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Small-scale irrigation in sub-Saharan Africa: sparse lessons, big problems, any solutions?

TONY BARNETT
University of East Anglia

SUMMARY

This paper identifies from studies made of specific schemes the major social and administrative problems confronting the improvement and extension of small-scale irrigation in Africa. The first section reviews the studies and notes the conclusions to be drawn from each separate one. Underlying these separate conclusions six general problems are identified and in the second section of the article each of these six is elaborated and discussed: the relation between the direct producer's benefit and wider social benefits; problems of control, commitment to hierarchy, the working of production units, and how to learn from farmers in respect of water use; and finally the general problem of how to plan for the further change that follows after irrigation is introduced.

This article is divided into two sections. In the first, the results of an extensive English language literature search and search for internal documents in various non-governmental organizations are discussed. The aim of this search was to identify what information was available and to draw some general principles from that information. In the second section, the implications of these general principles are explored at an even more general level in an attempt to identify the major social and administrative problems confronting the improvement and extension of small-scale irrigation in Africa.

1. THE AVAILABLE DATA AND ITS SPARSE LESSONS

In preparing this paper, a thorough English language literature search was undertaken to ascertain the availability of information. The Appendix indicates the 39 bibliographic and periodical sources which were examined. Overall there was a paucity of published references dealing with small-scale irrigation in general and on the social, psychological and administrative aspects in particular. There were even fewer references dealing with the problems of Africa. The criteria adopted for the literature search were as follows:

(1) *Regional*: Africa south of the Sahara.
(2) *Scale*: holding sizes of not more than 5 ha, or such as could be worked in principle with household labour supplemented by hired labour at peak periods.
(3) *Method of irrigation*: any method, but excluding very large-scale, centrally-controlled systems as far as possible.

Dr. A. S. Barnett is Senior Lecturer, School of Development Studies, University of East Anglia, Norwich, NR4 7TJ, U.K.

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A general rubric for the literature search was identification of contributions with titles such as 'Problems and policies concerning small-scale irrigation in X district or country'.

Most of the material identified looked at economic and technical aspects; few contributions dealt with social, psychological and administrative aspects either as a primary or subsidiary concern.

The lack of published information and its distribution over time can be shown by looking at the incidence of references to small-scale irrigation in *World Agricultural Economic and Rural Sociology Abstracts*. Between 1965 and 1970, practically nothing is reported on the subject of irrigation in general. The few reports concern U.K., U.S.A., India and Sri Lanka. The only African cases reported in this period are from Sudan and Kenya. In both these cases, attention is focused on large-scale irrigation, Gezira in Sudan and Mwea in Kenya. During the period 1970–1981, there is evidence of increasing concern with Africa, but most of this cites large-scale irrigation and settlement projects, and then it is the engineering, agricultural economic and agronomic aspects which predominate. *Overall then, little attention has been given to the subject in published matter.*

A further check on the availability of information was made by writing to a number of non-governmental and similar organizations. The response to these enquiries indicated that few such organizations saw themselves as involved with small-scale irrigation, and fewer still with small-scale irrigation in Africa south of the Sahara. There were two exceptions, one in Kenya, the other in Botswana.

In the end, the identifiably relevant and available sources which inform this paper are few and of very variable quality. They are listed in the References. The strong impression was formed, however, that there may be unpublished sources around, but if so these are scattered and difficult to obtain.

On the basis of the literature search, the following cases were examined. They were uneven in what they told of the social aspects of small-scale irrigation. They did, however, have the advantage of a fairly wide geographical spread. Listed by geographical area they are:

Zambia:	(a) Chiwefwe Mixed Farming Project, Mkushi District (b) other small-scale irrigation schemes in Central Province and the Copperbelt.
Senegal:	Various schemes in the area of the Société d'Aménagement et d'Exploitation des Terres du Delta du Fleuve Sénégal.
Tanzania:	(a) The Sonjo (b) The Chagga (c) speculation about the relation between irrigation and ujamaa.
The Gambia:	(a) Wasu irrigation scheme. (b) Saruja irrigation scheme.
Swaziland:	Vuvulane irrigated farms.
South Africa:	Taung irrigation scheme.
Nigeria:	Northern Nigeria: Yoba, Gwoza.
Zimbabwe:	S.E. lowveldt area, Chakowe Chisumbanje Sabi Valley peasant schemes.
Botswana:	Radisele area.
Kenya:	East Pokot agricultural project.

Zambia

(a) Chiwefwe mixed farm project, Mkushi district

The scheme was supposed to start in 1979, but was actually implemented in 1981. The delay arose because of protests from local people about the planned scheme. The foci of the protest were the following issues:

(i) The scheme was planned so as to remove the existing farmers and replace them with new 'emergent farmers' who would produce food crops for the urban sector.
(ii) Planners had unrealistic and unattainable expectations of what settlers could achieve - the settler household was expected to cultivate 16 ha of rain-fed crops plus 4 ha of irrigated crops with one pair of oxen.
(iii) Funding and organization of credit, marketing, inputs was not adequately considered by the planners.

An outline of the original conception of the Chiwefwe project appears in Table 1; the critical areas where the planners made unjustified social and economic assumptions are italicized.

An important feature of this scheme is that the site, originally an expatriate farm

Table 1. Summary sheet of the planning assumptions of original Chiwefwe project. (Italicized sections indicate unjustified planning assumptions.)

Land area	Irrigable land 80 ha Rainfed crops 320 ha Rough grazing 1250 ha
Settlers	* *Remove existing 29 families from site* * *Select 30 new settler families* * Each settler family has *16 ha* of rainfed land, 4 ha of irrigable land, and communal grazing rights * Settlers must possess oxen and *necessary equipment*, be *credit worthy*, have adequate *family labour*, have farming equipment, and be willing to join a co-operative * The holding will be *cultivated with* family labour and oxen although *some hire* of *tractors* and *casual labour* may be necessary * Each family will purchase 6 heifers and 4 milk calves *with credit*. This herd will supply work oxen * Each family will also own chickens to sell eggs and live birds
Profits	After 5 years *family profit* will be K7000 from crops. From crops and livestock it will be K9000. (Family profit is income after payment for inputs and hired labour but before payment of family labour and loan repayment)
Capital costs	Total capital costs are *K112,000*, i.e. *K5,600* per family
Support and inputs	Settlers will form *co-operative society*. This society will employ a full time manager to look after the supply of inputs, *necessary credit*, *marketing* and the maintenance of the scheme

K = Kwacha = £0.6
Source: Vincent (1981b)

of about 1780 ha, was not 'empty'. In fact 29 families were 'squatting' there. They consisted mainly of school leavers, local people who had lost their jobs, retired miners and government workers. These people had all worked together to maintain an irrigation furrow. Although the average size of holding was small—about 1.2 ha—the average gross income was about K730, with a wide dispersion around the mean. These farmers were growing mainly vegetables, using little of the rain-fed land but over one-third of the irrigable area.

By and large, the new settlers whom the government wanted to attract to the scheme were wealthier 'emergent' farmers. A comparison between the 'squatters' and the new applicants for farms in the project which was to replace them, made it clear that the new applicants were in general better endowed with capital than were the 'squatters'. In addition, their farming history showed that they were more commercially oriented.

General principles indicated from this study

(1) The planners did not try to adapt the new scheme to what existed on the ground. They assumed that the existing vegetable gardening plus subsistence production was unimportant; failing to consider that an improvement of this might have benefited more small farmers than the bigger project they had envisaged
(2) Planners did not consider carefully the production which was possible by the households either those in residence or to be settled, given their labour and capital endowments.
(3) Planners did not give adequate consideration to the provision of credit, marketing and input facilities, assuming instead that other parts of the administration would be able to respond to the needs.
(4) No attempt was made to involve the existing Chiwefwe farmers in the planning of the new development, or to learn how they had organized the maintenance and administration of their irrigation furrow.

(b) Mumbwa and Kabwe: Central Province

In Central Province a very large percentage of farm households grow *some* vegetables by irrigation, but only a very small proportion—11 per cent in Kabwe rural area—of the poorest households grow vegetables by irrigation *and* sell them. And yet over 60 per cent of the households in the Kabwe rural area were in the poorer group. In a survey at Mumbwa (Vincent, 1981a) only two of the three households selling irrigated crops were 'small' households, that is households cultivating less than 2 ha of rain-fed land. Thus there are few small or peasant households selling irrigated crops.

This study identifies the reasons why poorer and smaller than average households adopt irrigation as:

(1) lack of labour (Vincent, 1981a, pp. 12, 17)—the most important constraint
(2) risk avoidance; other sources of income were less risky (Vincent, 1981a, p. 15)
(3) lack of markets.

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But the study locates all of these problems and their solutions within the following general condition:

> ... the agricultural extension services, the agricultural loans, indeed most of the institutional and financial support has been provided to emergent and commercial farmers. This policy has brought with it the growth of capitalism in the countryside, but this growth is far too slow to be of much help to the rural poor. And so with the continuation of such policy the peasant households will continue to be left out in the cold. (Edwards, 1981, p.27).

General Principles

(1) Irrigation schemes and projects must find the right fit between land holding size and labour endowment of the household.
(2) Government resources must be organized to support small farmers—even, as in Zambia, to recognize that the word 'farmer' actually includes predominantly subsistence cultivators.
(3) Training of agricultural officers must emphasize point (2) above.
(4) National agricultural policy has to recognize the primacy of subsistence production for most farmers.

(c) Other small-scale irrigation in Zambia

The Mission Report of the Joint FAO/German/Dutch Consultancy Mission (FAO, 1972) recommends 'the development of small-scale schemes for traditional agriculture ...' but in the *Perspective Study of Agricultural Development for Zambia* (FAO, 1976) it is noted that 'most of the small farmer irrigation schemes in the country have been failures due to technical and managerial constraints'. The nature of these constraints is not explained.

General principles

In so far as this sparse information tells us anything, it points, through its reference to managerial problems, to the principles already indicated above.

Swaziland and South Africa

Information is available about two smallholder irrigation schemes, the Vuvulane Irrigated Farms in Swaziland and the Taung Irrigation Scheme in the so-called 'homeland' of Bophuthatswana, South Africa. The author of the report describes these as 'two of the more successful smallholder irrigation schemes in Southern Africa' (de Villiers, 1977, p. 108). The planning and organizational aspects of these two schemes are compared and contrasted in Table 2 (de Villiers, 1977, pp. 110-

Table 2. Planning and organizational aspects of two smallholder irrigation schemes in Swaziland and South Africa

Planning and organization	Taung Irrigation Scheme		Vuvulane irrigated farms
	Individual holdings	Partnerships	
Determining the agricultural potential			
Physical potential	Soil survey	Soil survey	Climatological, hydrological and soil surveys. Outlay of irrigation holdings
Economic potential	None	Crop programme study	Market potential. Crop programme. Size of holdings and irrigation system studies
Social potential	None	Farming system study	Selection standards and farming system studies
Settlement	Holdings allotted by tribal authority Individual freehold rights	Holdings allotted by tribal authority Farmers form own partnerships	Developed holdings advertized Applications made to district authority Selection made at this level and shortlist submitted to selection committee Final selection by selection committee consisting of irrigation authority and national assembly Successful applicants sign 20-year least contract
Holdings			
Size	Individual 1.7 ha	Partnership blocks of 20 ha, 3–6 farmers	Individual 4.0–6.5 ha
Land fees	(R12 holding) year (R7 ha) government levy	(R140 block) year (R7 ha) government levy	(R300–R480 holding) year (R75 ha) irrigation authority rent
Irrigation water use	On request	Irrigation programme controlled by Dept. of Agriculture	Irrigation programme for sugar cane controlled by irrigation authority
Irrigation fees	None	None	Average R100 ha year (basic and additional consumption fee)
Cultivation and harvesting services	By hand with own or hired labour	By hand with own or hired labour	Mechanical work for sugar cane provided by irrigation authority (controlled)
	Mechanical work by private contractors on request	Mechanical work by private contractors controlled by Dept. of Agriculture	Mechanical work or hired labour for other crops on request

Marketing services	No control over marketing of products. If surplus production exists it is marketed either by the co-operative or through private channels	Marketing of products controlled by co-operative	Marketing of sugar cane controlled by irrigation authority Marketing of other products through private channels
Credit services	Production-inputs available from co-operative on request on credit terms, repayable during marketing stage Co-operative levy of 5 per cent on value of products marketed + R5 membership fee annually	Production-inputs provided by co-operative on credit in consort with Dept. of Agriculture's crops programme. Credit repayable during marketing stage Co-operative levy of 5 per cent on value of products marketed + R5 membership fee annually	Production credit available from irrigation authority to a limit of R3000 small-holder at 8.5 per cent interest. Repayable from sugar cane sales Subsistence allowance of R15 a month for one year available to settlers from Oxfam at 6 per cent interest
Extension services	Provided by Dept. of Agriculture to shifting population	Provided by Dept. of Agriculture linked to crop programme, harvesting and marketing controls	Provided by irrigation authorities. In the case of sugar can extension is linked to production harvesting and marketing controls
Control regulations	Irrigation regulations cannot be effectively enforced on shifting population	Irrigation regulations enforced as it is linked to production, harvesting and marketing controls	Irrigation regulations specified in least contract and supported by eviction clauses
Local participation in management	Black extension officers and certain administrative positions of Dept. of Agriculture	Black extension officers and certain administrative positions of Dept. of Agriculture Farmers elected as directors of co-operative	Black extension officers and certain administrative and management positions in irrigation authority (see Annex) Farmers' Society presents farmers at irrigation authority, also controls sugar cane nursery
Social infrastructure	Responsible for own housing in adjacent township	Responsible for own housing in adjacent township	Credit available from irrigation authority to build houses on holdings Smallholders have access to all medical schools, sporting and retail facilities available within the total CDC project area

Source: de Villiers (1977), pp. 10–11

111). The goal of both these schemes is commercial production. The author concludes that the main elements in their success are:

(1) systematic planning
(2) the size of the holding is related to the capital and labour requirements of the farming system
(3) selection of farmers 'so that persons with the required background and characteristics are settled'
(4) involvement of the irrigation authority and the local authority in the selection of settlers
(5) extension programmes and control regulations should be linked to adequate training programmes.

General principles

These schemes are centrally managed and oriented to cash cropping. They do not have equity or poverty alleviation as major goals. Within those parameters, the preceding conclusions seem appropriate and commonsense. However, there is little recognition of any place for participation by the farmer in the planning and running of either of the schemes.

Nigeria

There is a considerable amount of dry-season irrigation in northern Nigeria. This is of long standing, using traditional methods such as the *shadoof*. However, little has been written about it. The last decade or so has seen attempts at implementing a number of very large-scale irrigation projects. In contrast to the poor record of those developments 'the irrigation activities which do seem to achieve a significant degree of success are the traditional dry season vegetable gardens watered by *shadoof*, and other small-scale irrigation facilities such as orchards and tree nurseries' (Carter, 1981, p. 1). With regard to all sizes of development, Carter concludes in his survey that 'Northern Nigerian projects to date show poor performance on the criteria of "convenience" and "stability" as defined by Chambers (1976)'. In Chambers' definition of those terms, this means that because of poor administration and management the farmers all too often cannot have confidence that the water and other inputs to their irrigated farms will be available when needed, and in addition, because of poor project planning, adverse environmental consequences quickly threaten the schemes with failure.

On the positive side, in contrast, Carter concludes that:

> The irrigation which undoubtedly does succeed in the area is that done privately by small farmers using traditional techniques—using the *shadoof* and perennial surface water or shallow ground water. All over the north in the major river valleys and other special locations these techniques can be seen producing marketable vegetable crops. (Carter, 1981, p. 10).

Carter comments in particular on a case at Yoba where a local government agricultural officer 'has enabled a *shadoof* irrigator to obtain a small pump and increase his holding to a few acres of productive irrigated land' (Carter, 1981, p. 10).

General principles

Carter's conclusions which are relevant to the present concerns are:

(i) the need for consultation with the farmers at the planning stage
(ii) adequate education and training at all levels of operating staff from farmer upwards
(iii) concern about the role of consultants in planning, ('I did not once hear of a feasibility report which concluded that the project under study was inappropriate or uneconomic ...' (Carter, 1981, p. 13) and suggests that:
(iv) 'it is vital for governments to think carefully about ways in which they can increase the accountability of consultants ...' (Carter, 1981, p. 14). He senses from this, the possibility that:
(v) the consultants involved in the feasibility studies should be excluded from the design and construction phases.

Senegal

Jamaane village scheme

This is the most thorough case study. The scheme starts with a small-scale irrigation system which was established by local people from their own resources, but local people had to respond to attempts by the Senegalese Government to become involved, together with USAID.

The scheme began when a local man returned to his home area in the early 1960s after many years working in France. He went back to France 'with a central aim in view; to acquire some means of improving farming at home' (Adams, 1977, p. 44). In 1973 he returned once again to his village bringing with him a cultivator and a small pump, together with the promise of an agricultural technician. In 1974 the technician arrived, funded by two British non-governmental organizations. A group of 40 people established a *champ collectif* of 1 ha and dug a well. By 1975 this group had increased to 270 members—200 men and 70 women. By mid 1975 all the villages along the river from Balou to Monderi had formed irrigated farming groups. 'The villagers had been somewhat wary of the plan at the outset; but it was presented to them by someone they knew and trusted, and came to seem something they themselves could control. Wariness turned to hope, in some cases to enthusiasm ...' (Adams, 1977, p. 45).

An application to USAID for $60,000 for the purchase of equipment led to the project being put under the aegis of the Société d'Aménagment et d'Exploitation des Terres du Fleuve Sénégal (SAED) which would channel the aid. The peasant response was that if they were going to lose control of what they had built, they would do without the aid and continue with their collective fields of millet and maize until they could finance their own purchases of equipment. They had heard that involvement with SAED led to loss of control over their production. At a later date another non-governmental organization, the Compagnie Internationale de Développment Rural (CIDR) which had been involved from the beginning, had its financial support from the two funding organizations withdrawn because they objected to funding an agency which had now agreed, admittedly unenthusiastically, to be an agent of the SAED.

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In response to the SAED involvement, the peasants formed a Fédération des Paysans Organisés en Zone Soninké de Bakel. The chairman of one of the village irrigation associations summed up the communal attitude to the SAED: 'We're not against the SAED, but we've seen how the SAED tells peasants nothing, and gets them into debt ... SAED doesn't make anyone any presents. SAED makes profits out of peasants, and makes them incur debts.' (Adams, 1977, p. 49).

The peasants made a distinction between 'développment paysan' and 'développment de functionnaires'. Adams concluded that the massive plans for SAED, financed by USAID might leave little room for the 'développment paysan'.

General principles

The principles which can be adduced from this case are the following:

(i) Local people can successfully work with non-governmental organizations without government and can establish a relatively successful small-scale irrigation scheme.
(ii) Government involvement can be a disincentive if its objectives differ from, or are perceived as differing from, those of local people.
(iii) Large-scale aid donors, bilateral or multilateral, by working through government may actually stifle local initiative.

Tanzania

The three sources considered in this section are contrasting. All deal with small-scale irrigation, but Allen and Gray describe systems which will undoubtedly have changed since they wrote, indeed in the case of the Chagga, were already changing quite radically. Mbawala speculates on the possibilities of combining Coward's (1977) suggestions as to principles for successful indigenous small-scale irrigation with the structure of the ujamaa village.

Allen's account (1965) is based on his own fieldwork in the 1950s and on accounts by a German traveller, Guttman, written in 1926.

Allen describes the Chagga system as follows:

> users of a furrow formed what was, in effect, a Water Users' Association, which met to decide upon the equitable division of water and to arrange a programme of maintenance by communal effort.
>
> Administrative rights, as Guttman describes them ..., were based on 'ownership' of canals and furrows. Some particularly large canals, constructed by communal effort, were owned by chiefs and operated by their appointed agents. Others were the property of the families of those who made the furrow. The head of an 'Association' using a furrow was normally a member and the representative of the owning family; he acquired his position by inheritance. The 'owner' of the furrow had religious as well as administrative duties. He had to organize and lead the annual cleaning and repair of the furrow, and all the members were required to help in this work. If a member failed to do so without

reasonable excuse, or to provide a substitute, he was liable to lose his rights to use the water from the furrow. The 'owner' also had to offer the sacrifices and prayers which would ensure the continuing flow of water, and he alone could do so. Water resources—springs and streams from which canals and furrows were taken off—and storage basins were also owned, and these owners received nominal gifts in recognition of their rights. Distribution of water among members of an Association was governed by rule, and doubtful cases were settled by discussion. The user at the lowest end of the furrow had first right of use and others in their turn up the furrow; but it was a general rule that the owner could dispose of water every third day if he wished. He was, however, expected to transfer his right to those in greatest need whose crops had reached the wilting point; these were the 'days of petition', when people in urgent need petitioned the owner for the use or water. The duties of the furrow owners, apart from their ritual functions, were not unlike those of the chairman of a regional water board.

The Associations of water users were not exclusive. A stranger could apply for membership but had to be introduced by the owner and accepted, after he had made an offering of beer. Chiefs had an ultimate right even in furrows they did not own. If an owning family died out or migrated, or if the sole heir was found to be unfit, ownership of the furrow reverted to the chief. He could also deprive a family and take ownership of their furrows himself if a member of the family committed a serious crime. Remnants of this organization survive, but responsibility for the water system is now largely in the hands of the modern Native Authority (Allen, 1965, pp. 165–166).

Gray's account (1963) of the irrigation practices of the Sonjo is based on his fieldwork during 1955. It is interesting in so far as he provides a fairly full description of the administration of the system of furrows and sluices which the Sonjo at that time used. Groups of fields are irrigated from the same furrow, and these may be owned by several men. The man who has the most authority soaks his own field first, and the water is then put onto the fields of his companions. The first waterer 'stands in a position of patron to the other men ... and allows them to use the water that is left over when his own needs are satisfied' (Gray, 1963, p. 57). The day is divided into 4 × 6 hourly irrigation periods. The village council plans and directs the whole system of irrigation 'with a view to utilizing the water with maximum efficiency' (Gray, 1963, p. 57). They also visit farms to offer advice or criticism.

The men of the village are divided into groups with different irrigation rights. Ultimate control is in the hands of a council of seventeen village elders, who hold their position as members by hereditary rights. The remaining men in the village are grouped into several categories. Gray describes the principles of Sonjo irrigation management as follows (Gray, 1963, pp. 58–61):

An irrigation cycle ... lasts for fourteen days. In starting a cycle, the [village elders] assign themselves the first periods; this takes about four

> days. Next in order of priority comes a group of eighteen men called 'minor' [elders] who also hold hereditary rights. In terms of individual water rights these men are equal to the [elders] proper but they have no control over the irrigation system as a whole ...
>
> After that the irrigation periods are assigned to a group of elders ... who have no hereditary or permanent water rights, but obtained temporary rights, through paying tribute to the [village elders].
>
> Individuals of this group are assigned irrigation rights for only short periods of time—month by month—and the number of [these third level elders] ... is limited by the need to keep the length of the cycle down to about fourteen days.
>
> The above three categories ... account for less than half of the men in the village who require irrigation water. The rest ... 'clients' ... have no primary rights but must apply for secondary water rights to individuals with primary rights.
>
> [A client] has to deal with the [primary right holders] as a corporate group [and pays tribute] ... lacking a relative to supply him with water, a client must compete with other clients ... It will be obvious that a client is often in a precarious position with regard to irrigation water.
>
> [The primary right holding elders derive most of their political authority] from control of irrigation water for they have the power of depriving individuals of the water which is an absolute necessity of raising crops.

In contrast to the two preceeding accounts, which concern systems as they were, Mbawala (1979) looks to the future in Tanzania and cites official TANU policy as recognizing the importance of small-scale irrigation (Mbawala, 1979, p. 99). He takes Coward's (1977) three principles of local organization: (i) leadership accountability, (ii) canal-based organization, (iii) micro-organization, and tries to apply them in the context of ujamaa structure. He suggests that the ten-house cell may be suitable as the basis for micro-organization (Mbawala, 1979, p. 101). In so far as he does not appear to be dealing with very much empirically derived information but merely speculates about possible arrangements, a detailed account will not be given here. However his main conclusions are of interest. He says that,

(1) A basic unit in the irrigation systems should be the shamba cell and that would be analogous to the way in which *vijiji* (villages) have been divided into *kijiji* (wards) which have in turn been divided into small components called *chama* cells (ten house cells).
(2) Where the composition of the shamba cell is congruent and consistent with the composition of *chama* cells, leadership in the two groups may be overlapping, but where the composition of the *shamba* cell cuts across the *chama* cell within the same *kijiji*, including people from different *vijiji*, then irrigation may not be overlapping with *chama* cell leadership (Mbawala, 1979, p. 108).

General principles

(1) The information from the Chagga, Sonjo and more speculatively from Mbawala's work, all point to the effectiveness of very local level irrigation associations, organized in relation to the unit of irrigation.
(2) Clear overall authority seems to have been important in the operation and maintenance of the Chagga and Sonjo systems.
(3) Irrigation users' community control over the determination of disputes was effective among the Chagga.
(4) The tail-ender problem was apparently solved in the Chagga system by giving them first use right.
(5) In the Sonjo system, where there was no equity objective and the society was obviously stratified, this stratification was maintained through control of water rights.
(6) Mbawala's comments, concerning a system of local administration where party and other authorities operate in parallel, suggest that clear authority in irrigation matters should be given to one or other of the authorities.

Botswana

This project, based on systems developed in Sudan by Doxiadis Associates, used conserved rainfall in excavated pits (FTDG, 1969). An experimental tank was constructed at Radisele by a mixture of local government, non-governmental organization and UNDP efforts. This then became the basis of an attempt to spread the idea through a training course to primary schools in the area, so that they would grow fruit and vegetables. The results were variable. The following *general principles* are all that can be advanced from a report that largely omits social and administrative aspects:

(1) The individual enthusiasm of teachers who had been on the training course was a major factor in the success or not of the project.
(2) Community participation was essential for success.

Zimbabwe

In the course of a much more general study, Mudekunye (1980) gives some information about small-scale irrigation in the South East Lowveldt of Zimbabwe. This is a minor aspect of his work, 'except for comparative purposes and as a pointer to what could be with a different development strategy in the Lowveldt' (Mudekunye, 1980, p. 181).

In the Sabi Valley the size of farms on the African schemes ranges from 1–4 ha, on a one year lease (Mudekunye, 1980, p. 188). Farmer evictions are rare, but are there as a threat to settlers. All of the small-scale irrigation is associated with large scale commercial projects. This need not work to the disadvantage of the small schemes (Hazelwood and Livingstone, 1978), but in Zimbabwe this has been the case in the past. Mudekunye notes that this has been the outcome of decisions at the highest political level (Mudekunye, 1980 pp. 194–195). An additional point which the

author makes is that where small-scale irrigation is associated with medium to large scale estates 'the tenants will be reduced to employee status, and thus be reluctant to join the scheme, reinforcing the management's tendency to engage in direct farming operations' (Mudekunye, 1980, p. 210). With reference to the Chisumbanje African Settlement Scheme, Mudekunye notes that, 'the behaviour of farmers should be related to the recurrent water supply problems on the less successful schemes, marketing problems, lack of complementary inputs' (Mudekunye, 1980, p. 215). Under these circumstances, cash cropping is risky. In his recommendations for the future, Mudekunye notes that 'settlers on the Sabi Valley Peasant Schemes are very much attached to the schemes after having followed ... [a] land development strategy ... [when] settlers are involved in the land development process and perform activities that can ... effectively be carried out by labour power' (Mudekunye, 1980, p. 541). He sees failure to do this as having contributed to the failure of the Chisumbanje Scheme (Mudekunye, 1980, p. 542).

Another point that Mudekunye makes is that it is not freehold tenure that is essential but security of tenure (Mudekunye, 1980, p. 544).

General principles

(1) The balance between small- and large-scale irrigation if they exist side by side must be decided as a matter of explicit policy.
(2) Where large-scale and small-scale irrigation are adjacent, the small-scale irrigators can be reduced to the level of employees, and thus be reluctant participants in either their own small-scale irrigation or in the large-scale irrigation.
(3) Certainty of water supply is of major importance.
(4) Cash cropping is high risk if water supply is uncertain.
(5) Participation in the building of a scheme for small-scale irrigation by the future settlers may be a positive experience for their future participation in working on it.
(6) Security of tenure and of access to water are essential.

Kenya: East Pokot agricultural projects

This is a project executed under the auspices of a non-governmental organization; it has various components including some irrigated farmers based on the flash flooding rivers. The project aims to use small-scale irrigation and water harvesting methods for increasing crop production. The project appears to have had a measure of sucess. The irrigation aspect has been largely concerned with tree planting in small rainwater catchments. The information in the report (Barrow, 1980) is very sketchy on the aspects with which we are concerned in this article, but three *general principles* can be derived which have contributed to a degree of 'success'.

(1) intensive teamwork by a small group of about six committed people involved in implementation
(2) the local people are enthusiastic and, perhaps by implication, this is related to
(3) absence of government involvement.

The Gambia: Saruja and Wasu

Various irrigated rice schemes have been developed in MacCarthy Island and Upper River Divisions by three separate programmes under the auspices of the Taiwanese (1966–1974), the IBRD (1973–1976) and the People's Republic of China (1975–present). Two schemes are fully described, particularly that around Saruja which formed part of the research over two years by Dey (1980). Indeed, this must be one of the most closely studied small scale irrigation projects in Africa.

The aim of the scheme had been to make The Gambia self-sufficient in rice by 1980. Dey comments, 'actual purchases of rice by [government] indicate that the irrigated rice programmes have failed in their objectives' (Dey, 1980, p. 12). She explains the poor results in terms of failure by planners to recognize the role of women in the prevailing farm system. The effect has been to give control of irrigated land exclusively to men, and deprive women of an independent source of income in the dry season.

Dey says:

> 'I would argue that if irrigated rice plots and the whole technology of growing irrigated rice together with the credits originally given the men by the Taiwanese and World Bank programmes had been made available to women as well as men, it is probable that double cropping of irrigated rice would have been achieved on the women's fields at least. Women are in a much stronger position than men to cultivate irrigated rice in the rains as labour demands fit in with the customary sexual division of labour ... women ... already have traditional reciprocal labour groups operating for their swamp rice. Those groups could easily work on the irrigated rice fields. Men do not have access to these female reciprocal labour groups ... The big advantage of these female reciprocal labour groups is that they are inexpensive, the only cost being food.' (Dey, 1980, p. 14).

In contrast to the scheme described by Dey, and to other small-scale irrigation schemes in The Gambia on which she has commented, a scheme at Wasu has been a success, achieving a higher cropping ratio than the scheme in Saruja. In particular, it should be noted that there is a supply of young male labourers in Wasu, the people were involved in the construction of the scheme and they manage the irrigation themeslves. In addition, the local agricultural officer in the early days of the scheme was extraordinarily energetic and enthusiastic (Barnett, 1979a).

General principles

(1) In planning small-scale irrigation the details of labour allocation practices and land rights ought to be carefully examined. (It should be noted here that Dey's data took two years to collect not the usual six weeks allocated to the 'social aspects' of feasibility studies).
(2) Women should be given irrigation rights as a matter of course.
(3) The personality of the local agricultural officer is frequently a major factor in success or failure.

This concludes the review of the evidence on small-scale irrigation schemes in Africa. On the basis of this evidence and building on the 'general principles' which affect success and failure, we can now attempt to define the broader social and administrative problems which contribute to success and failure of small-scale irrigation schemes in Africa.

2. BIG PROBLEMS AND FEW SOLUTIONS

Underlying the general principles identified in the first section, are the following six 'big problems'. These, it should be noted, are not problems which are only to be found in relation to small-scale projects, but exist in many types of agricultural and rural development projects. These problems are:

(1) the problem of the relation between social benefit, national economic strategies and the perceived benefits of the direct producer
(2) the problem of control: who has the effective decision-making power over such things as crop selection, rotation, marketing and perhaps more importantly, water use?
(3) the principle of hierarchy and the technical requirements of control over a 'lumpy' resource, water
(4) the problem of the production unit and the production process on which planning is to be based. Crucially, this involves consideration of: (a) family cycles; (b) women and their position in production
(5) the problem of water use and the adaptation to farmer experience of organizations such as ministries and research stations. In short, can bureaucrats and agronomists learn from the farmers?
(6) the general problem of 'planning for change' rather than 'planning change'.

We will consider further each of these big problems in turn.

2.1. Social benefit, national economic strategy and the perceived benefit of the direct producer

Irrigation may offer apparently vast increases in national production and national income. However, this increase, even if achieved, may not necessarily offer increased benefits to the direct producer. This problem is not restricted to irrigation, but applies to any major investment project. However, there are particular features associated with irrigation. Water in sub-Saharan Africa is usually a scarce resource and the costs of constructing irrigation systems will be costs to the entire society, in terms of imported inputs and the use of skilled manpower. The very nature of most irrigation schemes, which usually involve some form of reticulation, means that in their anxiety to meet project targets—usually increased productivity for the national unit—planners will opt for an authoritarian administration structure which compels the direct producers to comply with national goals. At this point, then, the principle of hierarchy can *appear* to be *naturally* appropriate. Yet the way in which it so appears is not 'natural', nor may it be necessarily predicated by the agronomic or

engineering constraints. Whether or not it is is a question which has to be examined for any particular case. This is rarely done.

It will certainly be the case that where national or planner's goals do take precedence they will have to be reconciled with local producer's household and individual goals. And, as Michael Crozier (1964) remarked in a different organizational context, "'hands'' are not just hands, they have hearts and heads and will play their own games', pursue their own goals within the structure which has been set for them by the organization, and the project may then become a political battlefield, an arena of social conflict.

An organization whether formally constituted as an integrated irrigation authority (such as Sudan Gezira Board, TVA, Mwea or an agglomerate of government agencies which forms the environment within which the direct producer operates) will fit in varying degrees with the particular goals of the 'farmer' as 'direct producer'. Of course, the concepts 'farmer' and 'direct producer' are abstractions. In fact, they are socially and economically differentiated, and will themselves have different goals and motivations for their participation in an irrigation project.

The preceding remarks indicate a number of points which require consideration. First of all, there is a need to define what is to be the balance of benefit between national policy and national benefit, and the benefits accruing to direct producers. This in itself involves clear recognition that 'national' or 'social' benefits, although having apparently clear definitions in economic theory and political rhetoric, become rather less clearcut when considered politically and socially.

The issue seems straightforward at an analytical level. Planners and politicians see problems from their own perspective, and that perspective is not neutral, it reflects their social positions and prejudices. In short, the reality for the direct producer of producing an increment to G.D.P. of £*n* may not be understood by the policy maker, or if understood, the difficulties may not be comprehended. As Kortenhorst (1980) notes, irrigation is a major intervention in a farming, ecological and social system. Within that system there exists a variety of interdependent risk calculations. The direct producers, although differentially located within what may be conceived of as a risk matrix, can be assumed to have an implicit schedule of risks which they are prepared to take. At the least risk end of the schedule might be acceptance of extension advice, at the greatest risk end will be major changes such as a switch to irrigated monocropping.

Unless we recognize this point as fundamental, we risk failure in any attempts we make to introduce irrigated agriculture. We cannot and must not assume identity of interest between planners and the direct producers. We can, however, attempt to define a *schedule of acceptable risks* which small farmers may be prepared to take. This would have to be constructed for each particular planned innovation. It would not be the same for all farmers in an area, and we would have to take account of different schedules of acceptable risk. In some respects, to say this is to suggest that direct producers must be involved from the beginning in the planning of change. However, it is also to suggest that we can move beyond this truism to a formal method whereby a risk schedule is drawn up for the different sections of the local community. For example, poor farmers and rich farmers, large households and small households, male headed and female headed households might be the initial categories with which we begin. We could then construct a matrix which would

award points for the degree of risk perceived by each of these categories for particular innovations to their household economy. And in this process, we must not assume that these people are all running their farms as separate businesses, when in fact their production activities are likely to be manifold and highly interdependent, with seasonality as an additional and important factor.

The matrix might look something like that shown in Figure 1.

Social category \ Innovation	extension advice	introduction of one new crop	credit	centrally controlled canalization	monocropping	water users' associations	strict water discipline	increased intensity of labour use	risk factor
rich farmers									
middle farmers									
poor farmers									
large households									
small households									
male headed									
female headed									
high status									
low status									

Figure 1.

The final scores would then provide guidelines for the socio-economic feasibility of the project; for the compromises which planners would have to make; for the support systems which would be necessary in order to cushion particular social groups against risks which they consider too great, but which the planners consider are essential if the project is to be attempted at all.

In the end, it must be recognized that it is the direct producers who take the main risks, and it is *their* appreciation of the costs and benefits to their household which will determine whether they are really prepared to enter the game at all.

2.2. The problem of control

Another dimension of the problem of risk and of national versus local benefit is that of control. Control, or lack of it, is the way that we can conceptualize an essential

element in risk calculations and risk scheduling. Keeping control means that fewer factors are at risk; giving away control involves accepting risks and this requires trust in those to whom control is being relinquished or with whom it is being shared.

In any farming system, there is a range of variables over which the farmer might wish to maintain or extend control. These include crop selection and mix, rotations, marketing. But when we discuss the problem of control in relation to irrigated development, we must consider the issue of water control. A classic text which appears to be about irrigation and society, that of Wittfogel (1957), proposed that there is a necessary correlation between centralized, immovable authority and the operation of large-scale water installations. That this is in fact the case is certainly not clear. Obvious examples which are produced to support the view, such as the Gezira and Mwea schemes have been constructed on that assumption. Their 'success' (a term which itself would have to be defined in terms of the questions raised in the preceding section of this paper) does not prove that this was the only way in which the projects could have been executed. The fairly large scale, interdependent irrigation systems developed by the Chagga in Tanzania and the people on the Red Sea Coast of Eritrea (Barnett, 1980), do not involve centralized control. What they do exhibit in their functioning is clear authority and clearcut rights and obligations. This is not precisely the same as centralized, authoritarian control which removes power from the producers.

What is the origin of the need for control? This may seem a curious question to pose. In the context of a set of guidelines, it could be reformulated as two separate questions:

(i) *What* does government need to control?
(ii) *Why* does it need to control it?

It is, though, a very important question: 'top-downery' can be the result of class prejudices, technical blinkering or just the assumptions that we make about our trust in others and their capacities. It can also reflect our wish to force people to do things which they do not wish to do. Additionally it can reflect a view that deviation from *a priori* principles is *ipso facto* 'wrong', uncreative and reflects 'irrationality' or 'ignorance' or 'laziness' on the part of the lower participants in the system. The classic case is Gouldner's account (1954) of a situation which led to a strike at a factory. The pattern of perceptions was as shown in Figure 2. Crozier (1964) has also

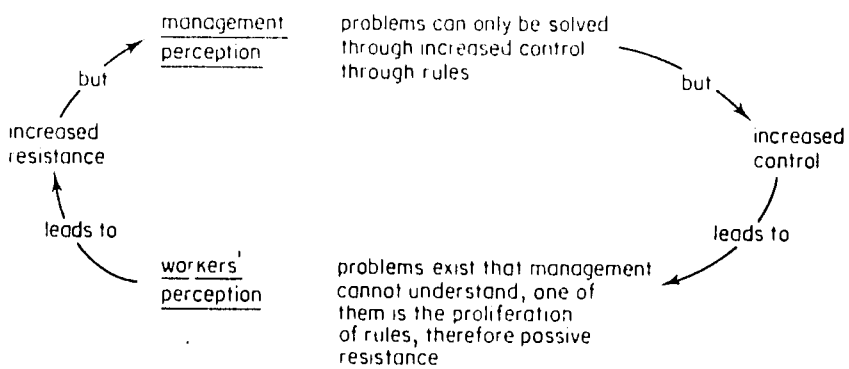

Figure 2.

noted this in a similar industrial context, and has labelled the phenomenon a 'bureaucratic vicious circle'.

If the issues raised in Section 2.1 of this paper have not been adequately confronted, then the appearance of the need for control is straightforward and probably symptomatic of an intractable problem – trying to make farmers do things (perhaps for the 'national good') that they do not really want to do, or without adequate evidence that if things go badly wrong they will receive adequate support and compensation. The evidence from those projects where producers have been forced against their judgement is that even if such projects endure, they are so riven by explicit tensions and passive resistances that they are inefficient and constantly produce problems, which are tackled by a management quest for increased control. A useful approach to the issue might be to develop a set of specified questions for each area of an irrigation development's operation which starts from the principle that as much control and responsibility should be given to the direct producers as possible. An important reason for this principle might be that of the direct producer's convenience which Chambers (1976) has discussed in some detail. We could envisage a set of questions which have to be addressed to each component of the project design. For example, let us take the crucial issue of water control. The matrix in Figure 3 could be constructed and form the basis for planning discussions; preferably involving the farmers. And, an additional, but in view of what will be said in Section 2.6 below, essential sophistication might be to provide a time dimension to this process. Thus, the matrix might be completed at the initial planning stage in the light of the experience that these farmers have with irrigation, which at that stage might be nil. It could be projected forward at, say, five year intervals to take account of the expected development of their experience and

	Questions			
Level or irrigation systems	Potential conflicts over water use?	Why is central control necessary?	What would happen if it is not centrally controlled?	Who could control it?
head works				
main channels				
secondary channels				
field channels				
plot watering methods				

Figure 3. Water control matrix

increasingly intimate knowledge of watering conditions in that particular place under those particular conditions. In a sense then, this approach raises afresh the questions about the locus of control at regular intervals, acting both as a planning and a monitoring instrument. It also forms the basis for the development of farmer support programmes.

Similar methods can be applied to other components of the project such as decisions regarding cropping patterns, water requirements, maintenance, credit allocation.

An important point which needs to be re-emphasized here is that the most frequent rationale for centralized control is the assumed ignorance, conservatism or laziness of farmers. And yet we know that these assumptions are at best half-truths, most of all because we are discussing people who daily and yearly take sophisticated farming decisions within their existing production system. The problem is to harness this risk-taking and planning capacity to a new system, not to assume that sophisticated farmers are suddenly transformed into untutored children without opinions, just because their system of production is being changed. This harnessing will only take place if there is individual and/or household benefit from involvement in the project. A basic guideline ought to be that at each stage of a project there should be a positive financial benefit to the direct producers and the farmers' food crops should be protected. Small farmers tend to be unfamiliar with the notions of internal rate of return and discounted cash flows, and are unlikely to be reassured by expectations of future gain.

2.3. The hierarchy principle: a problem

In this section, the intention is to examine the problem of control and authority from another angle, in much the same way as the issue of control as an aspect of risk was discussed previously. Once again a curious question will be posed. It is: why is it necessary for control authority, where it has to be exerted, to take the form of hierarchy?

It is difficult, and ultimately misleading, to make generalizations about local social organization in sub-Saharan Africa. It is the case, however, that in many areas, hierarchy has not been the social, economic and political form which has been developed historically by the people. Even in cases where there was social stratification, as among the Chagga or even something akin to caste groups, as among the Malinke, the principle of hierarchy does not appear to have been paramount. I think it could be argued that, to a large extent, the principle is something that was imported with the colonial administration, and has provided the idiom for all post-colonial state developments. The development of hierarchy is certainly assumed to be a central feature of some Western development models. And yet we know that in other cultures decisions are not usually taken on the basis of the hierarchical principle.

The point could justifiably be raised that hierarchy is in some way allied to 'efficiency', and is necessary for the transformation of inputs to outputs at least cost. In response to this point can be counterposed the question 'least cost in what and in whose terms'? One of the advantages which seems to accrue in non-hierarchical authority systems, and which might be labelled (I think unsatisfactorily) 'consensus systems of authority', is that while decisions may take longer to make,

they may be firmer decisions, for they will tend to take account of a wider range of risk schedules.

The tradition of hierarchy has been referred to as an 'idiom'. This is a carefully chosen term and a useful metaphor. The forms of association which are used in a society to achieve goals actually set the limits for the goals which can be achieved. If an irrigation project is run on quasi-military, disciplinarian lines, then this limits the degree of control over risk, the degree of innovativeness which participants at all levels will feel able to express. The administrative medium is often, indeed, the message.

Practically speaking, this issue could be approached in the following manner. A matrix similar to that proposed in Figure 3 above could be constructed, with the irrigation and agricultural operations in the left hand column. Each area of activity could then be addressed by the questions:

(i) how hierarchical does this process have to be?
(ii) why is hierarchy necesary?
(iii) what might happen if hierarchy is not the organizing principle?
(iv) what local experience in social organization might provide the source for an alternative method of working?

2.4. The production unit and the production process

Agricultural planning documents frequently contain calculations which involve counting the person-days required to produce a certain crop mix and reconciling this with the available person-days. This is a crude and destructive methodology which deforms reality. It is not individuals who produce, it is individuals in relation to each other—often something which we call for convenience 'the household'. The term production process has been used, in order to emphasize that the cultivator is not just a cultivator but is involved in a complex set of interrelated production activities—for example livestock keeping, collecting, labour migration, petty commodity production, domestic work, child care. As Kortenhorst (1980) notes, intervention in such a complex system is likely to have many and complex unanticipated consequences. This aspect will be considered in Section 2.6 below. For the moment some comments concerning practical aspects of what has been said above are in order. These comments concern:

(1) the household
(2) the role of women in production.

(1) *The household*: households are not identical, they vary from society to society, within societies and over time. These are in various degrees truisms. However, although we have come some way from the position of assuming that 'the abstract individual' is the analytic unit, and thus the planning unit, we have in many respects merely replaced that abstraction with another, that of 'the abstract individual household'. We need to be more sophisticated than this. The following distinctions can be made and then related to the irrigation project with which we are concerned:

(a) size of household and its age structure
(b) position of the household in its developmental cycle
(c) degree of extension of household and typical points of developmental schism. Any identifiable points of schism under irrigated conditions and with possible new land holding arrangements
(d) annual cycle of household membership taking into account migration
(e) forms of decision making in the household
(f) areas of decision and authority in the household
(g) for both (e) and (f) we need to ask the question: how do they change in relation to (a), (b) and (d)?

Why is all this important? Quite simply because this is the system of production relations to which an innovation has to be related if it is to be effective. And very specifically, all of these factors determine the rate at which labour does, or does not, become available, and indirectly the type and level of return which may be demanded for work.

(2) *Women*: we know that in many societies it is women who carry a huge burden of the production activity; who, in addition, do the domestic 'suport' work which makes it all possible and who may maintain the household plots while men go away as labour migrants.

And yet we also know, as Rogers (1980), Dey (1982) and many others have noted, that women are ignored by planners, taken for granted. It is an essential part of our problem to recognize that the position of women in the total production process should be carefully analysed in order to ensure, first, that they benefit and are given direct access to income-generating activities in their own right, and, second, that their burden of unpaid household labour and childcare is not increased to a level which effectively means that they are shouldering the efforts for increased national production.

2.5. Water use: a special case of the problem of control and hierarchy

I have discussed one particular example of this in some detail elsewhere (Barnett, 1979b), and touched on it by implication in several places above. The general point which needs to be emphasized is that in irrigation schemes, water is usually the scarcest resource. It thus gives rise to the greatest institutional anxiety, and the greatest demand for control. Thus it is *the* focus for the unnecessary appearance of hierarchical principles. An added twist is that water and plant growth is a specialized scientific area in which the weight of 'scientific' research is added to, and becomes the rationale for, ever greater demands for control and centralization. Yet, farmers also learn, innovate, experiment with water, plants and labour and at the same time balance risks *under field conditions*. Implications of this are:

(1) the recognition and evaluation of farmer innovation through an established system of monitoring and testing these innovations under field conditions
(2) a clear recognition that, in the face of farmer deviation from recommended watering practices, the response should not be to assume that they are wrong, lazy etc., but to ask 'what is their rationale for adopting this procedure?'

2.6. Planning for change v. planning change

Introducing irrigation is usually a major intervention. Inasmuch as this is the case it has to be recognized that such an intervention, if successful, will not lead to a new plateau of stability. Once a project has got off the ground it will take on a momentum and internal dynamic of its own. And while there may be plateau phases, these have to be seen as phases in project development.

The trick is to recognize this, and to plan for it creatively rather than to respond to unanticipated outcomes by panic measures. That is why the distinction has been made above between 'planning change' and 'planning for change'. In some of what has already been said, this has been an implicit assumption. The practical implications of this observation are first that, where methods such as sequence performance tables are adopted in the planning and execution of a project, an additional column should be added, perhaps headed 'unintended consequences'. At the planning stage, all that would be necessary to note in this column would be the *types* of consequence which could, from experience, be expected to develop. For example, adoption of new cultivation techniques; new irrigation methods; development of new forms of economic activity; new forms of organization and decision making; changes in household organization. If this exercise is carried out, then when, and if, they occur, creative responses could have been designed to build upon these changes.

The second practical implication is that such attention to unintended consequences should become a vital part of the monitoring and support system for small-scale irrigation developments. In effect, innovation at the farmer level should be positively sought and identified; it should be expected, and used to improve the operation of the project.

APPENDIX. SMALL SCALE IRRIGATION: SOURCES FOR LITERATURE SEARCH

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