish fields employed for food crop or use value production from plots planted for cash cropping or exchange. Plots on which family members labour for collective subsistence needs are conventionally referred to as household fields (Mandinka: *maruo*) and constitute the dominant form of family land use. In villages near lowland swamps, women plant rice as *maruo*. Men's *maruo* obligations are traditionally met on the uplands where they cultivate millet, sorghum and maize. While groundnuts are sometimes planted on household fields to finance food purchases, *maruo* crops are customarily not sold for profit. *Maruo* production comes under the jurisdiction of the male household head who controls storage, distribution and in the event of sale, marketing transactions. In return for their labour on household fields, family members receive usufructory rights over a small portion of household land. These individual fields, also referred to as *kamanyango*, provide female and junior male family members land for cash cropping. Groundnuts are the dominant *kamanyango* crop for all ethnic groups of the project area, save Mandinka women, whose work in the lowland production zone means rice is cultivated as both *maruo* and *kamanyango*. Thus, within the Gambian farming system family members are compensated for their labour on household plots by access to individual fields and direct control over the income benefits from the crops produced. *Kamanyango* crops provide subordinate family members their primary access to income.

The importance of language in expressing control over land, and particularly female labour, became evident during the first year of the project when all the pumped fields were termed household plots. Under intensified work routines, household heads are using the *maruo* designation to channel female labour obligations to produce marketable surpluses that will come under their control. Women, on the other hand, experience mechanised rice production as the imposition of an enormously demanding work routine to produce a crop which they see as "women's sweat". As production got underway in 1984, project households erupted into a contested terrain of struggle between men and women over access to and control of female labour.

6. CONTESTATION, RESISTANCE AND CONTRACT FARMING

The previous Chinese and World Bank irrigation projects where developed sites averaged only 20 hectares, left women continued access to lowland swamps outside the projects for rice cultivation. Jahaly-Pacharr, however, incorporated 1500 hectares of lowland swamps thus absorbing most of the area's swamp land available to female rice growers. During the project's first wet season cropping period, women provided most of the agricultural labour on the pumped *maruo* plots. But the following dry season cycle, when their promised *kamanyango* crop rights failed to materialise, women mobilised. They pressed the project management to designate the non-pump irrigated portion of the scheme (940 hectares for tidal and rainfed rice) as *kamanyango* fields. But the project management failed to support their cause and IFAD personnel were not present to intercede on the women's behalf. The inability to obtain institutional support for their customary crop rights forced project women to negotiate through the very patriarchal village and household structures that from the first land distribution sought to deny them access to project plots.

The differential effects of project development on women became evident during the first year. Women provided most of the project's field labour while the household head maintained his traditional control over the disposition of surplus produced on *maruo* land. This transformation of meaning in contract farmed plots proved significant. Irrigated rice production requires double the labour days over traditional swamp cultivation and demands about three times as much labour as groundnut cropping (Figure 1). Average yields on irrigated plots (6.5 tons/ha), however, represent nearly a four-fold increase over traditional swamp rice production. The creation of rice surpluses beyond household subsistence needs in the project's first years frequently resulted in a doubling of per capita income after loan repayment (pre-project per capita income averaged US$ 130). The naming of the project's pumped plots *maruo*, thus, enabled the household head to intensify female agricultural labour burdens and make claims to women's unpaid labour when the plot functions in part as his individual field. Within the project area it is the male household head who markets the plot's surplus rice and appropriates the profits generated. Rather than broaden women's crop rights and land access, development of the Jahaly-Pacharr project augmented the economic position and accumulation opportunities of male household heads to the detriment of female as well as subordinate male family members.

Women across all ethnic groups involved in the scheme, however, actively resisted the increased work burdens posed by project development. Their struggle pivoted on reaffirming pre-existing *kamanyango* crop rights which returned to them some benefits from their toil. While the Jahaly-Pacharr project is based on year-round cultivation, customary land rights and labour obligations had evolved out of a farming system regulated by a five month cropping cycle. As there were no customary precedents in local farming systems to claim women's *marou* labour for two cropping seasons, female rice growers demanded recompense for the loss of *kamanyango* crop rights. Aware that a household's inclusion in the project depended on strict adherence to cultivation schedules, women challenged male control of the economic rewards of their labour by demanding compensation.

7. ETHNIC DIFFERENCES

Of the four ethnic groups involved in the project, only the Mandinka and Serrahuli (33% and 23% of project population) previously planted rice. For Wolof and Fulani (27% and 18% of project population) women, project implementation heralded new agricultural practices that augmented their customary labour burdens. For the cattle-herding Fulani, agriculture was a secondary activity, with most of their labour confined to upland millet and groundnut projection. While Fulani women assisted in the cultivation of these crops, much of their labour was devoted to the animal husbandry sector and chiefly, the processing of dairy products for sale. Their important economic role to the household thus facilitated a fairly equitable labour burden in the project's plots between Fulani men and women.

Serrahuli and Wolof women, in contrast to the dominant ethnic group, the Mandinka, have individual crop rights established in upland groundnut fields unaffected by project development. Even though Serrahuli women also lost their rice fields, these plots were for communal subsistence (*maruo*) production only. Serrahuli and Wolof women, like subordinate male family members, still maintained the right to withdraw their labour for individual plot production during the rainy season. Customary access to productive upland cropping zones strengthened women's resistance to an intensified work burden. Consequently, when Serrahuli and Wolof women labour in the project's pumped plots during the wet season, they are usually compensated in paddy.

Mandinka women, on the other hand, found themselves in a much more vulnerable position since both their communal and individual fields were spatially segregated from men's. The incorporation of lowland swamps into the project made Mandinka women landless and in effect, proletarianised. Mandinka women were well aware that unless their *kamanyango* property rights were defended and renegotiated, they faced the erosion of all protection against household claims to their labour. Mandinka women's success in bargaining for labour compensation, however, has been uneven. But by the end of the project's third cropping year (1986), three generalised resolutions were evident. One adaptation is found in villages with pumped as well as improved swamp rice plots: women's crop rights are generally recognised through granting them *kamanyango* rights to tidal irrigated and rainfed areas. Another adaptation also honouring women's crop rights occurred in households with no or limited access to other types of project land; in this agreement men remunerate their wives' labour in pumped plots with a share of paddy. In the third generalised response, women's *kamanyango* crop rights have not been reasserted; the family unit does not provide access to other project plots nor labour remuneration.

These responses illuminate key structural patterns and relations that shaped the capacity of Mandinka women to secure crop rights or labour remuneration. In one village with both pumped and non-pumped plots, women received *kamanyango* rights in the tidal and rainfed areas. While their collective demands placed pressure on the male-dominated village social structure, the presence of the chief's daughter on the influential project land allocation committee proved crucial to the successful outcome. In a similar community nearby, women were unable to re-establish customary usufructory rights from village elders. In yet another Mandinka village without access to tidal or rainfed swamps, conflict resolution focused squarely on the issue of labour remuneration. However, the objective was only achieved by women in a handful of elite households with more than one project plot. About 15% of village households, who share a plot with other families and thus only meet subsistence needs from the scheme, were unable to compensate women for their labour. In this example, only about 20% of the village's households granted women a fixed share of paddy for their work. Failing to receive any form of remuneration, most Mandinka women in surplus-producing households throughout the project area have withdrawn their labour from pump irrigated rice production. This response has had far reaching consequences for the social organisation of Mandinka household production as well as anticipated productivities within the scheme.

First, female labour withdrawal has led men to increase their work in the pumped plots. However, given the high rate of polygynous marriage in the project area, men cannot compensate for the loss of skilled female labour through an intensification of their own. Consequently, an increase in labour hire, particularly during the rainy season when men plant groundnuts, has ensued. Twenty five percent of the field operations are carried out by hired labour (von Braun et al, 1989), but most of these wage labourers are Mandinka females who have become proletarianised with the advent of the Jahaly-Pacharr project.

Secondly, having lost access to rice land, women's economic activity now concentrates on the local wage labour market for irrigated farm work. This development has contributed to the transformation of Mandinka women's reciprocal labour networks (*kafo*). Historically, women's age sets mobilised large work groups for agricultural operations, or functioned as an auxiliary labour reserve for women who were sick, pregnant or unable to go to their fields. The money collected typically served as a common fund for financial assistance and for ceremonial occasions. For landless Mandinka women who have been transformed into wage labourers, reciprocal labour groups now serve as an institutional framework for recruiting female workers. In sharp contrast to the pre-project period, the *kafo* earnings are no longer accumulated for mutual needs but divided as a wage among individual female participants. By forming work groups, women receive a better rural wage than as day labourers, obtaining eight instead of five dalasis (US$ 0.96 rather than 0.70/day).

Finally, the changes in the social organisation of Mandinka production have contributed to a reduction in anticipated productivities. During the project's first year, 25% of Mandinka rice growers were already experiencing problems in ensuring loan repayment due to labour shortages. With female labour withdrawal, the problem has become more generalised. Some households do not command sufficient resources to hire labour, especially for transplanting and weeding, which present bottlenecks in cultivation schedules. Even those households which can afford work group labour find they are not always available when needed. Such households are consequently experiencing difficulties with the cropping schedule - a factor which contributes to lower yields and the management's oft-repeated contention that the Mandinka are the scheme's worst rice farmers.

These intra-household labour problems account for the reduction in average pump-irrigated rice yields that had occurred by 1987. Dry season yields per 0.5 hectare plot declined 3.3 tons to 2.0 tons, between 1984-86. Average yields during the wet season cycle, when labour demands intensify with groundnut cultivation, plummeted from 3.2 to 2.0 tons. In sum, average annual production declined from 6.5 to 4.9 tons per plot. After deducting the paddy sold for annual credit repayment (2.4 tons per annum), surplus production per 0.5 ha plot averaged 2.5 tons, providing little margin for sale over household subsistence requirements. By 1987 Jahaly-Pacharr was generating just half the 6000 tons of paddy anticipated by project planners. While the yield reductions had not yet led to evictions from the scheme, they had seriously limited the project's potential to deliver to its technological capability.

The attempt to raise small farmer productivity in irrigated rice through contract farming has thus had multiple effects on the peasant labour process and household social relations. The decrease in yields cannot easily be attributed to soil degradation when the socio-economic variables emerge so powerful. Yet loss of soil fertility in the pump irrigated area had indeed become a problem by 1990. No longer enriched by alluvial deposits from river tides, the pumped plots were producing no better than they had in the pre-project era as women's tidally irrigated farms. Moreover, women's traditional tidal rice production did not necessitate the purchase of inorganic fertilisers whose price has tripled in the aftermath of an IMF-induced structural adjustment programme.

The gender division of labour in the Jahaly-Pacharr project has undergone substantial transformation as men now cultivate rice. Male household heads have exercised their patriarchal control over property to capture female labour for the production of investible surpluses generated by the project. Women, however, have come to view themselves differently and acted to defend their pre-existing rights. Project households have experienced intense struggle, negotiation and partial victories which have challenged the dominant representations of gender and patriarchy. These factors have severely constrained contract farming's ability to increase marketed cereal surpluses.

8. CONCLUSION

By the end of the 1970s agricultural development policies in sub-Saharan Africa were converging on contract farming for its potential to convert agriculture into a dynamic sector. Contract farming presented a rural development strategy based on a partnership between smallholders and agribusiness capital which improved farmers' access to inputs, new technologies, national and international markets. As a means of dynamising agricultural production, contracting soon began to attract the interest of African states and foreign donors, interested in reaching smallholders unaffected by previous green revolution strategies.

The Gambian government, evaluating decades of failed irrigated rice projects, seized upon contract farming to lure donor investment in yet another attempt to achieve rice import-substitution policy objectives. In attracting the concessionary aid it sought, the Gambian government pioneered contract farming in a crop generally not cultivated elsewhere under contract.

Much of the literature on contract farming attributes its emergence to commodity and quality control characteristics. Binswanger and Rosenzweig's (1986) work argues that contracting develops in crops with agricultural processing requirements, such as sugar and tea and is not a viable strategy for cereals. Rice does not require agro-industrial processing, nor does horticulture, a major area into which Gambian contract farming is expanding. The significance of this case study rests on the use of mechanisms like contract farming to gain control over the labour process of peasant household producers for the policy objectives of the state and multi-lateral donors. What proves at stake, then, with contract farming is the on-going effort by international agencies and the state to shape the labour process of small farmer producers to its objectives. The viability of contract farming rests ultimately not on the type of crop grown, but rather on the effect of new contractual arrangements and forms of production on the social organisation of household labour.

Even though rice is traditionally a gendered crop among the Mandinka, this study argues that women's access to land remains crucial for achieving productivity and welfare objectives. Labour conflicts in households of the project's three other ethnic groups resulted in quite different resolutions for productivity and women's economic opportunities precisely because females retained access to the uplands, which were not incorporated into the Jahaly-Pacharr project.

Conflicts between men and women as occurred in Jahaly-Pacharr, however, are not unique to projects where food staples are contracted. Recent studies in Kenya (Jarosz, 1987), Tanzania (Mbilinyi, 1988), and Senegal (Mackintosh, 1989) show that gender struggles over resources and women's labour also occur with contracting export crops like sugar, tea and vegetables. Much of the literature, however, narrowly focuses on commodity characteristics, technological and market criteria, ignoring the effect on the social organisation of household labour and especially, female family members. Yet, the strict timing of work routines and intensified labour demands are critical features of contract farming. In view of the work loads burdening African women, debates that focus on the commodity characteristics and marketing arrangements of contract farming seem superfluous.

Since 1985, The Gambia has experienced IMF structural adjustment packages which are responsible for numerous changes in state policy. These are affecting the ability of irrigation projects to meet food, rather than export crop, production objectives. In 1988 the tax that had been placed on milled rice imports to protect Gambian domestic production with Jahaly-Pacharr became a casualty of IMF interventions. The abolition of rice import duties effectively lowered the producer paddy price (IFAD, 1988), while the mandated removal of fertiliser subsidies raised farmers' production costs. These measures contribute to lower profits and productivities. Mechanical soil preparation is now too costly, and fields are increasingly levelled and prepared by hand. While project labour demands increase, plot preparation falls behind projected cultivation schedules. Great disparities now exist in stages of rice planting between plots which contribute to inefficient irrigated water use. Water flows are regulated by centralised delivery systems that tie individual plots to production schedules for the larger land unit. Mechanical land preparation has also been plagued by spare parts and diesel delivery problems. In 1989, when world market prices in groundnuts increased two-thirds over the previous year, household heads shifted wet season production priorities from the project's irrigated rice plots to upland groundnut fields. The effect was dramatic: average yields on the project's pumped plots dropped to one ton per hectare.

Another result of IMF structural adjustment was the reorganisation of 'inefficient' government parastatals by 1989. The cooperatives were streamlined with the result that they would only purchase export crops, groundnuts and cotton. Consequently, Jahaly-Pacharr farmers can no longer sell their rice to the cooperatives. By summer 1990, the only farmers with a marketing outlet for their paddy were the wealthier ones who could manage storage and transport to regional and cross-border traders. The project manager's effort to interest the World Food Program in purchasing rice for Gambian 'food for work' programmes failed because of the World Food Program's structural organisation. It purchases rice supplies on commodity markets at the cheapest price, generally broken varieties of South East Asian provenance.

By examining the labour process of small farmer producers, this study illustrates the types of intra-household conflicts that emerge with agrarian change as well as their significance for productivity goals. Contract farming's potential in sub-Saharan Africa consequently cannot be assessed independently of the social relations regulating household production, nor without understanding the international, national and *domestic* economies within which both male and female peasant producers plant, harvest and sell their crops.

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IRRIGATION MANAGEMENT NETWORK
(Africa Edition)

Network Paper 16

IRRIGATION AND THE SONINKE PEOPLE: ORGANISATIONAL AND MANAGEMENT PROBLEMS: CURRENT SITUATION AND PROSPECTS

Georges Diawara

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IRRIGATION AND THE SONINKE PEOPLE: ORGANISATIONAL AND MANAGEMENT PROBLEMS: CURRENT SITUATION AND PROSPECTS

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[1] Executive Secretary, URCAK, Kayes, Mali. URCAK is Kayes Regional Union of Agricultural Cooperatives.

IRRIGATION AND THE SONINKE PEOPLE: ORGANISATIONAL AND MANAGEMENT PROBLEMS: CURRENT SITUATION AND PROSPECTS

Georges Diawara[1]

1. BACKGROUND INFORMATION

Like that of any other society, the history of the Soninke people is closely connected with the availability of water. In our study, we consider the case of the Soninke in the Sahelian region of present day Mali and more particularly along the Senegal river and its tributary, the Faleme.

Three phenomena are presently producing fundamental transformations in Soninke farming practices: drought which affects the whole population; development schemes in the Senegal river basin affecting the valley dwellers; and immigration. The second aspect took our interest and led us to base the study on experience with irrigation schemes, taking as our examples the Somankidi-coura, Moussala, Gakoura, Sobokou, and Lani-modi schemes on the Senegal river and Fegui, Sangalou and Gouthioube on the Faleme.

Our study considers a series of questions within the context of the Soninke culture, which is not a simple task. Soninke society, although it has become more open to the outside world since the decline of the empire of Ghana, nonetheless retains a traditional culture and its own sets of values, shrewdly absorbing external inputs in an unhurried, measured, discerning and tactful manner.

It is a dynamic society which has used its experience to bring about profound social transformations without brutality, on its own terms, giving pride of place to spiritual and economic matters. Mosques, health centres, water supply systems, wells and boreholes followed by schools, provide the physical evidence. Investment in transport and trade, animal husbandry and agriculture bear witness to the economic concerns which have created the image of the Soninke as peerless traders and tireless workers proud to display their assets. Naturally conservative, but great innovators with powers of observation and experimentation, the Soninke have a sense of moderation and caution which may make them appear outwardly naive, but fundamentally calculating.

The pride and sometimes arrogance they display is a clear sign of a minority people safeguarding its identity. To analyse the issue of irrigation and the Soninke people from an institutional and functional perspective thus requires a participatory approach, failing which a wall of silence will be encountered and only superficial interpretation will be possible.

1977 saw the first introduction of irrigated agriculture in the Soninke area, with the Somankidi-coura, Moussala and Gakoura schemes, followed by Sobokou and Sangalou in 1980, Lany-modi in 1981, Gouthioube in 1982 and Fegui in 1986. Eight schemes were set up over almost 10 years. The idea is presently fashionable in Soninke country for a number of reasons.

Several objectives lay behind the establishment of these schemes:

- The struggle to achieve food self sufficiency, income security and increased income for small farmers;
- The attempt to provide an alternative solution to rural exodus by setting up agricultural schemes to generate jobs for former or potential migrants;
- The introduction and extension of irrigated agriculture with a view to developing the Senegal river valley;
- The development of a region affected by drought and its socio-economic consequences.

The study does not attempt to verify whether all or some of these objectives have been achieved. What we have done is to obtain from Soninke people participating in such schemes (Guidimankan and mainly in Gadiaga) some views on the advantages based on difficulties they have encountered and the new problems to be dealt with.

The study thus operates at two levels: a description of past experience and dynamic research with a view to improving and ensuring the future success of irrigation schemes.

2. ORGANISATIONAL PROBLEMS

Any observer can see that the experience of setting up and managing irrigation schemes in Soninke country has been fraught with constraints. These constraints can only be tackled through organisation by the participants themselves: such organisation must necessarily be strong, multi-faceted and versatile.

Our study of the organisational problems encountered by selected schemes is based around results of a 10 day meeting in 1988 with all the officials involved in the field. We concentrate on the experience gained by participant farmers between 1977 and 1988: this enables us to identify the principal difficulties in irrigation in Soninke country up to the present day. We place these problems in four main categories to present a broad view of a novel and quite complex situation.

Setting up an irrigation scheme and acquiring the means to operate and manage it present a considerable challenge. What may seem obvious or commonplace to the layman will not be so in a real field situation. We should point out that Soninke country is not virgin territory, let alone neutral terrain.

2.1 Factors relating to infrastructure, equipment, finance and human resources

Infrastructure

Existing infrastructure is inadequate, inappropriate and in all cases unreliable when it comes to sustaining farming developments capable of expanding a new type of agriculture to achieve any one of the above mentioned objectives. The area to be developed (clearance, levelling, drainage, irrigation basins, channels, dams and dykes, field lay out, etc) rarely exceeds half or one third of the available land: guaranteeing water flow is a problem from the start.

The cost of such developments, estimated to be 2 million FCFA per hectare, far exceeds the financial capacity of farmers unless assistance can be obtained from the Malian government, bilateral or multilateral cooperation or NGO partners. In most cases, plans for development of the Senegal river basin are presented with no timetable for carrying out the work or indication of the funding available.

In addition, any observer can easily see that there is no adequate road infrastructure, proper health centres or village markets in the areas where these schemes are located. Genuine development in such areas is therefore not a very viable proposition. Present participants also point to the absence of warehouses to store produce and small plants to process vegetables or hull rice, which loses much of its commercial value if marketed as paddy.

The coexistence of agriculture and livestock husbandry around villages raises the issue of protecting cultivated areas with solid, durable fencing. Such investment is always beyond the reach of farmers. Solutions advocated by national as well as foreign technicians are either inappropriate or unrealistic in the absence of any partner prepared to provide funding. Some of them suggest environmental protection as if there were no cost attached.

Equipment

The oldest form of tool is still the *daba* (mattock), of various types according to the kind of work to be carried out. For irrigation, the indispensable tool or 'heart of the scheme', is the pumping station. The most common type is the English model Lister HR2 or HR3. Problems related to the pumping system are frequent breakdowns due to wear and tear and dilapidation of the equipment.

To begin with maintenance by many of the pump attendants was poor and repairs were often make-shift, undertaken by casual mechanics found in Mali, Senegal or Mauritania depending on the location of the scheme and existing skills.

It was also pointed out that some pumping stations were underpowered in relation to the size of the area to be irrigated. Furthermore, as the slope of the bank made access to the river difficult, it was essential to adopt pumps installed on moveable bases.

All participants stressed that farms were under equipped. Ox driven ploughs are still a luxury while the purchase of tractors by two migrant cooperatives, Sobokou and Lani-Mody, raises the issue of depreciation. Transport is also inadequate: bush taxis, where available, and canoes during the rainy season, do not offer a total solution. The high cost of transport will continue to be an obstacle to the expansion of irrigation schemes for some time. It is difficult to envisage the use of rail transport in view of the distance from stations and the frequency of passenger trains stopping at Ambididi and

Diboly: once a week for express trains in both directions between Bamako and Dakar and the passenger train plying between Dakar and Kayes.

Finance and human resources

Investment in irrigation schemes requires considerable personal effort by participants, in many aspects in the absence of revolving funds.

In view of the scale of problems encountered schemes have little chance of achieving self financing status. Participants often mentioned the low level of income per farmer. We shall come back to this point. The need for adequate and appropriate funding is felt at all stages. An agricultural enterprise, such as an irrigation scheme, cannot depend exclusively on the good will of participants, personal effort and voluntary provision of the various services required.

2.2 Relationships between participants and organisational structures

Problems identified fall into three categories:

- Relationships within villages and on farm;
- Relationships between schemes;
- Relationships between schemes, technical services and the administration.

Our study cannot go into all of these in depth. It will confine itself to describing and explaining them on the basis of work and meetings with participants in the field.

At village and farm level emphasis is always placed on access to land, land rights and problems with land owners under customary law. It should be noted that to date no scheme has title to the land on which it operates which, in legal terms, places schemes in a position of dependence. Changes in the balance of power can at any time lead to renegotiation of the tacit contract established when the scheme was set up.

Scheme officials point out frequent failure of their members to respect the statutes and internal regulations of small farm groups whether they be of a community or cooperative type. Leadership conflicts or frustrations encountered by members of lower social standing frequently occur, often attenuated by group consensus which tends to settle such conflicts within a society which is quite hierarchical and extremely traditional.

Such factors influence the effectiveness of the organisation, rendering it more fragile and vulnerable in the face of any social transformation following the introduction of a new type of land use. Structuring the group to achieve genuine union remains a task for all farmer leaders in the area. Social pressures are often exerted through different channels.

Migrants have little preparation for the management of such conflicts except by resorting to the organisational statutes or administration. Participants who have never left the village are even less well prepared to innovate in the face of social inertia. The alternative is to implement training, study days or calling in appropriate resource persons.

The reduction in the number of farmers participating is not just the result of internal conflicts. The introduction of irrigated agriculture with new equipment, especially in the context of drought, exodus or emigration, led small farmers to believe that their income would grow rapidly. The complexity of the work and low yields achieved quickly disappointed some members. The argument of a lack of motivation is often put forward, but the phenomenon is more complex.

Relationships between schemes operate on two levels: within the Kayes Regional Union of Agricultural Cooperatives (URCAK) and between neighbouring schemes. Exchange is felt to be inadequate, especially as it only occurs in the event of serious conflicts, pumping station breakdowns or in obtaining agricultural equipment, seeds or other inputs. URCAK's contribution to the schemes is substantial when viewed against the extent of needs expressed by farmers, the disengagement of the state, the modest financial support provided by NGO partners and the lack of consistent commitment by banks and donors with greater capacity.

Relationships of schemes with the technical services and the administration are a source of tension rather than frank cooperation. Amongst the complaints are the mediocre quality of the extension services, long drawn out administrative procedures to obtain official status as an agricultural cooperative, the slowness of other administrative formalities, the cupidity of some officials, and the pettiness of police and customs services on the road or at the border with Senegal. With regard to landholding, the administration is accused of laxity or indeed complicity in inter-village conflicts, as in the case of Soborou and Dikocori which led to deaths and imprisonments. The bank and in particular the BNDA (National Agricultural Development Bank) is the subject of more substantial grievances. Interest rates are high, while the terms for obtaining loans and the method of repayment are considered suspect and draconian. Some farmers have been charged by the police in the middle of the agricultural season. Distrust reached such a level as to harm relationships with the URCAK which had guaranteed the loans in 1984.

We cannot end without mentioning relationships with NGOs, mostly French (ACCIR/CCFD/CIMADE), who support the schemes through the URCAK. While support is considered to be substantial and appropriate to participants' needs, its negotiation, management and the evaluation of its impact, sometimes lead to sharp words. Experience of working together over several years leads to greater confidence and solidarity with French NGO partners.

As far as official French cooperation is concerned (FAC, Central Economic Cooperation Fund) distrust is mutual, even when financial packages are large. Management, and especially the conditions imposed, are always problematical and change according to the political whim of each French government and officials in Bamako. The impact of immigration will influence the attitude of one or other party for a long time to come.

2.3 Supply of inputs, marketing, transport and training

Input supply, marketing, transporation and training are also essential to agricultural schemes. Yet many initiatives in this respect encounter bottlenecks. The isolation of the region exacerbates this.

Fuel, spare parts and agricultural inputs are high in cost, while farm income is low. There are practically no local suppliers in Kayes and purchases must be made in Bamako or Dakar. Customs duty raises the cost price still higher, not to mention handling and transport charges.

Marketing usually takes place in Kayes, the only market town. Weekly village markets as found elsewhere in Mali do not exist here, with the former exception of Gouthioube: even this closed down some years ago as a result of excessive customs charges levied on neighbouring sellers from Mauritania and Senegal. Kayes market is sometimes over stocked. Produce from the different schemes arrives at the same time because cropping is not staggered and the purchasing power of the urban population is poor. This affects both rice and garden produce. There is also competition from rice imported from Asia.

The need for training is strongly expressed considering the illiteracy of the majority of participants. General training and more specifically technical training - mechanics, mechanisation, agriculture, animal husbandry, crafts, health - is in great demand in view of constraints encountered in irrigation organisation and operation. Management training is amongst the most sought after. This is discussed later in greater detail.

Very few farmers are informed about developments in the Senegal river basin. According to participants, no one is prepared for the aftermath of the Manantali dam, although rumours are coming through from Senegal and Mauritania. Farmers merely notice changes in the level of the river even in the midst of the dry season. Participants in these irrigation schemes do not know what their position will be in the future of water control in the sub region, nor what repercussions they must expect.

2.4 The production factor

The objective of all these efforts is to improve agro-pastoral production. Examination of their own situation by farmers highlights several constraints:

- Inappropriately located schemes: land near human settlements is often steep slopes. The soil is sometimes quite poor, and it is often difficult to level uneven terrain or drain marshland or pools. All schemes are affected by one or other of these handicaps. The proximity of the village also raises the problem of coexistence between irrigated agriculture and animal husbandry as the schemes tend to be the only green areas locally;

- Erosion and rapid soil exhaustion are resulting from mono-cropping;

- Access to water is not equal for everyone. Schemes along the Faleme suffer from inadequate water flow, especially in the dry season when the crops have the most need of water;

- Poor yields seem to be the corollary of all the constraints mentioned. With only two tons per hectare for cereals, many farmers are asking themselves when food self sufficiency could possibly be achieved.

The operation of irrigation schemes tends to become trapped in a vicious circle. The investment made and the scale of food and financial requirements compel the farmer to pull out all the stops to make the project succeed. The nature and size of the constraints lead to makeshift solutions or resignation. A climate of insecurity surrounds participants whose final hopes rest in the uncertain return of normal rainfall in order to be able, with the benefit of the experience they have gained, to ensure their basic subsistence by growing mostly cereals.

2.5 Achievements and perspectives

The participants, at least those who have remained as farmers, are still determined despite everything. For them, the major and inestimable benefit is the experience they have acquired through many years of practising irrigated agriculture. Amongst these advantages we shall single out:

- The ability to establish a farm organisation and manage it themselves;
- The development of certain traditional and new production and marketing techniques, for example:
  - agricultural techniques: market gardening, cereal growing, tree cultivation, cash crops (bananas)
  - market development, price setting, negotiation with retailers, recovery of debt, etc.
- Awareness of responsibilities and risks as a participant in irrigation schemes;
- A greater openness within the culture and with external partners;
- The establishment of information and communications networks between small farmers involved in such schemes.

2.6 Suggested solutions to organisational problems

The solutions advocated to achieve better organisation of the schemes to ensure that they operate to a high standard may be found within the following recommendations:

(a) Strengthening the coordination between agricultural and animal husbandry activities, and establishing hedges to protect the farms.

Funding

(a) Establishing a revolving fund in the form of a rural savings scheme;
(b) Widening the network of funding partners in development;
(c) Seeking funding for equipment, activities and development work;
(d) Obtaining bank guarantees.

Training

(a) Guaranteeing officials undergo training in ability to monitor and evaluate training;
(b) Providing training to consolidate and replicate achievements;
(c) Organising training sessions in the areas mentioned;
(d) Setting up a permanent training centre;
(e) Developing exchanges and study visits.

Institutional

(a) Participation in decision-making on development issues at the regional level;
(b) Ensuring that commitments are respected;
(c) Provision for regular meetings;
(d) Following the administrative procedures to obtain recognition of cooperative status.

3. MANAGEMENT PROBLEMS

Difficulties related to the management of hydro-agricultural schemes are numerous and diverse. They illustrate the complexity of the process for which few farmers have been prepared. Migrant farmers have had the advantage of training courses in France, but these have been inadequate in view of the scale of constraints in the field.

The study collected the views of the farmer participants:

- The main points mentioned in connection with agriculture are poor quality seeds, delays in input supply, attack by insects and toads, lack of experience of farmers leading to delays in planting out from the garden nurseries, poor maintenance of nurseries and wandering animals;

- At harvest time, constraints relate to the geographical isolation of the schemes, the poor state of the roads and farm tracks where these exist. All these factors raise the cost of transportation which is most often provided by private hauliers. The absence of village markets and the saturation of the only market in Kayes lead farmers to rely on full-time sellers in the market who are always indebted to the farmers. Temporary over-production leads to a crash in the price of produce marketed by all at the same time;

- Animal husbandry is centred on the production of manure and milk, and the fattening of sheep and cattle for the Tabaski and other festivals. The main difficulty is the lack of pasture as a result of inadequate rainfall;

- In mechanical terms, the scheme depends on irrigation pump equipment. The principal handicap is the frequent breakdown of pumping stations, the supply of spare parts and the dilapidation of the pumping equipment whose replacement is often out of the question as there is no funding available.

This list is incomplete, but illustrates the basic problems which face any manager or farmer.

More detailed examination of the two main constraints in the long list of problems highlights all the issues relating to management, whether schemes be of a village or cooperative nature, or started by migrants or by villagers.

3.1 Lack of confidence between members: causes and consequences for the agricultural scheme

Any experiment of this type will meet difficulties which must be overcome if the scheme is not to come to a total halt. The establishment of schemes brings together people of different social origins, sexes, ages and experience. The working conditions stipulated by the statutes and internal regulations are inspired by western values. Conflicts are minimised until they can no longer be contained and have to be settled by group consensus. Management is therefore a key issue and its importance must be stressed.

The effects and consequences of poor management identified by participants manifest themselves in:

- Non-payment of dues, i.e refusal to respect group agreements;
- Lack of motivation in work leading to a drop in production;
- The emergence of latent internal conflicts, which greatly exacerbate the climate of misunderstanding between the members;
- Scandal-mongering;
- Deterioration of the means of production (pumping stations and irrigation channels) results from the lack of self discipline and authority;
- Tasks going undone;
- Members resigning, thereby reducing the number of participants;
- Deliberate lateness at agreed rendezvous;
- Holding back effort (energy) in carrying out communal tasks;
- Individuality and the rise of egotism and jockeying for position;

- The emergence of factions, clans and closed circles;
- The impoverishment of farmers bringing forward the lean season (lack of food security);
- The temptation to renewed exodus and seasonal or permanent emigration;
- Indifference of members;
- Lack of initiative.

Any scheme affected by so many difficulties is heading for collapse. Managers put forward several reasons for these difficulties, based on their experience, of which the most obvious are listed hereunder:

- The lack of clarity in financial operations: very often only the president and the treasurer are aware of what is happening in financial terms, whether or not they have been trained to carry out these administrative and management functions;
- The lack of consultation between members about problems on the schemes;
- The lack or infrequency of meetings, although these are provided for in the statutes;
- The undemocratic selection of officials, with pressures operating in favour of a privileged circle when committees are established or due for renewal;
- Conflicts of objectives between farmers;
- Member's lack of knowledge of the objectives of the scheme;
- Absence or flouting of regulations;
- Lack of sanctions for offences;
- The social pressures relating to the social environment and areas in which these agricultural schemes are located;

- Non-voluntary membership;

- Failure to perceive the utility of community action;

- Inappropriate criteria for distributing income between farmers.

It is clear that the same difficulties do not arise together within any one scheme. However, they are characteristic of the constraints which may be expected in the development of any scheme. Hiding such difficulties can only prejudice the success of the pilot schemes.

3.2 The problem of non-reimbursement of loans: its causes and consequences for agricultural schemes.

Based on the experiences of managers in operating irrigation schemes in Soninke country, the study has identified a second problem which has a crucial influence on the success of any scheme, viz non reimbursement of loans. Loans contracted are of two types:

- Loans of equipment and agricultural inputs granted by the URCAK to schemes against subsidies from NGO partners and bilateral cooperation.

- Loans granted by the BNDA to some schemes including Gouthioube, Sangalou, Moussala and Gakoura, in the form of seasonal credits of fuel and inputs.

Discussion will concentrate on the first type. It is important first of all to point out the consequences of this loan defaulting:

- Financial crisis for the scheme;

- Fall in production and income;

- Hindrance of activities;

- Reduction in confidence amongst members;

- Failure to maintain the means of production;

- Legal action which is sometimes undertaken to recover debts;

- Exclusion or suspension of members, and thus a reduction in their numbers;
- Anarchy as everyone starts to imitate the non-payers;
- Damage to the cooperative's credibility.

These are general outcomes and the causes of default throw even greater light on the complexity of the problem. Participants consider defaulting of loan repayment to be the result of:

- Lack of motivation and absence of community spirit;
- Insufficient income and inadequate production;
- Farmers' lack of experience;
- Poor use of credit in the absence of a monitoring and control system;
- Non-existence of criteria for granting credit;
- Social constraints affecting officials and farmers;
- Absence of criteria to direct credit towards low risk activities;
- Natural disasters (drought, predators, etc);
- The acquisition of bad habits in relation to reimbursement of loans;
- Shortcomings in the production, marketing and supply structures;
- Dependency syndrome;
- The lack of incentive or encouragement to reimburse loans.

Participants did not see a need to differentiate the situation of one irrigation scheme from another. This study also avoids basing examination of problems on a particular case, and aims to achieve a general understanding of a complex phenomenon which is inherent to establishment and operation of an irrigation scheme.

The study goes beyond observation and analysis. Participants particularly stressed the need to find practical solutions to help to resolve the two problems: lack of confidence between members and non reimbursement of loans.

3.3 Recommended solutions

The quality of a scheme's management may be assessed according to the degree of resolution of social problems and management of economic and financial problems. We have stressed that these were quite complex in each case. The community or co-operative nature of groups participating in the irrigation schemes allows for a specific and more democratic form of management. It was in this spirit that the managers put forward their proposed solutions:

To build confidence between members: proposed action

(a) Prepare a timetable for meetings;

(b) Raise the awareness of cooperative members; slide projection followed by debate; make the activities of animators more dynamic; find particular topics to be debated by the rural radio station; organise guided exchange visits;

(c) Restructure the cooperative by defining functions and indicating the nature of the different responsibilities;

(d) Consider membership procedures which will enable a candidate's motivation to be assessed before acceptance;

(e) Set up a technical commission to discuss criteria for income distribution;

(f) Submit the work of the technical commission to the General Assembly for adoption;

(g) Insist that anyone conducting a mission for the group present a report to the General Assembly;

(h) Present the results of activities;

(i) Reflect on the duties which require much effort and time for the cooperatives activities;

(j) Select or elect someone to be responsible for controlling and monitoring the implementation of sanctions.

To ensure reimbursement of loans: proposed action

(a) Conduct awareness raising sessions to enable co-operative members to understand the need to reimburse credit;

(b) Define terms for granting credit;

(c) Formulate rules in respect of credit, providing sanctions for non-payers but also means of encouraging good payers;

(d) Set up units to monitor and follow up the proper use of the loans and ensure proper organisation of production and sale of produce;

(e) Describe the necessary tasks and make them known to those responsible for production, marketing and procurement;

(f) Consider the appropriateness or need to provide tools to ensure that the duties are performed properly.

4. CONCLUSION

As we conclude our brief overview of irrigation and the Soninke people, we cannot claim to have exhausted a topical subject which is constantly developing. We have merely elucidated considerations which inhibit the expansion of irrigation schemes in Soninke country and elsewhere in Mali. Some observations and suggestions follow by way of conclusion.

Controlling water supply with a view to promoting productive agricultural activity is quite a complex matter, especially in the zone studied. To launch into the establishment of irrigation schemes should not be the consequence of voluntarist action, improvisation or the belief that this is a simple solution to increase production. It is an initiative which must be prepared meticulously and conducted with dexterity.

An irrigation scheme is a precious asset in the Sahelian region. To invest in a scheme requires sufficient resources appropriate to all the activities to be conducted. Philanthropy merely provides a back-up: it is in most cases an expression of charity towards the poorest of the poor. For instance, if NGO support is not supplemented by additional financial, material or human resources, it is not sufficient to promote the genuine development to which the schemes in the region aspire.

An irrigation scheme must be one component in a genuine integrated development strategy. It cannot be an island of prosperity in a sea of poverty. Planning must incorporate ways and means to follow such a strategy, so that irrigation schemes can be a tool accessible to the people to transform living conditions in Sahelian villages. To this end, current pilot schemes must be viable for the initial participants in order to be attractive to others and avoid the common fate of fashions: abandonment after people become tired of them or when new models come on the market.

The question, therefore, is how to extend and replicate such schemes without encountering the constraints of the initial experiments; the question participants sought to address.

The lessons and recommendations from the first farmers participating in the schemes seem to be the need for preparation, training and a guarantee of sufficient and appropriate support. Any farmer or group wishing to take part in an irrigation scheme should:

- Undergo preparatory training in rural organisation. This will deal with all procedures necessary to access the resources and support required: access to land (good site, soil quality, suitability of land for development, land title, etc); sufficient infrastructure; good quality equipment suited to environmental and working conditions; consistent and easily available funding; multi-disciplinary and efficient human skills; available, credible and adequately operational services;

- Be trained in the management of agricultural schemes as profitable businesses. It was impossible for the initial schemes to achieve profitability in face of all the problems that we have examined. In future, a change in attitude must be encouraged: an agricultural cooperative is not a charity. It must create a spirit of solidarity between its members to promote the economic activities it undertakes to ensure the welfare of its members. Economic concerns must remain at the heart of any initiative, whatever its social nature; managing all aspects together by achieving a proper balance;

- Be confident that they have the support of an institutionalised organisation to defend their socio-economic rights. The development of a society is dependent upon the existence of law, otherwise all forms of abuse are possible. One of the fundamental rights of workers is precisely the ability to meet, to work together, to secure and develop the fruits of their labour. Very few states in Africa tolerate, let alone take part in the promotion of farmer unions. Yet it is up to unions to ensure the establishment of and respect for the rights of its members. This third element is as important as the other two recommendations.

The Soninke people will have to become increasingly involved in irrigation activities. Some villages are beginning to take control: others are observing current attempts. There are many signs that the Soninke people in the river valley are seeking to develop their region of origin or settlement: the hope inspired by the construction of major dams on the Senegal river; the recent decrease in the isolation of Gadiaga due to the construction of the Kayes-Kidira road, and the establishment of Kayes rural radio station; the beginnings of democratisation of civil life in Mali. The Soninke people are spurred on by the increasing fragility of the environment which is causing desertification and the ever growing difficulties experienced by emigrants. The culture of the Soninke people calls upon them to safeguard this region as it is their living space and the frame of their lives. We can only hope that they hold the winning cards ....

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1990-1991: executive secretary (salaried)

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The 14 Schemes belonging to the URCAK organisation in Mali;
Partner NGOs in France: ACCIR/CCFD/CIMADE.

4. **URCAK study days on the position of URCAK and the schemes, Somankidi-Coura, June 1988:**

Soninke participants:

Somankidi-Coura Scheme: Siré Soumaré (President of URCAK); Ladji Nianganè (Training Officer); Bakari Bathily; Madi Koïta Niakaté

Moussala Scheme: Waly Bathily (Social Affairs Officer)

Gokoura Scheme: Dioncounda Diabira; Mamadou Diabira

Sobokou Scheme: Oumar Dia (Vice-President); Moussa Sellou

Lani-Mody Scheme: Modiba Konaté (Procurement Officer)

Fegui Scheme: Ibrahim Soumaré (Production Manager); Sékou Soumaré

Sangalou Scheme: Harouna Nambounou; Sekou Nambounou

Gouthioubé Scheme: Sékou Fadé; Dalla Tall

Animation: Mamadou Cissoki (Trainer Fongs/Senegal)
Monitoring: Mathias Bassene (Representative Ford Foundation/Dakar)
Observer: Georges Diawara (Resource Person URCAK)

5. **Management Training Session run by URCAK for scheme managers, Kayes, July 1990:**

Soninke participants:

Somankidi-Coura Scheme: Madi Koïta Niakaté

Gakoura Scheme: Mamadou Diabira

Sobokou Scheme: Kalifa Sissoko

Lani-Mody Scheme: Dramane Sidibé

Fégui Scheme: Mamadou Touré

URCAK: Abdoulaye Coulibaly

Animation: Elhadj Ndong (OCSAT) (Management/Senegal)
Monitoring - Evaluation:Ladji Niangané (URCAK Training Officer)
Georges Diawara (URCAK Resource Person)

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Bocar N'Diaye

ANNEX: 1

SOME INDICATIVE FIGURES

Schemes	*Date of Establishment*	*Distance from Kayes (km)*	*Land Area (Ha)*		*Number of Members*	*Status*	
			Total	*Usable*		*Association*	*Cooperative*
Somankidi Coura	1977	20	60	10	14		✓
Moussala	1977	35	45	35	20	✓	
Gakoura	1977	40	27	5	38	✓	
Sobokou	1980	75	36	14	40		✓
Lani-Mody	1981	80	70	22	26		✓
Fegui	1986	110	50	10	17	✓	
Sangalou	1980	110	66	15	43	✓	
Gouthioube	1982	115	100	42	42	✓	
Total			**454**	**153**	**240**	**5**	**3**

Source: URCAK Study Days June 1988
Report of URCAK President to 1990 General Assembly
Letter from Monssala scheme forwarded by AIC/PROJJETI to URCAK

ANNEX 2: **INDICATIVE FIGURES**

Production	*Type of Produce*	*Yield T/Ha*	*Average Price (FCFA)*
Vegetables	- tomatoes	6,048	50 F
	- onions	2,683	100 F
	- okra	16,965	75 F
	- cabbages	16,891	50 F
	- aubergines	3,709	75 F
	- cow-peas	1,838	75 F
Fruit	- bananas	8,322	125 F
Cereals	- millet - sorghum	1,994	-
	- maize	1,248	-
	- rice	2,715	-

Source: Report by URCAK President to 1990 General Assembly

Agricultural Administration Unit
Overseas Development Institute, London

The Overseas Development Institute (ODI) is an independent, non-profit making research institute. Within it, the Agricultural Administration Unit (AAU) was established in 1975. Its mandate is to widen the state of knowledge and flow of information concerning the administration of agriculture in developing countries. It does this through a programme of policy-orientated research and dissemination. Research findings and the results of practical experience are exchanged through four Networks on Agricultural Research and Extension, Irrigation Management, Pastoral Development, and Rural Development Forestry. Membership is currently free of charge to professional people active in the appropriate area, but members are asked to provide their own publications in exchange, if possible. This creates the library which is central to information exchange.

Technical Centre for Agricultural and Rural Co-operation (CTA)

The Technical Centre for Agricultural and Rural Co-operation (CTA) was established in 1983 under the Lomé Convention and is based in Ede-Wageningen in the Netherlands. Its mandate is to help the African, Caribbean and Pacific countries which comprise the ACP group achieve greater food security by providing them with better access to scientific and technical information on all issues related to agricultural and rural development. Working in close cooperation with ACP and EEC countries and with international, regional and national institutions, CTA fulfils its mandate through a range of activities, including seminars, studies, publications and support to ACP documentation centres.

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IRRIGATION MANAGEMENT NETWORK
(Africa Edition)

Network Paper 17

INTEGRATING SMALL SCALE IRRIGATION DEVELOPMENT WITH THE EXISTING AGRICULTURAL SYSTEM: A CASE STUDY OF SMALL HOLDER SWAMP RICE SCHEMES IN SIERRA LEONE

Karlheinz Knickel

The Africa edition of the
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July 1992

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17 *Integrating Small Scale Irrigation Development with the Existing Agricultural System: A Case Study of Small Holder Swamp Rice Schemes in Sierra Leone* by Dr Karlheinz Knickel.

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INTEGRATING SMALL-SCALE IRRIGATION DEVELOPMENT WITH THE EXISTING AGRICULTURAL SYSTEM: A CASE STUDY OF SMALLHOLDER SWAMP RICE SCHEMES IN SIERRA LEONE[1]

Karlheinz Knickel[2]

1. BACKGROUND OF THE RESEARCH PROJECT

1.1 Bridging the Gap Between Development Theory and Project Implementation

Effective agricultural development programmes are those that build on the strengths of existing farming systems and, at the same time, take due account of the specific natural, socio-cultural, institutional and economic environments.

Correspondingly, development concepts need to be based on:

- a thorough understanding of existing and, under the given conditions, efficient farming patterns;
- an appreciation of farmers' needs, decision-making environment, indigenous resources, capabilities, experience and social structure;
- the identification of suitable, ecologically stable, socially acceptable and economically attractive development opportunities - farmers are responsive to suitable opportunities;

[1] This paper is a synopsis of a PhD thesis submitted to the Cranfield Institute of Technology, Silsoe College, UK. For the complete research report reference is made to Knickel, Karlheinz: Farming Systems Development - Smallholder Swamp Rice Schemes in Sierra Leone. Studien zur Integrierten Ländlichen Entwicklung, Band 27, Verlag Weltarchiv Hamburg (ISBN 3-87895-359-3).

[2] Post-doctoral Research Associate at the Institut für ländliche Strukturforschung, Johann Wolfgang Goethe-Universität, Zeppelinallee 31, D-6000 Frankfurt/M1, Germany.

- a socio-economic and institutional rural environment conducive to the adoption of technology;

- an implementation strategy which allows farmers to get to grips with the new technology or practices and to adapt them to their specific conditions of resources, risk and constraints.

The research presented here tries to apply this philosophy to the problem of effective implementation of small scale irrigation development: 75% of the 250 million hectares (ha) irrigated throughout the world can be referred to as peasant irrigation schemes, and expansion of small scale irrigation will be one of the most important issues in the coming years.

The possibility of conducting this research arose following a two year assignment by the author with the Food and Agriculture Organisation of the United Nations (FAO) in Sierra Leone, West Africa. The work included a wide range of field studies. After a preliminary analysis of the field data in Sierra Leone, a more thorough analysis was carried out at Cranfield Institute of Technology, Silsoe College, UK.

Besides deriving specific recommendations for swamp rice development in Sierra Leone, the research aimed to contribute to development of ex-ante appraisal techniques for the small scale irrigation sector. The central element of the research could be described as a systems approach to farm analysis, planning and development. Most of the studies carried out focus on the traditional agricultural system, including the economic, social and organisational aspects at the individual farm level. Attributes of the natural, socio-cultural, economic and institutional environment are taken into consideration as they affect farmers' decision-making.

1.2 Swamp Rice Development in Sierra Leone

The main emphasis in current agricultural development policies in Sierra Leone is on promoting more productive alternatives to the rotational bush fallow system ('Shifting Cultivation'). Although this system is highly efficient in terms of resource use under conditions of low population densities, its productivity, measured as rice yield, is not sufficient to satisfy urban food demand in the long term. In addition, shortening fallow periods, resulting from more intensive use of the land, are leading to incomplete regeneration of soil fertility. This has serious consequences for the sustainability of the entire system.

At the same time, Sierra Leone has tremendous potential for irrigated rice production. It is estimated that the potential Inland Valley Swamp (IVS) area in the country is not less than 360,000 ha. The possible benefits to be derived from irrigation development appear substantial: firstly, decreased dependence on rainfed agriculture and the ecologically fragile upland soils; secondly, the potential for increased cropping intensities; and thirdly, reduced risk of crop failure due to inadequate or erratic rainfall. The climate is characterised by a distinct dry season between December and April. Although average rainfall far exceeds evapotranspiration, soil moisture deficits restrict cropping during the dry season severely. Heavy rains during the wet season, in contrast, cause erosion, extensive leaching of nutrients and the flooding of lowlands. Humidity is high throughout the year.

The situation described above applies to other West African countries of the moist subhumid/ humid zone (Nigeria, Benin, Ghana, Togo, Cote D'Ivoire, Liberia, Guinea).

1.3 The Traditional Farming Systems

The structure of the agricultural sector of Sierra Leone is characterised by the predominance of the smallholder. Seventy-four percent of the farms were under 2 ha in 1985.

The central element of traditional farming systems is the mixed upland farm where rice is intercropped with a large number of other crops. The upland farm provides the farm family with a wide variety of food crops and has, as a result, priority over swamp cultivation. On 20-30% of farms it is complemented by the extensive cultivation of a smaller area of swamp land (traditional paddy or lowland rice cultivation). The swamps in the area are generally fertile, but flooded in the rainy season.

A tendency towards shortening fallow periods and the farmer's desire to generate a cash income make changes necessary. Maize and groundnut farms are becoming increasingly popular and some farmers are producing considerable marketable surpluses by using their traditional methods of farming more effectively. Most of the farms studied can be considered to be in a period of transition from subsistence to more commercial farming (Knickel, 1986).

1.4 Reasons for Introducing Improved Water Management

Alternatives to irrigation development have not had the desired impact or appear less appropriate:

- The scope for improving the productivity of the mixed upland system in terms of rice production is clearly limited. Tree crops and alley cropping are ecologically more stabile on the fragile upland soils and should therefore replace upland rice cultivation in the long term.

- The use of large scale mechanised power in rice farming has not only proved too expensive for the country but also unmanageable. Opportunities for farm-level or small-scale mechanisation are limited.

Swamp rice cultivation is already an important element of the existing farming system - complementary to mixed upland farming. Traditionally, however, water control is not practised, resulting in relatively low yields, limited productivity and limited development opportunities. There is therefore tremendous scope for introducing improved water management. The main components of such improvement are:

- Adjusting soil moisture and flooding levels to those required for optimum and uniform crop growth, including control of flood water discharges and thus damage to crops;

- Reducing the effects of the pronounced seasonal changes of rainfall and bringing the advantages of dry season cropping to bear (e.g decrease in crop pests and diseases, more efficient crop growth, drying of crops less difficult);

- Allowing more effective use of mineral fertiliser application and modern rice varieties, improving the uptake of soil nutrients, and reducing iron toxicity through drainage.

Consequently, there is considerable scope for increasing cropping intensity by introducing diverse dry season cropping and by improving the use of residual moisture. The introduction of water management practices can be seen as a major step towards multiple cropping systems. Farmers would, as a result, have more choice in terms of timing and cropping pattern, allowing a more effective utilisation of family labour. Overall, irrigation development would introduce flexibility into existing farming systems and increase the stability of upland and swamp land use patterns.

1.5 Some Organisational and Technical Aspects

Most swamp rice development programmes in Sierra Leone are part of larger integrated agricultural or rural development projects. Usually, swamp amelioration involves complete clearing and the construction of water control facilities, drainage channels, gravity flow irrigation systems, land levelling and bunding. After the physical improvement of land, farmers are expected to intensify crop production, aiming for both yield increases and multiple cropping patterns. Fertiliser application and the use of shorter duration varieties are the key elements of the more intensive cropping system. Emphasis in most programmes is given to maximum farmer participation and farmer control in terms of: (a) size and management of the scheme, and (b) labour and capital input.

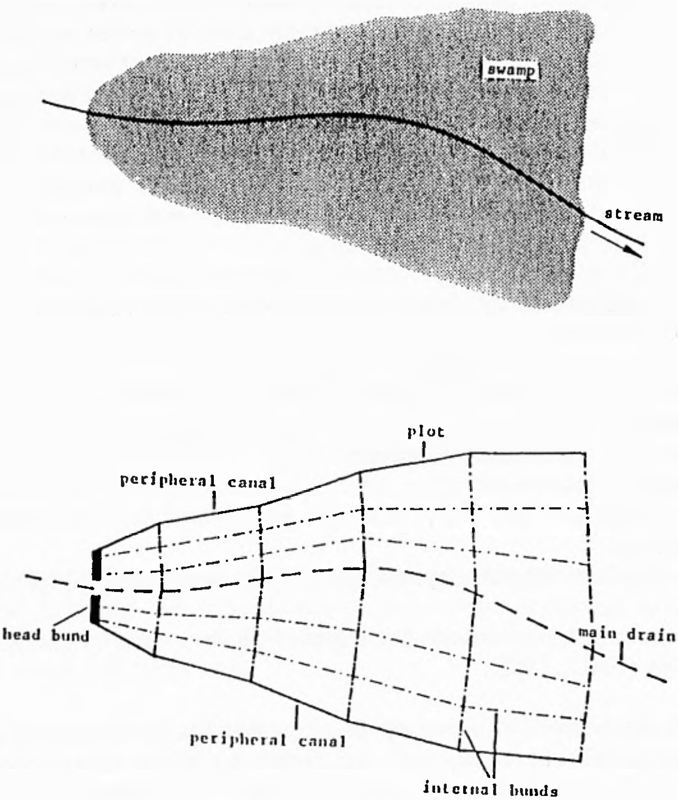
Taking the traditional system as a starting point, swamp development can be subdivided on the basis of degree of water control:

(0) Traditional (uncontrolled water; cropping pattern and rice variety are chosen according to given soil and water conditions)
(1) Better use of residual moisture
(2) Bunding, land levelling
(3) Flood control measures
(4) Drainage
(5) Gravity flow irrigation system (in combination with [1]-[4])

Figure 1 shows a typical layout for a gravity flow surface irrigation system using basins (FAO, 1985).

In Sierra Leone emphasis in swamp development has for some time been on the 'small scale' approach, i.e on "schemes which are under local responsibility, controlled and operated by the local people in response to their felt needs" (Underhill, 1984). The inherent, potential advantages of small scale irrigation development are the low-capital input, the cost effectiveness and the mobilisation of local resources, the sustainability of developments, and finally, the positive effect on rural development. Schemes aimed directly at the farmer seem to be a particularly valuable alternative to large scale, centrally planned schemes in difficult economical environments, and to developments in countries where there is little experience with irrigated farming.

Figure 1: Typical Layout for a Gravity Flow Surface Irrigation System Using Basins (FAO, 1985)



In spite of small scale programmes being a valid instrument of development policy, some weaknesses are inextricably interwoven with the potential strengths: farmers are eminently sensitive in rejecting new technologies, if these don't match their specific opportunities or goals. The problem is aggravated if technologies are too complex to allow farmers to experiment with them, without incurring considerable risks or substantial resource reallocation. Participation and initiative of the target groups, however, is the single most important factor in terms of uptake of technology, continued operation, management and maintenance.

1.6 The Experience

The technical feasibility and the potential of irrigated rice production can be shown in small pilot programmes. An extension of the technology on a wider scale has, however, generally not had the desired impact. To date, farmers are reluctant to adopt the new technology. The diffusion of improved water management practices, in particular, is minimal. Less than 60% of the supposedly developed swamp land in the study area was actually under crop production and less than 10% under double cropping (Knickel, 1985). A large scale yield survey indicated that in 78% of all swamps with drainage and irrigation structures the rather modest minimum yield required to offset total production costs (1.9 t/ha) was not reached (Knickel, 1986).

The major problems seemed to be (in random order):

- The fragmented and diverse nature of the irrigation schemes result in non-uniformity in their physical, social and economic characteristics.

- On the technical side, there have been design, lay-out and construction deficiencies which are compounded due to lack of proper maintenance and operational shortcomings. Farmers do not utilise structures to control water. Standards of watercourse operation and maintenance, and in-field irrigation and levelling, are often too low.

- Lack of a tradition in the discipline of irrigated agriculture, and of knowledge of the benefits of improved rice varieties and fertiliser is exacerbated by the inability of the greater proportion of farmers to buy these inputs.

- Marketing is inadequately organised and seems not to provide incentives to produce more.

- Small farmers may well prefer current low levels of income if higher levels are associated with additional risk. Present IVS development appears to reflect government policy objectives and meeting targets of agricultural development projects, rather than a positive decision by farmers for involvement.

- Many swamps have been partly developed and then abandoned, or farmed only for a few years and allowed to revert. Only a few swamps have been continuously farmed for lengthy periods.

- Farm inputs and services, such as supplies, credit, advice, and marketing, appear insufficient to support more commercial farming. Inadequate in-service training, limited staff mobility and lack of incentives reduce the capacity of the extension system.

- Land tenure problems seem to discourage investment in swamp amelioration in some cases.

If we look more carefully at the above list, some of the points appear to be symptoms and others causes. The research project attempted to ascertain the true underlying causes and to find the most appropriate manner in which to develop IVS crop production within the existing traditional farming system. Concurrently, an attempt was made to identify practical ways of integrating farming systems research with production-oriented projects.

2. CONCEPTUAL FRAMEWORK, DATA COLLECTION AND ANALYSIS

2.1 Conceptual Framework

The unique possibility of linking research and development during the field work phase enabled close coordination of the diagnosis, implementation and monitoring stages of the project. The research approach applied was essentially two-pronged: firstly, studying the existing agricultural system, and secondly, defining the developed swamp system in terms of input-output relationships. Finally, both systems were combined by means of (i) on-farm testing and farm case studies, and (ii) mathematical programming analysis and partial budgeting.

The first stage provided an understanding of the existing traditional farming system and identified inherent development opportunities: Why do farmers farm the way they do? What are the advantages of traditional cropping systems, and are there possibilities for increasing their productivity? What are the factors which determine "farmers' response to new technological opportunities"? (Tiffen, 1987).

The second stage defined the new technology under consideration in terms of input-output patterns and resource demand. This was linked to testing the compatibility of the new technology with the existing farming system, particularly with regard to critically limiting factors and to determination of the demand for external inputs and adjustments (analysis of the wider agricultural system).

The hypotheses which were tested evaluated alternative levels of technology and alternative time scales of development. These are listed in Sections 3.4 and 3.5.

2.2 Data Collection and Analysis

Weinberg (1975): "If we want to learn anything, we mustn't try to learn everything."

Each study or survey was based on earlier studies to provide continuity and to ensure that only relevant and adequately precise data were collected. The farm case studies and sample surveys conducted are summarised in Annex 1. In order to mitigate the limitations of a two year study, swamp rice development was examined at various stages of the development process on different farms. Technical coverage was restricted to core information.

A combination of statistical, economic and modelling approaches were used for data analysis. Relatively simple models have the advantage of being relatively easy to use, and of permitting the chain of causality between assumptions and model output to be more readily understood. Partial budgeting was used to assess the financial viability and comparative profitability of irrigated rice production. Different time periods for appraisal were considered by means of discounted cash flow analysis, to reflect the planning horizon in farmer' decision-making.

Treating swamp rice development more rigorously as a resource allocation problem requires linear programming (LP) analysis or similar methods for optimising the complete farming system. Using LP, different farm resource base situations were tested as they affect the compatibility of the new technology with the traditional rainfed systems: key resources were identified, and the effect on farm incomes and on the production of marketable rice surplus was assessed. Improved crop vectors with reduced levels of cash inputs were included in the matrix in order to allow a closer coordination of farm plans with given resource situations.

3. CORRELATION OF RESULTS

3.1 Agricultural Support Services and Socio-Economic Environment

Technological change requires both the organisational structures necessary for diffusion and adoption, and the people's participation. Disincentives for rice producers extend well beyond the pricing mechanism. Farmers may refuse to adopt new practices because external factors, such as inadequate input supply and advisory services or disincentive marketing policies discourage them. Agricultural support services need to be reliable and predictable. They need to be coordinated with the requirements of new technologies.

Advisory services The vast majority of farmers in the study area perceived the quality and capacity of the existing agricultural services as inadequate. The group of farmers particularly affected were those primarily concerned with more intensive swamp cultivation. Effective advisory services are especially required if the intensive rice system is to be implemented as a package within a short time frame. Longer term development, in contrast, is less dependent on the capacity of the extension system.

Farm input supply A characteristic of mixed upland and traditional swamp farming is that both systems do not depend on external production inputs. Immunity from the effects of unreliable or generally inadequate input availability is an important consideration in farmers' decision-making, and confidence in supply lines is a precondition to farmers' willingness to adopt more input-intensive production systems.

Producer prices Pricing of agricultural produce in relation to the price of farm inputs is a key factor in determining the optimum intensity of cultivation. In the case of Sierra Leone, recent pricing policies justify investment in swamp rice development. Farmers appear generally content with producer prices for rice.

Marketing facilities Wide producer price fluctuations for rice are largely due to the limitations of the existing marketing facilities (storage, transport, market transparency), and the fact that most farmers sell their rice at harvesting time or soon after.

Credit Financial assistance can easily undermine self-reliance and motivation if not carefully attuned to farmers own resources. It is not necessary if swamp rice development strategies are conceived in such a way that the improved cropping system evolves as a result of a series of discrete changes to the existing system. The package approach, in contrast, competes heavily for resources, which is also expressed in the need to hire additional labour.

Land tenure Some analysts argue that the communal land tenure system is a disincentive to investment in land amelioration. Although problems with respect to land tenure were more common among swamp farmers, this did not generally seem to be a primary constraint to an intensification of swamp cultivation. In cases where land tenure is a problem, the possibility of long-term lease arrangements could be explored with the local authorities as custodian.

3.2 Farmers' Objectives and Decision-Making

Subsistence Mixed upland farming is the cropping system which provides farmers and their families with most of the food crops they need. To secure family food requirements is farmers most dominant objective. Commercial farming is increasing in importance, but is still secondary to subsistence farming.

Commercial orientation Sole cropped upland maize is more orientated towards provision of a cash income for farm families. Fertilizer is required and most of the maize produced is for sale. The fact that maize farms are becoming increasingly popular in the study area, clearly indicates that farmers are becoming more inclined to produce for the market. For an estimated 20-30% of the farmers, production for the market seemed to be a primary objective.

Minimising risk Combining mixed upland with swamp farming can be seen as a measure to minimise the risk of inadequate or erratic rainfall which would result in insufficient rice production. The mixed upland system in itself is a risk aversion strategy: spreading risk by cultivating a range of crops in a mixed stand.

Efficient utilisation of available resources Resources are allocated to optimise benefits at the whole-farm level. One of the main concerns of the farmers studied was making the most effective use of available family labour by coordinating upland and swamp farming activities accordingly.

3.3 The Integration of Upland and Lowland Cropping Systems

Modelling traditional farms showed how well upland and lowland cropping systems are attuned to each other and to the given resource base. The main advantages of combining mixed upland cultivation with low-input swamp farming are:

- Climatic uncertainties and risk are minimised by making use of the two ecologically very different environments.

- Family labour input is more evenly distributed over the year by phasing upland and lowland crop calendars (Figure 2). In addition, all available land types are utilised, allowing farmers a lower intensity of land use.

- The greater flexibility farmers have, as a result of combining upland and lowland cropping systems, allows them to respond more easily to changing market and climatic conditions.

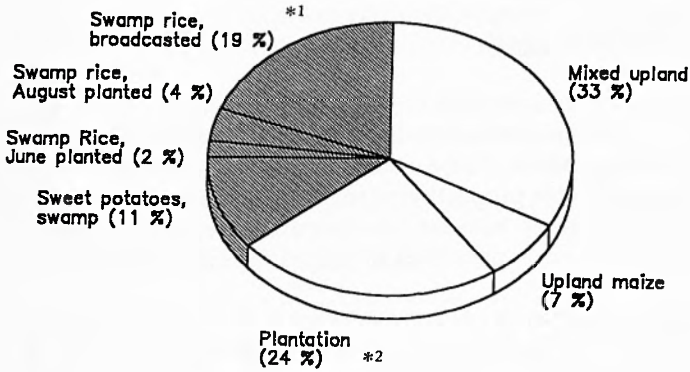
Empirical data on production and income was supported by LP analysis: farms based solely on swamp or solely on rainfed upland cultivation were less profitable than farms which combine both systems. Swamp-only farms achieved approximately half the potential increase in total crop net revenue possible from irrigated farming.

There are two main conclusions from this:

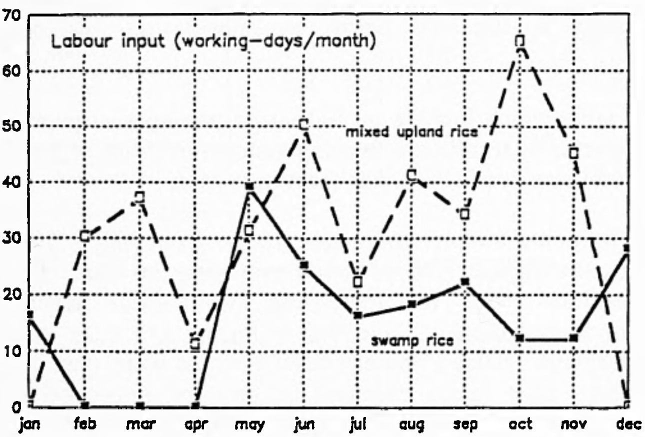
(a) Considering the limited range of available resources and their already efficient allocation in existing traditional farming systems, it is doubtful whether there is much scope for improving resource use efficiency without introducing some form of new technology.

Figure 2: Integration of Upland and Lowland Cropping Systems in the Traditional Farming System - an Analysis of the Phasing of Labour Input

(a) Traditional mixed farming system (farm plan derived from LP-analysis)



(b) Corresponding phasing of labour input (based on the above farm plan)



*[1] % refers to "percentage of total farm land farmed by one household"
*[2] Coffee and some citrus in upland areas; generally overaged, poorly maintained with marginal yields

Source: Knickel (1988)

(b) Compatibility between the main components of the existing farming system and the improved swamp rice technology is a fundamental issue. Less outside labour needs to be hired if sharp peaks in the demand for a workforce are avoided. In addition, the cost of fixed inputs, such as developed land, is lowered by improving the use of variable resources.

3.4 Level of Technology

Generally, a flexible approach towards swamp amelioration is necessary to allow for the heterogeneity of site conditions. Shortcomings in design, lay-out and construction create major operational problems (Weatherhead, 1984). A considerable proportion of technically sound water control systems are not used properly because the farmers have never been sufficiently introduced to the basic principles of irrigation water management.

With respect to the technical appropriateness of swamp development, more applied research seems to be needed on such issues as linking a specific set of soil-water parameters with the most suitable amelioration pattern. This work must consider the pronounced seasonality of rainfall, the fluctuation in stream flows, the water availability during the dry season and, as a result, the engineering design required. The problem of choosing an appropriate level of technology is discussed below by considering five different hypotheses.

Hypothesis 1: "Farms which include an 'intensive swamp rice production' enterprise are superior to traditional farming systems in terms of total crop net return and total rice production per farm and year."

Rice yields in traditional swamp cultivation range from below 1 t/ha to above 4 t/ha, with the highest 10% of yields averaging 3.6 t/ha. There is, therefore, tremendous scope for increasing swamp rice yields with comparatively low capital input. Some 'better farmer practices' could be identified. Experimental yields in ameliorated swamps were commonly in the range 3-5 t/ha. Rice yields obtained in farmers' improved swamp cultivation were on average, however, not significantly higher than the yields obtained in traditional swamps.

In spite of this, a small number of farmers showed that substantial increases in rice production and a diversification of cropping patterns following swamp development are possible and linked to higher farm incomes. LP analysis indicates that total crop net revenues, which constitute nearly three quarters of farm income, can be increased by 18% through irrigation development in seasonal swamp areas. In areas where swamps have perennial surface water the corresponding increase is 32%. With regard to partial development of swamps, net revenues could be raised by 17% in seasonal and by 26% in perennial swamps. The figures given are based on yield levels of 2-2.5 t/ha. They apply to technically sound irrigation development and depend on a full utilisation of the given production potential (Table 1).

Table 1: Linear Programming Solutions for Improved Swamp Systems

Water regime:	SEASONAL			PERENNIAL		
Degree of water control:	control	partially developed	irrigated	control	partially developed	irrigated
Net revenue (USD)	645,17	753,10	763,99	704,54	880,26	929,82
Increase (%)	.	16,7	1,4	.	24,9	5,6
Farm composition (ha/farm):						
upland:						
maize	0,7	0,1	-	0,3	0,1	-
plantation	1,0	1,0	1,0	1,0	1,0	1,0
groundnuts	-	0,4	0,5	-	0,4	0,1
mixed	1,6	1,1	0,8	1,4	1,1	0,7
swamp (rainy season):						
sweet potatoes	-	-	-	0,44	-	-
traditional rice	0,24	-	-	0,99	-	-
improved rice	-	0,9	1,2	-	0,9	1,5
swamp (dry season):						
vegetables	-	-	0,1	-	-	0,7
groundnuts	-	0,3	-	-	1,0	-
Credit required (USD):						
	-	22,64	30,63	-	22,87	39,48
Rice production (marketable surplus (above 2205 kg/year):						
kg/year	82	1226	1833	671	1254	2586
Source: KNICKEL (1988)						

It could be argued that economically optimal plans (as derived from the LP analysis) will not be achieved in reality and that, for this reason, predicted increases of 20-30% in total crop net revenue are not sufficient. Two aspects, however, ought to be considered. Firstly, producer prices for rice fluctuate widely, reaching their peak between June and August. Irrigation development would give farmers the flexibility to produce rice ready for harvesting at times of peak price. Secondly, the flexibility farmers ultimately have in fine-tuning improved farming systems, will tend to increase whole-farm productivity rather than decrease it.

Considering total annual rice production per farm and the production of marketable rice surplus (defined as rice production above 2.2 t/year), LP analysis indicates that improved farm systems are superior to traditional systems. Irrigation development in perennial swamps would raise total annual rice production per farm by 67%, which corresponds to an absolute surplus of about 2.6 t/yr farm. Overall, there appears to be sufficient evidence to support Hypothesis 1.

Hypothesis 2: "Intensive swamp rice production is compatible with farmers' overall objectives - considering needs, resources, alternatives and constraints."

Farmers tend to shift to more intensive lowland farming where rainfed upland farming is becoming more difficult. Examples are the drier northern and the more densely populated coastal areas. The decision to shift emphasis from mixed upland to swamp farming, where mixed upland farming is becoming less productive, or equally, where swamp farming is becoming more productive, can also be simulated by LP.

In terms of efficient use of scarce resources, an intensification of land use is not an obvious development in light of the relative abundancy of land. Nevertheless there appear to be three important aspects justifying irrigation development. Firstly, the efficiency of labour use will be increased. Secondly, returns to labour are generally higher in irrigated crop activities than in traditional activities. Thirdly, the opportunity cost of family labour during the dry season, when the major engineering works would be carried out, is low. The labour peaks in the traditional system are May-August (planting) and October-December (harvesting).

Farmers' aims to remain relatively independent of external inputs and to minimise capital input also seem consistent with - at least a stepwise -

intensification of swamp rice production. External inputs into small scale swamp amelioration are minimal, the main inputs are labour and local materials. Nevertheless, more emphasis should still be given to reduce the need for external inputs after swamp amelioration has been completed. Crop rotations with leguminous crops, for example, could reduce the need for mineral fertilisers and would at the same time widen the variety of crops produced (considering subsistence needs and food crop production).

The positive effects of intensification of swamp rice production on farm income and rice production levels are obviously consistent with farmers' objectives. All in all, Hypothesis 2 is supported by the findings of this study, particularly if the points made in Section 1.4 are also taken into account.

Hypothesis 3: "Intensive swamp rice production can be integrated with the traditional mixed upland farming system with respect to the family labour economy."

Whole-farm resource use and specifically the availability and allocation of family labour are central issues in the traditional farm system. Traditional extensive and 'late planted' - or alternatively, broadcasted - swamp rice fits well with the mixed upland system (Figure 2).

Interviews among farmers concerned with improved swamp cultivation indicated that the availability of family labour and cost and availability of hired labour are limiting to the cropping intensity and cultivated hectarage. Optimal farm plans obtained from the LP analysis show that an intensification of dry season crop production in swamps would lead to relatively even labour profiles and good utilisation of available family labour. This would largely be achieved by coordinating the crop calendar in improved swamp cultivation with the mixed upland calendar. Coordinating crop calendars in turn implies that agronomic recommendations take the whole-farm labour profile into account. Choosing an appropriate planting method is an obvious example: transplanted rice requires more labour for crop establishment but less for weeding. Wet seeding in improved swamp systems and the broadcasting of rice in traditional systems, in contrast, are characterised by the opposite pattern of labour use. Both direct seeding methods have advantages as long as swamp farming is to be combined with mixed upland farming. Direct seeding enables farmers to establish a lowland rice crop before the planting of upland farms. Yield losses due to late transplanting (i.e after planting of upland farms had been completed) are thus avoided. Similar considerations apply to choosing an appropriate weed control method.

Overall, it must be concluded that intensive swamp rice production can be integrated with the mixed upland system provided that agronomic recommendations and the planning of crop rotations take the whole-farm resource use pattern into account. Hypothesis 3 is therefore supported.

Hypothesis 4: "In seasonal swamp areas partial water control systems are superior to traditional swamp cultivation in terms of total crop net return and total annual rice production per farm."

The results of the LP analysis indicate that partial development of swamps with seasonal surface water availability is, in financial terms, worthwhile. Total crop net revenue would increase by 17%, and marketable rice surplus from nearly zero in the traditional system to more than 1.2 t per farm and year (Table 1). Hypothesis 4 is therefore supported.

Hypothesis 5: "In seasonal swamp areas partial water control systems are superior to complete water control systems in terms of costs and benefits."

Irrigation development is most appropriate for swamps with perennial surface water, allowing year-round cropping without the need to pump or store water. In perennial swamps, irrigation development adds another 6% to the increase achieved with partial development, giving an overall 32% increase in total crop net revenue (Table 1).

Most of the increase in total crop net revenue and marketable rice surplus per farm in seasonal swamps is, in contrast, already achieved with partial development. Irrigation development would, on average, add only another 1% increase on top of that, which again on average, does not justify additional costs. Hypothesis 5 is therefore supported.

Where other factors are particularly favourable (e.g farmers' interest in multiple cropping systems, experience with partial water control, other agro-ecological factors), irrigation development could still be recommended.

3.5 Time Scale of Development

As important as the right type of technology is an appropriate strategy for its introduction. Swamp amelioration means investing limited resources into a production system from which substantial benefits accrue only from year three to four onwards. A comparison with the traditional swamp rice systems shows that incremental benefits are less than incremental costs during the first three years (i.e during the development phase). Farmers' time horizon thus plays an important role in deciding on adoption or non-adoption of the improved rice production system.

In the case of implementing the system fully within the first year, net benefits are already substantial in year two. One major disadvantage of this approach is, however, the relatively high take-off point, i.e specifically the much greater expenditures during year one.

Hypothesis 6: "The introduction of 'intensive swamp rice production' as a package is feasible from a farm management point of view and in financial terms worthwhile."

Production packages have been developed to capture the synergistic effects between several components. A typical example is the swamp rice package: water control - fertiliser application - improved rice variety. One dilemma with technology packages is that they soon become too complex, too risky or too demanding in terms of capital investment and managerial capabilities. The adoption of the complete irrigated rice cultivation package would require major or complete change to the existing farming system. In optimal farm plans, the mixed upland rice area is reduced by nearly 40% in seasonal swamp areas and by 50% in perennial swamp areas (Table 1). Although this is in financial terms an attractive long-term goal, the changes required do not seem feasible within one or two years.

Initial resource requirements To implement the irrigated rice system completely within one year, available family labour during the main development period February-April would, on average, only be sufficient for about 0.25 ha per farm household. For larger areas labour input into development would have to be hired which is associated with additional costs and the need for credit.

Experience Characteristic of the extensive nature of traditional swamp rice cultivation is that comparatively labour intensive water control practices are generally not used. Farmers have, as a consequence, no background in irrigation to build upon. In fact, the traditional crop management concept is totally different (Knickel, 1986, 1988).

Most farmers who actually completed swamp amelioration, had not altered cropping patterns in line with irrigation possibilities. Differences in cropping pattern between improved and traditional swamp farmers were, apart from the use of improved rice varieties, marginal. Particularly critical practices with respect to the effectiveness of improved rice systems were the late planting and inadequate levels of mineral fertiliser application or, in more general terms, the problem of soil fertility management. Until now farmers have relied almost exclusively on the rotational fallow system to sustain soil fertility, in upland as well as in swamp farming. Multiple cropping is hardly practised.

Complexity Swamp rice development requires a wide range of changes. The innovation comprises engineering works, irrigation water management, different agronomic practices and substantial financial management - specifically, investment in land improvement, purchase of production inputs and marketing of produce.

The improved cropping system is too complex to be learned within a short time. It is too different from traditional production systems. Farmers do not have the essential agronomic foundation and hydrology skills. They lack knowledge of the practices needed to fully utilise the potential.

Advisory services and production inputs The capacity of advisory services appears insufficient to sustain the relatively high level of technology aimed for: long-term agricultural investment and environmental control (i.e irrigation water management and fertiliser application) are fundamentally different managerial concepts which would require a very strong extension system.

Risk Considering the points made above the new technology probably appears too risky to farmers, although it would ultimately reduce risk and uncertainty.

Financial The most important reasons for farmers' reluctance to adopt the new technology are not economic. Breakeven yields are relatively low, 1.7 t/ha for irrigated and 1.5-1.6 t/ha for partially developed swamps. The problem is that potential yields in improved swamp rice cultivation are generally not achieved at present, and that purchased inputs are not effectively transformed into additional crop output. A number of technical and management problems associated with too rapid an introduction of the new rice technology are largely responsible for the relatively low yields.

In summary, the complexity of the innovation, its high initial resource requirements, the lack of experience with irrigated agriculture in the region and the limited capacity of agricultural services exclude the possibility of a package approach towards the intensification of swamp rice systems. The evidence from the research appears sufficient to refute Hypothesis 6.

Similar difficulties with regard to the implementation of complex technology packages are reported by other analysts: Collinson (1980), Norman et al (1985), Barlow et al (1986), Byerlee et al (1986) and CIRAD (1987).

Hypothesis 7: "The introduction of 'intensive swamp rice production' in a stepwise, incremental manner is feasible from a farm management point of view and in financial terms worthwhile."

In response to the problems involved with extending technology packages, various authors have suggested disaggregation of packages into component subsets. These should allow critical interactions to be exploited. Initial steps should be with the components which are relatively compatible with farmers' existing resource allocation. More complex steps will be possible as farm productivity and farmers' confidence in absorbing new technology improves (Byerlee et al, 1982) (Norman et al, 1985).

Analysing the question of time scale of development again, this time in view of an incremental approach, shows that the main problems described above can be at least reduced, if not completely by-passed. In contrast to a package approach, an incremental approach would give farmers time to gradually develop the necessary skills and experience of irrigated farming. This is also in line with two other aspects: firstly, the need to strike a balance between the large loans required for one-off development and the low household incomes (the cash flow pattern for an incremental approach is better suited to the limited financial resource base); secondly, the need to upgrade agricultural support services.

With respect to financial benefits, yield increases obtained with relatively small changes, such as improved agronomic practices or fertiliser application, are considerable. Financial returns to such improvements are, at enterprise level, correspondingly high. The fact that net present value is only slightly higher in the long term for a package approach indicates that the additional resources and extension service capacity required for this are not justifiable.

Changes in agronomic practices should be seen as a means to initiate longer term swamp rice development programmes. When recommending practices which seem favourable at enterprise level, such as early transplanting, impact on overall resource efficiency also needs to be considered.

Sufficient field experience with a more incremental approach towards the intensification of swamp rice cultivation is not available. This research, however, indicates that field-level programmes should generally give more attention to the question of an appropriate time scale of development. Taking the available evidence into account, the conclusion is that Hypothesis 7 is supported.

4. IMPLICATIONS FOR INLAND VALLEY SWAMP (IVS) DEVELOPMENT POLICIES

4.1 Integrity of IVS Development Programmes

The problems of development and production need to be separated. Development involves people as well as land and water and must therefore start with the farmer and his or her traditions (Carter et al, reviewing irrigation development in Nigeria, 1983). The studies carried out in the framework of this research project indicate that the same applies to small scale irrigation development policies in Sierra Leone. Farmers need to understand the basics of the improved production system at an early stage because understanding is directly linked with motivation and participation.

There is a need for better institutional coordination and cooperation particularly in the fields of agricultural support services and applied research programmes. Research, extension and the farmer should ideally form a single system, expressed in the link between on-farm testing, monitoring, evaluation, analysis and training. Pilot swamp development programmes simultaneously provide a possibility to test technology under local farmer conditions, to train extension staff, to collect farm level data in key areas, to organise field days and to learn farmers' views. Implementation, monitoring, evaluation and planning should be continually in progress, each influencing the other (Sequential Programme Planning and Implementation, GTZ 1984).

The requirements of the new technology need to be coordinated with the capacity and quality of agricultural services. Farmers concerned with more intensive production systems have been facing difficulties with regard to input supply and insufficient technical guidance. Weatherhead (1984) points out that the engineering knowledge required must remain within the capability of field staff.

Projects should seek target outputs instead of target areas. This would involve more longer term, continuous efforts in already reclaimed swamps and in the field of actual rice production. Carruthers and Upton (1982) point out that new forms of cooperation are needed to sustain irrigation development over longer periods.

4.2 Need for a Long-term Strategy

The process of development must be slow and incremental, with low investment sustained over a long period (Kay et al, 1985). An incremental approach to the extension of the irrigated rice system appears feasible and ought to be tested in pilot programmes. Practical on-farm trials are necessary in order to enable farmers to appreciate the possible benefits of swamp rice development.

During the first one or two cropping seasons only minor adjustments should be aimed for in order to minimise risk to the farmer and build trust in the programme: farmers need to be introduced to the concept of soil fertility management on continuously cultivated land. Date of planting, plant spacing and density, crop care and the prevention of post-harvest losses are other important fields. Ideally, the production levels achieved and farming practices used by more productive farms should form the basis for production targets and recommended practices that are used by the less productive farms. At regional level, emphasis during the first phase should be given to upgrading agricultural support services, i.e to training, the mobility of extension staff, to input supply and marketing facilities.

After farmers have acquired some experience with more continuous and intensive cultivation patterns in swamps, the need for better water control will become obvious to the farmers themselves. Building on farmers' motivation to improve the system further and on their willingness to shift emphasis gradually away from mixed upland farming towards more intensive swamp cultivation, introduction of simple water management practices should only be a small step. In perennial swamps this would lead to the construction of irrigation structures. Mechanised swamp clearing and possibly land levelling services, the two operations requiring major labour input, could be offered to farmers on semi-commercial or commercial lines.

4.3 Integrating Rainfed Upland with Irrigated Swamp Cultivation

The most profitable and, with respect to the diversity of enterprises, stable farm structure is achieved by integrating rainfed upland with irrigated swamp cultivation. Bush fallow system and irrigation development should not be regarded as mutually exclusive, but should be developed simultaneously in the areas suitable to each. This will allow farmers to shift emphasis gradually from upland farming to more intensive swamp cultivation and gives them the necessary flexibility to experiment with the irrigated rice technology on a smaller, less risky scale: cautious learning is possible, economic vulnerability is minimised, and the capital resources required are marginal.

4.4 Stratifying Recommendations

(a) Swamp amelioration patterns need to be better adjusted to the given agro-ecological and farm resource situation. "Extension advice must recognise that swamp rice is only one element in a sophisticated mixed farming system, allow for the diversity in farms and take more account of individual circumstances" (Weatherhead, 1984). The recommended amelioration pattern ought to reflect:

- *swamp characteristics* — water regime over the year, soil type, catchment, flood discharges, topography.
- *farm situation* — structure of the existing farm system, given resource base and allocation, management skills, experience, goals, alternative production systems and non-farming activities.
- *environmental factors* — natural, institutional, infrastructural and socio-cultural aspects.

(b) More attention should be given to flexible cropping patterns. Crop rotations should include drought tolerant upland crops, as well as rice, in order to utilise available soil moisture and low rainfall during the tail end of the rainy season more effectively.

(c) In areas where perennial swamps are not available, emphasis should be placed on the study of possibilities of creating small reservoirs upstream of the swamp for supplementary irrigation in the dry season. An alternative to reservoirs could be the use of simple devices for lifting irrigation water from shallow wells.

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ANNEX 1

Field Surveys and Case Studies

The following field surveys and case studies were carried out between October 1984 and August 1986 in Moyamba District, South-Western Region, Sierra Leone. The study area accommodates nearly 20,000 farm holdings, corresponding to about 9% of the country's total. Seven percent of the holders are women.

(1) *Baseline survey* Sample size 100; random sampling; Moyamba District; multiple choice.

(2) *Farmers' perception of alternative rice cropping systems* Sample size 75; stratified random sampling; Moyamba District; 28 options; translated into local language (Mende).

(3) *Extension workers' views on swamp rice development* Sample size 17; all senior and intermediate level extension staff in Moyamba District; open-ended questions.

(4) *Utilisation study of existing developed swamps* Sample size 20; complete survey of swamps developed before 1983; Moyamba District; multiple choice questions.

(5) *Field yield assessment (FYA) 1985/86* Sample size 300 (swamp rice), 30 (mixed upland rice); stratified random sampling; Moyamba District; crop cuttings in farmers' fields; three plots of 10 sq m each per field (i.e per sample); questionnaire on the history of the particular crop stand sampled (17 factors); multiple choice; Subject: To obtain a reliable and comprehensive data base on rice yields and cropping patterns at different levels of technology and at various management levels.

(6) *FYA follow-up survey: 'High' and 'Low' yield groups* Sample size 45 (and 35 in control group); Moyamba District; stratified random sampling (traditional, improved); above 2.3 t/ha 'high', below 1.3 t/ha 'low'; multiple choice questions.

(7) *FAO/MANRF Pilot Swamp Development Programme 1985* 16 participating farmers representing the recommendation domain; Moyamba District; Subjects: Implementation of irrigation development at farm-level; labour input records; followed by a crop production programme; all participating farms were included in (5).

(8) *Multiple visit survey (MVS)/ Simplified farm accounting (FA)* 10 participating farmers (MVS), including 6 farms where daily records were kept (MVS/FA); Moyamba District; farmers selected as representative or typical; survey extended over one farming calendar year.

Agricultural Administration Unit
Overseas Development Institute, London

The Overseas Development Institute (ODI) is an independent, non-profit making research institute. Within it, the Agricultural Administration Unit (AAU) was established in 1975. Its mandate is to widen the state of knowledge and flow of information concerning the administration of agriculture in developing countries. It does this through a programme of policy-orientated research and dissemination. Research findings and the results of practical experience are exchanged through four Networks on Agricultural Research and Extension, Irrigation Management, Pastoral Development, and Rural Development Forestry. Membership is currently free of charge to professional people active in the appropriate area, but members are asked to provide their own publications in exchange, if possible. This creates the library which is central to information exchange.

Technical Centre for Agricultural and Rural Co-operation (CTA)

The Technical Centre for Agricultural and Rural Co-operation (CTA) was established in 1983 under the Lomé Convention and is based in Ede-Wageningen in the Netherlands. Its mandate is to help the African, Caribbean and Pacific countries which comprise the ACP group achieve greater food security by providing them with better access to scientific and technical information on all issues related to agricultural and rural development. Working in close cooperation with ACP and EEC countries and with international, regional and national institutions, CTA fulfils its mandate through a range of activities, including seminars, studies, publications and support to ACP documentation centres.

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IRRIGATION MANAGEMENT NETWORK

NEWSLETTER

October 1992

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Overseas Development Institute

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IRRIGATION MANAGEMENT NETWORK

NEWSLETTER

October 1992

1. NEWS FROM THE IMN

We have received a massive postbag from Network members as a response to our Registration initiative. We thank everyone who has sent us in papers and information on their work.

It is impossible for us to review or cite all the material we have received during the last six months. We have therefore put priority on listing papers received; we have only reviewed some of the books received. Our next set will carry a longer section on book reviews, particularly dealing with material received from Africa and Latin America.

We are still processing the information for the new Register of Members. Our special initiative on information exchange in African irrigation, funded by CTA, ends this year. We are currently evaluating this initiative and considering future activities in French and English. We hope a revised Register may be released in early 1993.

After two Newsletter sets which have primarily examined issues in the organisation of irrigation schemes, we would like to suggest some new topics for debate in 1993.

1. Coordination of irrigation and water management activities on cross river basins by farmers and water organisations;

2. The economic conditions of irrigators, especially the links between irrigation and poverty. We plan to carry responses to the mailshot on 'irrigation and poverty alleviation' in the next Newsletter.

Our next Newsletter set should be issued in April 1993.

Network Papers in this set

This set does not include shorter articles under 'News from the Field'. We have been holding several papers ready, including some from Africa, but communication difficulties have prevented us from clearing the drafts.

The papers in the current set continue with the theme of working with local irrigators and local organisations, but focus on large-scale irrigation schemes. The papers deal in particular with the gap between the theory and reality of scheme performance. They look at the key actors in bridging this gap - especially the water guards delivering water locally, and departments responsible for 'on-farm development' - and also the responses of the farmers themselves. They all help to show how improved performance must come from a balance of technical and social interventions. The papers also give insights into the problem of water scheduling - should it be 'on-demand', should it be 'crop-based' i.e calculated in relation to cropping patterns and environmental conditions, or should older 'supply-based' systems continue to provide a measure of drought-proofing to a larger number of farmers?

Paper 18 *Crop-Based Irrigation in Pakistan: Initial Efforts in the North West Frontier Province* by D J Bandaragoda and Carlos Garces-Restrepo. This paper looks at some of the technical, organisational and psychological challenges in rehabilitating and modernising two schemes in Pakistan. In these schemes water supplies were increased to deal with problems of water scarcity, with new operations geared to a new crop-based irrigation approach, rather than the traditional supply-based irrigation, and the 'on-demand' system currently practised by some farmers. However, there has been a heavy resistance to change both by the irrigation authorities and farmers, which reflect the way supposed advantages of the current *warabandi* system have been internalised by officials and farmers. The authors discuss the gap between myth and reality in the current distribution system, the impact of new water releases and the need to use both technical and social interventions to consolidate advantages from new water releases.

Paper 19 *Users, Operators and Hydraulic Structures: A Case of Irrigation Management in Western Mexico* by Pieter van der Zaag. This paper reminds us of the important role played by the water guards in the operation of irrigation schemes. These important actors have often been forgotten in debates on the strengthening of water user associations, and in reforming operations. In many schemes, local water staff have been seen as ineffective. This paper demonstrates their important role in coordinating water to meet farmers' needs, and negotiating on their behalf.

Paper 20 *Command Area Development Programme in India: A Policy Perspective* by M V K Sivamohan and Christopher A Scott. This paper traces the fortunes of policy and programme initiatives to improve 'on-farm development' in irrigation schemes where irrigation potential appeared under-utilised. While there have been difficulties in integrating interventions from both the irrigation and agriculture departments, the authors suggest that water scarcity is also a key factor in this under-utilisation of supposed potential.

Paper 21 *Irrigation Panchayats in Madhya Pradesh: A Case Study* by K V Raju continues with our overall theme of local organisations in large-scale irrigation schemes. He traces the decline in performance of the Mahanadi Command Area. His observations on the poor social studies that accompanied rehabilitation provide some practical examples of the difficulties mentioned in the paper by M V Sivamohan and C Scott. His observations on the variable performance of the water guard contrast with the strong role of the Mexican guards described in the paper by Pieter van der Zaag.

Paper 22 *Evaluating Irrigation System Performance with Measures of Irrigation Efficiencies* by Leslie E Small debates the use of irrigation efficiencies as a tool for performance monitoring. He looks at the value judgments and standards in deciding what are 'poor' or 'high' efficiencies. Given the central role of efficiency factors in design procedures, this paper should generate considerable interest among Network members.

2. NEWS FROM NETWORK MEMBERS

Anyone working in water resources planning, or concerned with water scarcity and allocation problems should obtain the following papers:

1. Rodgers, P. (1992) 'Comprehensive Water Resources Management: A Concept Paper'. World Bank Policy Research Working Paper 879, p 18. Available via Danielle Ranger, Room S11-043, The World Bank, 1818 H Street, NW, Washington DC 10433, USA.

2. Winpenny, J. (1992) 'Water as an Economic Resource'. London: Overseas Development Institute. A paper submitted to the conference on 'Priorities for Water Resources Allocation and Management', the Overseas Development Administration, July 1992.

Peter Rodgers' paper examines conceptual approaches to water resources management; the various economic tools that are now being used in 'valuing' water and in making allocation decisions, and the reasons why these tools may still not be working properly. Jim Winpenny's paper makes a broader, more practical review of economic tools. Both are useful, easy-to-read guides to current economic ideas. Sadly, while both acknowledge the importance of relevant administrative structures which can perform and utilise such analyses, time, space and focus mean they cannot give examples of actual examples. We know there are real dilemmas here as financial reform are affecting the options of many bureaucratic departments to use new techniques, and to change administrative structures. However, new links may be emerging between public and private organisations, and between government and academic departments to undertake such work. Please let Linden Vincent know if you are currently involved in any such programmes in planning and allocating water resources.

Dr C M Wijayaratna has taken over as Head of Sri Lanka Field Operations (SLFO) at IIMI. Dr Douglas Merrey, the previous Head of SLFO, is now working for the Performance Task Force Program at IIMI headquarters. IIMI plans to launch two long-term projects in the Philippines and may select a new person in due course. We wish both success in their new positions.

Are you a Portuguese speaker, or have interests in Mozambique? Then you may be interested in *Âgua e Desenvolvmento (Revista de divulgação de hidraulica agricola)*. The recent edition we received has an illustrated article on irrigation methods and their different advantages and disadvantages, and a special discussion on small-scale irrigation, plus a special supplement on water law. For more information contact: Joao Mendes, Rua da Resistência, No 1746, CP 2013, Maputo, Mozambique.

Are you involved in training, particularly in India? Several new publications have been received from the Water Resources Management and Training Project:

1. *Bibliography of Publications and Audio-visuals.* This gives a full summary and details of how to obtain publications;

2. *Manual on Computer-aided Design of Broad-crested Weir Flume.* Technical Report No 52;

3. *Irrigation System Operation Plan - Gayathri Medium Irrigation Project, Kerala, India.* This publication documents the preparation of an improved systems operation plan for the scheme, through the joint initiatives of government officials and researchers.

For more information, write to Tom Kajer, Louis Berger International Inc/WAPCOS, 213 Ansal Chambers II, 6 Bhikaji Cama Place, New Delhi 110 066, India.

The East-West Environment and Policy Institute runs a Land and Water Programme with a focus on the interplay of land, water, and people. Current topics of investigation are biological diversity conservation and protected areas; small island ecosystem management; social forestry; water-use conflicts; watershed management; ecologically fragile mountain environments; application of geographic information systems to resource management; applied transactions cost analysis; agroecosystem studies; lake management; community and environmental interactions with tourism; and the consequences of forest degradation on society, the environment, and climate. For more information, contact Dr John E Bardach, Interim Director, Environment and Policy Institute, East-West Center, 1777 East-West Road, Honolulu, HI 96848, USA. Tel: (1)808-944 7555; Fax: 944 7970; Tlx: 989171 EWC UD.

Suggestions for improvements in **water distribution schedules** interest many of our Network members, especially in schemes where current patterns of water releases are inadequate and create tail-end problems. Jacques Arrighi de Casanova has sent us a paper on calculations used to improve the water distribution rota in Carpentras, France, while also increasing the area irrigated. If you would like a copy of his paper *Organisation of Irrigation Water Distribution*, write to us at ODI or directly to Mr J Arrighi de Casanova at 42 rue de l'Yvette, 75016 Paris, France.

R S Saksena has sent in a paper **'Drip Irrigation in India - Status and Issues'**, published in the *Land Bank Journal*, Bombay, March 1992. This paper looks at the role of government policy in assisting the adoption of drip technology as well as summarising various economic and technical issues in the performance of this technology in India. He notes the variability in subsidies between states and questions the current high costs of technology in India. You can contact him for information at the Planning Commission, Irrigation and Command Area Division, 319-B (SFS Flats), C-3 Janakpuri, Pankha Road, New Delhi 110 058, India.

A special issue on **'Planning for Groundwater Development in Arid and Semi-Arid Regions'** was produced by *Water Resources Development* 8(2) June 1992. Titles by Asit Biswas, M Abu-Zeid, W van der Molden and Abdu A Shata are listed in section 6 of the Newsletter.

AgAccess has now released a new and expanded agricultural book catalogue. The comprehensive catalogue contains hundreds of book titles on subjects such as horticulture, vegetable crops, fruit production, pest management, water and irrigation, soil fertility, biotechnology, sustainable agriculture, plus many more subjects. The catalogue also describes how to use the agAccess Research and Information Service. AgAccess supplies all English language (and some Spanish language) agricultural books in print from over 900 publishers. AgAccess is pleased to send free copies of the 88-page *Agricultural Books Catalog*. For more information, write to Jeffrey Harpain, agAccess, 603 Fourth Street, Davis, CA 95616. Tel: (1)916-756 7177; Fax: 756 7188.

The fifth edition of *Geraghty & Miller's Groundwater Bibliography* by Frits van der Leeden, has been published by Water Information Center Inc and Lewis Publishers Inc. The 507 page paperback contains approximately 5,600 selected references, 600 more entries than the 1987 update, to both classic works and significant new papers. Areas of current interest and research such as groundwater contamination, modelling, and legal issues are included. Also, new to the fifth edition is the inclusion of a 58-page author index for easier reference. The bibliography is available for $69.95 plus $2 postage and handling from the Water Information Center Inc, 125 East Bethpage Road, Plainview, NY 11803, USA. Tel: (1)516-249 7634.

The ***Journal of Water and Land-Use Management*** has been launched by the Marudhara Academy, Jaipur, Rajasthan, India. The first edition has papers on the development of irrigation in India (R K Sampath); the Command Area Development Programme in India (R Kooja); agro-industries in the Punjab (D S Sidhu et al); irrigation supply in arid areas with reference to Rajasthan (P C Mathur); and the land-water environmental crisis in

Rajasthan (R K Gurfar). It is available by subscription. For more information contact Professor N L Gupta (ed), Marudhara Academy, 24 Friends Colony, Gandhi Nagar Moad, Jaipur 302015, India.

Previously, we noted the development of the IPTRID programme, and members may like an update, especially on plans to develop a Network. **The broad objective of the International Program on Technology Research in Irrigation and Drainage (IPTRID)** is to promote technology research and development in irrigation and drainage, particularly in developing countries. Priority themes are: modernisation of irrigation and drainage systems; ensuring sustainability of land and water use; and improving technologies for maintenance. These themes have now all been initiated by the IPTRID Secretariat at the World Bank, Washington DC. IPTRID has now sent expert team missions to Egypt, Pakistan, Mexico, Morocco and China to identify the most pressing problems related to water resources and to formulate relevant and appropriate research projects.

IPTRID's primary strategy in promoting the technology R&D related to these priority themes is through the two main activities networking and human resource development. The present planning for the **IPTRID Network** envisages a three-tier structure. The international activities of the IPTRID Network will be led and coordinated by the following organisations: Hydraulics Research (Wallingford, UK), ILRI (Wageningen, Netherlands), CEMAGREF (Montpellier, France), and the IPTRID Secretariat (Washington, USA). Intra-national activities of the IPTRID Network will be promoted and carried out by a designated centre in each country (or region) with strong irrigation and drainage interests. Professional organisations, commercial organisations, research organisations, academic institutions and individuals interested in using, or contributing to, the IPTRID Network form the third tier. For more information, write to Mr G Pearce, Hydraulics Research Ltd, Wallingford, Oxfordshire OX10 8BA, UK.

Do you work in pumping station design and operation? The Pumping Station Department in Shanxi Province held a workshop in 1991. This looked at the problems of lifting water with a high silt content, rehabilitation of pumping stations and site selection for new developments. Participants also discussed the gaps between theoretical models and practice in optimising regulation of multistage pumping stations, and problems from electricity supply. For more information on the meeting, and Chinese initiatives to solve these problems, write to Professor Xu Zhifang, Wuhan University of Hydraulic and Electrical Engineering, Wuhan 430072, China.

Water requirements for rice production have long interested many agronomists, but increasingly exercise irrigation planners as water becomes scarcer. Wang Guiting from Zhejiang Province in China has sent a paper which examines new schedules for applying water to rice. These greatly reduce losses to evapotranspiration and seepage (up to 40% of traditional water consumption). Although average yield is reduced, problems from lodging decreased. The paper seems likely to stimulate many questions about field-level water management for rice. If you are interested, write to the IMN for a copy, and we will forward correspondence to the author.

Bank damage by pests exercises many field engineers. Termites are a major source of damage and danger, weakening earth dams and embankments. Mr Xu Zihong has sent us a paper looking at ways to deal with this problem. If you face similar problems, write to us for this paper and we will forward on correspondence.

Sprinkler and drip technology is of interest to many Network members. China has a network CNSITIN which promotes exchange of information about sprinkler and micro-irrigation. It also has a quarterly journal *Sprinkler Irrigation Technique* which is distributed worldwide. CNSITIN is interested to exchange information internationally. For more information, contact Mr Chen Dadiao, Wuhan University of Hydraulic and Electrical Engineering, Luojiashan, Wuhan 430072, China.

China also has an information network studying **technical problems in irrigation canals.** The network has made a major contribution to design and construction initiatives to reduce seepage, control frost and pest damage, the use of appropriate materials and linings, and has organised special training programmes. For more details on their work and publications, contact the IMN, or write directly to Professor Xu Zhifang, Wuhan University of Hydraulic and Electrical Engineering, Wuhan 430072, China.

3. INFORMATION EXCHANGE ON AFRICAN AGRICULTURE

If you are interested in rural development in Africa, GRET's 'Researche Developpement' have recently published their register of members (1992). Their 'réseau Recherche-Développement' had over 1800 members in April 1992, throughout the world, but with strong African representation. It publishes a Newsletter that promotes exchange of information on agricultural research and extension, and on the design and impact of development initiatives. It has a special group interested in irrigated agriculture. For information contact Christian Castallenet, Réseau Recherche-Développement, c/o GRET, 213 rue La Fayette 75010 Paris, France. Tel: (33)1-40 35 13 14; Fax: 40 35 64 92.

IRED-Forum (Innovations et Réseaux por le développement) is the communications tool of an international network of 1000 peasant associations, artisans' and women's groups, organisations for development action in urban surroundings, and of centres and institutions giving their support to grassroots groups. For regional information, contact:

> **East and Southern Africa**, Mrs Rudo M Chiiga-Machingauta, Director, Development Support Service of IRED, PO Box 8242, Causeway, Harare, Zimbabwe. Tel: (263)796 853; Fax: 722 421; Tlx: 22055.
>
> **West and Central Africa/Sahel**, Boukary Younoussi, Director, Service d'Echanges et d'Appui à la Gestion (SEAG), BP 12675, Niamey, Niger. Tel: (227)733 527; Fax: 723 204; Tlx: c/o 5505 COOP NI.
>
> **Zaïre, Rwanda, Burundi**, Zihindula Ngombe-Ya-Mwami, Animator, BP 2375, Bukavu, Zaire. Tlx: (Zaire) c/o 21501 CAB TXBKV, *or* BP 257, Cyangugu, Rwanda. Tlx: (Rwanda) c/o 22608 PUB CYA; Fax: (250)37300.

The November 1991 (No 23) issue of *ATI Bulletin* gives details of Appropriate Technology International's programme on **local production and dissemination of treadle pumps in Africa.** For a copy contact: Appropriate Technology International, 1331 H Street NW, Washington, DC 20005, USA. Tel: (1)202-879 2900; Fax: 628 4622; Tlx: 64661 ATI.

Four new French publications have been released by Centre Sahel-Université Laval. These cover agricultural development, changing technology, and structural adjustment issues. For further information, write to: Centre Sahel, Local 0407, Pavillon Charles-De Koninck, Université Laval, Québec, Canada, G1K 7P4. Tel: (1)418-656 5448; Fax: 656 7461; Tlx: 31621.

IIMI's Burkina Faso country programme is built around a 4-year African Development Bank (AfDB) funded project focused on improving the performance of small scale, reservoir-based village irrigation schemes through collaborative research, training, and information dissemination.

Six irrigation schemes located in central Burkina Faso (600 to 800 mm mean annual rainfall) serve as field research sites. Activities include: (a) multi-disciplinary analysis-diagnosis to identify technical and organisational constraints to efficient irrigation system management, and (b) formulating, pilot-testing and evaluating proposals to improve performance, making better use of existing resources.

The primary vehicle for information dissemination is the bilingual (French-English) West African Irrigation Network Newsletter. The edition and production of the newsletter is a joint activity with IIMI's Niger country program. Issue Number 1 was produced in July 1991, and Issue Number 2 is in preparation.

A newsletter in Mooré (the most widely spoken local language in Burkina Faso) focusing on environmental issues was also prepared in collaboration with the local IUCN representation, which is financing this effort.

'Rice Cultivation and Irrigation Management' was the title of a 4-week training programme jointly organised by IIMI, WARDA and l'Ecole Inter-Etats d'Ingénieurs de l'Equipement Rural (EIER) from 2-26 March 1992 in Burkina Faso. The course was targeted at engineers and system managers concerned with irrigation management problems in West Africa, particularly with reference to rice cultivation. It incorporated both classroom and field-based activities. For information write to Dr Hilmy Sally, IIMI, Burkina Faso Field Operations, 01 BP 5373, Ouagadougou 01, Burkina Faso. Tel: (226)308489; Fax: 318489; Tlx: 5381 BF.

The Proceedings of the 5th African Water Technology Conference held in Nairobi on 25-27 February 1992, is published in A4 paperback only and is available for £34.00 sterling inside Africa and £36.00 outside Africa. For a copy, please write to: African Water Technology Conference, Robart Technical Services Ltd, 212 Molyneux Road, Liverpool L6 6AW, UK. Tel: (44)51-263 7552; Fax: 260 4097.

4. PUBLICATIONS REVIEWED

Orstrom, Elinor. (1992) *Crafting Institutions for Self-Governing Irrigation Systems.* Center for Self-Governance, Institute for Contemporary Studies, San Francisco, USA: pp 125, ISBN: 1-55185-179-6.
Irrigation systems throughout the developing world have attracted prodigious

funding from governments and international donor agencies during the post-war era. Yet many projects have proved to be poor investments, whose net costs have exceeded their benefits. Elinor Ostrom counsels planners to look beyond a narrow concern with engineering and to let irrigation consumers involve themselves actively in the design, operation, and maintenance of water-supply systems. She shows that such "self-governing" systems are more flexible, distribute water more equitably, and counteract the "perverse incentives" that lead managers and consumers to abuse and neglect irrigation facilities.

The book provides some important insights on how *institutions* evolve for irrigation, as well as the more visible *organisations* and *practices*, and thus is highly relevant to programmes for institutional strengthening. Focusing on successful community-organised irrigation networks in the Philippines, Nepal, Spain, and elsewhere, she also identifies eight "design principles" - tools to help replicate systems that operate responsively and efficiently, and are good investments too.

Biswas, A K., and Agarwala, S B C. (1992) *Environmental Impact Assessment for Developing Countries.*
This book is based on a conference held in New Delhi, India. The conference reflects the widespread belief in the importance of EIA, and in developing relevant procedures for the South where environment must not be ignored, but development must not be impeded. Delegates discussed the emergence and effectiveness of government machinery as well as assessment techniques, and effective dialogue between donors, government and project staff. The book does not include any specific papers on irrigation, but the papers range across a wide spectrum of pollution problems and should be of interest to anyone working in this field.

Bobiash, Donald. (1992) *South-South Aid: How Developing Countries Can Help Each Other*. UK: Macmillan (London).
How effective is South-South aid, and is it different from North-South aid? Is South-South aid less costly? Are the technologies provided appropriate to developing country conditions? These are some of the questions this book examines. *South-South Aid* is of value to those interested in aid, Third World development, and the international relations of developing countries. The book's case studies are of particular interest to specialists in such topics as Third World health care, agriculture, and human resource development.

Castallenet, C. (1992) *L'Irrigation Villageoise (Village Irrigation)*. GRET, 213 rue La Fayette, 75010 Paris, France.
This book (in French) aims to provide a manual for field staff on social, economic and technical issues in small-scale irrigation in the Sahel. In addition to providing practical technical advice and social insights, it also suggests questions for staff to consider during their field work, to encourage better understanding of problems and improved dialogue between farmers and support staff. Information is given from Senegal, Mauritania, Mali, Burkina Faso and Niger.

Darkoh, M B K. (ed) (1992) *African River Basins and Dryland Crises*. Departments of Human and Physical Geography, Uppsala University, PO Box 554, S-75122 Uppsala, Sweden.
This book is the proceedings of a conference which examined the social, economic, political and environmental dimensions of East African river basins, with special attention to the precarious situation of the drylands that surround these African rivers. Papers document the past and present geopolitics of these river basins, population mobility and re-distribution consequent to drought and desertification, conflicts over water and settlement projects (including irrigation schemes). Papers on the Jonglei project, and irrigation in Kenya, Sudan and Nigeria may be of special interest to Network members.

Diemer, Geert. and F P Huibers. (1991) *Farmer-Managed Irrigation in the Senegal Valley: Implications for the Current Design Method*. End-of-project report, WARDA/Wageningen Agricultural University, Water Management Project. St Louis and Wageningen.
This report is based on field research in the Senegal River valley. It shows how farmers manage irrigation schemes, relating management to scheme design. One chapter treats the characteristics and utilisation of the relatively successful village irrigation schemes. Others are devoted to the concept of so-called intermediate schemes, which are larger in scale and designed with the market production of rice as the objective. Irrigation will only contribute to development if planners and engineers develop a better design method. The end-of-project report shows that designing effective irrigation schemes requires the integration of technical and socio-cultural elements.

Diemer, Geert. and Jacques Slabbers. (eds) (1992) *Irrigators and Engineers: Essays in Honour of Lucas Horst*. Amsterdam: Thesis Publishers.
Until the 1980s, irrigation development in Asia, Africa and South America was viewed by many as a hard-nosed, purely physical enterprise.

In response to disappointing hardware performance, irrigation engineers developed a new consensus: not only plants, soils and water required attention, the management of canal networks needed it too. It remains uncertain whether this insight is sufficient to make irrigation infrastructures more productive. It may be supposed that reasons for the poor performance of irrigation schemes must also be looked for in the design and implementation processes from which they originate. The essays in this book focus on both. A number of engineers and social scientists deconstruct current design method and related procedures for planning and implementation. Some add proposals for alternative procedures or report experiments, others focus on management issues. The essays were written in honour of Lucas Horst, Professor Emeritus of Irrigation at Wageningen Agricultural University.

Jaim, W M H., and Sarker, R L. (1991) *Irrigation Issues in Bangladesh*. Rural Development Academy, Bogra, and Winrock International, Dhaka.
These workshop proceedings present a set of papers which look at key issues in future irrigation developments, as well as presenting summaries of research findings. The effects of privatisation of equipment receives strong analysis, as does the inter-relationship between irrigation development and agrarian change. The monograph also contains a substantial bibliography on water management in Bangladesh.

McGowan, E., and Jonathon Hodgkin. (1992) *Pump Selection: A Field Guide for Energy Efficient and Cost Effective Water Pumping Systems for Developing Countries*, Technical Report No 61. Virginia, USA: WASH.
This manual is an updated version of an earlier 'Pump Selection' report dated January 1989. The revisions are based on field trails and experiences carried out during the intervening years.

The purpose of this manual is to assist engineers, economists, managers, and designers in developing countries to select water pumping systems for rural and small scale peri-urban water users. It is intended to enable readers to better understand and evaluate the advantages and disadvantages of different types of pumping systems and their components (e.g pumps, engines, and controls), associated costs, and long-term O&M requirements. With this information, readers can made knowledgeable, cost-effective choices of water pumping equipment, which will result in water development projects that are more effective and that offer increased water availability and minimise costs to users. While this manual focuses on pumps for potable water supplies, it can also be used to determine pumping equipment for small to medium scale agricultural use. This manual addresses four kinds of pumped water systems: diesel, wind, solar, and hand pumps. However, the methods can be applied easily to any kind of system (grid-electric, gasoline engines, etc). For more information, contact Phil Roark at the WASH Operations Center, 1611 North Kent Street, Room 1001, Arlington, Virginia 22209-2111, USA.

Shui Yan Tang. (1992) *Institutions and Collective Action: Self-Governance in Irrigation*. Institute for Contemporary Studies, San Francisco, California. No one questions the critical need for effective use of natural resources: water, forests, fisheries, grazing land. The question is simply how this is best handled. Is direct control by government bureaucracies necessary? Or can community-run, self-governing organisations manage these resources economically through collective action? Is it possible to have a working partnership between the two?

This book explores these questions, using institutional analysis and transaction cost economies to evaluate 47 irrigation systems worldwide. Professor Tang compares performances of bureaucratic and community-run systems and explains how institutional, cultural, and physical factors account for their differences. The result is a better understanding of the conditions in which self-governing systems work best, as well as when and how government intervention can help solve collective-action problems.

Zaag, Pieter van der. (1992) *Chicanery at the Canal: Changing Practice in Irrigation Management in Western Mexico*. Centre for Latin American Research and Documentation: The Netherlands. ISBN 90-70280-34-5. Irrigation systems are micro-societies with clear technical and social dimensions. *Chicanery at the Canal* is a monograph on a medium-sized irrigation system in Western Mexico. It introduces the reader to the often fascinating practices of farmers, leaders, field officers and engineers, and shows how they cope with each other and with the constraints put forward by the canal system. Through this account, the author attempts to clarify the formal and informal organising processes in irrigation systems. The publication links up with recent trends in transferring management responsibilities to water users' associations. It describes in detail which forces emerge when water users start participating in the management of a government-operated irrigation system, and analyses how practices gradually change. This allows the author to elaborate a model for diagnosing irrigation organisation and to propose a practical intervention strategy. IMN Paper 19 in this set is derived from this study.

International Irrigation Management Institute (IIMI) (1992). *Advancements in IIMI's Research 1989-91 A selection of papers presented at Internal Program Reviews*. Colombo, Sri Lanka: IIMI. pp 268.
IIMI has, through field research and programmes of thematic research, studied the problems that developing countries must confront in managing their irrigation systems. This volume, in four parts, contains the first set of scientific findings to be published by IIMI in a consolidated form. Papers are provided from the Philippines, Sri Lanka, Bangladesh and Pakistan.

Part 1 focuses on the financial and human resource implications of management strategies to render development, operation, and maintenance of irrigation systems more efficient and effective. Part 2 focuses on improvements to the management of irrigation systems and the relationships with the ultimate beneficiaries - the farmers. Part 3 addresses emerging issues deriving from the first successes of IIMI's research, for example, in conjunctive management of groundwater and surface irrigation systems. The results of experience in tackling problems arising from salinisation, waterlogging, and connected issues are dealt with in some depth. Part 4 deals with performance, principally on mechanisms and innovations which have been empirically tested for reliability and which hold out promise of better performance in the irrigated sector.

Second International Water Tribunal: The Case Books. 7 volumes. The Netherlands: International Books. ISBN: 90-6224 900 0 (series).
Water mismanagement in developing countries was the subject of the second International Water Tribunal (IWT), held in February 1992 in Amsterdam. Of 22 worldwide cases of water mismanagement, 12 were successfully judged by an international jury on scientific and legal evidence. The accused were companies, governments and international financial institutes. The Tribunal is not a legal court; its verdicts were based on universal principles and carries moral and ethical consequences.

All the cases presented at the Tribunal have been published in the first four books in the series on: *Dams*; *Pollution*; *Mining*; and *Management*. The fifth book *The Declaration of Amsterdam* details the universal principles on which the verdicts were based. In *Environmental and Water Law in the South*, the sixth book, details of the legal backgrounds to each of the cases, as well as an extensive overview of the current status - local, regional, national and international - of the legal protection of water resources in the Pacific, Africa, Asia and Latin America, are described. The seventh book in the series presents the history and background of IWT and the recommendations to the UNCED 1992 agenda.

5. SHORT REPORTS AND JOURNAL ARTICLES RECEIVED

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6. REPORTS ON PAST CONFERENCES AND WORKSHOPS

Workshop on Irrigation Research Methodologies
16-17 December 1991, Trivandrum, India

An IFPRI-sponsored workshop on irrigation research methodologies was held in Trivandrum, India.

The purpose of the workshop was to enhance the capacity for interdisciplinary research on Indian irrigation. It approached this task in a two-fold manner. First because of its participatory format, the workshop gave researchers a chance to enhance their own skills by sharing experiences and insights with each other. Second, material presented and discussed at the workshop is being organised and consolidated to create a workbook which will guide other researchers in planning and carrying out irrigation system research in India.

Although the range of issues covered by this topic is obviously extremely broad, scope of discussion was limited by four general principles. First, only approaches and techniques appropriate to the study of whole irrigation systems were considered. This focus contrasted with the village-based perspective often taken by social scientists, or the technology-based approach often adopted by engineers. Second, it was assumed that the study would be undertaken from a variety of disciplinary perspectives. Much discussion, therefore, related to ways in which the boundary and data needs of the different disciplines could be brought together. Third, it was posited that both secondary and primary data were valuable resources which should be utilised jointly to the greatest possible extent. India is particularly rich in secondary data resources, yet these resources are often under-utilised when the research design also includes primary data collection. Considerable attention was given to identifying sources of secondary data and highlighting ways in which secondary and primary data could be integrated into a common analytical framework. Fourth, priority was given to practical aspects of research design, data collection and management, and analysis. Information which is readily available in standard textbooks or reference works was generally not covered.

A brief volume of the workshop proceedings will be available shortly. The workbook should be available by the end of 1992. For more details, contact the workshop organisers, Mark Svendsen and Ruth Meinsen-Dick at IRPRI, Environment and Production Technology Division, 1776 Massachusetts Avenue, NW, Washington DC 20036, USA.

Groundwater Farmer-Managed Irrigation Systems and Sustainable Groundwater Management
18-21 May 1992, Dhaka, Bangladesh

This IIMI-FMIS workshop brought together papers from Bangladesh, India, Sri Lanka, Nepal, Pakistan, Indonesia, the Philippines, and China. Presentation of the papers and discussion attempted to look at strategic issues as well as different hydrological environments. There were groups on water-surplus areas, water deficit areas and conjunctive use, as well as looking at support services to farmers using groundwater and the provision of relevant monitoring and planning capacity for sustainable development and use of groundwater resources. For more information, contact Shaul Manor at IIMI, PO Box 2075, Colombo, Sri Lanka.

7. FUTURE INTERNATIONAL CONFERENCES AND WORKSHOPS

3rd Pan-American Regional Conference, Modernisation of Irrigation Districts
3-5 September 1992, Mexico
For further details contact: Ing Manual Contijoch Escontria, Presidente del Comite Nacional Mexicans de la ICID, Apartado Postal 4-957, Mexico, DF, CP 06400, Mexico.

International Seminar on Supplementary Irrigation and Drought Management
28 September-1 October 1992, Bari, Italy
Contact: Dr Atef Hamdy, Instituto Agronomico Mediterraneo, via Caglia 23, Cap 70010, Valenzano (Bari).

Asian Regional Workshop on the Inventory of Farmer-Managed Irrigation Systems and Management Information Systems
13-15 October 1992, Manila, Philippines
For more details, write to: IIMI, PO Box 2075, Colombo, Sri Lanka.

28th American Water Resources Association: Conference and Symposium on Managing Water Resources During Global Change
1-5 November 1992, Reno, NV, USA
Contact: Raymond Herrmann, Water Resources, Cooperative Park Studies Unit, 223 Natural Resources, Colorado State University, Fort Collins, CO 80523, USA. Tel: (1)303-491 7825.

International Conference on Water Related National Disasters and Their Environmental Impacts
1-5 November 1992, Bangkok, Thailand
Contact: Professor A Das Gupta, AIT, GPO Box 2754, Bangkok 10501, Thailand.

Seminar on Environmental Aspects of Estuary and Coastal Water Management
11-12 November 1992, Wallingford, Oxon, UK
Contact: Mrs Hazel Dandridge/Mrs Fieona M Farnsworth, HR Wallingford Ltd, Wallingford, Oxfordshire OX10 8BA, UK. Tel: (44)0491-35381; Fax: 32233.

2nd Triennial Conference on Science and Technology in Third World Development
5-7 April 1993, University of Strathclyde, Glasgow, UK
For enquiries, contact: Dr Richard Heeks, Programme Secretary, STD '93,

Institute for Development Policy and Management, Precinct Centre, Manchester, M13 9QS, UK. Tel: (44)61-275 2870; Fax: 273 8829; Tlx: 669755 office G att IDPM.

International Conference on Rain Water Catchment Systems
August 1993, Nairobi, Kenya
The theme of the conference is "rainwater, the principal sources of water supply to most low-income communities". For information contact: The Organising Committee, 6th International Conference on Rain Water Cistern Systems, PO Box 56, Nakuru, Kenya.

15th International Congress on Irrigation and Drainage
30 August-12 September 1993, The Hague, The Netherlands
Contact: Secretary-General, International Commission on Irrigation and Drainage, 48 Nyaya Marg, Chanakyapuri, New Delhi 110 021, India.

44th International Executive Council Meeting and 15th Congress on Irrigation and Drainage
3-11 September 1993, The Hague, The Netherlands
For further details contact: N Tyler, Secretary, British National Committee ICID, Institution of Civil Engineers, Great George Street, London SW1P 3AA. Tel: (44)71-839 9835; Fax: 222 7500.

International Conference on Environmentally Sound Water Resources Utilisation
8-11 November 1993, Bangkok, Thailand
Enquiries should be addressed to Professor Tawatchai Tingsanchali, Chairman of the Organising Committee, International Conference on Environmentally Sound Water Resources Utilisation, Division of Water Resources Engineering, Asian Institute of Technology, PO Box 2754, Bangkok 10501, Thailand. Tel: (66)2-524-5559; Fax: 516-2126; Tlx: 84276 AIT TH.

8. TRAINING COURSES

The Department of Agricultural Water Management at Silsoe College runs a number of irrigation-related MSc courses. A 12-week course in Agricultural Water Management is held annually in April. For information contact: The Student Recruitment Executive, Silsoe College, Silsoe, Bedford MK45 4DT. Tel: (44)525-860428; Fax: 861527.

The 1992 *Compendium of International Shortcourses, Workshops and Conferences on Water Resources Management and Related Topics* has been prepared by Louis Berger International Inc and Water and Power Consultancy Services (India) Ltd. This fifth annual compendium is produced as an aid in selecting and arranging international training in water resources management and related topics. For more information contact: Mr Tom Kajer, Winrock Training Specialist, LBII/WAPCOS, 213 Ansal Chambers II, 6 Bhikaji Cama Place, New Delhi 110066, India.

CEFIGRE organise courses in French and English, which will be of interest to engineers, water management and environmental protection executives. CEFIGRE is conducting these activities mainly in the fields of water resources, urban water supply and sanitation, rural development (water, sanitation, irrigation), environmental management, and institutional development. Countries hosting their courses include Thailand, Cote D'Ivoire, Burkina Faso, Niger, Cameroon and France. Write to CEFIGRE, Sophia Antipolis, BP 113, 06560 Valbonne Cedex, France.

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IRRIGATION MANAGEMENT NETWORK

CROP-BASED IRRIGATION IN PAKISTAN: INITIAL EFFORTS IN THE NORTH WEST FRONTIER PROVINCE

D J Bandaragoda and Carlos Garces-Restrepo

Network Paper 18

October 1992

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19 *Users, Operators and Hydraulic Structures: A Case of Irrigation Management in Western Mexico* by Pieter van der Zaag

20 *The Command Area Development Programme in India: A Policy Perspective* by M V K Sivamohan and Christopher A Scott

21 *Irrigation Panchayats in Madhya Pradesh: A Case Study* by K V Raju

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CROP-BASED IRRIGATION IN PAKISTAN: INITIAL EFFORTS IN THE NORTH WEST FRONTIER PROVINCE

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CROP-BASED IRRIGATION IN PAKISTAN: INITIAL EFFORTS IN THE NORTH WEST FRONTIER PROVINCE

D J Bandaragoda and Carlos Garces-Restrepo[1]

1. INTRODUCTION

There is a general appreciation that a shift from the traditional system of supply-oriented irrigation operations to one that is based on realistic crop-water requirements is among the most challenging issues confronting the irrigation sector of Pakistan. The issue is compounded by the peculiar complexity and size of Pakistan's canal irrigation system, and the dominant social and institutional influences associated with its operation.

A recognition of these difficulties is reflected in the cautious approach adopted at the policy level. While a closer link between the irrigation supplies and the crop-water requirements was seen as a necessary step, crop zoning and water scheduling which might be needed for this purpose were to be taken up initially on a pilot scale before their wider application (National Commission of Agriculture, 1988: 300).

As two modernised systems in the North West Frontier Province (NWFP) of Pakistan seemed to offer special opportunities for such an effort, Pakistan authorities requested the International Irrigation Management Institute (IIMI) to carry out a study in these systems. IIMI conducted preliminary investigations and started a programme of research activities aimed at a pilot trial on crop-based irrigation operations. The study is being conducted in selected areas within the two modernised systems in the NWFP, and includes an action research component to be implemented in close collaboration with irrigation-related agencies of the province.

The use of the terminology 'crop-based irrigation operations', serves to distinguish between two systems: the 'on-demand' system operations, where individual farmers control when and how much water they receive, and the intended 'crop-based' system management. The latter aims to supply water to the watercourse head and the farms on the basis of crop water requirements, determined from monitored information on aspects such as cropping patterns and environmental factors.

This paper derives from the preliminary investigations carried out so far, both during the study development stage, and the inception phase of the study started in July 1991. The paper examines policy, organisational and technical concerns regarding modernisation and perceived management flexibility. With special reference to the case studies, the paper also discusses some constraints and opportunities that can be identified at this stage in embarking upon a study of crop-based irrigation operations.

2. IRRIGATION IN PAKISTAN

2.1 The Supply-Oriented System

Pakistan has an arid sub-tropical climate with an average annual precipitation less than 300 mm. The country's natural endowment of glacier-based water resources in the northern mountainous region overlooks a vast flat valley with an average slope of about 0.2 m per km, which extends for more than a thousand kilometres to the southern coastline. The present diversion capacity of the canals of Pakistan is 7,318 cubic metres per second. The network of canals of about 64,000 km in total length, and watercourses totalling to about another 1.6 million km in length delivers water to the fields through 89,100 farm outlets.

The irrigation system of Pakistan has been designed as a run-of-the-river system with an objective to command maximum area with the available supplies in the river, ensuring "equitable distribution" between various canals, branches and distributaries and also between individual outlets. The concept was to provide 'protective' irrigation. The duty of water was fixed relatively low in order to irrigate maximum command, the typical duty being 210 to 280 litres/sec per 1000 hectares (3-4 cusecs per 1000 acres). The irrigation intensity was also designed to be kept low at about 75% for the two seasons, rabi and khariff.

Following what is now called the 'Regime Theory' of Mr Lacey, an irrigation engineer of the Punjab Irrigation Department in the late 1930s, the canals were designed with slopes, velocities and sections to minimise silting and scouring. The canals were to run most of the time at authorised full supply level, or at least at 75% of the full supply discharge to avoid silting.

An additional design objective has been to keep the administrative and operational requirements as low as possible. The "equitable distribution" of water was to be effected without much interference by the operators. The number of control structures in a canal was kept to a minimum. Finally, the distributary outlets were not gated, but had fixed structures to provide discharges proportional to the area to be irrigated in the watercourse commands.

2.2 Policy Concerns on System Limitations

With the introduction of Green Revolution technology, irrigated agriculture in Pakistan underwent some rapid changes. Irrigation intensity increased far beyond the design stage expectations, partly aided by the development of groundwater. New and improved crop varieties were introduced to produce high yields, most in combination with inputs and highly sensitive to irrigation water. Cropping patterns changed, requiring increased quantity and reliability of farmgate water supply. Thus, a departure seemed necessary from the traditional approach of 'protective' irrigation to that of 'productive' irrigation[2].

An instance of official recognition of the perceived inadequacy of Pakistan's traditional 'protective' irrigation system can be seen in the Report of the National Commission on Agriculture (1988: 287). Here, two specific problems relating to the canal irrigation system have been noted: (1) the persistent tendency of the supply-based system to spread existing supplies widely and thinly; and (2) the consequent difficulty of varying the water supply according to crop water needs. The Report also notes that "not only does the availability of canal water vary seasonally, the distribution process itself suffers from certain chronic inequalities, the worst sufferers being tailenders" (p 289).

Another instance of national level concern in this regard was seen at the series of deliberations that took place in finalising the Water Sector Investment Plan (WSIP) of October 1990.

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[2] The concept of 'productive' irrigation aims to increase irrigation water availability and to manage irrigation deliveries to meet the consumptive water requirements of the crop (crop demand), and thus create opportunities for improved agricultural production.

In a working paper for the WSIP on policy and management issues, Kirmani[3] isolates the major factors depressing crop yields as: (1) inequitable distribution of water; and (2) lack of adequate matching of water supplies with crop requirements. The latter problem was linked to the practice of using historic withdrawals as the index for water allocation[4].

3. MOVING TOWARDS CROP-BASED IRRIGATION

3.1 Modernised Physical Systems

The NWFP, which has only 5% of Pakistan's irrigated area, but is primarily an agricultural region, has responded to some of these policy concerns. In an effort to improve irrigation performance, the province has introduced some changes in the planning of its new irrigation systems, leading to a substantial increase in the water duty (rate of water delivery per unit area).

These changes can be seen in two major projects of the NWFP: the Chashma Right Bank Canal (CRBC) off-taking from the Indus and the Lower Swat Canal (LSC) which derives its supplies from the Swat river. The design of CRBC and remodelling of LSC are based on main canal capacities of about 0.60 lps per hectare and 0.77 lps per hectare respectively, compared to the more traditional system capacity of 0.28 lps per hectare.

The change represents a shift in the philosophy of designing systems from 'protective' to 'productive' irrigation (see Section 2.2). The revised water duties for channel and outlet designs attempt to provide channel capacities that permit more appropriate matching of water deliveries to crop water needs, as reflected by an anticipated or desired cropping pattern with optimum productivity levels.

The main features of these two systems are given in Table 1.

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[3] 'Comprehensive Water Resources Management: A Prerequisite for Progress in Pakistan's Irrigated Agriculture', by S S Kirmani was one of three main working papers at the Consultative Meeting on the WSIP.

[4] Kirmani's paper concludes: "More water can be made available for productive use by changing the historic withdrawal pattern to a crop needs pattern, by ensuring equitable distribution and by conjunctive use of surface and groundwater storage. These management methods will not affect the water rights of the canal commands ..."

TABLE 1: MAIN FEATURES OF CRBC AND LSC SYSTEMS

Feature (Unit)	CRBC	LSC
Year Built	1986, still under construction	1885, remodelled in 1935 and 1987
Supply source	Indus, Kabul river	Swat river
Source regulation	Chasma barrage	run of river
Type of system	gravity flow	gravity flow
Design discharge (cumecs)	138.07	54.90
Average water allowance (1ps/ha)	0.60	0.77
Length of main canal (km)	271.92	35.40
Type of main canal	partially lined	unlined
Length of network canals (km)	603.37	112.63
Number of distributaries	40	10
Type of outlets	pipe	gates/APMs
Drainage system	No	under Mardan SCARP
Cultivable command (ha)	230,675	50,040
Design cropping pattern (total %) (kharif, rabi)	150 (60,90)	180 (90,90)
Other features	integrates old Paharpur canal system	none

3.2 Technical Constraints in the Modernised Systems

3.2.1 CRBC System

Although there seems to be no problem of feeding the CRBC at the head as it draws its supplies from the Indus River at Chashma Barrage having a small storage component, consideration of crop water requirements does not enjoy any primacy. The monthly pattern of water allocation has been fixed taking account of two more factors: the inter-provincial character of the canal and the barrage limitations.

The CRBC has been designed as a gravity canal to run at nearly full supply discharge to maintain its regime and avoid siltation. For demand-based operations CRBC will run only 40% of the time with discharges above 75% of the full supply level (FSL), while 60% of the time it will run with variable low supplies (with 20% of the time running at less than 50% of the FSL). This running of variable low flows can have serious repercussions on the regime conditions of the canal, primarily related to siltation and potential damage to the lined portion if changes in the discharge are made abruptly.

Although the capacity of the CRBC system has been worked out on the basis of the maximum requirements of the culturable command area, no infra-structure has been provided to run the system with variable discharges according to the crop requirements. In the 79 km length of the main canal in Stage I, there are only two cross regulators: one at 19.5 km and the other one at 49.5 km downstream of the head regulator. These control structures as provided are insufficient at main canal level. While three escape structures are contemplated in the main canal (for construction and safety-related reasons more than for managerial purposes), escapes at distributary level have not been provided which greatly hampers the flexibility required to introduce demand-based operations. If the option of varying flows in the main canal is not or can not be exercised, then escape structures in the distributaries should have been the obvious next choice; as indicated this was not the case.

The design of CRBC envisages a conventional system of distribution of supplies from the distributaries to the outlets, i.e to deliver fixed discharges at full supply level without any managerial intervention. The conventional outlets (open flume or APM) have been redesigned to only deliver increased discharge. No provision of gates have been made to deliver variable discharges according to crop water requirements. It may be interesting to note that resistance to installation of gates has come more from the Irrigation Department than from the farmers, on the grounds that the farmers cannot be made to understand how these devices ought to be managed. Also, the operating agency would see the gates as an extra burden on their supervisory activities.

The communication system is also inadequate. Only few regulating structures have been provided with telephone connections and therefore regulation messages are sent through messengers to other regulation points. An efficient communication system is essential between all regulation points along the main canal and the distributaries for introduction of demand-based operations. Automation or remote control of some key control points may be required for efficient operation. In addition, a communication system between the water users and managers of the delivery system, for timely intimation of demand and subsequent delivery schedule, is a basic need. No such system exists nor is being contemplated.

Finally, the old irrigation system of Paharpur Canal (which is now incorporated into the CRBC after being remodelled for the increased discharges), poses an additional issue for management. Neither the operating staff nor the farmers appear to be running the system or using the water in the field according to the requirements of the crops. They seem to be delivering and using the additional water to increase the acreage of cash crops. This trend is likely to continue, to the limit of available water. The ability to deliver additional water during periods of peak need appears to be inadequate under conditions of full development with water demanding crops like rice and sugar cane[5]. Thus, if this trend were to continue, the objective of matching the deliveries to crop-based needs is unlikely to be met.

3.2.2 LSC System

The design for remodelling the LSC System to meet the crop water requirements of its command area, included two main features: (1) increased system capacity, and (2) regulation at both the distributary and the watercourse heads. The capacity of the canals is being increased, and some of the existing watercourses are being converted into minors due to increase in discharge (a rule of thumb prevailing is that any watercourse having a discharge of 140 lps or more as a result of the water-duty increase would

[5] Known locally as 'high delta crops'.

automatically become a minor, and come under agency or joint control). The outlets are being redesigned and provided with gates to deliver varied discharges at different times as per water requirement of the area. However, the system is still not ready to switch over to crop-based operations. The issues which need further consideration are given below.

The system has been redesigned on the assumption that run-of-the-river supplies will be available for ten months of the year to meet the crop water requirements of the area. This gap in supplies can widen in case the demand rises due to increase in intensity or shift in cropping pattern from the design assumptions. With the increase in water supply at the outlet head, the farmers have a tendency to grow water demanding crops like rice or sugar cane. Eventually, they will demand more water which the system will not be able to deliver, the supplies will fall short over a longer period of time and thus affect the crop production.

The main canal and the distributaries, from the headworks up to the outlets, are all unlined. These have been designed for maximum discharge on the 'Regime Theory' concept, and are supposed to run at near design discharge (see Section 2.1). However, the operation of the system with less than 75% of design discharge most of the time as required for crop-based irrigation in its command area, would upset the regime of the canal.

No cross regulators have been provided for feeding the off-taking distributaries. It will not be possible to feed these distributaries without control structures when the canal will be running with low discharges most of the year. The operation of distributaries with partial supplies, already a difficult proposition as seen above, will be further exacerbated with the provision of gated outlets. Farmers in head reaches will be tempted to draw more water, which will encourage inequity in distribution of water. An increased need for patrolling of canals is a foregone conclusion. However, how to cope with the additional cost of this intervention has not been seriously considered.

Escape structures have been provided only on the main canal, and not on the distributaries and minors to dispose of surplus water. This results in flooding of tail reaches during low demand period. Farmers in these areas are already requesting for an effective drainage system. The area is in fact being provided with drainage facilities under the salinity control and reclamation project (SCARP Mardan).

3.3 Mismatch between Physical and Management Systems

3.3.1 Unchanged management systems

While steps have been taken to redesign and remodel these irrigation systems and to provide larger water allocations for more intensive cropping, this effort has not been accompanied by the development of irrigation management procedures to achieve more appropriate matching of delivery and crop water requirements. The additional water allocated through the usual timed water-turn (*warabandi*) system provides capability to: (1) increase cropped area; (2) produce at a higher level in the same cropped area; and (3) change the cropping pattern. A combination of all three options appear to be taking place in the project areas, but it is unlikely that performance is at an optimum, technically, economically or socially. Also, there is a general recognition that the additional opportunities associated with the greater flexibility in water use may bring with them the danger of increased inefficiency, and that the higher water allocation through the remodelled system in this context may exacerbate drainage problems.

Although substantial improvements in system performance and agricultural production are possible using the 'productive' concept of irrigation, changes in system management and operation must occur, both in terms of physical control and organisational procedures. However, if the traditional supply-oriented operational practices are allowed to continue in these systems, inefficiencies in water use will aggravate existing drainage problems, and depress the productivity of water and overall system performance because of the higher water availability. This in turn will have a severe negative impact on benefits from the substantial investments in irrigation infrastructure.

3.3.2 Organisation for increased management needs

Some elements of the modernised physical systems required changes in the organisation for system operation. This was particularly felt in the case of the LSC. Although the design of the LSC required gates to be installed in the distributary outlets, apparently there was no plan to establish the necessary organization for operating them. It is not inconceivable that the planner's intention was to use farmer organisations or their representatives for this purpose. However, there is no evidence that any preparation in this direction had ever been thought about.

During a protracted period of construction, the gates installed in the upper reaches of the system are already found to be either damaged or unusable due to neglect. The Irrigation Department has not taken them over yet from the constructing authority, WAPDA, and this situation has led to a total organisational vacuum in this regard. This lack of preparedness for effectively handling the operational aspects of the new physical features of the system, coupled with farmer resistance to new features is likely to delay the process of using the LSC for crop-based irrigation operations.

Lack of coordination between the concerned agencies throughout the various stages of planning and implementing the rehabilitation work in the LSC is clearly discernible from the current ground situation, and poses a significant management issue for the future. This situation is likely to affect the CRBC as well, since the same agencies are involved in design, construction and operation activities in both project areas.

Another striking feature of the current organisational arrangements for operating the new systems in both project areas is the low profile of the extension staff. Any preparedness or enthusiasm for exploring the opportunities and avoiding the constraints embodied in the new design of the physical system, and for paying attention towards increased agricultural production in this new context, cannot be clearly seen in the field.

3.3.3 Water users associations

A move towards crop-based irrigation operations requires the efficient use of water at the farm level. Water users associations (WUAs) are the essential part of this effort. There are no WUAs in either of the two project areas, except on watercourses where physical improvements have been done with some farmer involvement under the On-farm Water Management (OFWM) programme. The absence of any agency charged with the specific responsibility of promoting farmer organisation for irrigation is a conspicuous feature in the context of a profusion of state agencies for numerous other activities. This particular deficiency may significantly contribute to the difficulties which are likely to confront any attempt towards more flexible management.

Distribution of water within a watercourse has always been the responsibility of the farmers. New or more explicit institutional arrangements will be required to make this responsibility be effectively discharged in view of the new situation with additional supplies. Developing mechanisms for equitable distribution of water in the present context of dominance by a few farmers will require special consideration on the potential for viable farmer organizations. To utilise water and to ascertain the timing and quantity of water to be given to the crop, such alternatives would need the farmers to be trained more systematically, which in turn seems to require a re-orientation of many others interacting with the farmers.

4. MYTH AND REALITY OF WARABANDI

4.1 Tradition of *Warabandi*

The term *warabandi* means "fixed (*bandi*) turns (*wahr*)"[6]. *Warabandi* is described as a water management system which aims to achieve high efficiency in water use by **imposing water scarcity on each and every user,** and by focusing on **equity in distribution** (Malhotra, 1982). Its origin can be traced to the early period of irrigation development in the north-western part of the sub-continent, when irrigation had to be extended to a much larger area than could be supported by the lowest available supply.

According to this *warabandi* system, a central irrigation agency is to deliver water at the head of the tertiary level watercourse through an outlet (*mogha*) which is designed to provide a quantity of water proportional to the watercourse's culturable command area. Farmers within the watercourse are expected to manage on-farm distribution of water according to an agreed (and most often officially ratified) rotation of water delivery for a duration proportional to the area of each farm plot, taking account of the practice of both day and night irrigation. The rotation begins at the head and proceeds to the tail of the watercourse. Usually, a seven-day rotation forms one complete cycle in which each parcel of land in a watercourse receives its water once per week.

During each farmer's turn, he has the right to all the water flowing in the watercourse. Once this arrangement of turns has been agreed upon, the agency does not interfere unless a dispute arises among the farmers.

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[6] The Punjab PWD Revenue Manual (Reprint of 1987:3) defines it as "*Wahr-Bandi*- the scheme or list of rotational turns or times at which each share-holder in a watercourse obtains his supply, or each outlet in a distributary is allowed to be open".

There was flexibility in the old farmer-established *kacha warabandi* system, ensuring water for all the farmers. However, increased frequency of disputes among farmers led to increased agency involvement. In an attempt to formalise the traditional arrangement, a more regulated "*pucca warabandi*" system emerged in which a weekly rotation was fixed by the canal officer on request by the disputing farmers in a watercourse[7]. Once fixed, it assumes common agreement; the turns are supposed to be followed unaltered and become binding on all the farmers who have to take water at his turn irrespective of his need. The previous practice of assigning day and night turns to two sets of farmers permanently, however, has been changed to allow for each set of farmers to shift between day and night irrigation on an annual basis.

Although *warabandi* is practised within the watercourse command, for some of its features to be ensured, the agency that delivers water has to establish some essential conditions in the canal system above the *mogha*. These conditions add to the assumed pattern of behaviour, and together they form the concept of a *warabandi* system.

Thus, theoretically the *warabandi* system in Pakistan is characterised, among other things by:

(a) a shortage of the water supply;

(b) main canal operating at full supply level;

(c) distributary operation at no less than 75% of full supply level (when this is not possible, distributaries are rotated);

(d) only 'authorised' outlets;

(e) outlets which are ungated and delivering a flow rate proportional to the area commanded (they remain open all the time);

(f) each farmer receiving the total allocated flow of the watercourse for a duration proportional to his area;

[7] Appendix E of the PWD Punjab Revenue Manual provides detailed instructions for preparation and modification of *wahr-bandis*, and explains the responsibilities of Patwaris, Zilladars and the Canal Officers.

(g) maintaining the designed hydraulic characteristics of the channels to ensure the intended system performance;

(h) 'equity' of water distribution being the central value commonly perceived by those concerned with the *warabandi* system.

4.2 The Reality as Seen in the Two Systems

The technical and institutional imperatives to make this system fully operational might have been satisfied some decades ago, but they seem to have gradually eroded with the changes occurring in the physical, social and economic environment of Pakistan's irrigation.

Preliminary field observations indicate that the idealised conditions for the *warabandi* system as understood in its traditional 'image' no longer hold true in either CRBC or LSC. In fact, it appears that there is already a move towards a flexible system of incipient crop-based irrigation operation.

The observable deviations from the traditionally accepted *warabandi* norms are as follows:

- The water supply has been enhanced substantially through increased canal capacity. For peak requirements, this increase means a capacity for a water duty of about 0.60 lps per hectare in the CRBC and about 0.77 lps per hectare in the LSC as against the traditional duty of 0.28 lps per hectare.

- Distributaries are operated at levels that range from above the full supply level (FSL) to less than the accepted minimum requirement of 75% of FSL.

- The outlets are closed by the farmers at times when no water is required, and the distributaries are obstructed with temporary (illegal) checks to increase flows into specific outlets.

- Watercourse outlets have been modified, either permanently or temporarily, to alter flow rates (this can be more clearly seen in the LSC). Some of the outlets draw water at rates exceeding design water duties, often causing some others to draw less water.

- The farmer turns are influenced by large land-owners and other 'influentials'.

- 'Equity' is no longer a strong shared value among the officials, farmers and politicians.

These observations are common to both study areas. The reality that emerges in these situations dispel several myths associated with the popularly known concept of the *warabandi* system, described earlier. Some of the myths relate to the way *warabandi* is (or ought to be) applied and practised and some to the effect of *warabandi*. Foremost among them is the notion that *warabandi* corresponds to equity in water distribution. On the contrary, equitable distribution is eroded by both the physical conditions such as less than FSL deliveries in the canal, as well as the institutional factors such as power and influence of the large land-owners. At best, it remains as an equitable distribution of time, and not of water.

Although the observations are limited to two specific system areas and as mentioned below, the two systems differ from each other in terms of the maturity of their irrigation practices and therefore might not be representative of the whole of the well established irrigation sector in Pakistan, the story of myth and reality of *warabandi* appears to be having a wider application[8].

The LSC which was built in 1885 and therefore has a longer irrigation tradition, offers better information on the types of change that have taken place in the *warabandi* practice at the watercourse level.

A rapid appraisal conducted during October 1991 brings out some interesting features of this change[9]. They need to be studied further before a firm assessment can be made, but as can be seen in a rapid appraisal, the following features emerge:

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[8] See Merrey (1987: Chapter 17, and 1990: Chapter 28). He questions the long term sustainability of the present *warabandi* system in Pakistan while acknowledging the limitations of available technical alternatives and the 'imbeddedness' of *warabandi* in local social structure.

[9] A team consisting of a social anthropologist, an agronomist and an irrigation engineer conducted a rapid appraisal in the study area in the LSC (Ref: EDC, 1991).

- '*Warabandi*' as a broad concept has become deeply imbedded in local irrigation tradition in the area.

- Attempts to escape from the *warabandi*-imposed rigidity in the allocation of water have caused many water-related conflicts among the farmers.

- The conflicts have led to a heavy involvement by irrigation staff in conflict-resolution. The approach is officially on the basis of formal rules provided in the Canal and Drainage Act and the related Manuals of Procedure, but it actually has resulted in (rent-seeking) informal behaviour.

- In an administrative structure which is ostensibly for equitable access and distributive justice, *warabandi* has become vulnerable to manipulation by powerful and influential landowners.

- In some parts of the LSC, state regulation does not operate, and instead, an indigenous *khangi warabandi* (internally- decided *warabandi*) form is practised. In this, the water turns are determined locally by the farmers themselves, but often the decisions are with the big landowners, and the turns are usually inequitable.

- Observed deviations from the time-based 'rota' system of *warabandi* includes the sharing of water by farmers.

- In some places, farmers at the head reaches and those who are powerful tend to apply water during the day time and let the water flow at night. Tailenders complain that they are being turned into permanent night irrigators.

Although the water supply is becoming insufficient for increasing needs in the LSC, the few years of indiscipline in irrigation since the rehabilitation work was started has generally resulted in the collapse of any equitable form of water distribution that may have existed before. In some places, the small farmers in particular wish to see the return of a regulated normal *warabandi*.

In its present form, the management of water distribution in the area seems to have reached a dilemma. In one direction, the collusion between the officials and the big landowners has subverted the regulated *pucca warabandi* and made it very ineffective as an equitable mode of management. In another direction, the period of flux due to the construction phase of the project has re-introduced the informal *warabandi* in which the small farmers have lost their due share due to discriminatory decision-making by the influential farmers. In either case, the equity image of *warabandi* is overshadowed by its reality founded on power and influence.

5. PILOT EFFORT FOR MANAGEMENT CHANGE

5.1 IIMI's Study on Crop-based Irrigation Operations

Farmers and system operators in completed areas of both CRBC and LSC, are not yet fully aware of the opportunities and constraints of the newly introduced systems and increased water allowance. They are initially inclined to grow crops with high water requirements. Both wastage of water and the appearance of local waterlogging and salinity problems have been observed.

These trends and the need to formalise policies and procedures for the operation of systems with high water allocations, form the basis for IIMI's study. The following specific points further explains the rationale of the study for a pilot trial on crop-based irrigation operations in the two modernised systems:

(i) water resources are limited/constrained despite increased water availability at the system level;

(ii) inefficient use of increased water availability may result in waterlogging and deprive downstream areas of adequate access to required water resources;

(iii) agency personnel and farmers are not geared up to, or prepared for, effective utilisation of the increased water availability.

The study aims broadly to improve the overall productivity of water through improved system management and irrigation operations, in accordance with crop water requirements within the authorised water allocations and subject to available supplies.

The **specific** objectives are to:

(i) identify a flexible management approach for irrigation operations that responds to crop water requirements under prevailing supply conditions;

(ii) increase understanding of crop-based irrigation operations by agency personnel and farmers, and identify training needs;

(iii) field-test and refine the management approach identified for crop-based irrigation operations;

(iv) evaluate the benefits of crop-based irrigation operations and identify costs and opportunities for implementation on a wider scale.

5.2 Study Interventions

Water distribution: A key issue in the design of the CRBC irrigation system was the increase in water duty from the traditional value of 0.21 lps/ha (3 cusecs/1000 acres) to 0.60 lps/ha (8.56 cusec/1000 acres). The water supply in the selected distributary and watercourses will be closely monitored. These figures will be matched with the requirement at different levels of the system to determine the real impact of the modification.

Delivery Performance Ratio (DPR), water losses, Relative Water Supply (RWS) at distributary and watercourse level, and crop areas and cropping patterns will be determined as the key parameters.

Crop data has been a fairly unreliable element in the information available, and this problem can be compounded by the fact that, unlike Punjab, where the land has been divided in a square grid fashion, the NWFP presents a very irregular scheme which makes assessing the cropping pattern a rather difficult undertaking. To tackle this particular problem, a combination of three different approaches will be taken into consideration: (i) the cropping pattern reported by the revenue agency, (ii) the cropping pattern derived from an intensive field assessment, and (iii) the cropping pattern derived from a 'transect' approach where, depending on shape and area of the watercourse, a number of 'runs' in the field will be made to determine the crop configuration along those transects.

Simulation of main canal management: In Pakistan's traditional systems the design criteria for a main channel requires that it runs near the design discharge all the time in order to keep the canal in regime. Moving towards an increased management level by trying to better match the needs of the agricultural system (that is, not only the crop requirements per se, but also cultural practices such as land preparation or harvesting, etc) may require, at least as an option, that the traditional management of the main canal be modified. It is seen as pertinent that the effects of such potential changes be carefully assessed. The best way to assess the impact that flow fluctuations in the main canal can have on system performance is through a simulation model.

Water management at distributary level: To document both agency and farmer activities, special observations are made throughout the season. Under the ideal *warabandi* conditions discussed earlier, farmers' interventions at this level in the system should be non-existent; but this is not the case according to our observations. The type and reasons for these illegal or 'unauthorised' interventions will be recorded to help us better understand the inter-relationships between farmers and irrigation agency personnel.

Water management in Girsal Minor: Because of the integration of the old Paharpur Canal Irrigation System into the new CRBC system, Girsal Minor is essentially a continuation of distributary number 3, which we have selected for our main study. Flows at selected points of the Minor will essentially reflect the management of the tail-end of the distributary. Information obtained here will also be useful to compare farmers' water-related responses in the new developed areas of CRBC vis-a-vis the old areas of Paharpur.

Study activities in the institutional component will concentrate on aspects of irrigation institutions which often are inter-related, such as agency organizations (Irrigation Department, Agriculture Department, WAPDA), farmer organisations, the formal rules underlying these organisations, and informal rules (traditions, norms and practices, etc) that tend to fashion the behaviour of individuals and groups. The emphasis will be to find the relationships between the technical factors and the institutional factors, and to assess what combinations of these two aspects affect performance. This will be useful in the action research phase in finding appropriate management flexibility. While these investigations are being carried out, an effort will be made to develop close collaborative relationships with operating agencies and with farmers. In collaboration with operating agencies, an attempt will be made to establish mechanisms for field level coordination and farmer organisation.

Economics of Crop Based Irrigation Operations: Through socio-economic surveys and farm records an attempt can be made to determine the costs and benefits of any improvements to be considered in system management. In establishing a benchmark that would allow future comparisons, two situations can be used: (i) the situation prior to the introduction of the higher water duties, and (ii) the current situation, with higher water duties, but with no change in management intensity. For both, the old Paharpur Canal Irrigation System and the new CRBC (Stage I) area provide an ideal setting. Through the use of historical records the changes can be evaluated in the 'before' and 'after' situation, and 'with' and 'without' situation. To evaluate the benefits, it will be necessary to establish some performance indicators that can be used to define the potential areas of benefit. The following may serve this purpose:

(a) **Biological efficiency** to be determined by assessing the yield per unit of water. This will be specially valuable in evaluating the impact of operational changes on the efficiency in using the resource.

(b) **Technical efficiency:** The relationship between output (water used by the crops) and input (water supply, including rainfall). This parameter will give a good measure of the substitution of water for management. The physical efficiency can also be assessed by the relationship between the number of hectare-days (theoretical) and hectare-days (actual) that can be covered with the actual water supplies. This would provide at least a rough idea of where on the production function the farmers are operating.

(c) **economic return:** Rupees/farm; rupees/unit water; rupees/unit land. The first would give information useful for understanding farmer response to changes, as well as a direct measure of the economic benefit. The second would provide the information on the economic efficiency in using the resource. The last probably is the least useful since it confounds within it the decisions of the farmers on how to spread the water supply over their area. It may be useful, however, in comparing farmer water-spreading strategies in different parts of the system.

6. CONCLUSIONS

Modernisation of physical systems in the CRBC and the LSC have served the limited purpose of providing increased conveyance capacity to meet peak water requirements. While there are some significant technical deficiencies remaining, there is also a glaring mismatch between physical and management systems.

Preliminary work carried out under this study in the two modernised systems of the Northwest Frontier Province, indicates that it is not unreasonable to expect positive results from this pilot effort. The process is bound to be long, involving the improvement of compatibility between the physical, management and social structures. The *de facto* intensive water management on the part of the farmers in responding to the changing conditions in the field, as a result of increased water supplies, can be built upon to form a more flexible management system based on crop water requirements.

A distinction is made between the **concept of overall *warabandi* system** and the **farm level *warabandi* practice** in support of our observation that there is already a change in the management level in these modernised systems. The former includes the conditions that have to be met **within** and **above** the watercourse level. What happens at main and distributary canal level down to the outlet is decisive for the '*warabandi*' practice which takes place **only within** the watercourse. The changed social values have affected the overall system including both the aspects, the conditions as well as the practices.

While software-related institutional, organisational and management innovations (particularly the organization of farmers) may go a long way in moving towards more flexible management systems, for the idea of crop-based irrigation operations to be fully implemented, the introduction of a somewhat higher level of hardware into the existing physical systems seems necessary.

Some of the physical constraints can be easily overcome; some others may form the framework within which management changes have to be formulated. However, the institutional constraints seem to be linked with a heavy resistance to change, and may pose greater hurdles in the introduction of alternative management approaches.

For instance, the fact that the notion of *warabandi* is deeply rooted in the minds of the farmers and agency personnel, though in reality it does no longer exists as such, is a major constraint towards even the testing of alternatives. To overcome this resistance against the introduction of changes, a long drawn out effort may be needed through the improvement of awareness of both the generic conceptual issues and the costs and benefits involved in a shift towards crop-based irrigation.

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USERS, OPERATORS AND HYDRAULIC STRUCTURES: A CASE OF IRRIGATION MANAGEMENT IN WESTERN MEXICO

Pieter van der Zaag

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USERS, OPERATORS AND HYDRAULIC STRUCTURES: A CASE OF IRRIGATION MANAGEMENT IN WESTERN MEXICO[1]

Pieter van der Zaag[2]

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USERS, OPERATORS AND HYDRAULIC STRUCTURES: A CASE OF IRRIGATION MANAGEMENT IN WESTERN MEXICO

Pieter van der Zaag

1. INTRODUCTION

This paper analyses how physical structures in irrigation systems influence the social practice of water management. It argues that irrigation design is less of a determinant for particular water management patterns than is sometimes assumed by engineers, and that it may not be necessary to change the design of canal structures fundamentally for new management practices to emerge. This has implications for interventions in the management of irrigation systems.

Underlying this paper is a polemic between different approaches to understanding irrigation development, involving both physical and social phenomena. As yet, little theoretical exploration of the interaction between physical and social factors has been made. Practitioners, perhaps as a result of this, take either physical structures or social actors as a point of departure for planning. Their choice has far-reaching consequences in their conceptualisation of irrigation design and management. Exploration of this socio-technical no-man's land may develop when it is accepted that physical infrastructures have a social dimension, and that social practice has a material component.

Some authors argue that it is often forgotten that technology is socially constructed, because physical structures appear to us as mere objects and are usually viewed as culturally neutral. Diemer (1990) has convincingly shown that irrigation systems developed by farmers differ markedly from systems developed by European engineers.

The irrigation design, then, has an underlying sense of order which is absorbed by the users and influences the users' disposition (Bourdieu, 1977). At the same time, the physical irrigation infrastructure provides new opportunities to the users, who will devise a variety of strategies with regard to the system. In this way, social practice is influenced by the physical irrigation infrastructure, and in turn it actively shapes how that infrastructure is used.

This paper focuses on the interaction between social practice and physical infrastructure. It first examines an engineer's view of the type of canal infrastructure most likely to improve irrigation performance. This design assumption is then related to irrigation as practised in a system in Western Mexico, raising implications for future irrigation development.

2. DESIGN ENGINEERS AND THE CANAL SYSTEM

Engineers designing irrigation systems have responded in two ways to the problem of low irrigation performance. One group of engineers opts for a more sophisticated canal infrastructure, operated by continuous measurement of water flows and crop demand throughout the irrigated area, enabling the water distribution to follow changes in crop water requirements more precisely. They develop elaborate mathematical programming models which are fed with field measurement data, and which produce clear, unambiguous decisions to be implemented by the operators (Chávez-Morales et al, 1987; Boman and Hill, 1989).

A second group of engineers advocates a canal infrastructure which is easy to manage, but does not enable water distribution to be precisely matched to the changing crop demand for water. These engineers, such as Horst (1983, 1987), promote simpler systems with fewer decision-making points, and thus with lower skill requirements of staff. The premise is that simplicity of operation, even at the cost of some water loss, will eventually lead to higher efficiencies.

Both groups of engineers contend that a higher efficiency of water distribution will be attained by their strategies, and hence system performance improved. They share a view on how the canal infrastructure operates: both regard irrigation personnel in charge of operation with suspicion, and do not expect a positive contribution from them. Their attitude is that, in the former case, staff should follow the mathematical procedures prescribed and implement the resulting decisions or, in the latter case, staff numbers should be reduced to the absolute minimum in a simple system. Irrigation staff are expected to passively endure the canal system that the design engineers have concocted, by merely implementing actions which are wholly determined by the planning models.

From the design engineers' point of view, physical infrastructure (the canal system) takes precedence over actors (irrigation staff), and procedures over personnel. The following case study shows that in a complex irrigation system, with flexible structures, the practices of irrigation staff and water users are crucial to the smooth functioning of the system. They overcome some of the limitations presented by both canal structures and management.

3. WATER DISTRIBUTION: THE DUTIES OF THE WATER GUARD

Autlán-El Grullo irrigation system in Western Mexico, known as *El Operado* is used as a case study (van der Zaag, 1992). Constructed in the 1950s, it serves 8,700 ha of which 6,000 ha are currently planted with sugar cane. Water distribution efficiency, defined as the volume of irrigation water reaching the fields in proportion to the volume entering the system's head works, is around 60%. Water distribution and canal maintenance are performed by personnel of the District, the local office of the Ministry of Agriculture and Hydraulic Resources (SARH).

The head of the District operation department is responsible for water distribution, supported by staff at the District offices. The most junior staff are the six water guards (*canaleros*), the field personnel who distribute the irrigation water. They ensure that water is diverted from the river into the main canals, from the main into the lateral and sub-lateral canals, and from these to the individual farm plots. The water guards physically move the weirs and sluices, and have elaborate rules of thumb as to how water flows change after lowering a particular gate by a certain number of screw threads. They work out (in their heads, not on paper) the water distribution programmes. Water guards form the frontline of the District, since they communicate every day with both farmers and District engineers. Farmers put forward a request for an irrigation turn to the water guard in his or her zone and, if the request is reasonable[1], the farmer will expect to receive water (normally within one to five days). Farmers themselves do not move gates.

Each of the six water guards is responsible for an area of approximately 1,500 ha, containing some 300 fields. One water guard deals with 250 water users, and controls the gates and sluices of 30 to 40 kilometres of lined

[1] For sugar cane, an irrigation interval of three to six weeks is observed, for maize between two and three weeks, etc.

canals (in the main canal alone there are 25 to 30 gates and sluices per water guard). Normally he 'carries' a water flow in the order of 700-2,000 litres per second. A water guard works some 60 hours per week. Every day of the week he rides 50 to 80 kilometres through his zone on his motorbike to check all irrigation turns that at that moment are 'running', adjusting gates and talking to between 20 to 30 farmers or their labourers. The water guard plans a water distribution schedule for all of his canals. Water demand may vary considerably from field to field depending on crop and soil, limitations set by the canal infrastructure and the requests from farmers themselves. This complicates greatly the pattern of turns within one lateral canal. The pattern evolves during the irrigation season, since water demand gradually increases from November to March with changes in climatic conditions and crop stage. The water guard, thus, gradually builds up a progressively more complex water schedule for his zone and along each canal.

4. HOW THE WATER GUARD HAS 'INTERNALISED' THE PHYSICAL SYSTEM

The water guards have a specialised knowledge of the specific characteristics of both the canals and structures in their zone, and of the characteristics of all plots (soil quality, ease of irrigation, crops sown). They also know well all the farmers, share-croppers and irrigators working the fields. Three examples, given below, illustrate how the water guard absorbs detail of the system's features and uses this in his work: the first example concerns his knowledge of the physical infrastructure; the second deals with his stock of information about farmers and plots; and the third shows the sense of responsibility the water guard feels for his canals, and how he tries to resolve problems created by others.

Water guards are regularly confronted with technical problems, often related to shortcomings in the canal infrastructure. When I was present, they frequently asked my advice. My suggested solutions were often dismissed, although the water guards could not explain why in detail. On one occasion, a water guard followed my advice, although he did not believe my solution was feasible. He feared that carrying out my suggestion would cause problems to his downstream colleague, which I refuted on the basis of 'hard' calculations. The problems he faced were pressing, so he followed my advice, which had disastrous consequences for the established water flows.

As the water guard had predicted, the next day his downstream colleague accused him of having taken 200 litres per second of water.

The water guard, through his experience of working with the canal structures, has learned the whims of the system and is able to predict the effect of new manipulations. His knowledge of the infrastructure is both situation specific and implicit. It is as if he can feel how the system reacts. He has assimilated and 'internalised' the whole system, including canals, plots and farmers, and constructed an adequate model of it in his mind. To exemplify this, consider the crucial link that the water guards form between the District and the sugar refinery. This link becomes apparent during the daily meetings that the water guards have in the District office with their superiors.

One of the regular topics in this meeting is sugar cane irrigation. The water guards are informed which sugar cane plots have received the order of 'suspension of irrigation', scheduled at four to six weeks prior to harvest. The operation department of the District receives this list of suspended plots every few days from the sugar refinery. However, this information is unintelligible to the District office personnel, because the refinery's nomenclature of plots is not compatible with the District's nomenclature system. The District registers all plots of *El Operado* with a 4-digit number recorded against the official plot-owner's name. This plot number is not used by the refinery. The refinery bases its administration upon the farmer owning the crop (which is quite often different from the one registered as the plot owner in the District's system), with each crop-owner having a 6-digit identification number. Furthermore, the area under sugar cane, as registered by the refinery, concerns the *net* area planted and thus is normally less than the area used by the District in its administration.

The water guards are the only people in the District able to decipher the refinery lists and translate them into terms intelligible by the District. Thus, they form the link between the two administrations. It is amazing to see the speed with which this is possible. The engineer reads aloud the sugar cane growers' name and cane acreage and normally, within seconds, the water guard has produced the corresponding District plot number which he writes down in his note book. Errors in the refinery's computerised list are immediately recognised by the water guards, causing some hilarity in cases where the plot, supposedly ready to be cut, has already been harvested some months before for use as planting material (this is an activity not administered by the refinery).

The refinery cannot enforce the irrigation suspension without cooperation of the water guards. Therefore, the water guards are also the frontline of the refinery, often acting as policemen, since the farmers usually hear first from the water guard that the irrigation service to their plots has been suspended. Farmers tend to disagree with this decision as an extra irrigation before the harvest increases the gross weight of the cane, and farmers are paid per ton of cane. Thus, water guards not only absorb detailed factual information about the physical system, they also assume responsibilities over sugar cane growers. They embody the relationship that these cane growers maintain with the refinery. Needless to say, the water guards also, for all water users, embody 'the District'.

A meeting of water guards took place at the District in November, when problems concerning silted canals were most notorious. Juan, a tail end water guard, complained, for perhaps the tenth time, that he needed 800 litres per second (lps) but that only 200 lps was running into his zone. The main canal had severely silted and was now at peak capacity with only 200 lps, whereas normally it could carry 1000 lps. He complained about it again to the head of the operation department four weeks later, and stated that the canal had to be cleaned by the hydraulic excavator because the water users badly needed their first irrigation. The head engineer responded as usual: "Yes, I have contacted the head of the maintenance department and we are looking into this matter, but the problem is that the machine has broken down and is being repaired". Juan insisted that the situation had become unbearable. Pedro, another water guard, exclaimed:

"Juan, you need 800 litres for your farmers? Why then don't you ask for it? Why worry that the canal cannot carry it? If it flows over and the canal breaks down, that is not your problem, is it?"

All the water guards nodded and the head engineer continued to say that they were working hard on it. The next day, 4 tail-end farmers threatened to beat Juan up if they did not get water, and Juan simply did not show up for a week in the tail-end part of his zone. Finally, the machine was repaired and the main canal cleaned. This illustrates how strong the tendency is for water guards to assume total responsibility for their zones, taking problems created by others as their own concern.

In conclusion, low-rank field personnel interact intensively with both the physical infrastructure and the farmers they serve. The water guard emerges as a key actor who makes the system work. It is not then so simple as the head of the operation department makes out: "the water guard distributes the water, and we do the rest". Engineers in their offices have a limited view of what actually happens in the field. Water guards, through practice, have created their own autonomous system of action. The water guards' technical competence, and moreso, ability to deliver water efficiently, is directly related to the type of infrastructure he has to work with. The typical canal design is characterised by adjustable gates and intakes, which is potentially flexible in meeting the varying demands for irrigation water by users. However, to achieve flexibility the structures have to be operated correctly. The flexibility is therefore provided by the water guard.

Such flexibility is only achieved by water guards not strictly conforming to the District's organisation chart and guidelines, which are far too broad to be operational. If the water guard rigidly adhered to them, he would be confronted by many farmers in problematic situations: farmers with crops on sandy soils; farmers with flowering maize; those affected by the 'suspension' of a nearby sugar cane plot. The District guidelines are translated into far more complex actions by the water guards, which reflect the diversity of needs found in the field. The water guards have memorised the detail of the physical infrastructure through practice. Although designed by a distant institution or engineer and therefore alien at first to the water guards, the canal infrastructure is familiarised and manipulated to fit needs.

5. MAINTENANCE: FARMERS' APPROPRIATION OF CANALS

Water guards are not alone in taking some aspects of the complex irrigation system into their own hands; farmers also do so, illustrated by their approach to canal maintenance.

Whereas farmers are quite satisfied with the way water is distributed by the water guards, most are discontented with canal maintenance as performed by the District maintenance department. Each year after the rainy-season, many canals become silted up severely reducing flow capacities, and water shortages occur along many canals. As the maintenance department seems unable to cope with its task of cleaning these silted canals in time, farmers experience difficulties. During 1987 and 1988, numerous groups of water users took initiatives to solve their problems. Some groups opted to go to the District head engineer to complain and demand cleaning of their canal. Other groups decided instead to clean their canal themselves by hand. Of course, silted canals also existed where farmers were unable to unite, and instead they began to quarrel among themselves over the scarce water.

The remarkable difference in performance between the operation and the maintenance departments of the District causes problems each year concerning the silted canals. These problems give rise to intense interactions: among farmers served by a common canal; between farmers and District functionaries; and between farmers and the canal infrastructure. Since similar problems recur each year, different groups of farmers have developed different ways of coping vis-à-vis silted canals. This in turn has changed the way farmers perceive the canal system, the District, and each other.

There is an example of a small canal where farmers decided to organise a joint work-party or *faena*, and in half a day they had their canal cleaned. Remarkably, the water users of this canal made little reference to the maintenance department of the District when interviewed about the *faena*. They hadn't even considered going to the District to complain. The *faena* was exclusively between farmers and fellow villagers, with no place for the District. This is an important observation: through the *faena* the cultivators have reaffirmed their ultimate ownership of the canal infrastructure. The *faena* for them is an experience which will be remembered and which has changed them.

During the following year, the group of people engaged in the *faena* became involved in other joint initiatives concerning the canal system. The complete rehabilitation of the intake structure of the secondary canal, irrigating some 500 ha, stands out here. On several occasions the farmers had requested the maintenance department to enlarge their water intake, but received only negative responses. Discontent, they decided to do it themselves by collecting money. The water guard was very satisfied, as he could then direct sufficient water to that particular canal more easily.

The canal has gradually become a symbol for the farmers. They refer to it as an example of their successful communal operation, and of the successful 'domestication' of a government property. The *faena* has achieved a lasting effect, not only evident in the new intake structure, but also in the minds of the participating farmers. As one farmer put it:

"*We have made up our minds. We, all water users of this canal, are ready to take over, to arrange our affairs ourselves without those engineers in their* *offices.*" He smiles, "*We simply say that is it now our canal, and that we do not allow them to enter*".

Through demolishing the obsolete intake and constructing a new one, farmers have appropriated the canal. Formerly it had been unclear who owned the canals in this government-managed system. Now, after investing labour, organisation and money in the canal, it has become apparent that the farmers own it and the District has lost its control over it (Coward, 1986a, 1986b).

The case of the silted canal shows that social relationships change in response to particular problems which require users to act on physical structures. This is a very practical, down-to-earth process of appropriation, which has implications for planning the management of irrigation systems.

6. WATER MANAGEMENT: IMPLICATIONS FOR IRRIGATION DESIGN

This case study concerns an irrigation system with an on-request water delivery method. This leaves water users relatively free in taking individual farm decisions if the water delivery is efficient. It also implies that the canal system must be complex, all canal structures being adjustable. The degree of freedom left to water users enhances their willingness to concede authority to a specialised agency - the District operation department. Farmers participate little in water distribution, because they do not feel the need to do so. Farmers participate in cleaning the canals, a service they find unreliable, because they have no other option. The emerging farmer practices, however, have far-reaching consequences for the way they perceive the system. Gradually, they appropriate the canal infrastructure, thereby changing the relationship they maintain with fellow farmers, with District officials and with the canals. Pursuing the argument, the social relationships between major groups of actors found in an irrigation system are partially structured by the practical experience the respective groups have in coping with the physical infrastructure. This practical experience builds up social relationships.

The complex irrigation system, with an on-request delivery method, puts a burden on the specialised field staff distributing the water. To achieve their task, the water guards have absorbed physical detail and social characteristics of structures, plots, farmers and superiors. Interaction between people and physical structures is intense in this system. It is not that water guards simply *use* the physical infrastructure: water guards have become part of the structure, and the structures have taken a place in their minds. The practice of the water guard, then, cannot be separated from the physical object he uses to achieve his task. From these examples, it can be concluded that irrigation practice is comprised of a material dimension which impinges upon the social relationships that emerge around irrigation systems.

The irrigation system referred to here respects individual farm decisions, with water distribution being tailored to specific needs of plots, crops and cultivators. This makes the system complex, but not too complex to operate. The canal design has prompted water guards and farmers to observe, interpret, and to develop strategies. These have profoundly influenced the system's management and the social relationships between farmers, functionaries and water guards. The canal design has prompted and enabled water guards and farmers to become actors.

The processes of 'internalisation' of the system's detail by the water guards, and appropriation of the canals by the farmers have made the system work. This suggests that in inefficient irrigation systems, it may not be necessary to change the hardware (canal infrastructure) in order to enhance software (management). The problem may be that the irrigation infrastructure still stands as an alien, unarticulated object in the landscape. When managers start to acknowledge the crucial role and proficiency of field personnel, when responsibilities are re-allocated, and when property relations are defined more precisely, appropriate conditions may be set to stimulate the processes of both 'internalisation' and appropriation.

This conclusion is somewhat premature, being based on only one case study. It may not be valid for other irrigation systems in Mexico, let alone for other countries. It may therefore be worthwhile to study water guard and farmer behaviour in other contexts, to see whether the processes of internalisation and appropriation occur, and if so, how they influence the management of irrigation systems.

Design engineers who suggest that they largely select possible management options (Horst, 1990:12), and that efficiency will be obtained by operation staff blindly following a pre-determined set of technical procedures, appear to be wrong. This paper has attempted to show that, through practice, actors assimilate, understand and re-define the workings of the irrigation system. Consequently, operation of the irrigation system may change and evolve in to something very different from the designer's original vision. Not only does the final design result from a process of social construction, but the physical system also becomes involved in a process of socialisation. Analysing field practice in irrigation systems, as in this study, may thus offer a strategy for identifying ways to ensure that benefits to farmers are greater and more equitable.

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THE COMMAND AREA DEVELOPMENT PROGRAMME IN INDIA: A POLICY PERSPECTIVE

M V K Sivamohan and Christopher A Scott

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THE COMMAND AREA DEVELOPMENT PROGRAMME IN INDIA: A POLICY PERSPECTIVE

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THE COMMAND AREA DEVELOPMENT PROGRAMME IN INDIA: A POLICY PERSPECTIVE

M V K Sivamohan and Christopher A Scott

1. INTRODUCTION

This paper traces the evolution of the Command Area Development Programme in India in the context of planned development. It examines processes both in the evolution of new policies, and their revision over time. The paper first summarises the development context in India, and the way in which early emphasis on on-farm development (OFD) resulted from the growing gap between the irrigation potential created in the post-independence boom in irrigation infrastructure, and the irrigation potential actually utilised. The unreliability of main system management, however, was seen to obviate initiatives below the outlet, and subsequent efforts were made to integrate the agriculture and irrigation departments in the CAD programme. The paper also examines how the CAD programmes themselves underwent policy revision on priorities and responsible agencies that reflected difficulties in their implementation and improved utilisation of irrigation potential. However, this paper suggests that the gap between potential and utilisation results as much from inherent water scarcity as from inefficient water use and inadequate management. It is argued that the continuing *impasse* can only be remedied through articulation of a comprehensive strategy of development which includes disparate fields previously thought to be unrelated to irrigated agriculture.

2. THE DEVELOPMENT CONTEXT

The early efforts in development in India before independence were characterised by individual initiative and vision. Many of the development projects taken up during that period came to be known by the names of the individuals who were associated with them[3]. It took five years after independence for the state to slowly gear up for development activities. In 1951, The Planning Commission was established to initiate planned development in the country.

The First Phase

During the first decade after 1951, emphasis was laid on welfare goals and infrastructural works for rural development. The Community Development Programme, launched in 1952, envisaged the development of rural areas through concentration of efforts on individuals, primary cultivators and some changes in government administration at the district and below. The programme's origin was in the early experiments already mentioned - especially the Etawah project and Nilokheri project of S K Dey in rehabilitating refugees from Pakistan. Its thrust was promotion of welfare in the villages. The Community Development Programme was implemented along with the National Extension Service to bring about a progressive outlook among people, promote cooperative action and enhance increased production and employment in rural areas. Thus, the first phase of development efforts attempted to create an egalitarian rural society. The strategy adopted was based on the recognition of the need for structural changes such as land reforms.

The Second Phase

In the second phase of developmental efforts during the 1960s, productivity goals dominated planning. As the growth rate in the agricultural sector was not found satisfactory, in 1958 the Government of India approached the Ford Foundation to examine the ways and means of increasing food production in the country. Their report entitled *India's Food Crises and Steps to Meet It* identified pitfalls in food production. It suggested a programme entitled Intensive Agricultural Development Programme (IADP) to be introduced in eighteen selected districts. According to American and Indian experts, this report accurately highlighted the programmes needed for

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[3] Notable among the efforts by individuals were Gandhiji's experiment in Champaran (1917), the Shantiniketan experiment in Bengal by Rabindranath Tagore (1920), Spencer Hatch's Marthandam project in the erstwhile Madras Presidency (1921), Brayne's Gurgaon experiment in Punjab (1920), V T Krishnamachari's rural reconstruction movement in Baroda (1930), Gandhiji's Sevagram project (1936) and the Etawah project (1947).

India to attain the increase in agricultural production which was sought[4]. IADP has changed the direction and structure of development efforts by making them function on the basis of dominant goals[5]. While the community development strategy spread resources thinly across wide areas, IADP strategy was based on an intensive approach to maximise gains through integrated efforts[6]. However, the strategy of intensification of efforts - administrative, technical and financial - on an area basis did not achieve rapid increase in the levels of agricultural production.

Only in three of the eighteen selected districts were perceptible changes in food grain yields noticed[7]. The lessons of IADP showed that creating irrigation potential and providing extension support was not sufficient to step up agricultural production. Hence, the High Yielding Variety Programme (HYVP) to introduce improved seeds, chemical fertilisers, and other inputs was developed as a component for the IADP. Simultaneously, local pressure to launch identical agricultural development programmes was building up in districts where IADP had not been introduced. This resulted in the starting up of the Intensive Agricultural Area Programme (IAAP), identical in philosophy and approach to IADP, in as many as 114 districts. The second decade thus saw the emergence of area-based programmes such as IADP, HYVP and IAAP, all aimed at accelerating technological change to induce output and productivity improvements in the agricultural sector. The approach proved to be sound and resulted in the spread of the Green Revolution.

The Third Phase

Then came the third phase of development efforts where attention was focused on those who could not derive benefit from the earlier

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4 Taylor, Carl C., et al. (1967) *India's Roots of Democracy*. New Delhi, Orient Longmans, pp 245-6.

5 Fredericks, L J. (1978) Comparative Study of Goals, Policies, Strategies for Rural Development, in Amara Raksasataya and L J Fredericks (eds) *Rural Development: Training to Meet New Challenges* Vol 1. Kuala Lumpur, Asian and Pacific Development Administration Center, p 78.

6 Mukherji, B. (1961) *Community Development in India*. New Delhi, Orient Longmans.

7 Brown, D D. (1971) *Agricultural Development in India's Districts*. Cambridge, Harvard University Press.

developmental programmes. In 1970, a special agency called the Small Farmers Development Agency (SFDA) was established in forty-six districts, following the advice of the All India Credit Review Committee of the Reserve Bank of India. SFDA was in several ways different from the earlier programmes. Firstly, the approach was largely group-oriented. Secondly, loans with subsidy were extended as financial assistance. Finally, the primary emphasis was to enable small landholders to become viable producers - an approach which was not found in past development efforts.

At the same time, marginal farmers and landless labourers were catered to by yet another development programme called the Marginal Farmers and Agricultural Labourers (MFAL) programme. The activities included under SFDA and MFAL programmers were minor irrigation schemes (wells), agricultural development, dairying, sheep and goat rearing, fisheries, sericulture and the like.

Attempts were made in the 1970s to generate employment through development programmes in rural areas. In 1971-72 for the first time, the Crash Scheme for Rural Employment (CSRE) was launched which was latter on intensified under the Pilot Intensified Employment Project (PIREP).

Areas such as deserts, drought-affected regions and hill regions did not benefit from such programmes as IADP, HYVP and IAAP. Hence, in the 1970s, special developmental programmes like the Drought Prone Area Programme (DPAP), the Hill Area Development Programme (HADP), and the Desert Development Programme (DDP) were initiated.

It was in this developmental context that, in 1974, the Command Area Development (CAD) programme was introduced as an integrated area development programme.

3. HISTORICAL PERSPECTIVE ON IRRIGATION

Prior to and since independence, India has been an agricultural state. With the partition of the sub-continent at the time of independence, although India was left with 80% of the population, it lost 31% of the irrigated land on which the country was dependent for its cereals, fibers and oilseeds. This loss was not merely in the area irrigated, or the quantity and quality of food grain production, but also the loss of some of the major irrigation systems, such as the Sutlej Valley Project and the Sukkur Barrage across the Sind River. The food situation which as already in a critical state further deteriorated with the loss and resulted in a deficit of four million tons of food grains in 1947[8].

The tasks before the India irrigation sector after independence were threefold: (1) the immediate creation of irrigation potential; (2) efficient distribution of irrigation; and (3) effective utilisation of the irrigation potential created. Irrigation management aims to achieve a balance among these three objectives. In the following paragraphs is presented at review of irrigation management as part of India's planned development process.

Era of Planned Development

When the era of planning began in 1951, heavy emphasis was naturally placed on irrigation development for raising agricultural production. At the time of launching the first five year plan, a gross area of 22.6 million ha was under irrigation; this constituted 17.1% of the total gross sown area of 131.9 million ha at the end of 1950-51[9]. The gross irrigated area was made up of 9.7 million ha under major and medium irrigation projects and 12.9 million ha under minor schemes[10].

The two decades of development that followed 1951 saw the creation of considerable irrigation potential through the construction of several major and medium projects. In addition, there was a spurt of growth of minor irrigation projects and in the exploitation of groundwater resources.

The country's efforts in the four five year plans up to 1974 resulted in increasing irrigation potential from all sources at an average rate of one million ha per year (see Table 1). Although this growth was still insufficient in terms of the total irrigation requirement, it was considered to be most

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[8] Government of India. (1972) *Report of the Irrigation Commission (1972) Vol 1.* New Delhi, Ministry of Irrigation and Power, p 2.

[9] Banerjee, S K. (1978) CAD: Its Genesis, Objectives and Main Features, *Kurukshetra*, xxvi (24), p 11.

[10] For administrative purposes, the government classifies irrigation projects having cultivable command area (CCA) of more than 10,000 ha as "major" and those with CCA less than 2,000 ha as "minor". All projects in between are classified as "medium".

impressive[11]. By that time, the area covered by irrigation was only half the country's irrigable area, yet it constituted over one fifth of the world's total irrigated acreage[12]. While the irrigation potential created through major and medium irrigation projects was 21.6 million ha, its utilisation stood at 19.2 ha.

Table 1: Irrigation Potential Created and Utilised Under Major and Medium Projects in India, 1950-74 (in million ha)

Period	*Potential Created*		*Potential Utilised*	
	During the plan period	*Cumulative*	*During the plan period*	*Cumulative*
Up to 1950		9.70		9.70
First Plan (1951-56)	2.49	12.19	1.28	10.98
Second Plan (1956-61)	4.36	14.33	3.37	13.07
Third Plan (1961-66)	6.86	16.57	5.47	16.76
Annual Plans (1966-69)	8.40	18.10	7.06	16.76
Fourth Plan (1969-74)	11.00	20.70	8.98	18.69

Source: Central Water Commission

The issue of the gap between the potential created and the area actually utilised came to the forefront, causing grave concern to the government during the early 1970s when the country was experiencing a continued food shortage. The increasing trend in the gap between potential created and utilised in major and medium projects is given in Table 2. It can be seen

[11] United Nations, Department of Economic and Social Affairs. (1974) *National Systems for Water Administration*. New York, p 13.

[12] *ibid*, p 4.

from Figure 1 that, according to official data, there was a gap of 15%. Observers, however, placed it between 20 and 70% in various projects[13].

Table 2: Creation and Utilisation of Irrigation Through Major and Medium Projects in India, 1956-90 (in million ha)

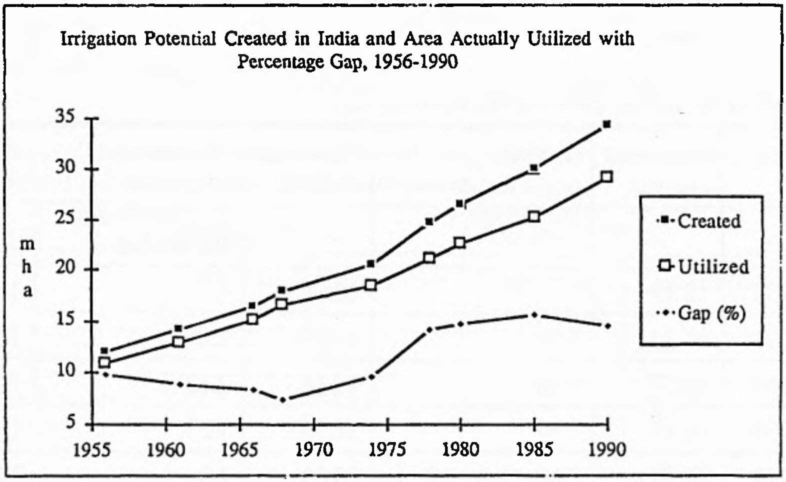
Year	*Potential created*	*Increase in potential during the period*	*Potential utilised*	*Increase in potential utilised during the period*	*Gap*
1956	12.19		10.99		1.20
1961	14.33	2.14	13.05	2.06	1.28
1966	16.57	2.24	15.18	2.13	1.39
1968	18.10	1.67	16.75	1.57	1.35
1974	20.70	2.60	18.69	1.94	2.01
1978	24.72	4.02	21.16	2.47	3.56
1980	26.61	1.89	22.65	1.49	3.96
1985	30.10	3.49	25.33	2.68	4.77
1990*	34.31	4.21	29.24	3.91	5.07

* anticipated

Source: Government of India, Ministry of Water Resources (mimeograph), 1989

13 Dasadra, H M. (1983) Winking at Water, *Economic and Political Weekly* 31(30):1352-54; and K Ramanujam. (1983) Nine Years of Command Area Development, in Government of Uttar Pradesh, *National Seminar on Impact of Command Area Development Programme, Technical Presentation* Vol 1, Lucknow, pp 2-4.

Figure 1: Irrigation Potential Created in India and Area Actually Utilised with Percentage Gap, 1956-1990



Note: Separate data in m ha and % can conveniently be presented on the same axis.

On the other hand, the recent status report of the Ministry of Water Resources published in June 1990 indicates that the potential utilised as a percentage of that created - which was hovering around 70% during the early 1980s in the 131 projects under the CAD programme - has picked up and has reached 77.4% in 1986-87 (see Table 3).

Concern for the Gap in Utilisation

The concern for under-utilisation in irrigation potential was voiced by several committees and commissions. The Irrigation Commission (1972) touched upon this problem and emphasized the need for a coordinated action to optimise the benefits from irrigated agriculture[14]. A conference of state irrigation and power ministers, held in 1972, took serious note of this malady. In August 1972, the Ministry of Irrigation and Power set up a committee, which in its report submitted in June 1973, pointed out the inadequate planning of irrigation projects and lack of one or more of the essential ingredients for irrigated agriculture. The committee suggested the

[14] Government of India. (1972) *Report of Irrigation Commission* Vol 1, op cit, p 3.

provision of water courses or field channels extending right up to the field, land levelling and shaping, conjunctive use of ground and surface water, arrangements for input supply and credit, provision of infrastructure facilities and also provision for training and extension[15]. The concern for better utilisation of the irrigation potential already created became even more pronounced in 1973 after the initiation of action by the Union Government. On 3 May 1973, letters on this subject addressed to the chief ministers by the then union ministers of planning and agriculture highlighted the concern of the government. The concern of the government to eliminate the gap in irrigation utilisation set the way to start the CAD programme in 1974. There were several interrelated factors which facilitated its formulation.

Table 3: Creation and Utilisation of Irrigation in the Projects Covered by the CAD Programme

Year	*Potential created since 1956 (m ha)*	*Potential utilised (m ha)*	*Percentage utilisation*
1979-90	11.09	7.77	70.0
1980-81	11.82	8.48	71.7
1981-82	12.51	8.79	70.3
1982-83	12.77	9.04	70.8
1983-84	13.07	9.32	71.3
1984-85	13.82	10.43	75.5
1985-86	14.00	10.40	74.4
1986-87	14.41	11.16	77.4
1987-88	14.54	10.72	73.2

Change in the Conception of Irrigated Agriculture

First, there was change in the very concept of irrigation itself. Irrigation was no longer viewed as a mere protective measure against recurrent droughts and famines in the interests of subsistence agriculture in the country. It had come to be viewed rather as a critical factor in productive agriculture.

[15] Banerjee, S K. *op cit*, p 11.

Secondly, there was a new appreciation of the role of agriculture in the rural and national economies. It was no longer considered merely as a way of life but as a commercial venture based on the scientific exploitation of the genetic capabilities of high yielding varieties and the management of market forces for maximum returns. The culmination of these two conceptual shifts, themselves the outcome of historical trends, resulted in a thinking which was fundamental to the concept of command area development, namely, that any effort to increase irrigation potential must be accompanied by a better and more scientific use of water and associated inputs for agriculture.

Responsibility for Infrastructural Development

Another factor which was most important in the conceptualisation of the CAD programme was the need for an institutional framework to undertake and integrate various activities and functions below the outlet of the irrigation distribution system. The entire work of transporting irrigation supplies from the outlet to the fields by constructing properly aligned field channels, land levelling and the like, were traditionally considered as the responsibility of the users and were hitherto left entirely to their initiative. The nature of such works and the inherent difficulties in their execution called for an integrated organisational structure to fill the vacuum. On-farm development activities were to become the mainstay of the CAD programme.

Distributive Justice

Yet another important factor that promoted the CAD concept was the principle of distributive justice. Lessons learned during the previous twenty years indicated that the unirrigated lands within the potential command areas were located primarily in the systems' tailend regions. By improving utilisation, both productivity and equity goals would be served. Thus, the need for equitable distribution of irrigation water to marginal, small or tailend farms formed an important aspect in the CAD concept.

The Command Area Development Authorities (CADs): A Suggested Model

The National Commission on Agriculture emphasised the need for the development of command areas in a manner comprising: (1) the efficient layout of plots and facilities like water courses, field channels, drains and farm roads; (2) consolidated of farmers' scattered plots into one or two operational holdings; (3) construction of water courses and field channels;

(4) construction of field drains where necessary and linking them with connecting drains; (5) construction of farm roads; and (6) land formation to suitable slopes[16].

The concept envisaged by the National Commission on Agriculture was later developed into an action programme during the consequent visits of a central team headed by B Sivaraman, a member of the planning commission, to all states, following the union minister of agriculture's letter in May 1973. The consensus that emerged from the discussions of the team with representatives of the states, favoured an area development approach for the major and medium irrigation commands instead of taking up different development programmes independently. "It was recommended that a Command Area Authority (in each major irrigation project) would be established with reasonable autonomy in administrative control and fiscal control over the several departments concerned with the above programme[17].

The CAD concept as perceived in 1973 was novel in the sense that it was viewed as an integrated area development programme with an attempt to synchronise systematically various activities under one roof to facilitate optimum productivity in irrigation and agriculture for overall development.

Launching the CAD Programme

The recommendations of the central team were communicated to the state governments with a request to set up CAD authorities (CADAs) in the irrigation projects identified in consultation with the representatives of the respective state governments. In total, fifty projects were identified. Following the directives of the central government, by the end of 1981, forty-five CADAs were constituted for seventy-one of the seventy-six important irrigation projects spread over sixteen states and one union territory (UT). Most of the states started organising CADAs in 1974

[16] Government of India. (1976) *Report of the National Commission on Agriculture: Resources and Irrigation*. New Delhi, Ministry of Agriculture, p 112.

[17] Sivaraman, B. (1977) Command Area Development, in K K Singh and R Cidambi (eds) *Command Area Development: Success and Learnings*. Hyderabad, Administrative Staff College of India, p 3.

itself[18]. The sequential inclusion of irrigation projects in the CAD programme is as follows (Table 4):

Table 4: Sequential Inclusion of Irrigation Projects in the CAD Programme

Period	*Number of projects included**	*Cumulative number of projects*	*Number of states included*
1974-75	60	60	13
1978-79	16	76	
1983-84	29	102	
1985-86	31	NA	
1988-89	4	131	20+2 UTs**

* 9 projects were deleted during the 1980s
** UT = Union Territories

Objectives of the Programme

An examination of the ordinances and executive orders creating CAD Authorities in various states showed that the CADAs were envisaged to address a wide range of objectives and diverse tasks in order to promote integrated area development in their respective service areas. Therefore, the priorities of individual CADAs varied from state to state. Each state, with its own administrative system and ethos, developed separate work strategies and basic tasks, taking into account such factors like agricultural tradition, tenancy pattern and physical parameters, such as topography, soil, rainfall, and the like.

The initial working paper of the Government of India on command area development suggested inclusion of several components to achieve irrigation utilisation and increased agricultural production[19].

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[18] Government of India. (1982) *Report of the High Level Committee.* New Delhi, Ministry of Irrigation, p 21.

[19] Hashim S Ali. Problems in Management of Large Irrigation Schemes: Integration of Agricultural Engineering and Administrative Staff and Farmers at Field Level,

1. Modernisation, maintenance and efficient operation of irrigation systems down to the outlet of one cusec capacity.

2. Development and maintenance of main and intermediate drainage systems.

3. Development of field channels and field drains within the command of each outlet.

4. Land levelling on the basis of an outlet command for the type of irrigated crop that is to be grown.

5. Consolidation of holdings and redrawing of field boundaries on an outlet command basis.

6. Enforcement of a proper system of *warabandi* and equitable distribution of water to individual fields.

7. Development of groundwater for conjunctive use.

8. Selection and introduction of suitable cropping pattern.

9. Supply of inputs and services including credit.

10. Development of marketing and processing facilities and communication.

11. Preparing individual programmes for action for small farmers and agricultural labourers as part of a master plan.

12. Diversification of agriculture and development of activities like animal husbandry, farm forestry, and poultry.

13. Soil conservation and afforestation where necessary.

14. Town planning.

The CADAs created in the country since 1974 have incorporated virtually all the work ingredients suggested by the Government of India. As

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(mimeo).

mentioned, however, the priorities accorded to the tasks changed from time to time.

Financial Support

The proposed financial support for the CAD programme was tentatively outlined in an August 1973 letter of the union minister of agriculture. The magnitude of financial support, Rs 1 billion in the central sector under the department of agriculture, and Rs 9.6 million in the state plans, was finalised in the fifth five year plan. The pattern of financial support was approved by the public investment board in December 1974 and has been changing over the years suiting to the requirements of CAD programme as they emerged and to some extent adjusting to the Authorities' environmental conditions. A comparative statement of the financing pattern before and after 1 April 1986 is given in Table 5.

CAD Policy

Irrigation and agriculture being state subjects, command area development has to be implemented by the state governments. On the advice of the central government, the states went about creating CADAs to suit their individual administrative traditions and preferences. By and large, most states located the CADAs under the department of agriculture.

Initially, CADAs were entrusted with numerous responsibilities in accordance with the overall focus on area development rather than on irrigation development alone. For example, rural infrastructural development, development of animal husbandry, improving the economic conditions of the rural poor, afforestation, horticulture and a variety of programmes were implemented by the project authorities. This comprehensive area development approach, however, gradually lost focus when the many complex problems associated with the development of irrigation and its utilisation began to surface. For instance, in most projects, farmers did not contribute to the expenses for the comprehensive on-farm development (OFD) package recommended to them.

Table 5: Central Financing for Irrigation Activities Before and After 1 April 1986

Activity	*Central assistance (%)*	
	Before 1 April 1986	*After 1 April 1986*
Grants		
Establishment, planning and surveys	50	50
Warabandi	50	50 (including wireless communication)
Crop compensation	50 (2/3 of crop value)	50 (2/3 of crop value)
Adaptive trials, demonstration and training	50	50
Subsidy for small and marginal farmers on IRDP pattern	50 (adjusted against loan)	50 (adjusted against loan)
Construction of field channels	25 (of the cost to individual fields)	50 (of the cost to outlet block of 5-8 ha)
Construction of field drains	Nil	25
Management subsidy for farmers' association	Nil	50 (Rs 100/ha for first 2 years, Rs 75/ha for third year)
Orientation training of senior officers	Nil	100
Evaluation studies	50	50
Loans		
Construction of field channels	25 (of cost from outlet to fields)	25 (of cost within 5-8 ha blocks)
Construction of field drains	Nil	25
Equipment and machinery	50	50
Equity support to land development corporation and farmers' service societies	50	50
Special loan account for financing ineligible farmers for execution of OFD* works	50	50

Source: Government of Indi: , Ministry of Water Resources, 1990

The necessity to confront such problems directly, since they lay at the core of irrigated agriculture, led to changes in programme perspective and policy. Attention turned from an overall perspective on rural development to the need to tackle specific problems of irrigation development and utilisation. Here too, the development of the irrigation infrastructure below the outlet became the focus. Supplying water to farmers' fields and providing the necessary support became the most important issues. This change was reflected in a definite shift in policy.The then minister concerned with CAD in the Government of India noted that, "for the time being, the CAD authorities should confine their activities to only those items which have a direct bearing on utilisation of irrigation potential and optimisation of agricultural production"[20].

Physical Development Below the Outlet

In the early years of CAD, a package of OFD practices were prescribed. It included topographic surveys, construction of field channels and water courses, land levelling and shaping within farmers' fields, construction of drop structures and distribution boxes and, finally, providing drainage an outlet to each irrigation block. In some places for holdings with proper layout of plots, trunk drainage channels, approach roads and irrigation channels were provided for a block as a whole.

A policy focus is reflected in the preamble to the CAD section of the sixth five year plan document (1980-85). "For obtaining benefits from irrigation water ..... a comprehensive programme of CAD ..... which will include systematic programming of land consolidation, scientific land shaping, construction of water courses and field channels to carry water to individual fields, field drains to carry surplus water ..... will be necessary[21].

Soon, however, it was found that a comprehensive OFD package was extremely time consuming to implement. Farmers resisted any major attempt to realign their fields. Few were willing to donate land for drainage. Many did not see the value of land levelling or shaping and even if they did, they did not have the money to finance it. Many had taken other loans and were not eligible for institutional loans meant for OFD. Due to numerous

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[20] Minister for Irrigation, inaugural address to the conference of state secretaries in charge of Command Area Development, New Delhi, 18 June 1983 (mimeo).

[21] Government of India. *Sixth Five Year Plan 1980-85*. New Delhi, Planning Commission, p 156.

such problems the progress of the CAD programme was seriously hampered. Project administrators openly complained about the difficulties in achieving targets. A review of policy was called for and carried out.

Focus on Construction of Field Channels

Priority was now given to the construction of field channels over all other items of the OFD package[22]. Instead of going in for a comprehensive OFD package, it was decided, as a matter of deliberate policy, to concentrate on linking the source of water with each farmer's holding or a common point between fields from where water could easily flow to fields and farmers could benefit from irrigation. Construction of irrigation channels and suitable infrastructure for irrigation in the outlet command became the main objective of CAD.

As mentioned earlier, one of the important reasons for the large gap between potential created and utilised was taken to be the under-development of irrigation infrastructure between the main system and farmers' fields. It was now recognised that this gap had to be tackled directly by concentrating on the construction of field channels and supplying water as close to the farmers' fields as possible. In 1983, the union minister for irrigation expressed the opinion that even though the CAD programme had been in operation from the beginning of the fifth five year plan, the construction of field channels received pointed attention only during the sixth plan period[23]. Though the policy focus continued on the activities below the outlet, an important change was brought about. Attention turned to field channels as against a comprehensive OFD package. This change in approach was reflected in the pattern of financial assistance given by the central government.

Rotational Water Supply

During the sixth and seventh plan periods, the construction of field channels and the completion of the irrigation infrastructure below the outlet were implemented at top speed. This was to make irrigation water accessible to each farmer's fields. But, for water to actually run into fields it must first be available in sufficient quantity at the outlet. In addition, for the last

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[22] Ali, Hashim S. Practical Experience of Irrigation Reform, Andhra Pradesh, in Ian Carruthers (ed) *Social and Economic Perspectives on Irrigation Management*, p 21.

[23] Government of India, Minister of Irrigation, *op cit* (mimeo).

farmer to draw his rightful share, those above must take only their legitimate share. Should canal operations fail to deliver the designed discharge at the outlet or the upper reach, farmers would draw more than their share with the resulting shortage of water.

Though there has been widespread awareness of the difficulties faced by the tailenders in an irrigation system, the implications for CAD were not realised until the prioritisation of the development of the outlet command with the sole purpose of carrying water to the last fields. Time and again it was observed that in spite of irrigation channels being excavated and being in good shape, tailend farmers could not draw water because there was not enough flow. Water scarcity was compounded by difficulties in operations that resulted from defects in the main system, sometimes for operational reasons and also because of inadequate maintenance funds[24]. The realisation that field channels alone could not ensure the delivery of water to all eligible farmers led to the conclusion that a system of water rotation was necessary along with the development of the outlet command to provide for equity and regularity in the supply of water.

While looking for a suitable model for operation of water supply, attention turned to *warabandi* practised in the northern canal systems, *shejpali* in Maharashtra and Gujarat, and comparable systems in operation under tanks in the southern states of India. In the first half of the 1980s the central government took the decision to implement rotational water supply in the command areas of all major and medium irrigation projects. Subsequently, *warabandi* (or rotational water supply, RWS) was included as a regular item of the CAD programme for which central assistance was made available to the states.

It did not take long, however, to realise that rotation water supply would not work unless farmers cooperated with one another. This was found to be especially true in areas where the idea of RWS was new and farmers had already developed set habits of responding to government-managed irrigation systems according to their social position and the location for their fields. Involving farmers in irrigation matters became an important issue and this continues even today. The initial success with RWS supported with irrigation associations of the involved farmers led to the belief that outlet-based committees such as "pipe" committees, *kolaba samitis*, or *pani*

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[24] Ali, Hashim S. (1983) *One Season of Integrated Water Management in Andhra Pradesh*. London: Overseas Development Institute, p 4.

panchayats would be able to manage irrigation on their own. But this was not to be.

It was soon learned that wherever RWS was introduced with the participation of the new system of water distribution, it began to break down because farmers could not cooperate with one another. An enquiry into the reason for this led to a significant finding. Quite often breakdown of the farmers' associations was directly related to the inability of the association to draw its share of water at the outlet point. When water is scarce, competition among water users for a valued commodity which is in short supply leads to conflict and erosion of communal ethics. Outlet-based irrigation associations are highly vulnerable to water shortages due to main system operations. Once they do not have enough water to ensure equitable distribution among all users, they cannot discipline members.

Some new approaches to farmers' associations were tried out, namely, an association that covered a number of outlets located on a minor or a distributary, or water cooperatives, but invariably the question of organisational viability vis-a-vis unsatisfactory main systems operations was encountered. No workable solution has been found.

Integrated Water Management

The difficulties encountered with the unsatisfactory management of RWS made it clear that the management of irrigation below the outlet of a distribution network was highly dependent on the operations and maintenance of the system above the outlet. Although there have been marked differences among irrigation managers about the reasons why RWS ran into difficulties, to the outside observer there was no doubt that it arose from such reasons as the limitations of the main system, operational deficiencies, and indiscipline among farmers. To these observers, physical improvements in canal systems, superior methods of operations and maintenance and the involvement of farmers were essential to promote better utilisation of irrigation resources[25]. Views have converged on the point that upgrading the irrigation infrastructure below the outlet was by itself no answer to better irrigation utilisation. Simultaneous investments were required to allow for greater control over water delivery. System

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[25] Chambers, Robert. (1988) *Managing Canal Irrigation*. New Delhi: Oxford & IBH Publishing Co, pp 90-91; and Hashim S Ali. *One Season of Integrated Water Management*, op cit, p 8.

operations had to be geared to agricultural needs and forums created for dialogue between irrigation officials (canal managers) and the users of irrigation water at different levels of the canal system.

Major shifts in command area development policy took place as a better understanding was developed concerning what lies at the root of inadequate or improper water utilisation. The CAD programme highlighted the various limitations of the irrigation system and its management. Starting from a comprehensive area development approach in which focus was on increased agricultural production and investments for rural prosperity, change first took place in favour of investments below the outlet, then RWS, followed by emphasis on RWS supported by irrigation associations and, finally, integrated water management in which investments in the main system and its management along with direct dialogue with water users was seen as integral to the attempt to bridge the gap between irrigation potential created and utilised.

Policy Process at Work

As one can surmise from the preceding discussion, state governments participate in policy formulation through the annual review meetings of secretaries and ministers of the states convened by the union minister in charge of the CAD programme. The states also elaborate the policy guidelines by programmes and approaches which are suited to their requirements. The Ministry of Water Resources is the nodal agency to assist policy formulation and to coordinate CAD programmes in different states. Some of the factors that have influenced policy are reviewed in the following paragraphs.

Departmental Responsibility

Traditionally, the government did not take any responsibility for the construction or maintenance of irrigation channels from outlet points to the farmers' fields. CAD made a significant departure from this tradition when the government openly took on responsibility for ensuring the delivery of water to the farmer. In the initial years of CAD, the state irrigation departments did not take active interest. Work below the outlet was not their area of operation. The responsibility for CAD fell to the department of agriculture. In Andhra Pradesh, a separate CAD department was created under the ministry of agriculture to integrate irrigation development with agriculture. It was headed by a separate secretary to the government who was later appointed as the agricultural production commissioner. However, the integration ran into a major difficulty, like in all other states.

The irrigation department, which controls the delivery of water, did not consider itself a part of CAD. As a result, comprehensive policies and enabling solutions to boost irrigated agriculture were not evolved. The preoccupation continued to be with OFD without a concomitant commitment to deliver water which the farm distribution system could carry to farmers' fields. When the futility of implementing OFD works without assured water supply was brought to people's notice, attempts at the highest level were made to reorganise the CADAs in 1980-81. The policy was to recommend that CADAs in the states be brought under the irrigation departments and that irrigation utilisation (synonymous with CAD), be viewed as an integrated problem from the reservoir or diversion point to the farmers' field. In fact, this design was being followed in Maharashtra. The linking of CAD with irrigation was called the "Maharashtra pattern" and was referred to all states to examine and implement. From 1981 onwards, this change was introduced in many states.

While the CAD-irrigation department merger helped improve water delivery, it created peculiar problems of its own, especially in Andhra Pradesh. One direct outcome was that the agriculture function of CAD was neglected. The officers of the agriculture department working under CAD were withdrawn. Agriculture in CAD projects has since been looked after by the agriculture department as a normal activity in the state as a whole. The integrated approach to agriculture in irrigated areas has been abandoned. The CADAs do not have expertise of their own to educate farmers on irrigation and agriculture. The policy thrust developed in the earlier years of CAD has been more or less lost in all the states.

Making Policy Work

The review of CAD policy in India brings out several salient points. There is a need for a comprehensive policy. The central and state governments along with the CADAs have to evolve a comprehensive CAD policy covering all aspects such as irrigation engineering, agriculture and cooperation. The policy goals differ from state to state depending on the local requirements and other policies and laws in operation. Though there is a positive recognition of the problems of irrigation utilisation in successive plans, integrated efforts by the government based on a well thought out policy are still to emerge.

The CAD programme is a centrally sponsored programme while the issues addressed, irrigation and agriculture, are under state governments' preview. The central government must evolve a comprehensive CAD policy which leaves options to the state government and the respective CADA for detailed development of the policy. The central government need not go to the extent of preparing operation manuals, as it did for the implementation at the field level. In a vast and diverse country like India, it is difficult to prescribe a single policy to be fitted everywhere. Having initiated the programme and having invested money, the central government should ensure systematic monitoring of the programme through state governments.

The policies, rules and procedures of the departments closely linked to the CAD programme must also be looked into and streamlined to the extent necessary. In Andhra Pradesh, for example, the policy of localisation[26] must be re-examined thoroughly to facilitate CAD policy. One of the goals of CAD is achievement of equity in its service delivery. The policy of localisation or the attempts to relocalise areas would lead to inequity and haphazard development of lands. Although under the existing acts and rules, the government can prohibit the growth of any crop under pain of penalty, such enabling provisions are likely to be oppressive and are unsuited to the present day socio-political environment. Modern technological advances in the management of soils, water and crops, and the rights and privileges enjoyed by the people of a free country do not favour imposition of such restrictions, particularly in the services from a public system. The farmers in the command should have equal opportunity of access to water and option to grow the crops of their choice. If the state government or CADA wants to encourage or discourage the growth of any crop in the interest of the community, it should do so not through the process of localisation, but through the means of support prices for the produce, pricing of irrigation water, allocation of water per unit area, system operational procedures and the like.

Canal Operations for Demand-Based Irrigation

While evolving policies related to canal operation, it must be borne in mind that future operations must respond increasingly to a demand schedule of

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[26] "Localisation" is the term used in South Indian irrigation commands for the process of demarcating certain lands for cultivation of less water-demanding crops (called "irrigated dry", or ID) mostly in the head reaches, and certain lands for "wet" crops, i.e water-demanding crops, in the lower reaches.

irrigation for diversified cropping. Hence, the old systems require remodelling in order to facilitate introduction of future innovations for farmer-responsive operations. New infrastructure may be required for downstream control. It is likely in some systems that operation will increasingly be done by remote control and automated water distribution structures. In still others, the increasing shift toward demand-based irrigation will require dynamic regulation, whereby the entire system must respond not only to changing demand schedules but also to fluctuations in water availability.

4. CONCLUSION

There can be no single development policy goal. It is possible to conceive of an interrelated set of policy goals for each of the major components of development, such as agriculture, education, health, social welfare, industry, power, transport, communications, etc. Agricultural development policy in turn resolves itself into several components such as land, irrigation, cooperation, extension education, pricing, marketing, warehousing, etc. The irrigation development policies can in turn be related to major, medium and minor irrigation projects, command area development, conjunctive use of surface and groundwater, flood control, water logging and drainage systems.

The concept of CAD is very unique. It aims to integrate a very wide range of developmental, sectoral, and functional components and sub-components of development. Meaningful articulation of this nexus into a unified, integrated and comprehensive CAD policy calls for innovation in the policy making structure and process.

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IRRIGATION MANAGEMENT NETWORK

IRRIGATION PANCHAYATS IN MADHYA PRADESH: A CASE STUDY

K V Raju

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IRRIGATION PANCHAYATS IN MADHYA PRADESH: A CASE STUDY

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[1] K V Raju is social scientist for Louis Berger International Inc, Water & Power Consultancy Services (India) Ltd, 213 Ansal Chambers II, 6 Bhikaiji Cama Place, R K Puram, New Delhi 110066, India. A longer version of this paper with a fuller study of the Mahanadi Command is available from the author on request.

IRRIGATION PANCHAYATS IN MADHYA PRADESH: A CASE STUDY

K V Raju

1. INTRODUCTION

In Madhya Pradesh, the formation of Irrigation Panchayats (IPs) is compulsory under the Madhya Pradesh Irrigation Act, modified in 1974. IPs have been functioning for 50-60 years in both major and medium canal irrigation systems, mainly in the rice-growing Chattisgarh region. The size of each IP usually coincides with a village size. As of 1990, in the Mahanadi Command Area, there were 736 IPs, with a total irrigated area of 183,000 hectares (ha). Each IP has a small committee elected once in three years and serves on an average 251 ha.

The genesis of irrigation in Chattisgarh region lies in the famines of the last century. The Mahanadi Canal Project began in 1905, when a scheme was discussed to divert part of the monsoon flow of the Mahanadi river, to irrigate wet-season (*kharif*) crops. The project began supplying water in 1915 and was completed in 1925. In the Chattisgarh region, local self-government had a long history. So the Panchayat idea was spontaneously developed for the local distribution of canal water.

2. THE PROVISIONS OF THE MADHYA PRADESH IRRIGATION ACT

The Madhya Pradesh Irrigation Act, 1931, defines the functions and powers of IPs. An IP is established for every village or *chak*, and at the discretion of the Collector, for a group of villages in the command area of the canal. Such Panchayats consist of a *sarpanch* and two or more members elected by the permanent holders and occupiers of the land from among themselves. Elections are subject to approval by the Collector, who can nominate one member of any Panchayat and, with written justification, dismiss any member and to dissolve any Panchayat subject to an appeal.

The IPs:

(a) assist the Irrigation Department in the construction of water-courses, in recording and checking irrigation, and in settling disputes;

(b) collect irrigation revenue and remit it to the treasurer; and

(c) arrange for the maintenance and repair of water-courses.

Fines can be levied by the IP for default on maintenance duties, water rates, damage to structures and illegal use of water. Money collected must be spent by the IP, on irrigation or on any public work in the village, with the collector's approval.

An agreement may be made between the state government and the permanent landowners for the supply of water for irrigation. This may be either short (less than a year) or long term, at rates fixed by the state government. The short term agreement can be cancelled by mutual consent with a minimum of two-thirds majority. The Superintending Engineer may, after giving notice, cancel an irrigation agreement if irrigators fail to maintain their water courses in proper repair. However, the Act does not clarify whether the state government can cancel an irrigation agreement for non-payment of water charges.

IP officials are remunerated for responsibilities through commission:

(i) For revenue collection, at the rate of 3% for the first Rs 1000 of canal revenue collected, and 2% for all sums in excess of this amount collected;

(ii) For administrative work, for which the maximum sum payable is Rs 0.2 per ha assessed or irrigated.

A weak link of the Act is that water rates are payable on land under agreement, whether or not it has been sown or irrigated. Most conflicts and complaints which arise in IPs are due to inadequate water supply. Nevertheless, the Act forbids claims for compensation against the government for loss arising from either inadequate or excess irrigation water.

How justifiable is this? The emphasis is on powers of the authority, rather than on execution of its duties. Users have no say, and have been given no opportunity to debate this Act. A considerable percentage of annual collections may fall in this 'pay - even if you do not eat' category.

Not all villages in the Mahanadi Command Area form IPs and arrange agreements, because water supply is inadequate. For example, in Mahanadi Head Works Sub-Division, while irrigation was designed for 138 villages, 26 villages stayed out of agreements due to poor water supply. There is very little growth in the number of IPs in the last decade, and the data shows that not all IPs renew their agreements, probably for the same reason. However, more than 96% of the villages under Mahanadi Command Area have formed IPs, and 99% of the total IPs were functioning in 1990. Their performance in terms of water distribution, water revenue collection, and in resolving conflicts varies. There is no readily available data to assess this performance.

The average number of elected members (3.3) per IP is static over the years. The total area under IPs in the Mahanadi Command Area varies between 445,000-460,000.

Change has been experienced in annual water revenue collected and thus in commission paid to IPs. At command area level, collections have reduced to 11% of target (1989-90) from 53% (1986-87). At the head-works division, collection has deteriorated badly, falling to 20% from as high as 94% in 1987-88, and 106% (including arrears) in 1985-86. In Telansatti village collections gradually declined to 5% from 73% in 1984-85, and 90% in 1986-87. These trends appear all over the Command Area. Unlike previous fluctuations attributed to natural calamities, present problems stem from political motives to waive the arrears. During the 1989-90 elections, two major political parties assured the waiving of farmers debts, including irrigation charges, in their manifesto. The decline in water rates collection also reflects drought conditions in 1988-89 and 1989-90. Nevertheless, the trend is to postpone payments and hope debts will be waived in the next elections. In 1989-90, arrears totalled Rs 365,000. Commission paid to IPs is low and declining over the years, from 3.32% in 1983-84 to 2.78% in 1986-87, suggesting few IP officials now collect revenues over 1000 Rs.

The irrationality of low commissions for IPs can be demonstrated hypothetically. If the Department appoints a waterman for the present functions of IPs at the rate of Rs 20 per day, for eight months, in 736 IPs, it totals Rs 35.32 lakhs. This is 22% of the annual target of water revenue and constitutes 43% of the actual annual collections of 1983-84 and 1986-87 respectively. IPs, however, are paid only 2-4% of the actual annual collection. At the elected member level, the commission received for their work does not even match 3-5 days wages fixed at government daily rates.

However, both field level and supervisory officials of the Department, whole-heartedly accept and support the pivotal role being played by IPs: they take responsibilities in water distribution and maintenance below the outlet; the IPs resolve conflict; they assist in collection of water revenue, which without IPs is very difficult for the Department; manpower requirement has been reduced considerably: 736 watermen, for eight months a year, with goverment fixed wage rates, would be otherwise required; and the Department has an easy contact point in the *sarpanch*, reducing time in the field.

However, the Department does not seem to be serious about collection of arrears. In 1986 a scheme was launched to encourage better performance from both IPs and field officials by providing a 'best performance' award if water revenue collection is 100%. Field officials were supposed to get an appreciation certificate if collection is more than 90% in their jurisdiction. There was a major response. Upper Mahanadi sub-division alone in 1986 collected Rs 10,003,000, three times more than the normal collections. A head-works sub-division totalled Rs 2,750,000 during the same year. Around 40 IPs won the award. However, field officials did not receive certificates.

On withdrawal of the scheme after one year, head-works sub-division's collection dropped by four and a half times, and there was widespread disappointment among field officials. Why was the scheme withdrawn? Senior officials of the Department felt the scheme affected routine work of field officers, including the canal Deputy Collector, Sub-engineers or Section officers, and the *Irrigation Amin*, who controls water distribution. Field officers, however, disagree with this analysis. Insufficient evidence was available to determine whether field officers work was affected or not.

3. A FIELD STUDY OF PROBLEMS

Three IPs, located at different distributaries, were selected for field observations, including a good, bad and average example based on sub-divisional officer's guidance.

Telansatti Village formed its IP in 1968, with an agreement for 574 acres and 190 voters. The original design had only five outlets in the village, but due to distribution and drainage problems farmers carved out two more outlets. This initially facilitated flow, but after some time only three outlets could get water. The remaining four outlets are now dry most of the time. One of the local sub-minors is old, unlined and not properly graded for gravity flow. Repeated requests for assistance made by farmers through the IP have not yielded results. Farmers were unable to mobilise sufficient money for repairs.

Each family contributes one person's labour for one or two days *shramdan* to clean the field channels. The *sarpanch* estimated the work of *shramdan* is worth nearly Rs 4000 per year. The farmers have practised this maintenance since the IP began.

The *sarpanch* maintains a register of all transactions related to the IP. He purchased the register with his own money. The previous *sarpanch* issued plain paper receipts and used the money for personal expenses. The farmers complained to the District Collector, who held fresh elections to appoint the present *sarpanch.* Since then printed receipts have been provided for water fee payments.

All farmer-voters meet before the *kharif* season to decide water requirements and timing. Paddy is the main crop in the *kharif* season. In the *rabi* (dry season) season, only some farmers opt for fodder or pulse production. Farmers using groundwater irrigation, harvest two crops per year.

The IP, with village agreement, has appointed three *banihars* (water guard), one for each of the three minors serving a total area of 573 ha. A *banihar* earns approximately Rs 5 per ha for water distribution in his jurisdiction. He requests help from farmers during a crisis, to personally supervise irrigation of their fields. The *banihar* forms a group of farmers during the crisis to supervise, in shifts, the smooth flow of water at the head reach.

Dandesara Village got irrigation facilities in 1962, followed by the formation of the IP, with an agreement for 263.50 ha, and a membership of 168. The village has a total of 650 ha of agricultural land, and a population of 1100.

The *sarpanch* has been in post for the last five years. Unusually, both the *sarpanch* and one committee member are under 35 years old. The *sarpanch* has a small shop and trading business as his main occupation, leaving little time to supervise water distribution. He is emphatic about the poor incentive of low commission to do his work, and collection of water revenue is falling each year. The *sarpanch* did not volunteer but was chosen through a lottery method after the death of his predecessor. The IP feels arrears should be collected by the Department.

Dandesara village has lower water fee collection and less cooperation from voters than Telansatti village, and has not appointed *banihars*. Farmers manage water distribution individually. Efforts were made, particularly by tail-enders, to appoint *banihars*, but the head reach farmers would not agree to pay *banihars*' fees. The *sarpanch* and one member, being young, were unable to resolve the conflicts. The main problems are unlined canals, high water travel time, seepage losses, land levelling, and tail-ender problems.

Chhati village has a comparatively larger area of 1717 ha under agreement. The IP was formed in 1962, by 656 voters out of a total population of 3000. The total agricultural area is 2200 ha. Here the *sarpanch*, elected in 1962, retained his position till 1984 by members' demand. This long-established *sarpanch* made a habit of visiting fields to check the water distribution, and continues as a member. His impartiality, service-oriented philosophy and helpfulness, led to his long term position as *sarpanch*. Today he is worried about the sorry state of affairs in IPs, observing the decline in public-spirit and the way dissatisfaction at low commission influences the actions of elected members. This retired *sarpanch* is even against increasing commission. This may be because Chhati village, being larger, generates comparatively more commission. *Banihars* are not appointed, as the *sarpanch* reasons he can supervise water distribution together with the farmers.

Farmers' Evaluation of IPs

The *sarpanch*, elected members and voters of all three IPs were consulted during field visits. All support the important role being played by the IP, and see it as a major local institution. The following discussion summarises their main points.

Water supply is not fully assured. In spite of having only one-season irrigation per year, most conflicts are due to inadequate water. Old and unlined canals intensify this problem. Necessary on-farm development works were not carried out in any of the villages observed, and improved methods of irrigation were not taught. IPs also need support with other inputs. Presently, distance to sale outlets, and non-availability of agricultural inputs on time, limit farmers' returns. Production losses are claimed to be a contributory factor to defaults in payment.

The *kharif* cropping pattern is dominated by paddy. A small area is cultivated in *rabi* for wheat, pulses, and fodder crops, but most lands are kept fallow, unless farmers have access to groundwater. Generally, paddy is broadcast giving lower yields. The impact of the Training and Visit (T&V) system, demonstration plots, 'lab to land' programmes and other agricultural extension schemes are minimal, with farmers hardly aware of such efforts. There is little crop diversification. However, in recent years, about 10% of the rice crop is transplanted from seedlings grown in nurseries where water is assured (high yield varities [HYVs]) that give an average of 2.9 tonnes per ha, while local varieties yield 1.8 tonnes per ha.

Present water rates (Rs 32 per acre paddy) are thought to be just right, but could be increased slightly, if the money was spent on improving water courses and lining canals by the Department. The IPs could share expenditure incurred on improving the canal system, but would need to pay in installments.

Collection of arrears is irregular. However, the IPs feel it should be "collected in a strict manner by the Irrigation Department". If necessary, the IP committee can cooperate with the Department in this, but cannot handle all the arrears problems for social reasons. Additional (legal) powers are required to collect arrears, deal with defaulters, and resolve conflicts. These are difficult to use in a close-knit, village society where one cannot, even as an elected member/*sarpanch*, act as a policeman. What is needed is mutual understanding and a persuasive capacity, backed regularly by Department officials.

The IPs' commission ranges from 1-4%. At this rate, an elected member gets less than three days wages (as per government norms), in return for duties on and off for 240 days, of which 60 days in January-March are intensive. Thus, all three IPs want an increase in their commission. The annual commission received of Rs 0.2 per ha is equivalent to 2% of the annual total collection. It has not been changed since the British period, while irrigation water rates have increased thirteen fold in the same period.

4. PROSPECTS FOR IMPROVEMENT THROUGH REHABILITATION

Most of the canal structures in the existing areas of Mahanadi Command Area require rehabilitation. Any substantial increase in peak canal discharge or change in canal cross sections will make structures even more unsuitable for further service. Canal modernisation and lining is in progress. Under the World Bank assistance and guidelines, the Department has further developed the command area, by constructing a micro-distribution network (*disnet*) from 40 ha down to 8 ha *chaks*. Previously, cultivators obtained water by field to field irrigation beyond the outlets. In the *disnet* development, delivery of water is extended to conveyance channels by constructing water courses within the outlet command. A sub-minor is constructed for a 40 ha *chak*, which starts from the outlets of minor. This 40 ha *chak* is further divided into sub-*chaks* by constructing turnouts for individual sub-*chaks*. A 14,810 ha area is identified for *disnet* development under the Mahanadi Feeder Command Development. It is proposed to include lining work in the *disnet* development down to the 8 ha level for an area of 1500 ha.

A President is to be elected for each sub-*chak* and *chak*. The President elected at *chak* level ***has to be a tail-ender***. However, this approach may change the jurisdiction of earlier IPs, using a hydraulic boundary approach where previously boundaries were hydraulic or administrative. The initial appraisal reports by the World Bank in 1981 did not make clear reference to the IPs, even though these were long-standing local institutions.

At the time of the field visit, the Rotational Water Distribution Schedule had just begun in a pilot site. As schedule, based on landholding size, is prepared, showing the date and time of water deliveries to each cultivator. Water travelling time, at the rate of 5 minutes per turnout, and thus 2 hours per week as calculated by farmers, was added to the schedule.

However, under the new *disnet* development, problems persist. Compensation has not been paid to owners for land utilised for the construction of minors and sub-minors according to an official. Hence, deprived landowners frequently agitate and demolish the structures. A Department circular has indicated it does not intend to pay any compensation!

5. SOME POLICY ISSUES

There is a growing recognition that farmers' organisations and their active participation in water management will improve irrigation performance. The organisation and participation may be in a number of ways and at different levels. In this case study IPs at village level have three main tasks: (1) water distribution; (2) collection of water revenue; and (3) resolving conflicts. Observations indicate that farmers' emphasis is on the first activity.

A major policy issue for IPs is whether to retain their present form and functions, which have existed for five to six decades and have almost become customary. The priority should be to build on existing IP structures with some modifications.

Organisationally, existing IPs remain as individual units, with hardly any horizontal or vertical integration. This creates problems, particularly during crisis periods, such as droughts, when there are standing crops. In the past, police action has been necessary to maintain the distribution system between Panchayats.

One or two sub-minor or distributary-based organisations may start on an experimental basis. A group of these organisations can form two or three tiered vertical structures of an overall organisation with an apex body to exclusively handle IPs. The outlet committees, though essential, cannot fulfill the role of this broad organisational structure alone: as a small entity, they can play useful supportive roles.

The present commission incentives do not evoke sufficient interest among the elected body to encourage an active role. In addition to increasing the commission percentage, the *sarpanch* and members should be provided with all books and formats to maintain the necessary accounts. Presently, most of the records are maintained informally.

The IPs function of water distribution remains below the outlet. Irrespective of the number of outlets in a village, the village boundary is an administrative area, rather than a hydraulic boundary. It is desirable, for successful function, to broaden the adminisation boundary on hydraulic lines but keep it linked to meaningful social boundaries, e.g. one organisation for one sub-minor or distributary, based on farmer's consent.

Local organisations, based on hydraulic or social boundaries, should also have a multi-purpose role in order to influence farmers' participation. The organisation should provide seeds, fertiliser, and pesticides, and coordinate with credit and marketing institutions. This supportive role can contribute to controlling spiralling defaulting of water payments. It also helps to earn support, rather than demand, for various tasks of the organisation. Instructions from the bureacracy are less likely to be sustainable, or supported, than those from a well-structured farmers' organisation, as is evident from other irrigated areas.

In Kerala, the prevalence of small holdings probably encourages farmers in group action for procuring inputs and services. The agricultural division in the Command Area Development Authority trains members of farmers' organisation committees to handle their responsibilities. It also takes them to neighbouring states to show working farmers' organisations. Even in a dry-land area, as in Karimnagar in Andhra Pradesh, the Mulkanoor multi-purpose cooperative society is managed successfully by farmers. This supplies inputs and assists in marketing agricultural produce, besides other activities. The farmers' organisation in the 'action research' area (Thirivaroor) of the Irrigation Management and Training Institute, besides training in water distribution, lends pesticide sprayers, arranges seeds distribution, and plans to purchase a tractor for individual hire. On members' demand, it constructed a threshing floor for paddy. The successful lift irrigation cooperatives in Maharashtra maintain their own book-keeping quite professionally. They also arrange bank loans if necessary, and adhere to bank repayment schedules.

IPs in the MCA need organisational restructuring. Intensive training should be provided for IP committee members on their role and responsibilities, organisation structure, interaction with other IPs, the conduct of meetings and use of information from the membership, decision-making processes, and interaction with the Department and its personnel. There are advantages in developing a structure of IPs leading to a project level committee. Over a period of time there should be opportunities to upgrade skills and handle larger issues. There could be experimentation, with farmers' consent, with irrigation organisers appointed as catalysts. If the Irrigation Department and Agricultural Department can spare interested assistant engineers to act as village level workers, they may play a catalyst role after intensive training. Overall monitoring of this process should be with an autonomous body, maybe an NGO to begin with, at every minor level (a group of IPs).

Later, at distributory level, there should be a memorandum of understanding with the Department regarding water delivery, water revenue collection, regular operation and maintenance, proportionate commission as against revenue collection, regular elections to IP committee, powers to procure and distribute inputs, and to handle on-farm development works. These types of memorandum are being used in Maharashtra, Tamil Nadu, Bihar, and Gujarat at present. In Madhya Pradesh, there is only a people's organisation at the bottom (IP) and a bureaucratic body (collectors office) at the top, with poor linkages. In the collector's office, IPs do not necessarily have priority. People dealing with IPs may not even be professionally trained for the job. Little effort has been invested in reviving the IPs or training them for its improved function.

As important as evolution of ideas and programmes, is political support for change, both at high and at local levels. Once a programme is launched its continuation and further evolution depend on recurrent inputs and ideas.

A state-level workshop was held in February 1991 on 'farmers' organisations', at the Water and Land Management Institute, Bhopal. This made a number of general recommendations on the role and needs of IPs, and practical recommendations for the project, which reflect many points raised in this paper. Further details are given in the original paper, which is available from the author. We hope 'follow-up' on these recommendations can be reported through the Irrigation Management Network in the future.

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EVALUATING IRRIGATION SYSTEM PERFORMANCE WITH MEASURES OF IRRIGATION EFFICIENCIES

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EVALUATING IRRIGATION SYSTEM PERFORMANCE WITH MEASURES OF IRRIGATION EFFICIENCIES

Leslie E Small

1. INTRODUCTION

In many developing countries huge investments in irrigation have been made over the past three decades. These investments, in conjunction with new agricultural technology in the form of fertiliser-responsive varieties, have helped fuel significant increases in agricultural production over this period of time. Even so, a widespread perception exists that irrigation projects typically perform far below their potential. This has led to many operational interventions and research activities designed to diagnose problems and remedy deficiencies.

In spite of the considerable efforts that have been made to improve the performance of irrigation systems, there is surprisingly little agreement on how this performance should be assessed. Disciplinary biases are often evident in the choice of performance measures. Some social scientists place considerable emphasis on the nature and extent of farmer participation in irrigation decisions. Economists are likely to approach the problem through some form of benefit-cost analysis. Agronomists may focus on production, while engineers often focus on irrigation efficiencies.

Small and Svendsen (1990; 1991) have developed a conceptual framework designed to establish a context in which the great variety of different approaches to irrigation performance assessment can be understood and related to one another. This framework takes a systemic viewpoint, in which irrigation is considered to be a system operating within broader agricultural and socio-political systems. Within this framework, performance measures are categorised according to whether they focus on the irrigation system's internal *processes* (in which inputs are transformed into outputs), on its *outputs* (the amount, timing, uniformity and quality of water delivered to the fields and provided to the root zone of the crops), or on the system's *impacts* on the larger agricultural and socio-political systems in which it exists. The framework also distinguishes between *achievement* measures of performances, where the focus is on some desired output or outcome, and *efficiency* measures of performance where desired outputs or outcomes are related, usually in the form of a ratio, to certain inputs (Small and Svendsen, 1991).

In addition to categorising the types of performance measures, Small and Svendsen emphasise the importance of normative standards in the assessment of irrigation performance. Regardless of which type of assessment measure is chose, evaluation of performance can only proceed when it is possible to compare the observed value of the performance indicator against some standard that is established for the indicator. All such standards are derived from explicit or implicit value judgments. as a result, value judgments are an inherent part of all assessment of irrigation performance.

Indicators of irrigation efficiency comprise one set of performance measures commonly used, particularly by agricultural scientists and engineers. An irrigation efficiency measure of performance relates the output of irrigation water at some place in the system to the input of irrigation water at some other place[2]. Irrigation efficiency is thus considered to be "a parameter to assess the performance of irrigation water use from a water conservation perspective" (Bos and Wolters, p 268). Furthermore, because it is a ratio of water outputs to water inputs, it is often considered to be a "technical" measure of efficiency (Hillel, 1990, p 27). As such, irrigation efficiency is often presumed to be free of the kinds of social value judgments that underlie concepts such as economic efficiency. This is, perhaps, why it is sometimes seen as a more appropriate or "objective" indicator of irrigation performance.

But "technical" efficiency measures also utilise value judgements and standards. The statement, quoted above, relating irrigation efficiency to "a water conservation perspective" implies a set of broad value judgments associated with conservation. Furthermore, a careful examination of the concept of irrigation efficiency reveals the existence of several specific value judgments and standards, some of which have important implications for the

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[2] There is some confusion in the literature over the use of the terms "irrigation efficiency" and "water use efficiency". The two terms are sometimes used interchangeably in the physical engineering sense of a ratio of water outputs to water inputs (see, for example, Heermann et al., 1990, pp 132-133). Generally, however, the latter term is used in a very different biological sense to indicate a ratio of crop production outputs to water inputs (Hillel, 1990, p 27; Howell et al., 1990, p 94; Jensen et al., 1990, p 48).

use of irrigation efficiency as a performance indicator. These value judgements and standards are of two types: those embodied in the very definition of efficiency itself, and those used as normative "yardsticks" against which empirical measurements of efficiency can be compared. It is the purpose of this paper to examine critically these two categories of value judgments and standards with respect to their implications for the use of irrigation efficiency as an indicator of irrigation performance.

2. VALUES AND STANDARDS EMBODIED IN THE DEFINITION OF IRRIGATION EFFICIENCY

Measures of efficiency are never simply measures of total outputs to total inputs. The laws of thermodynamics imply that for any system, total outputs must equal total inputs. Efficiency becomes a meaningful concept only when it compares *useful* or *desirable* outputs to inputs. All efficiency measures, including those considered to measure efficiency in some "technical" sense must therefore incorporate explicit or implicit value judgments associated with the identification or definition of "useful outputs".

In their definitive work on irrigation efficiencies, now in its fourth edition, Bos and Nugteren (1990) define three irrigation efficiency measures (application efficiency, tertiary unit efficiency and overall or project efficiency) that incorporate a common measure of useful output: the "volume of irrigation water needed, and made available, for evapotranspiration by the crop to avoid undesirable water stress in the plants throughout the growing cycle" (p 18). At least three value judgments are involved in this definition.

First, implicit in the definition is the value judgment that *all* water provided for evapotranspiration (with the exception of any water in excess of the amount that would be needed to prevent undesirable water stress) is a useful output of an irrigation system, regardless of the ultimate impact that this water has on crop production. Given this definition, it is, as Hall has noted, "entirely possible always to irrigation with an application efficiency of 100% and still fail to grow a decent crop" (1960, p 75). Even in the extreme case of a crop that fails to produce any economically useful output because of severed water stress, most or all of the irrigation water delivered, having been used for evapotranspiration by the failed crop, would still be considered to have been a useful output. For this situation one might suggest, as an alternative and perhaps more intuitively plausible value judgment, that the irrigation water had been wasted.

This is not to say that this particular value judgment implied in the definition of irrigation efficiency is "wrong" or "bad", but rather to note its existence, and its somewhat peculiar and counter-intuitive nature. As in the medical situation suggested by the old saw that "the operation was a success, but the patient died", a failure to fully comprehend the value judgments involved in "technical" measures of performance easily results in misleading interpretations.

A second value judgment implicit in the definition of irrigation efficiency is that *only* irrigation water used for evapotranspiration is part of the "useful output" of the irrigation system. Yet in addition to supporting evapotranspiration, irrigation water plays many other useful roles in the sense that it creates value to the irrigators and to society. This is perhaps most obvious in the frequent case of irrigated rice grown under flooded conditions. Flooding of the fields, which results in such non-evapotranspiration uses of water as lateral seepage and deep percolation, can affect rice production through its effects on the physical and chemical properties of the soil, and on fertilisers and pesticides incorporated into the soil. In regions where temperatures are high, continuously flowing irrigation water may increase yields by reducing soil temperature (De Datta, 1981, p 322). Water may also substitute for mechanical or chemical means of weed and pest control (ibid., pp 300, 314). In many areas, water also plays an extremely important role in land preparation. By softening soils that have become hard during a dry season, water often substitutes for mechanical power in land preparation. Water used to facilitate land preparation often accounts for roughly 40% of the total amount of water used to produce an irrigated rice crop (IRRI, 1978; Wickham and Sen, 1978).

Water may also create value in its roles in the transport of those water molecules that are actually used for evapotranspiration. In irrigation channels, for example, water may substitute for certain types of costly conveyance structures or improvements, such as closed pipes or lined channels. On individual farm fields, water may substitute for land levelling with the result that in order to flood the higher parts of a field, lower areas are flooded to a greater depth than would otherwise be necessary.

Water thus creates economic value in a variety of ways that are arbitrarily excluded from the "useful output" identified by the commonly-accepted definition of irrigation efficiency. The definition's narrow linkage of the concept of useful output to the biophysical process of evapotranspiration represents only one of many possible value judgments that could be used. The advantage of this value judgment is that it ties the concept of efficiency to biophysical ("technical") processes that are the same throughout the world. The disadvantage, however, is that it ignores much of what makes irrigation water valuable[3].

One alternative value judgment would be to consider all water that creates any positive economic value in the production process to be a "useful output" of irrigation. Under this definition, irrigation water would be considered useful as long as the value of its marginal product were greater than zero. Another alternative value judgment would be to limit the concept of "useful output" to water for which the value of the marginal product is greater than its marginal cost. Both of these alternatives would move the definition of irrigation efficiency in the direction of systematic incorporation of economic considerations.

A third value judgment implicit in the definition of the useful output of irrigation as the "volume of irrigation water needed, and made available, for evapotranspiration by the crop to avoid undesirable water stress in the plants" involves the meaning given to the phrase "undesirable water stress". This phrase, in fact, opens the door to the possibility of excluding some of the water used for evapotranspiration from the definition of useful output. But what is to be excluded depends on one's perspective regarding "undesirable water stress".

Somewhat surprisingly, those who incorporate this phrase in their efficiency definitions (Bos and Nugteren 1990; Heermann et al., 1990) provide no

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[3] Although Boss and Nugteren's (1990) linkage of "useful output" to crop evapotranspiration is consistent with fairly widespread usage (see, for example, Hillel, 1990; Stewart and Hagan, 1973), the American Society for Civil Engineers has developed a broader definition of irrigation efficiency that incorporates, in addition to evapotranspiration, water used for leaching to maintain a favourable salt balance in the soil, water used to protect the crop from frost or from excessive heat, and water used in the process of applying fertiliser or pesticides (American Society for Civil Engineers, 1978 as cited in Heermann et al, 1990, pp 132-133). But by arbitrarily incorporating only a small subset of the many non-evapotranspiration uses of water which create economic value, this broader definition would seem even more problematic, having given up the advantage of the narrower definition that is limited to biophysical processes that are the same throughout the world, while still sharing with that definition the disadvantage of ignoring many ways in which irrigation water creates economic value.

discussion of its meaning[4]. It is clear, however, that different meanings, each reflecting different value judgments, could exist. One might, for example, consider stress to be undesirable only as long as it causes a reduction either in the total dry matter production of the plant (a value judgment based on biological considerations) or in the production of the economically useful portion of the plant (a value judgment based on a combination of biological and economic considerations). From either of these perspectives, water used for additional evapotranspiration associated with zero or negative changes in production would be excluded from "useful output"[5].

Another possibility stems from the recognition that many plants can tolerate small amounts of water stress with minimal negative effects on production. Agricultural scientists sometimes identify a critical soil moisture content level for a corp. As long as soil moisture does not fall below this critical level, the stress on the plant has a minimal effect on evapotranspiration, and thus on yields. But if the soil moisture falls below this critical level, a sharp negative effect on both evapotranspiration and crop yield can be expected (James, 1988, pp 4-6). Although the concept of critical soil moisture content is based in biological considerations, economic value judgments also come into play in the actual delineation of this level in any given situation. It has been suggested, for example, that the critical soil moisture level should be set at

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[4] Although they do not discuss the meaning of this phrase, Bos and Nugteren (1990) include an appendix in which they give an example, based on the actual questionnaire data they collected under an international survey, of the calculation of irrigation efficiencies. The numerator for their efficiency calculations (i.e the "useful output" of irrigation), is calculated to be equal to the crop's total "consumptive use" of water - which is essentially the same as total evapotranspiration (James, 1988, pp 9-10) - minus an adjustment to reflect the contribution of rainfall. The calculations thus ignore the possibility, incorporated into the author's definition of irrigation efficiency, that an excessive amount of water could be used for evapotranspiration.

[5] Because yields are generally considered to rise linearly with evapotranspiration (ET), reaching a maximum at a level often referred to as "ET_{max}", the idea that ET could increase even after yields had reached their peak might appear to be incorrect "ET_{max}" is not actually defined as the maximum possible ET, however, but rather as the *minimum* ET associated with maximum yields (Stewart and Hagan, 1973). For example, in experimental treatments where irrigation was deliberately designed to be excessive, Steward and Hagan observed the actual ET to exceed, by 25 mm, the ET at which yields were maximised. Accordingly, the empirical value that they assigned to "ET_{max}" was 25 mm less that the maximum ET actually observed.

higher levels in situations where "market conditions require the highest possible yield per land area" (ibid, p 6).

If one accepts the idea that water stress is not undesirable in situations where it causes only a very small decline in yields, then economic factors come to the fore in the precise determination of this optimal level of stress. A farmer who must purchase irrigation water under a volumetric pricing system, for example, would consider the optimal amount of stress to be that which equated the value of the marginal production of irrigation water with its price[6]. "Undesirable water stress" would thus exist in any situation in which the value of water's marginal product exceeded its price. One implication of the use of this economic value judgment in defining "undesirable" stress is that irrigation efficiency could not be determined independently of such economic considerations as crop prices and the prices of water and other production inputs.

More generally, the operational definition of "undesirable" plant stress would need to reflect judgments that involve an effort to balance considerations about the value of the crop loss prevented by irrigation, on the one hand, with those about the cost of providing the amount of irrigation water required to avoid that loss, on the other. This leads directly to the economist's definition of undesirable stress, namely, stress such that the value to society of the marginal product of water exceeds society's marginal opportunity cost of providing and applying the water. Such a definition implies, however, a concept of irrigation efficiency that would hardly be considered to be a technical concept.

It thus appears that if irrigation efficiency were to be defined as a "technical" measure that could be determined independently of economic values, it would have to be based on the qualitative biological relationship between water and crop production. This implies that for the purpose of defining irrigation efficiency, water stress leading to *any* reduction in production, however tiny, would have to be considered undesirable. Although there would be nothing inappropriate about the use of this value judgment, it should be recognised that it implies a very narrow and specialised meaning for the term "undesirable", and that most irrigators, as well as those who operate irrigation systems, probably have rather different operational definitions of "undesirable water stress".

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[6] In fact, however, as discussed by Small and Carruthers (1991) farmers rarely pay for irrigation water on this basis.

3. STANDARDS USED TO EVALUATE MEASURED IRRIGATION EFFICIENCIES

If irrigation efficiencies are to be used to assess irrigation performance, it is important that some type of performance standards be identified against which empirical measurements of irrigation efficiencies in actual irrigation systems can be compared. In the complete absence of standards, it becomes impossible to evaluate the performance implications of any particular measured irrigation efficiency. As with the case of value judgments discussed in the previous section, standards may be either explicit or implicit.

One of the greatest dangers in the use of most efficiency measures of performance is the tendency to use an implicit standard of 100% efficiency. Even though one may recognise that 100% efficiency is unobtainable, it is easy to assume that the closer an observed efficiency is to 100%, the better. This is the trap of the implicit efficiency standard.

It is particularly easy to fall into this trap in the case of irrigation efficiency, which, as noted at the beginning of this paper, is a performance parameter reflecting a water conservation perspective. Superficially, it would seem that from this perspective, more conservation (i.e higher efficiency) is better. That this is not necessarily true has long been recognised by agricultural experts, who are aware that high efficiencies may simply reflect situations where water shortages are severe and yields are extremely low (Hall, 1960). The value judgments implicit in the water conservation perspective involve the desire to "save" water while simultaneously using it to produce an agricultural crop; therefore, an irrigation system that operates in ways that conserve water but lead to crop failures cannot be considered to be performing well.

Once it is recognised that the implicit irrigation efficiency standard of "more is better" is not appropriate, the importance of defining explicit standards becomes evident. It is difficult, however, to find any examples of carefully defined efficiency standards. In part this may reflect the fact that irrigation specialists have not always recognised the problem of the implicit efficiency standard. For example, one writer states that it has been proven that an irrigation efficiency of 90% is "possible" with "proper management", and that therefore there is much room for improvement for most irrigation systems (Hillel, 1990, p 28). This is basically just another version of the implicit efficiency standard: a version that recognises the near impossibility of attaining 100% efficiency, and replaces that figure with a modestly lower one that is arguably attainable. It is very doubtful, however, that a 90% standard for irrigation efficiency is appropriate for most irrigation systems. Efforts to achieve such a standard could generally be expected to involve much economic waste.

But the failure of most irrigation experts to carefully define explicit irrigation efficiency standards reflects an additional complexity regarding the use of irrigation efficiency as a measure of performance. The problem is that efficiency standards for acceptable performance would need to vary according to a large variety of conditions. For example, because of all the useful non-evapotranspiration functions of water in the case of flooded rice production, irrigation efficiency standards for systems supporting rice production would generally need to be lower than standards for systems in which crops are grown under non-flooded conditions. A host of other considerations, not all of which are easily identifiable, would also affect the standards to be used. Examples include project size, abundance of irrigation water relative to the irrigable area, extent of opportunities for re-use of drainage water, soil texture, extensiveness and nature of control structures in the main canals, climate, and method of irrigation (sprinkler, flooding, furrow, drip, etc)[7]. The task of developing explicit standards that are useful and appropriate for all of these varying situations is daunting indeed. Ultimately, one might conclude that separate standards are needed for each individual irrigation project.

In the absence of specific performance standards for irrigation efficiency, it may still be possible for experienced irrigation experts to make informed judgments about whether the efficiency of a given project is above, below or somewhere near some vaguely-defined notion of a desirable level. They can do so, however, only by taking into consideration a substantial amount of additional information beyond the data on irrigation efficiency.

This need to take other information into consideration highlights the key limitation of irrigation efficiency as an indicator of irrigation performance. Irrigation efficiency by itself is a descriptive, not a prescriptive measure. It is not possible, in the absence of further information, to judge whether an

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[7] The need to incorporate these factors in the efficiency standards is merely a reflection of the fact, discussed in the previous section, that the traditional definition of irrigation efficiency involves a concept of "useful" water output that arbitrarily excludes many functions of water that create economic value. The problem would be eliminated if all truly "useful" functions of water were included in the definition of irrigation efficiency.

irrigation system performing at X percent efficiency is performing well or poorly. Because the measures of irrigation efficiency is affected by many different factors, no single useful performance standard can be set.

It is sometimes suggested that standards, rather than being based on some "desirable" conditions, could be based instead on the average actual performance of some group of irrigation projects. Assuming an appropriate group of projects against which the irrigation efficiency of a given project is to be compared (e.g a project designed to irrigated flooded rice in a semi-humid region compared with a group of projects with these same characteristics), some useful descriptive information may be provided with the use of such "relative" standards. Even in this case, however, the standards are only descriptive, and cannot be used in a prescriptive sense.

The inability to use irrigation efficiency standards in a prescriptive sense can be illustrated by a simple example. Assume a situation in which irrigation efficiency is 40%, but could be increased to 50% either by lining canals or by modifying operating procedures, and could be increased to 60% by doing both. Without examining the economics of each of these alternatives, it is impossible to say whether it would be desirable to undertake either or both of them. Only after the economic analysis had been undertaken and the optimal alternative(s) identified would it be possible to determine a desirable efficiency standard. Such a standard would thus describe or reflect the efficiency implications of the results of the economic analysis of the alternative courses of action. It is the economic analysis that prescribes the appropriate course of action, which in turn defines the efficiency standard.

Irrigation efficiency may have utility because it can be defined in ways that make comparable calculations possible regardless of the nature or location of the irrigation system. But the impossibility of developing standards that are independent of other considerations severely limits the usefulness of irrigation efficiency as a measure of irrigation performance.

4. CONCLUSIONS

Measures of irrigation efficiency represent one set of indicators that may be used to assess the performance of irrigation systems. Irrigation efficiencies are arguably the most widely used performance measures among many irrigation specialists. Although such measures are sometimes considered to be "technical" and therefore free of value judgments, both explicit and implicit value judgments are involved in using them to evaluate irrigation system performance.

Because the value judgment inherent in the very definition of irrigation efficiencies do not incorporate many of the values that those wishing to evaluate irrigation systems consider to be important, it becomes necessary to account for these values in the efficiency standards that are established as "yardsticks" against which actual efficiencies are to be compared. Standards appropriate to the assessment of performance of one irrigation system may thus differ significantly from those appropriate for the assessment of another. This reflects the fact that irrigation efficiencies are descriptive parameters. They provide certain information about the pattern of water use within the system. But because they cannot provide the information that would be needed to determine the optimal pattern of water use, they have limited usefulness as general measures for evaluating irrigation system performance.

The traditional definition of irrigation efficiencies is widely accepted and used. The discussion in this paper is not intended to argue that the definition should be changed, or the concept abandoned. Rather, its purposes have been to demonstrate the error of the view that irrigation efficiencies are technical, value-free measures of irrigation performance, to emphasise the nature and limitations of the value judgments incorporated, and to explore the implications of alternative value judgments.

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