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PLANNED IRRIGATED SETTLEMENT

A study of four villages in
Dodoma and Singida regions
TANZANIA

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MUHTASARI

Ripoti hii ni matokeo ya uchunguzi uliofanyika katika vijiji vinne katika mikoa ya Singida na Dodoma hasa mnamo mwaka wa 1968 hadi mwaka wa 1969. Vijiji vitatu kati ya hivi - Ikowa, Mang'onyi na Mgori vilikuwa na mabwawa ya maji, na pia vilikuwa vimetayarishwa viwe makazi ya ukulima wa kumwagilia maji. Kijiji cha nne - Puma - kimekuwa na mpango wa kutumia maji kiasili.

Uchunguzi huu unajaribu kujibu maswali yafuatayo:

- (1) Maji yanayopatikana katika sehemu hizi nne yametumika vizuri kiasi gani katika kukuza kilimo cha kumwagilia maji.
- (2) Jee, inawezekana kukuza zaidi matumizi ya ardhi na maji yanayopatikana katika vijiji hivi kufuatana na hali za watu, siasa ya nchi yetu na uchumi bora.
- (3) Mafanikio na matatizo yanayoonekana katika sehemu hizi yanafananaje na yale yanayopatikana katika sehemu nyingine zenye mipango kama hii ya matumizi ya maji katika kilimo. Kuna mafunzo gani ya faida ambayo yanawezekana kutumiwa katika sehemu nyingine.

Mapendekezo makuu yanayotokana na uchunguzi huu ni haya yafuatayo:

- (1) Pasianzishwe mpango wowote wa ukulima wa kumwagilia maji bila kuwa na soko kamili la mazao yanayopatikana.
- (2) Pawe na shamba la majaribio na mpango kamili wa kutoa mafunzo kwa wakulima.
- (3) Mazao mapya ya biashara na mengine ya aina mbali mbali yanayostawi vyema kutokana na umwagiliaji wa maji yaanzishwe.
- (4) Mipango ya umwagiliaji maji ya jinsi hii itakuwa na faida ikiwa itatimiza yafuatayo:
 - (a) Kusaidia kukuza na kuendeleza kilimo na uchumi vijijini kwa ujumla.
 - (b) Kutosheleza mahitaji maalum katika masoko.
 - (c) Mipango hiyo iwe vyombo na mahali pa kufundishia wakulima ujuzi wa kilimo bora.
 - (d) Mipango hiyo iwe ni sehemu ya mipango mikuu ya wilaya na ya mikoa.

SUMMARY

This paper is the result of a study of 4 villages in Singida and Dodoma region, mainly carried out in 1968 and 1969. Three, Ikowa, Mang'onyi and Mgori were at the site of dams, and had been planned at least in part as settlements for irrigated agriculture, the other Puma uses a traditional form of water control.

The study attempts to analyse:

- (1) How well have the water resources of these areas been used in the development of irrigation farming.
- (2) Is it economically, socially and politically possible to improve the utilisation of available land and water.
- (3) How far are the experiences and problems of these areas, typical of other village irrigation schemes and what lessons can be derived which can benefit other areas.

The major recommendations are:

- (1) No village irrigation scheme should be undertaken without any economically attractive market for its products.
- (2) There should be a demonstration farm and a training programme in such schemes.

- (3) New cash crops and varieties showing good results from irrigation should be introduced.
- (4) Such small schemes are worthwhile as long as they can.
 - (a) Serve a role in local agricultural and economic development.
 - (b) Meet specific market needs
 - (c) Serve consciously as a training ground for farmers in techniques of education.
 - (d) Be integrated into district and regional development programmes..

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INTRODUCTION

Village scale irrigation schemes have been one aspect of rural development in the current Five Year Plan in Tanzania and are likely to be undertaken in the future as well. Some 18 such schemes are listed in an appendix to a recent working party paper produced in preparation for the Second Five Year Plan 1969-1974. The schemes listed vary in size from 150-1,000 acres (60-400 hectares) and in capital cost from 177,000/00 to 4,000,000/00. The average capital cost per acre was 1,118/00. (2,795/00 per hectare). Most of these schemes were initiated before independence and very few of these started off as comprehensively planned projects. Because of this only limited lessons can probably be drawn from them in relation to the future development of irrigation in Tanzania. But they do represent a local experience which should be analysed if only to get the maximum benefit from future development programmes.

The Bureau of Resource Assessment and Land Use Planning has recently completed a study of a number of village settlements in Tanzania and of these four are of relevance to irrigation prospects in the country. Two (Mang'onyi and Ikowa) are included in the list of irrigation settlements mentioned above and two (Mgori and Puma) though not listed are significant for water development programmes.

(Map. 1) At Puma (27 kms. south of Singida) traditional farming in a dry area includes a measure of water control from local high water tables and at Mgori-although a dam and irrigation potential exists-there has been negligible utilization of water for irrigation so far.

In our study of these four villages we have tried to gather information which will help us to assess:-

- (1) How well have the water resources of these areas been used in the development of irrigation farming?
- (2) What are the major bottlenecks in effective utilization of water and land?
- (3) Is it economically possible to improve utilization of the available land and water?
- (4) Is it socially and politically possible to improve utilization?
- (5) How far are the experiences and problems of these areas, typical of other village irrigation schemes and what lessons may be derived which can benefit other areas?

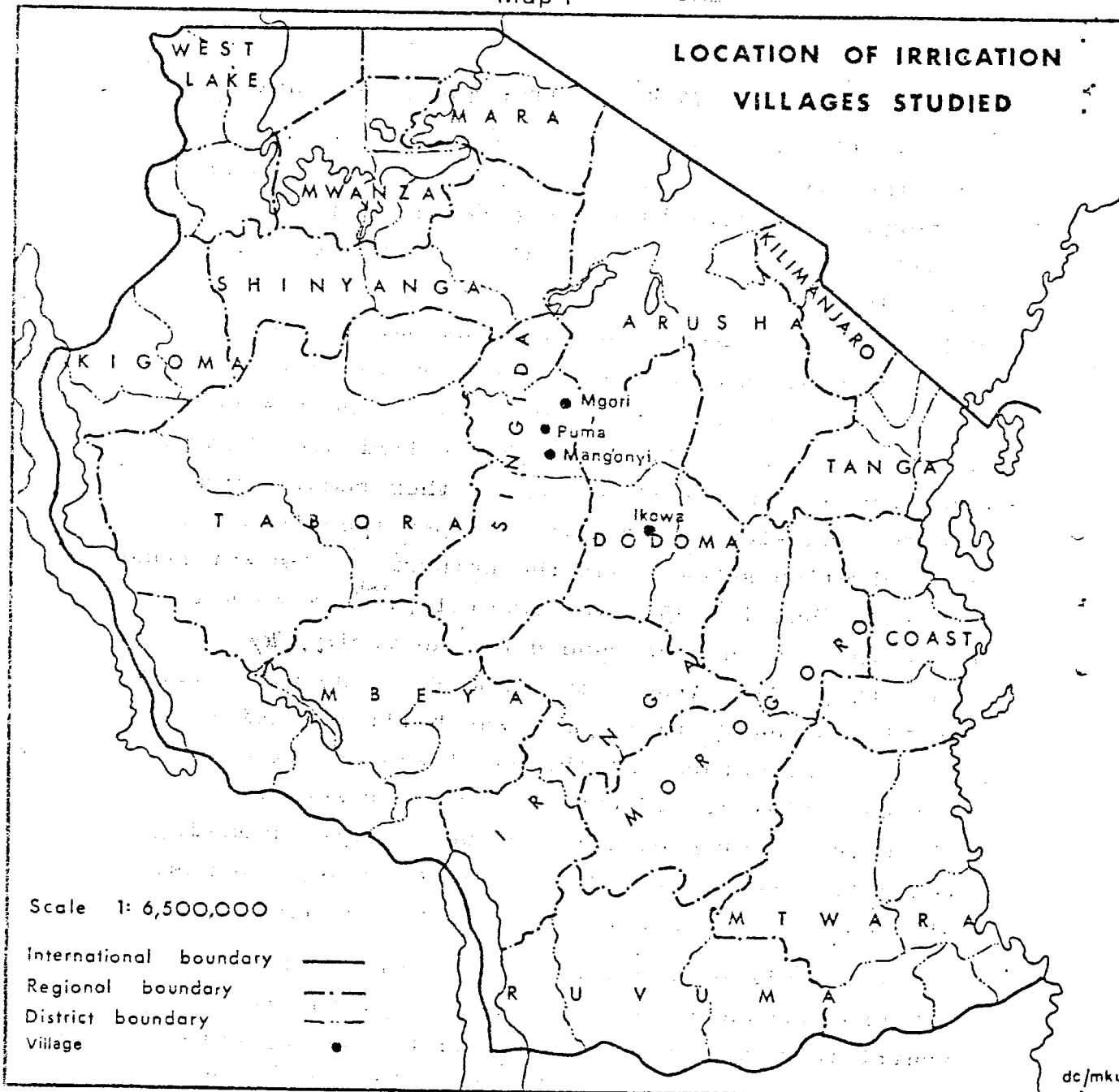
MANG'ONYI

Mang'onyi, 77 kilometres south of Singida, is a settlement which is served by irrigation water from the river Mianji. It has a long and complex history. The river Mianji was first dammed by a locally built earth dam in 1951 with the idea of providing watering for stock. As the dam rapidly filled up the possibility of using the stored water for irrigation was realised by the colonial authorities and the area commanded by the reservoir was searched for suitable land for irrigated farming. The area eventually chosen was rather remote from the dam and sloped much more steeply than is usual in irrigation schemes but the enthusiasm for water-use was such that in 1956 experimental plots were set up in the area now commanded by the irrigation canal (Map. 2). Around the same time the W.D. & I.D. dam with take-off facilities was built replacing the older structure and the canal was constructed to take a flow of 0.7 cubic metres per second (25 cusecs). Crop experiments were quite promising even coffee being grown with some success; bananas, chillies and onions were other promising crops.

In this period there were visions of a large cash crop producing scheme possibly attracting expatriate commercial farmers and the dam appears to have been constructed with this in mind. However, the later analysis of topography and soils of the irrigated area soon made it obvious that considerable adjustments downward in the prospects of the scheme were necessary. Planning then proceeded along the lines of a peasant cash-cropping irrigated agriculture.

Map 1

LOCATION OF IRRIGATION VILLAGES STUDIED



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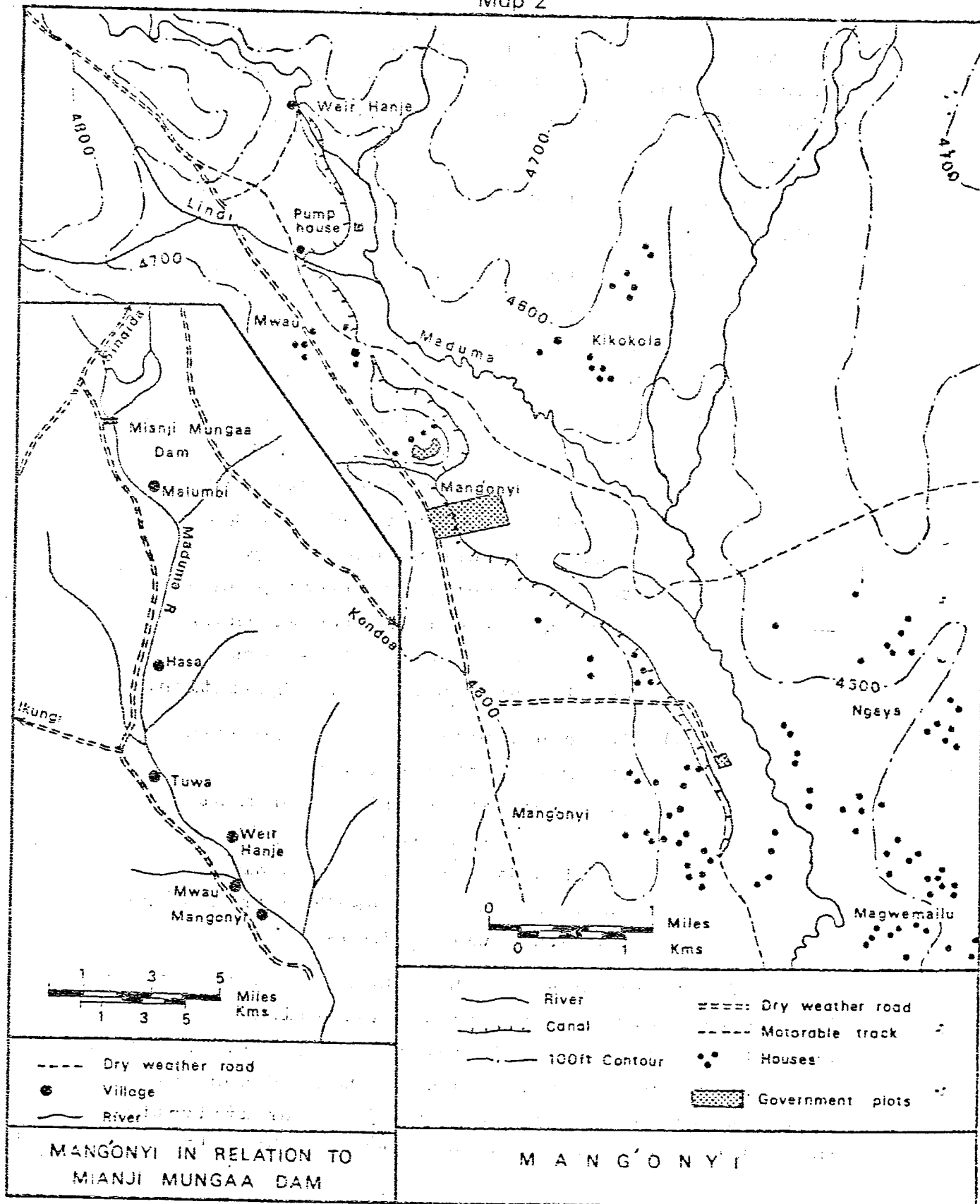
Farmers were encouraged to take up 1.25 hectare irrigated plots with other land not under irrigation being available and by 1960 about 80 farmers were on site.

Three problems caused difficulties in those early years:

- (1) The dam water was becoming more saline. This was considerably reduced by flushing out the dam in 1957.
- (2) Land tenure problems arose. The scheme when completed by W.D. & I.D. was handed over to the District Council who then found that they could not borrow money to extend the canal until the local people were prepared to surrender their local land rights. This took a considerable period of negotiation.
- (3) The construction of the dam with the result that water was now available in the river for most of the year attracted elephant, previously absent, to the area and much crop damage resulted from these and other wild animals.

The first phase of the scheme ended in 1961 when in this exceedingly dry year the dam dried up, no irrigation water was available and many farmers left the scheme. By 1962 only 16 farmers remained and only 8 hectares out of a possible 200 were under irrigation. The canals were very much neglected during this period.

Map 2



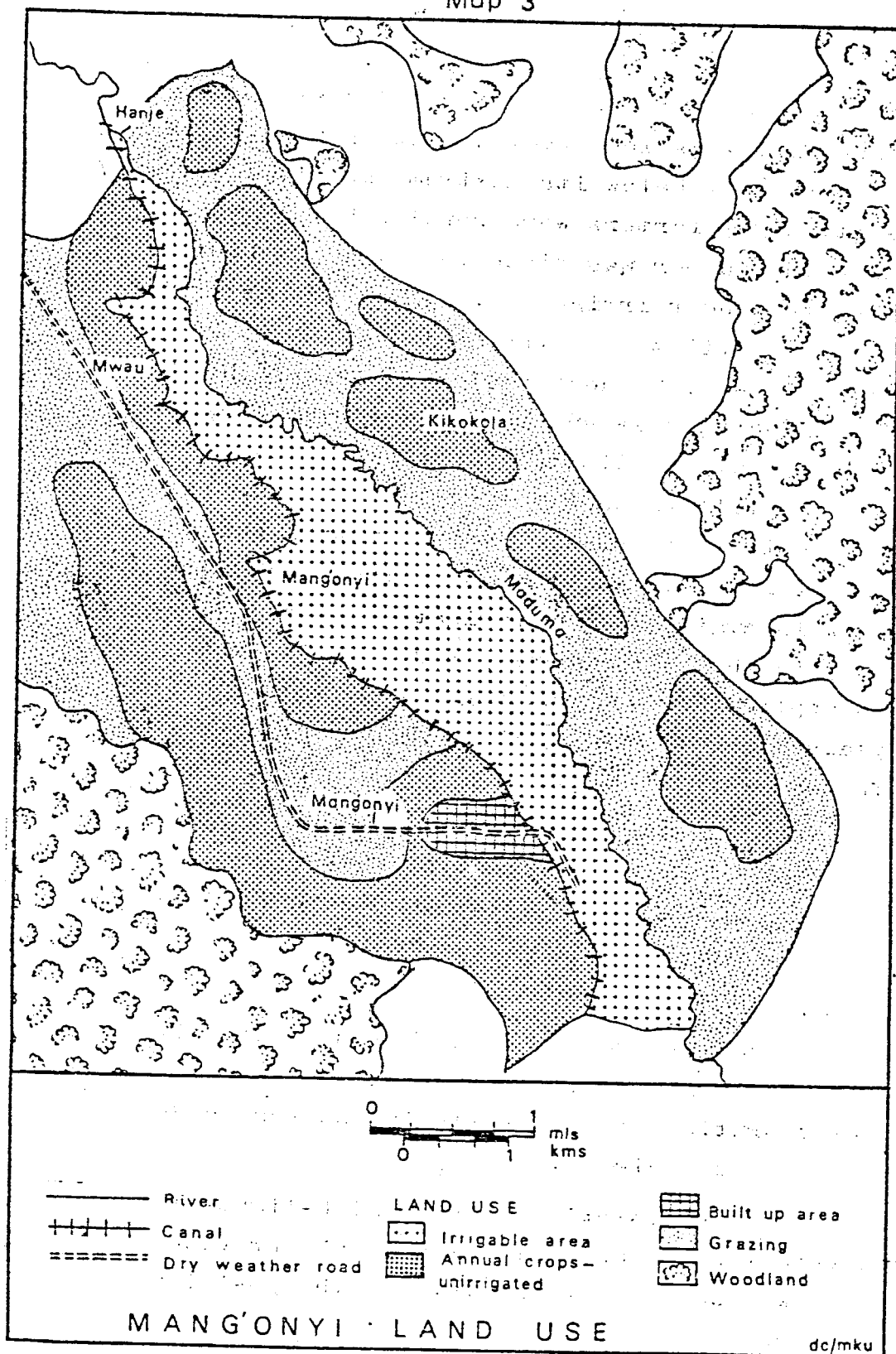
The next few years recorded slow progress back from this low level and the scheme continued to work well below its maximum capacity. By 1967 sixty eight farmers were working here, and since then the number has risen to 101 with about 87 hectares under irrigation. This contrasts with various estimates of irrigible land that ranged from 200 - 1,200 hectares (the W.D. & I.D. figure in current use is 400 hectares). However, available water is also a limiting factor. The dam capacity is 8.63 million cubic metres and the supply canal was designed to pass 0.7 cubic metres per second but it is estimated that only 16% of the daily flow is available for irrigation at the supply end, in the eight hours per day during which water is applied. Water shortages thus occur in drier years and a report of the land planning officer in 1967 says:

"Until or unless more water
can be made available the
available water should be
used on the best soils of
scheme A only"

He also recommended that more attention be given to drainage and pointed out the gradual deterioration of some soils in the scheme due to lack of drainage.

This historical review high-lights the physical problems of the scheme and provides a background to our analysis of the position in 1968.

Map 3



The Present Position

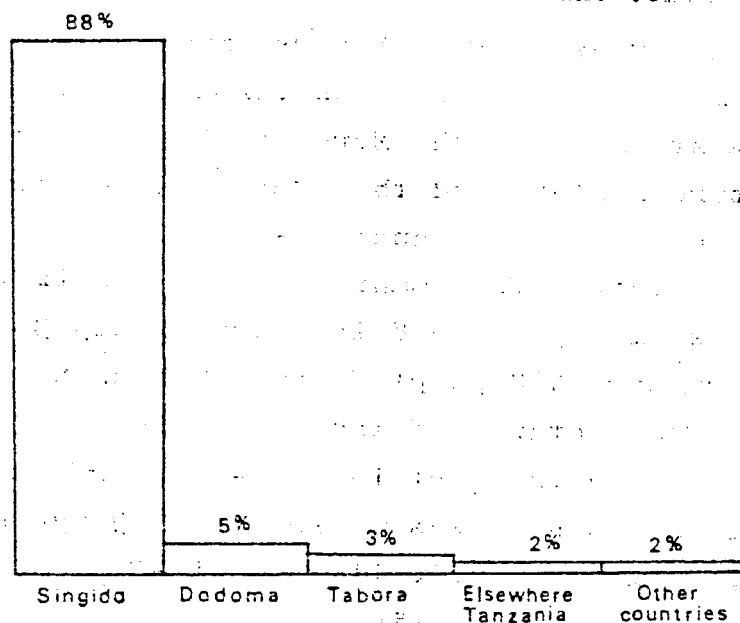
Two analyses of the farmers and farms of the scheme have recently been carried out; a survey by students of the Morogoro College of Agriculture in 1967 and the Bureau of Resource Assessment and Land Use Planning study in 1968. Data from the latter is summarised in Appendix II while land use in April 1968 is shown on Map 3. In 1968 there were 462 people from 101 households cultivating 166 hectares of land of which about 51% were irrigated and the rest in rain-fed agriculture. The agricultural system was a mixture of 3 types of farming; irrigated agriculture, rain-fed agriculture and cattle rearing.

The People

Of the 462 people and 101 families in Mang'onyi only 20% are representatives of the original farmers who settled on the scheme. As suggested earlier there has been a new wave of people settling in the scheme in the last two years. However, most farms are run by family groups and there is a suggestion in the sex ratio (92) that some men with families in the settlement are working elsewhere.

Figure 1 indicates diagrammatically the origin of the settlers 87% of whom were born in Singida region. The people here are essentially familiar with the environment and almost all of them have previous farming experience. Our analysis of farmers expectations of life on

FIGURE 1. ORIGIN OF PEOPLE AT MANGONI



the settlement suggests that most of the people in Mang'onyi are optimistic about the possibilities of subsistence agriculture there and that many (80% of sample) expect higher returns than this - implying that improved living conditions for themselves were to be expected from residence and cultivation at Mang'onyi. However, Mang'onyi was set up to introduce to peasant farmers a new technique of farming, irrigation, and it appears that almost none of the settlers have had previous experience with this type of farming. None of the farmers comes from a district where irrigation is a common feature of farming practice and only the agricultural field assistant has had previous work experience and training which may be relevant to irrigation. Though our studies in Puma indicate that some form of water control is practised in Singida, irrigation is a specialised form of farming requiring either previous experience or some programme of on the job training.

Our analysis of the skills and experience of settlers shows that at present besides farming skills individual settlers have had some range of experience including: a garage mechanic, bricklayer, driver, carpenter, etc. (see Appendix II). However, it is not clear how far such skills are used at all in the community though they might become available if an improvement in the communal activities could be made.

The Land

The area south of Singida is an undulating plateau with the general surface at about 1,585 - 1,615 metres and a slight though general slope to the south.

Many of the hilltops are capped by small boulder outcrops and rocky hills of granite usually only 15 - 30m high. Drainage in this area is to the south and stream valleys are set up to 100m below the plateau. On the surface of the plateau soils are shallow and predominately sandy, easily eroded and not very fertile, but on the valley margins clay loams are more common, while in patches in the valley bottoms mbuga soils with impeded drainage are found.

The Mianji Mungaa Dam reservoir is about 1,565m above sea level and immediately below the dam the valley is narrow and there are few possibilities of irrigated farming. Water is allowed to flow away down the main stream for some 27 kilometres and the site of the Mang'onyi irrigation scheme is a part of the valley side and valley floor of the Mianji river where the valley widens out and irrigation is possible. The canal takes off at a weir at about 1,400m. above sea level and drops to 1,300m at the end of the canals. The area commanded is a strip of the west valley side which slopes at about 6 degrees flattening somewhat above the canal and also near the valley floor. The strip is wide (200m.) enough in most places to get the land of each farmer in one strip between the canal and valley floor although not all of this land is used.

The soils have been studied by the land planning officer in 1967 who reports on seven selected profiles. He found as had previous surveys that the best soils were in block A area (Map 3).

Soil

Generally the soils have a loamy surface texture but in some places there is a defined sub-surface gravel layer which promotes sub-soil seepage. In fact in the first mile of the canal sub-surface water is available and irrigation should not be necessary, the soils rather needing drainage. The effect of irrigation has generally been to change the soils from weakly acid to full base saturation with a high proportion of available sodium. There is a tendency to form a surface capping and for the soils to become less pervious. However from the soil aspects there appears to be no reason why with intensive cropping and the proper application of nitrogen and phosphate fertiliser as part of an organised system of irrigation and drainage, good yields of a wide variety of crops should not be grown.

Climate

The need for irrigation for reliable cropping in Mang'onyi is suggested by the climatic statistics. The nearest station is at Ihanja Mission some 32 kms. away and the records show that over 13 years of measurement the range of annual rainfall has been from 70 mms. to 838 mms. with a mean of 500 mms. The growing season is from December to April and most of the rain falls in this period. The lowest figure recorded (70mms.) is very small compared with other stations in Singida and may be an incomplete recording. However wide fluctuations in rainfall do occur.

The Agricultural Pattern

Farmers come to Mang'onyi with a tradition of subsistence farming and for most of them with some experience of cash crops and the market economy. They also come from animal rearing traditions in which cattle form an important part of individual and collective wealth. Miss Jellicoe in a forthcoming publication has outlined the pattern of social and agricultural life in this area. In April 1968 the crop land of the village was made up of 87 hectares under irrigation and 80 hectares of rain fed crops. In addition members of the settlement owned an average 1.6 units of livestock per capita.

Crops grown in Mang'onyi include:

Maize	18	hectares	in	sample
Groundnuts	$\frac{1}{2}$	"	"	"
Beans	4	"	"	"
Sugar Cane	2	"	"	"
Maize-Bean mixture	10	"	"	"
Cotton	2	"	"	"

while small amounts of tobacco, potatoes, cassava and millet are also grown.

Sugar cane and most of the beans are grown only on the irrigated areas but the other crops are grown both with and without the aid of irrigation. There is a considerable variation in the size of holding the largest farm in our sample being 5 hectares, half of which was irrigated, and the smallest under 0.4 hectare.

Similarly the number of cattle owned varied considerably and animals seem to be kept somewhat separate from the irrigated farming areas (Appendix II).

Agricultural Inputs

For the land under irrigation a major input is of course the investment in the dam and in the delivery canals and there is a continuing input in the maintenance and control of these waters and in the distribution system on to the fields. The other major input is labour and nearly all work at Mang'onyi is carried out by hand with hoes and similar hand tools. Most of this is contributed by the farmers themselves and hired labour plays only a minor part in agricultural production. A few farms do use ox ploughs on hire but the brighter spot in Mang'onyi inputs is that most farmers use bought and presumably selected seeds and there is a good opportunity of introduction of improved varieties through this practice. However, in common with most other villages studied there are no investments in fertilizer though some animal manure is being used on the land (Appendix II).

The Marketing Network

Mang'onyi is reached from Singida by travelling 64 kms. on the Singida - Dodoma road and then for 13 kms. down a poorly maintained rough road to the settlement. The only potential market for produce from Mang'onyi is Singida which is reached by a once-weekly bus service. Marketing is thus a considerable problem.

Maize is usually sold by the bag which is transported by bus - and the transport costs total 50% of the value at Singida. Other crops sold usually reached the market by the same way and with similar cost disincentives.

Organisation

The settlement at Mang'onyi consisted in 1968 and still does in 1969, of individual households mainly concerned with the cultivation of their own land. A nucleation is found in Mwamvua village where there are some 50 houses and 300 people. Otherwise apart from one group of 6 houses the dwellings are scattered, being above the canal in the scheme area. However a Lower Primary school and a duka are located in the major settlement area, and a dispensary elsewhere on the scheme.

There is a communal farm of 20 hectares in the settlement, this is on unirrigated land and appears to be allocated in 1 acre plots (4,050 sq. metres) for farmers to cultivate. Each farmer sells his own produce from his plot and apparently gets the returns from this.

There is a TANU secretary in the village and he is responsible for the communal farm. On the other hand there is a farmers committee which allocates plots in the irrigated area and is responsible to the Singida District Council for the proper use of these plots. The rules include the provision that at least $\frac{1}{2}$ hectares of the irrigated plot must be cultivated.

The Major Problems

Thus after 12 years of development Mang'onyi is a workable irrigation scheme but one in which the intensity of use would not have justified the initial investment or the many, but diffuse efforts to improve its output.

There appear to be three fundamental problems at Mang'onyi each of which have led to others. They are:

- (1) The failure of the water-supply in 1961 and the loss of farmers
- (2) The failure of farmers to use irrigation for a different kind of agriculture than the traditional one.
- (3) The distance from and capacity of the local market.

Of the three and the other subsidiary problems the latter is probably the most difficult. It appears that little attention has so far been given to the question of outlets for crops for this area. Maize is hardly the best crop for irrigated farming but a large percentage of the irrigated land is in maize. The success of proposals for other crops would need a carefully integrated scheme in which markets were first analysed and marketing structures examined. A preliminary analysis of local possibilities is not promising. Thus although the farmers here have not produced irrigation crops, they can hardly be blamed under these severe market constraints.

At various points in this account other problems have been mentioned; the problem of adequate water, the use of available water on the best soils, the drainage of other soils, the lack of experience of the peasants in using irrigation water. However, there is no great value of seeking solutions to these problems without first examining the whole viability of the scheme in its present location. There is no question that a good food supply for the farmers and some small cash crops are being gained from the project, but with an estimated cost of 1,140/00 per capita we need to ask whether and how this project can be made more useful to the nation as a whole.

Some conclusions

Mang'oniyi was never planned as a whole and although a considerable amount of technical assistance and expertise has been available, it has not been co-ordinated to provide an overall assessment of the scheme. Most of these errors resulted from the very differing concepts of the scheme which occurred in the 1950's. A further major set-back in 1961 was a result of the very dry year.

It is clear that it is technically possible to irrigate land in this area, and that problems of soils and water use could be overcome. However, it also seems clear that without considerable additional investment water shortages are likely to prove a handicap to any great expansion of irrigated land.

If we wish to make the most of the existing investment in water resources several questions need to be answered.

1. What crop or crops can be grown at Mang'onyi which can easily be marketed in Singida or further afield. The transport costs provide considerable limitations.

2. If the answer to this question is inconclusive or negative, it would be instructive to ask how could the irrigated land be used to support the animal husbandry output of the village. Can the farmers be persuaded to combine subsistence crop farming with meat production. The social problems are considerable but this appears to be one possible future of the area.

3. In terms of the national goal of Ujamaa, Mang'onyi has much to learn, yet co-operative work on the irrigated communal plot could have a real demonstration benefit.

If a decision could be made of the most beneficial marketed crops to produce in the light of the marketing problems it should be possible to give the settlement a new focus. The crop(s) could be introduced on a genuine co-operative plot and the resident agricultural officer could be trained to introduce a whole package of improvements on the plot which could later be extended to the rest of the scheme. Co-operative marketing should be organised within the scheme and some assistance given in the early stages of the co-operative. However all this can only be viable in terms of an overall plan for the project.

I K O W A

Like Mang'onyi Ikowa has had a varied history. The scheme is situated close to the Dodoma-Kongwa road some 60 km. from Dodoma and 31 km. from Kongwa. It began as a scheme of flood control which was to prevent erosion of the East-West road. The river Majenjeuli crosses the road some 2 km. north of the site of the Ikowa Dam. Above this point it has a catchment of 613 sq. km. and has a highly variable seasonal flow with a maximum recorded run off of 700 cumecs. The original dam, from plans put forward in 1955 was for three purposes, mainly erosion control with subsidiary cattle watering and irrigation prospects (Report on Ikowa irrigation scheme W.D. & I.D. 1955).

In the original plan this involved an area of 65 sq. km. with tenant farmers working a mixed holding of irrigated and dry grazing. It was estimated that there were 240 to 400 hectares of irrigable land. A soil study was made revealing the following soil types in the irrigated area.

Soil Groups in Ikowa:

Gp. 1. Skeletal	60.0	hectares
Gp. 2. Red and red brown sandy loams and sand/clay loams.	53.0	"
Gp. 3. Brown sandy or silty clay	12.1	"
Gp. 4. Grey sandy clay underlain by calcareous rubble.	19.8	"
Gp. 5. Alluvial grey silty clay	17.0	"
Gp. 6. Alluvial brown or dark/grey brown silty or sandy clay underlain by calcareous rubble	48.0	"
Gp. 7. Alluvial dark grey clay or silty clay of Mbuga	<u>30.4</u>	"

Total 240.3 hectares

Of these soil types the last (48 hectares) was considered to be potentially the most productive.

The dam was completed in 1957 and then had an irrigation capacity at full supply level of 3.8 million cubic metres. The farm was started the same year under the auspices of the Regional Agricultural Extension Division of the Ministry of Agriculture. At that time it was run as an Agricultural Experimental Station with tenant farmers. One of these Mr. Kanyamala is now Chairman of the Farmers' Association at Ikowa. Maize, vegetables, various fruits, groundnuts and beans were among the crops tried. Initial yields were good and prospects encouraging (for example 64 bags of groundnuts were achieved in the first year).

It is not easy to find detailed records of the number of people and of the crops grown by the tenants in their first few years but in 1961 the Agricultural Station was closed down, partly it seems through shortage of funds and partly because the first set of trials had been completed. However, by this time the scheme was considered a failure locally. It is difficult to find all the reasons but the final blow was again the very dry season in 1961 when irrigation water was not available. The scheme was handed over to the district council at this time!

In the next year a report said, "Unfortunately the dam dried out in 1961 preventing irrigation and many local people have lost interest in the scheme, although attempts are being made to form an agricultural association. The local people feel that

traditional wet season farming is adequate to supply their own food demand or it is difficult to provide a sufficiently remunerative cash crop to interest them in working during the dry season" (Report on Ikowa (Dodoma) and Mang'onyi (Singida) Irrigation Schemes June 1962. E.A. Institute for Medical Research Mwanza).

A small Farmers' Association was started about this time. In addition in 1964 a group of Tanu Youth League Volunteers moved in to cultivate the farm and about the same time a group of about 40 women were sent here to settle and cultivate. The TYL group was quite vigorous and attempted to grow rice, maize, and onions. But they had had little previous farming experience and after about a year their numbers dropped off rapidly as did those of the women. A small number of each group do, however, remain on the scheme. In February, 1965 an FAO report noted that only about 40 acres (16 hectares) were being cultivated by 26 tenants many of whom were not in evidence around the scheme. The dam then was being used for:

1. Flood control
2. Domestic water supply for 3,000 people
3. Cattle watering for 4,500 head.

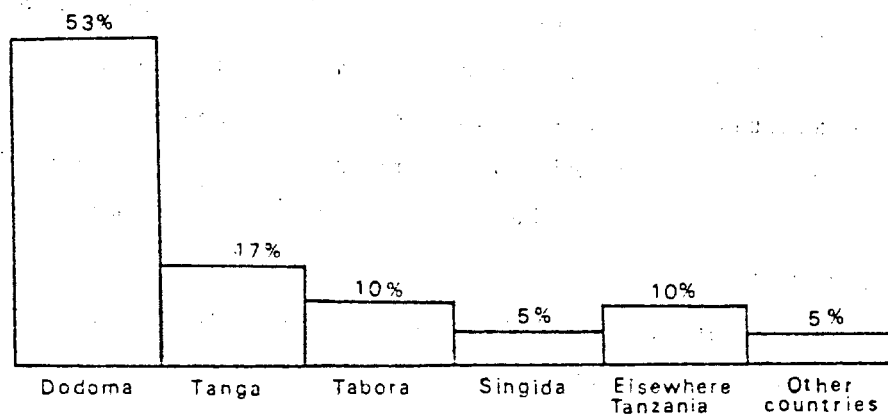
In 1966 the local farmers succeeded in forming and properly registering a Farmers' Association with the long term tenant and settler Mr. Kanyamala as Chairman. TANU and the V.D.C. encouraged the formation of this association and the land and water was hired to the groups on a 99 years lease. The Association has a farm manager, a treasurer, a secretary and a functioning committee.

The Present Position (1968/69)

The Bureau of Resource Assessment and Land Use Planning study covers the period April 1968 - September 1969 and involved a comprehensive interview and investigation of the farmers and crops. No detailed studies of the physical characteristics of the area were made at this time as considerable earlier data existed.

In April 1968, 285 people in 58 households were connected with the Ikowa scheme. This compares well with past figures. About one fifth of these were original settlers and 11 households had been in the settlement for less than two years. Fig. 2 shows the origin of the settlers at Ikowa with over half of them coming from Dodoma region. Very few had any experience at all with irrigated farming before they arrived here but most of the present farmers have an agricultural background. A feature of Ikowa is that a number of the tenants (possibly 20) live in Dodoma. Part time farmers travel out daily from Dodoma in busy seasons, though some employ hired labour to assist them. A number do have a house at Ikowa as well as their residence in the town. The group does bring some new ideas on cultivation and crops to the scheme and their TANU connections should be beneficial in promoting a rapid flow of ideas to the other farms. However, there has been some lack of communication between the two groups and with two such types of farmers in one scheme the move to genuine ujamaa-type co-operation is more difficult

FIGURE 2. ORIGIN OF PEOPLE AT IKOWA



to achieve. There is thus a tendency for two groups of farmers to be defined, those resident at the Scheme and those in Dodoma.

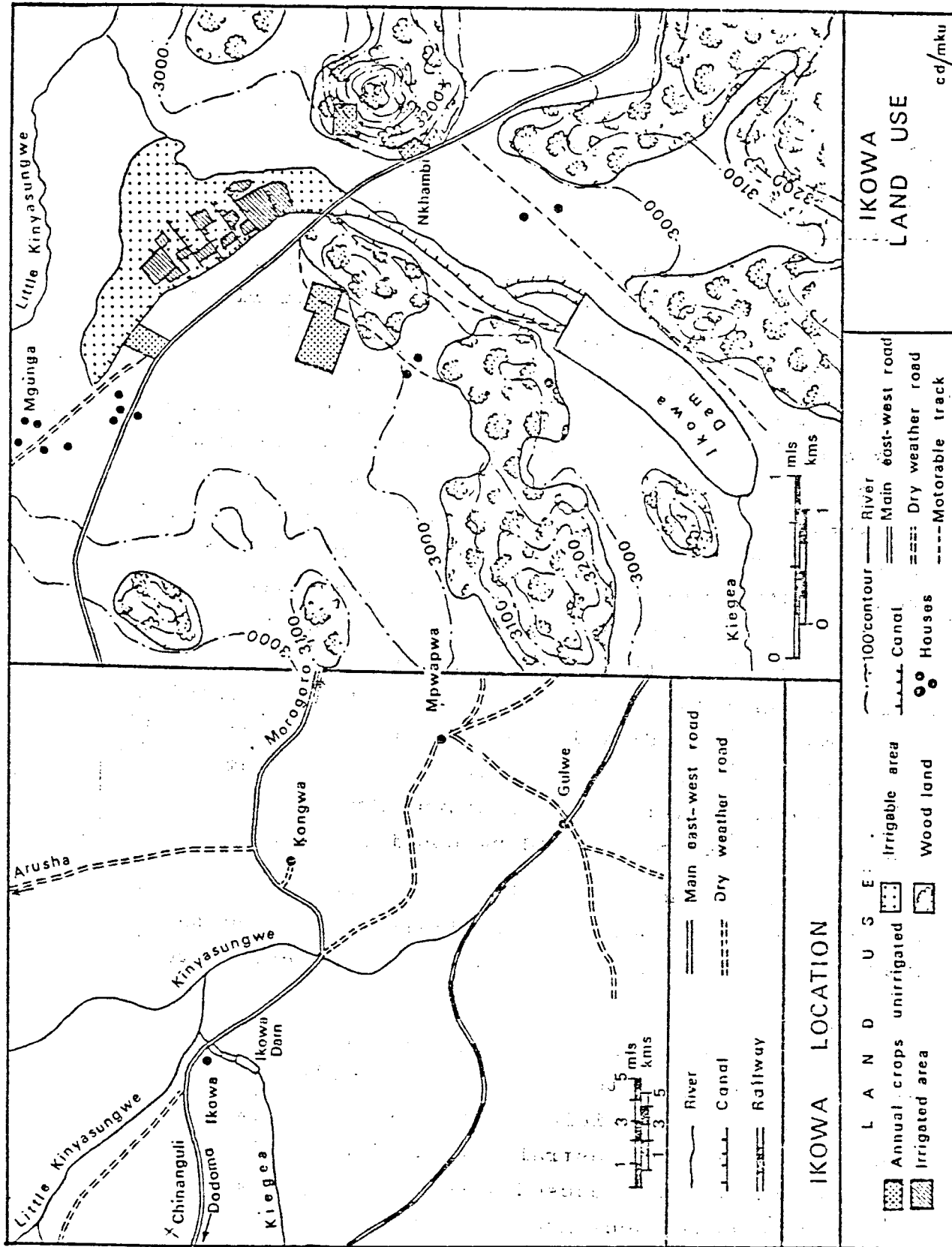
The Land:

The area most suitable for irrigation is the inner part of a large bend of the Majenjeuli river (Map. 4). The red soils are derived from the weathering of local granites and form the higher ground while progressively towards the river alluvial dark clays derived from river deposits are encountered and these become calcareous near the river. The area at present under irrigation is marked in Map. 4 (Land Use Map). In 1968 about 40 hectares were irrigated mainly on the red clay loams and alluvial dark clay soils, while it was variously estimated that 180 - 240 hectares could be irrigated. However extension of the irrigated area by a considerable amount would entail a new layout of the distribution canals and clearing the present ones. The costs of this would be about 20,000/00 but naturally the returns from the additional investment would be considerable.

On the land already irrigated and even more so on the lower land suitable for irrigation adequate drainage is essential but this could be accommodated in the above estimate.

A major constraint on the extension of the irrigated area is water. More water could be made available by more efficient water use (see next section). A second restraint is drainage. The lack of drainage has caused water logging in some areas and a consequent great reduction in crop yields.

MAP 4



Water Supply

The original capacity of the reservoir was estimated at about 3.8 million cu. m. During the period 1957 - 1964 the average inflow into the reservoir has been of the order of 4 million cu. m. per year though there are considerable fluctuations from year to year (Fig. 3). With an average rainfall in the catchment of about 610mms. this suggests a run-off ratio of $1\frac{1}{2}\%$. The nearest rainfall station is at Kinyasungwe, some 16 kms. away but this has only 4 years of records. 610 mm. may be on the high side for a long term figure viewed in comparison with Dodoma totals over a much longer period.

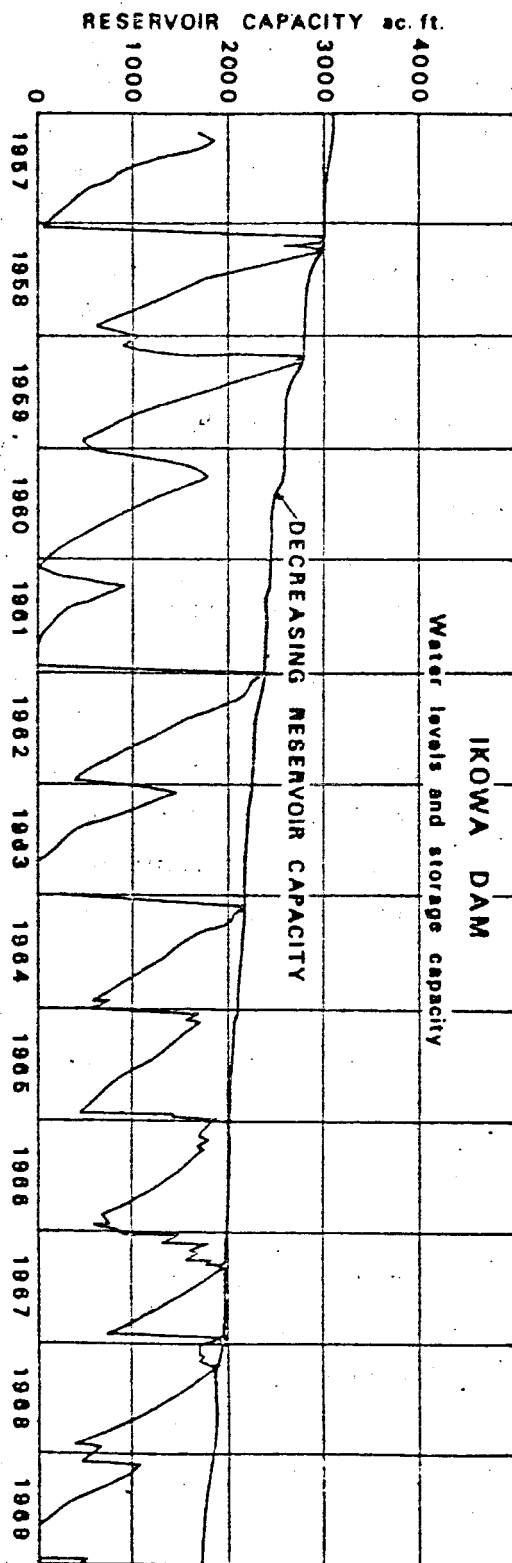
However, the catchment is very heavily grazed and the silting of the reservoir has been rapid. Surveys have been carried out in 1959, 1961 and 1963 by W.D. & I.D. and in 1969 by the Bureau of Resource Assessment and Land Use Planning. By 1963 the capacity of the reservoir had been reduced to about 2.7 million cu. m., a reduction of almost 30%. Since 1963 the rate has been reduced somewhat but the capacity in 1969 is estimated as about 2 million cu. m.

In 1965 this situation was recognised and the following recommendations were made:

"It is strongly recommended that investigations are started in order to make possible a revival of the scheme on a small scale. Investigations are therefore suggested along the following lines:

1. To investigate the possibility of directing the river into the Nyika ya Itumbi Mbuga. If easy diversion appears to be possible the Mbuga could be used as a silt-trap since the average slope of the river will be decreased $2\frac{1}{2}$ times locally

FIG. 3



2. To investigate the possibility of enlarging the reservoir capacity either by increasing dam height and spillway sill level or by temporary measures which will be washed away by extremely high spillway discharges.

The diversion of the river through the above mentioned mbugas is likely to reduce the peaks of flash floods.

3. To gauge the feeling of the farmers concerned about reorganisation of the scheme. Without a check on the excessive water waste no irrigation scheme in the true sense of the word is possible.

4. To investigate water losses in the canals in order to come to a rational ratio between water released at the outlet and water requirements in the field. It should be realised that there is no cure against a possible drought year as experienced in 1961 when only 1.1 million cu. m. of water was collected in the reservoir. Therefore the scheme should be made flexible and geared to the water yield as collected each year in the reservoir." (F.A.O. report 1965)

Such recommendations are now more urgent in 1969 unless the whole investment is soon to be written off. In 1968/69 water was supplied to the scheme at .08 cubic metres per second for 11 hours a day (5 a.m. - 4 p.m.) which is equivalent to 12.6 mm. of water per day to all the 40 hectares. Much of this is lost on to the unused land and water use is very inefficient. If this supply rate were kept up it would be equivalent to approximately 1.5 million cu. m. per year but in fact there is considerable variation in water use from one month to the next. However, it still seems possible to rethink the water needs and the optimal periods

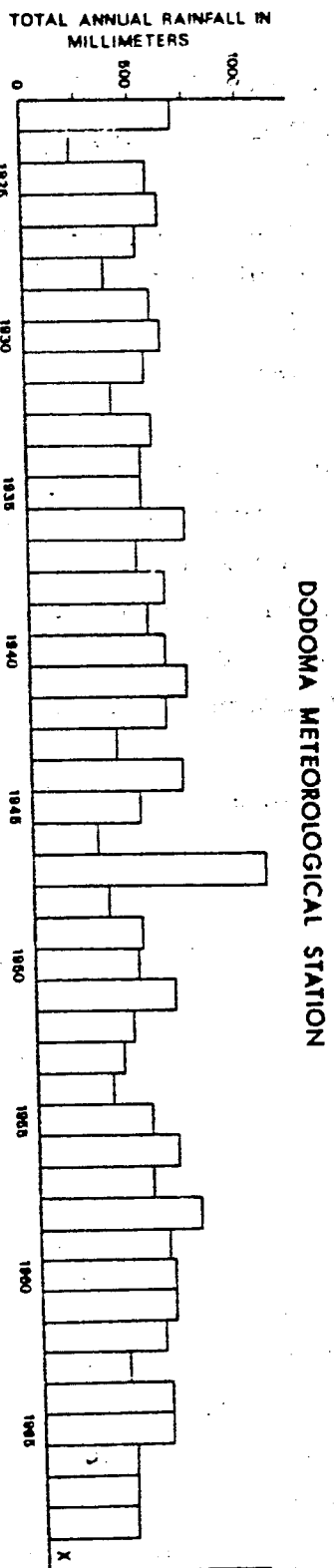
of water supply; to increase greatly the efficiency of water use and for some years to come to irrigate more land than at present but only on the basis of a vastly improved internal organisation.

Our field study indicates that although unused irrigable land is available 59% of the land cultivated by the tenants is not irrigated. This land is usually the red clay loam soils of the lower hill slopes which are usually planted with maize (88%) or millet (12%). The rainfed crops are, of course, dependent on the seasonal rains and in dry years are subject to failure. Dodoma has long term rainfall records, and annual totals are graphed in Figure 4. These show a very considerable year to year variation. The picture is completed by the graph of reservoir levels even over the short period since the construction of the dam. The indications are that full reservoirs even at the reduced capacity are likely only in about 50 - 60% of years. Water supply is thus a major variable in any plans for this area and efficient water use vital.

The Farming System:

Most farmers at Ikowa cultivate their own plots though there is now discussion of setting up a communal citrus plantation. Farmers normally have crops under irrigation and some land under rain fed cultivation. Animals play a significant part in the system and there is an average of just under 1 head of cattle per capita, though the residential farmers appear to have a higher ratio and those living in Dodoma considerably lower.

FIG. 4



In the sample farms studied (17 of the 58 households), there was in April 1968, a range of crops, maize occupying 59% of the land, rice 23% mixed crops 8%, millet 6% and there were a number of other crops. However, double cropping is usual on the irrigated land and onions are here important. Rice, vegetables, groundnuts, beans, bananas and sugar cane together with some maize are grown under irrigation. Maize and millet are grown on rainfed land. Acreage of rain fed crops is usually about $1\frac{1}{2}$ times that of irrigated crops but there is a considerable variation from year to year. Total acreage of 97.1 hectares in 1968 was rather less than 1.4 hectares per capita, partly reflecting the double cropping use of land, but also influenced by the number of off-site farms.

In 1968 the land under onions was much below normal, the seed which had been ordered from India did not arrive and other locally brought seed when planted turned out not to be onions at all.

Farming Inputs:

A major general input into the farming system is the dam and irrigation layout. As irrigation is only one use of the dam which in addition supplies water to some 3,000 people and 5,000 cattle the total cost of the dam cannot be calculated as being for the irrigation scheme. The cost of the dam in 1958 was 635,487/00 and a further 99,111/00

was spent on layout of channels and canals. Maintenance of the dam and outlets appears to cost between 6,000- 12,000/00 a year.

The next major input is labour. The survey did not attempt a year round labour budget survey but some data was collected in September, 1968. Though the actual figures are rather unreliable it does appear in all cases that much more attention and time is spent on the irrigation and that rice cultivation is a major time consuming occupation though this crop does not occupy the largest area.

Of the labour input some 50% of our sample used hired labour at some stage of the farming operations, though on questioning later only 1 gave details of such use. 10 of the 17 sample farmers used bought and improved seed varieties and prospects for bringing improvements through this medium were very good, 5 people had used a tractor on hire but no ox-ploughs were used. No farmer in the sample, and it appears none on the site, used fertiliser.

Returns - Farming Output:

It is difficult to measure the output from this area and without a detailed year round survey it would be impossible to get exact figures. In 1968 farmers of the scheme obtained food to subsist and a number were able to sell crops. In our sample in September 1968, 6 out of 12 admitted to selling crops. Two sold rice, three sold maize and one sold sunflower and in addition 2 others gained income from a shop and from carpentry.

Income totals varied from 11/00 to 481/00 but none of these totals included the normally marketed onion harvest.

Farmers when questioned about yields for maize suggested a wide range of figures on irrigated land from 470 - 2,138 kilos per hectare and on unirrigated land from 112 - 1,635 per hectare. In the drought of 1969 no maize ripened on unirrigated land.

Marketing:

Maize and ground nuts when sold are marketed through the Central Region Co-operative Union (CRCU) and rice could be marketed through this channel also except that it appears to be either eaten or sold to neighbouring farmers. The Union is not prepared to market onions or other vegetables from Ikowa because of the uneven supply and the perishable nature of many vegetables. The Farmers' Association have thus in the past arranged the marketing of onions. Dodoma presents a good and reasonably accessible market with regular communications possible, but the output from the scheme at least in 1968 was not organised enough to really reap the benefit of this proximity.

In discussions of the advantages and disadvantages of co-operative marketing all of the farmers complained of the low prices offered by the co-operative, 7 farmers out of 12 could however see partly compensating advantages of co-operative marketing.

Organisation:

After many changes in organisation, Ikowa is now under the influence of at least three bodies. The Water Department and Irrigation Division is responsible for the upkeep of the dam and the first part of the canal and for supplying the water required by the farmers; it has no responsibility for or control over water use. An agricultural field officer is responsible for the trial plots and provides advice to the farmers, again he has no direct controlling voice in land and water use. Thirdly, the Farmers' Association forms the sole controlling body on water and land. It deals with membership, allocation of irrigated plots and is responsible for the clearing of canals and the other responsibilities of the farmers. As mentioned earlier some seed is purchased by the Farmers' Association and this body also markets the onions.

Despite the prominent role of the Farmers' Association very little co-operative work appears to take place on the scheme. In April 1968 and September 1968 a spirit of competition and individualism was dominant. Some help between individual farmers occurs when it is needed but there is no organised communal farming although a communal citrus plot is under consideration. One problem appears to be the relationship between farmers who live in Dodoma and those who live on the scheme.

Other Activities:

There is no organised fisheries scheme at Ikowa. The small available staff at Regional Headquarters have concentrated on other sites because of the rapidly declining fish population in Ikowa, probably due to the high silt content and the decreasing depth of the reservoir. Because of this there is no control on the fishing or any records of quantities caught. There are three professional fishermen here, all originally from Lake Nyasa. They sell fish at Mpwapwa, Kongwa and Kilosa. There are few local sales as the Gogo people do not eat fish. In 1969 the reservoir has dried up completely.

Although there are these problems with the fishing industry at Ikowa the fish caught have been good quality tilapia as the water is less acidic than in most reservoirs. Its position on the main road is also an advantage.

The Problems of Ikowa:

1. Irrigation schemes in the dry central parts of Tanzania will necessarily experience years in which water supply is poor and the farming system needs to be adapted to cope with this situation. However in Ikowa the long run problem is of the continual silting up of the reservoir, which although now apparently at a slightly reduced rate, threatens the future water supply of the project. A decision on the future of the scheme needs to be made and

investigation of the feasibility of the earlier F.A.O. proposals carried out. Drainage of the irrigated plots is also important.

2. This examination of the physical resource base will be of little value unless the organisation of Ikowa can be improved. The present Farmers' Association lacks the experience, and knowledge to administer such a scheme. Professional advice is available but not often sought and not often given.

3. Dual nature of tenants: the Dodoma based farmers are more progressive and help to introduce innovations, but they are essentially part-time and their livelihood does not depend entirely on the scheme. Problems thus arise particularly as the committee consisted largely of such people in 1968.

It is important to note that here marketing should not prove such a major problem, it is mainly the production end of the system that needs attention.

Future Prospects:

The scheme has considerable potential but to achieve such a potential the following matters need consideration and action.

1. The organisation of the distribution channels, levelling of plots, economic use of water and improvement of the drainage of plots. This would probably cost 20,000/00 but if followed up by the other measures recommended, should show very good returns for this investment.

2. A review of the possibility of further controlling the silt problem or of otherwise increasing the storage capacity of the reservoir.

3. The organisation of the scheme: Ideally the present Farmers' Association needs strengthening and to be given more direct advice. If the scheme could move to a more ujamaa type organisation based mainly on resident farmers the way would appear to be clear for more help and advice from Kilimo. The Dodoma farmers could be of real help in this innovation if some at least could live and work at Ikowa.

4. Agricultural re-organisation should move towards real irrigation farming in which a beginning has been made. Two or three crops a year should be possible and markets are available.

5. Marketing: Market prospects for the right crops are good, vegetables and rice are needed in the Dodoma market and if an organised system of production is set up this should in our opinion be accompanied by help in marketing. The Farmers' Association properly reconstituted and advised should be capable of arranging a workable marketing procedure.

In general, despite the real production, water supply and organisational difficulties at Ikowa, a further attempt should be made to put this project on its feet. Such an attempt can only succeed if a co-ordinated approach to the several problems is made.

MGORI AND MGORI DAM

Mgori is situated about 26 kilometres east of Singida and the dam has been built some 8 kilometres south of the village. The scheme is an example of a multipurpose project, initially designed to alleviate problems of water supply for people and cattle. Water supply is always a problem in this area and at least two local attempts were made to build an earth embankment that would pond back water for this purpose. These failed as floods overtopped the structure and breaches occurred. As a result of strong local representation a more permanent structure was designed and completed in 1959. It was a considerable undertaking with a full supply level capacity of 1.9 million cubic metres. Total construction costs were 232,510/00 and recurrent costs are about 1% of this annually. As well as drinking water for animals and people it was planned to provide a source of fish for local markets and to irrigate a small area below the dam. About 4.8 hectares of potentially good soil were demarcated and an irrigation channel capable of providing 0.224 cumecs (2 cusecs) was part of the original design.

Local people did not move voluntarily into the irrigated area as planned and little use was made of the irrigable land until 1961 when about 40 TYL members and some other volunteers were moved into the area. They cultivated partly on the red loam soils on the slopes surrounding the dam and partly on the irrigable mbuga soils. Crops seemed

quite promising but the work was hard and immediate financial returns not encouraging (42/00 in the first year). The second year was one of very dry conditions, and as the pressure on the settlers to remain there relaxed a little, the project disintegrated. Among the attendant problems was the damage done to crops by wild animals, which seem to be very numerous near the dam.

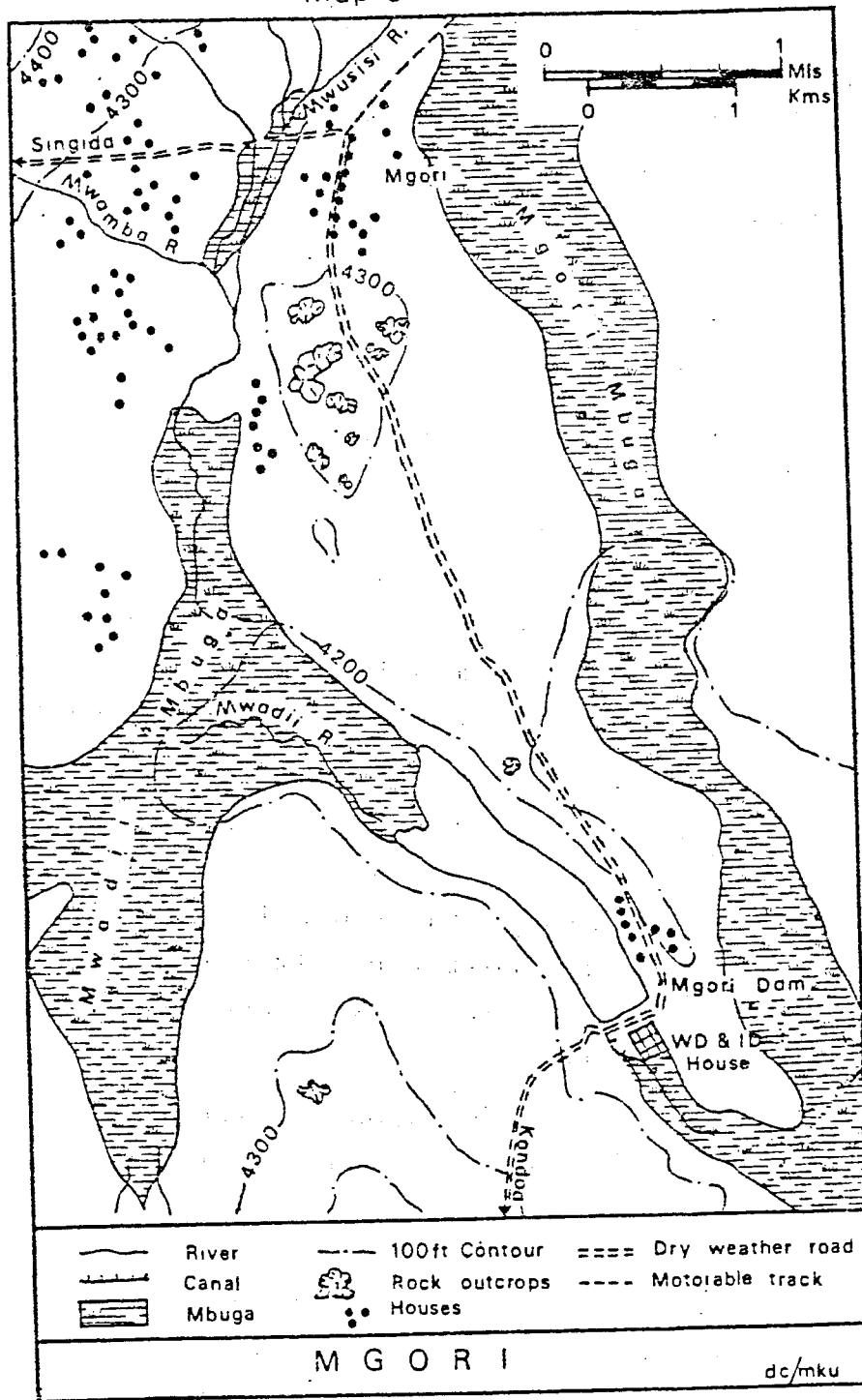
Present Survey:

The BRALUP study in this area was made in an attempt to find the reasons why full use is not being made of the dam and in particular why no attempt has been made to develop the admittedly small potential for irrigation. Two studies were made, one of a sample of farms at the long established Mgori village on the main road and the other of the group of people living near the dam. At Mgori dam there are about 20 households while 53 households in and near Mgori were included in that section of the study.

The Land:

Mgori is situated on a slight ridge which is typical of many parts of the area around Singida. Rocky outcrops of granite form the ridge top and the gently sloping margins of the hill are characterised by loose rather sandy soils derived from the granite. However on either side of Mgori ridge (Map. 5) there are mbuga valley floors of the Mwusisi stream on the west and the Mgori mbuga on the east. The old village has grown up on the dry higher land between 1,275 - 1,300 metres and the ridge is used by the road to Misughaa.

Map 5



Six kilometres to the south the mbuga narrows and Mgori dam has been constructed. The small village of Ngii (here referred to as Mgori dam settlement) has grown up again on the slightly higher ground above the reservoir. The soils here are more varied, consisting of:

- (i) Red soils - loams of the lower part of the granite catena. These occur on the ridge around Ngii village.
- (ii) Sandy soils west of the dam, similar to those in Mgori.
- (iii) Clay/loams of the mbuga floor below the dam. One small section of these soils is recognised by the local people as being too salty for normal cultivation.

In response to questions on the soils of the area farmers typically displayed a clear knowledge of these soil types, regarding the red soils and the clay/loams as being the best for cultivation. They recognised problems of heavy working and water logging in mbuga soils.

Another difference between the two areas is in the vegetation cover. Around Mgori land has been generally cleared but south along the ridge the scrub is thicker and there are patches of woodland. This is seen as a major local problem as wild animals were an important factor in the loss of crops in the TYL scheme and tsetse fly are common in the area. However the woodland is used for honey gathering.

Rainfall has been recorded at Mgori mission for 8 years and over that period there was an average of 665 mm, while in the driest year there was only 490 mm. Irrigation could be valuable to extend the growing season, to reduce the uncertainties of annual fluctuations, and to provide even in average and wet years the necessary moisture for particular crops.

The People:

The origin of the people in the two areas is given below.

Table 1

ORIGIN OF FARMERS AT MGORI AND MGORI DAM

TRIBE	NO. OF HOUSEHOLDS			
	MGORI		MGORI DAM	
Nyaturu	39	(73)	9	(45)
Nyamwezi	6	(11)		
'Arab'	2	(4)		
Nyiramba	2	(4)	1	(5)
Bondei	1	(2)		
Somali	1	(2)		
Burange	1	(2)		
Sondeni	11	(2)		
Matumbi			1	(5)
Gogo			2	(10)
Ha			1	(5)
Rundi			1	(5)
Kikuyu			1	(5)
Tusi			1	(5)
Nyasa			2	(10)
Pogoro			1	(5)
Total	53	100	20	100

Nearly three-quarters of the population of the long established village at Mgori are local people while over half of the smaller group at the dam have come from elsewhere. This is in part due to the specialised occupation, fishing, of a considerable number of people at the dam. It is noteworthy that the 'outsiders' at the dam and the village are two distinct groups, the Nyaturu forming the main linking body of people. The sex ratio of 71 for Mgori suggests that many men are absent working elsewhere, that of 100 for Mgori Dam probably reflects the presence of some men without their families.

The Agricultural System:

The traditional agricultural system in this part of Singida district is subsistence food production accompanied by cattle rearing. At Mgori village, maize, sweet potatoes and beans are grown with a small amount of cotton as a cash crop while there are an average 2.7 head of livestock per capita. The cattle therefore provide the main income in case of drought or when cash income is needed. They also of course have a major social significance. As table 2 shows there is an appreciable difference in the cultivation system at the dam, farms are smaller, maize acreage is lower and beans are not grown very much, probably because fishing is an important element here.

Table 2

CROP PRODUCTION AT MGORI

	<u>MGORI</u>	<u>MGORI DAM</u>
Maize	0.64 hectares/household	0.36 hectares/household
S. Potatoes	0.24 " "	0.24 " "
Beans	0.18 " "	0.004 " "
Cotton	0.2 " "	0.12 " "
Crop Land	1.51 hectares (3.75 acres)/household	0.97 hectares (2.41 acres)/household
Livestock per capita	2.7	1.7

There is no evidence to suggest that yields are much different between the two areas.

In livestock totals the settlement at Mgori Dam supports 1.7 head of cattle per capita, an important part of the system though much less than at Mgori.

Fishing:

Half of the households living at the dam include at least one fisherman and fish are the main 'cash crop' of this area, perhaps explaining lower cultivated areas and livestock numbers. The ten fishermen took an estimated crop of 30 tons of fish from the dam in 1966 and this was maintained in 1967 and 1968. The value of the 1967 catch was 16,800/00. This represents a very considerable cash income though it is not clear what the fishermen actually get for their fish. The main markets are in Mgori village, Singida and Babati and these should continue to provide markets for fish in the foreseeable future

So far there appears to have been no significant fall in the quantity of fish in the dam though the locals say that there is a substantial loss of young fish over the outlets and through the drain-off pipeline.

Inputs in Agriculture:

There are some signs that the pattern of subsistence crop production in the area is beginning to change and these may suggest some possibilities for re-examination of the irrigation question. We do not however have any detailed labour figures from our study. At Mgori 9 out of 13 sample farms were using improved seeds and 4 had used tractors for cultivation, but only one used fertiliser and most made some use of hired labour. The pattern of inputs was similar at the dam though one ox-plough was in use here and no-one used a tractor.

Outputs:

Apart from a little cotton people in this area do not appear to have experience of growing crops for market sale and cash income is derived mainly from the occasional sale of a cow and the fish. Most of the crop produce is consumed and a little sold locally.

The Possibility for Irrigated Farming:

The water in the dam is available for irrigation, the land below the dam is apparently suitable for irrigated agriculture, the take-off pipe is installed and yet at present there is virtually no use made of this opportunity. Why is this so?

Our study and particular questions to the local farmers did not reveal very major obstacles to irrigation in the area, but it is equally clear that none of the farmers living in Mgori or Mgori dam settlement have any experience of irrigated farming, and of the problems and benefits it brings. Of the farmers living near the dam at least half are trained fishermen and are doing quite well from this activity and their crops provide a useful subsistence income. It would appear to be difficult and unwise to attempt to persuade this group to undertake irrigated farming as an additional output of their farming system. Irrigation is labour intensive and time would be a major constraint.

On being questioned about the possibilities of irrigation a number of farmers in Mgori and one or two at the dam were interested, others equally were hesitant and evasive. Those who were interested felt that some definite lead by government should be made and that other people could also be attracted particularly by the provision of amenities at the dam site and by assistance with ox-ploughs in the early stages. It seems to us that a concentrated effort with the assistance of an agricultural field assistant who understands irrigation could result in the setting up of an ujamaa village using irrigation. Irrigation techniques should be introduced with the new crops and crops should be chosen both for their marketability in Singida or elsewhere and their effective use of irrigation; onions and other vegetables appear to be the most promising

Some effort should be made to attract a nucleus of farmers who have experience with water use and these could help to establish an ujamaa setting and with the help of the agricultural officer teach the others. Nothing much less than this sort of programme can result in successful irrigation here.

It is suggested locally that one of the problems of introducing more cash crops is the low prices paid for the current cash crops by the co-operatives. A good deal of honey produced locally is sold on the black market where prices are $1\frac{1}{2}$ times those of the co-operative and farmers are dissatisfied with the co-operative price of beans. Apart from this there are considerable local transport difficulties for the co-operative and it is difficult to inform people in advance of visits by the buyer. Although Singida is not far away there is a steep escarpment to be negotiated and in the wet season the road may be impassable to heavy vehicles. Marketing problems therefore figure large in a projected expansion of cash cropping.

Organisation:

There is no strong local organisation in these two villages, except the government appointed officials, though 'councillors' are elected to represent the village at different levels.

There is some traditional co-operation in the agricultural system in which people work together on a variety of tasks and are usually

provided with pombe and food by the farmer on whose land the work is done. The transition to ujamaa would involve some major changes but there are enough people from other parts of the country particularly at the dam to provide a variety of experience and skills for a successful attempt.

Problems of Mgori:

In terms of water for stock and in terms of the development of fishing the dam at Mgori has been a success although water outlets need improvement and health hazards need attention. However, the recurrent costs of the dam estimated on construction costs are around 23,250/00 while the cash yield from fisheries is estimated at 16,800/00 per annum so that all of the capital cost and 25% of recurrent costs have to be allocated against the water supply benefits of the dam. About 800 cattle belong to the two settlements and it is probable many others water at the dam particularly in the dry season. If 2,000 - 3,000 heads are served this would probably justify the remainder of the recurrent cost. However to get a better return on the capital expended and on the opportunity presented every effort should be made to improve crop production.

If we are to contemplate the development of irrigation some small crop experiments need to be set up and the marketing possibilities examined. A survey of the people around the dam suggested no basic inhibiting factors preventing the use of irrigation techniques.

People were however, rather cautious of the area near the dam and the record so far of crop production. A locally inspired programme of production and marketing linking the cash crops and the fish might be successful. With the success of the fishing some fish culture ponds might be attempted in the areas below the dam.

PUMA VILLAGE

The three villages considered so far in this paper have been part of new 'transformation' type schemes in which water control has been a major factor. Puma is a long established settlement about 22 kilometres south of Singida where farming is in conditions typical of a good part of Singida District. It is useful to consider Puma in this study partly because it provides some indication of the level of traditional agricultural enterprise but particularly because the farmers here have for a considerable time used the seasonal high water table on the lower slopes for additional irrigation-based water supply for their crops. Such long continued, locally developed water control may be of some value in our study of how better to effect water development programmes in the district.

Some small holder settlement has existed in the area for many years, but the construction of the railway to Kinyangiri resulted in a small station being located at Puma. The colonial authorities encouraged settlement around the station and a number of traders began to establish themselves. However, when the market place had become well established the line was closed down in 1947 and trade declined and many people left the area. Others who remained concentrated on farming. The centre is still an important one with 4 shops, a primary court, a dispensary, two primary schools, a mosque, a church, and a community development centre, together with UWT and TANU organisations. This is obviously

not a community which is supported entirely by agriculture and it has a central place function for the surrounding area. Nevertheless agriculture plays a significant part in the income of the majority of the people here.

The Land:

The land around Puma is rather typical of much of Singida District. The area is dotted with low hills which are little more than piles of granite boulders rising 10 - 12 metres above gently sloping plateau surfaces. Soils are generally sandy over most of the area but the valley floors are flanked by strips of flat clayey mbuga soils and the lower slopes also have patches of heavier soils, clay loams derived from the weathering of the granite.

The soils thus represent a toposequence or catena, with rocky outcrops, followed downslope by wide sandy pediment surfaces with 1° - 2° slopes. The soils of the lower slopes are dark clay loams which are transgressed by flat or gently sloping alluvial clays in the valley floor.

During and after the rains the water-table in the weathered material rises and on some of the steeper valley sides with a 2° - 3° slope springs and small water seepages occur. Water can be led from these localities through shallow trenches onto the lower slopes and the margins of the mbuga.

The old railway embankment has been used as a dam in the valley west of the settlement and this now provides a supply of drinking water for animals during the dry season. Fish have been introduced and a limited amount of fishing is carried out.

The nearest rainfall records are from a mission 17 kilometres away and are probably typical of the area. In 16 years of records a range of annual rainfall from 217 to 962 mm. has occurred with a mean of 605 mm. The wide range has obvious disadvantages for agriculture. In an average year the growing season extends from November to April and there is very little rainfall outside these months. The benefit of continued moisture supply through the high water table is thus very important.

The BRALUP Survey:

An area of about 7.8 sq. km. (Map. 6) west of the road and including Puma village was the main focus of the field investigation. In this area were 430 people in 77 households. While these were covered with a short overall census and questionnaires, 20 households were used for a more detailed sample study.

The People:

The people of Puma are mainly from Singida district and 59 households representing 76% of the population are Nyaturu, 4 households (8%) are Nyamwezi;

another 4 households Nguu, and 2 households are Sumbwa and Zaramo. The rest are made up of one household each of Rangì, Galla, Ngouri, Rufiji, Manyema and one of mixed race. The area has a mixed character though the large majority are indigenous, 84% being born in Singida Region. The sex ratio of 90 suggests that a number of men are away working elsewhere.

The Agricultural System:

The farming system is based on millets, maize and cassava, with some sweet potatoes and cotton. Cattle are an important part of the system with an average of 1.5 animal units per capita. (8.4 per household).

Table 5

Crop areas at Puma - based
on sample of 17 farmers

Millet	5.1 hectares	40%
Maize	3.5 "	27%
Cassava	1.9 "	15%
Sweet Potatoes	1.1 "	8%
Sugar Cane	0.6 "	4%
Cotton	0.1 "	

In the area studied about 17% of the land has some form of supplementary water supply, using the high water table as a source after the end of the rains and in dry periods in the rains. The crops grown on this land are sugar cane, bananas and sweet potatoes. It appeared to us that rice and onions would also be productive crops on this land.

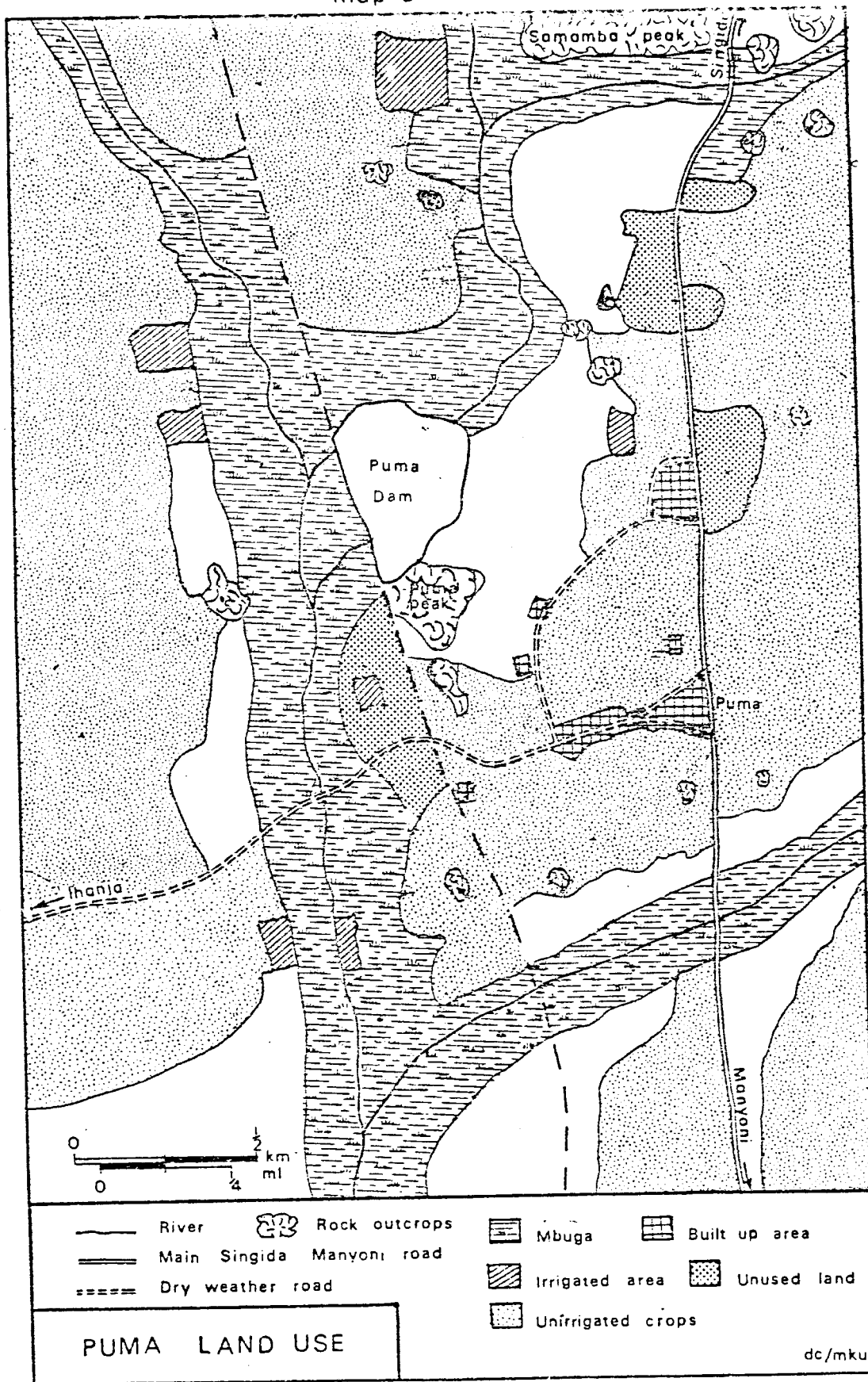
It is interesting to note that the local farmers have a good idea of the basic principles of irrigation. In some areas where water is abundant the ridges are made to lead it away on to other parts of the slope, in other areas small bunds are made to retain water and allow it to soak into the soil.

One feature of Puma is the small amount of land under cultivation, less than 80 hectares for 77 households, an average of about 1 hectare per household and 0.2 per capita. This in a region where soils are generally poor probably reflects the character of the settlement with other income playing an important part in the livelihood of many families.

Inputs:

From our study it appeared that much of the farming here was on a subsistence basis with very little inputs other than the farmer's family labour. However about half of the farmers studied in detail had bought seed during the last year, and over a third had used some form of hired labour; none had bought any fertiliser or used ox-ploughs or tractors in their cultivation. It seemed also that Puma people did not make as much use of animal manure as many people in Singida District though this practice is quite common in the surrounding areas.

Map 6



Marketing:

The Co-operative office at Puma buys castor-oil seeds, beans, maize, millet, groundnuts, wax and honey and serves a much wider area than the study area. The Co-operative does not buy perishable goods, such as bananas, or crops produced in small quantities, such as sugar cane. Passengers on the way to or from Singida form an important local market for eggs, bananas, fish (from the dam) and sugar cane.

There is the suggestion locally that farmers have been dissuaded from growing castor by what they consider are the low co-operative prices; alternatively they attempt to sell any they grow on the black market. The other major co-operative problem appears to be the wide area one buyer has to cover resulting in uncertainty of when he will visit the Puma office, which happens sometimes at intervals of 5 - 6 weeks.

Organisation:

Puma is a well defined nucleated village which serves a considerable area. Services available include four dukas, a dispensary, two primary schools, a mosque, a Lutheran church, a primary court and a community development centre with literacy classes, and a piped water supply. It is thus far from a typical agricultural settlement.

The local organisation is based officially on the Assistant Divisional Executive Officer, the Village Executive Officer and then the ten house cell leaders.

There is a TANU branch here and a UWT branch. However communal activity is mainly of the traditional kind with exchange of labour between farmers in return for pombe or food. There is some communal grazing land in the traditional fashion but in 1968/69 there was no communal shamba.

Some Problems at Puma

Puma farmland is a rather poor part of what is generally a poor region. The farmers have begun to develop one of their local resources, the high water table, but this has not been developed nearly to the fullest extent.

One of the major problems here appears to be land tenure. Traditionally the mbuga areas have been grazing land and most of them are still 'owned' by individuals who use this for grazing. However, as suggested above there are good possibilities for extending agriculture where sub-surface water is available. Traditional holds are very strong and in some cases where the local authorities have stepped in and allocated some of the grazing land for cultivation the farmers have been very reluctant to take it up. Pressures put on them include the threat of witchcraft and understandably they are hesitant.

However, we were not able in the time allotted to this study, to pay any detailed attention to the problem of cattle and grazing lands and this was a serious deficiency in our work.

Cattle in this as in other communities provide an important reserve in famine years and are a source of cash. Good grazing land is scarce in Puma and it would be unwise to recommend development of the traditional grazing areas without a picture of the overall land use problem.

It is clear that good agricultural land is short and that more productive use can be made of the slopes where water is available. This can only be done properly if at the same time grazing problems are dealt with. If any attempt is made to develop this special pattern of agriculture, attempts should be made at the same time to introduce other crops and encourage the use of fertilisers.

Alternatively it may be possible to encourage some of the farmers at Puma with their experience of irrigation to play a part in the re-invigoration of the Mgori dam irrigation project.

SOME RECOMMENDATIONS AND COMMENTS ARISING
OUT OF 4 STUDIES OF IRRIGATION IN SINGIDA
AND DODOMA DISTRICTS

Although each of these three irrigation schemes studied show individual features general points arise which may be of value in considering the future of such schemes and other new projects. Some detailed suggestions referring to each particular area are given in the individual sections.

Water Resource Development:

Each of the three dams was built initially for erosion control and cattle watering purposes. At some later date when it was evident that an additional water resource was available (or going to be available) measures were put forward to use it. The irrigation aspects of the schemes were not therefore integrated with marketing prospects, local capabilities of using irrigation, etc. As the provision of irrigation water was not a major feature of the original proposals the problem of water supplies for irrigation in low years was not taken a great deal into account.

Arising from these problems the following recommendations are put forward:

1. No village irrigation scheme should be undertaken without an economically attractive organised market for its products. This should be viewed as a technical problem equal to water provision and should require the same level of technical assistance.

2. Where irrigation is developed as part of water resource development adequate funds should be set aside for a demonstration farm and a training programme for the farmers in these new techniques. Every effort should be made to attract to the scheme a nucleus of farmers that have some experience with irrigation. This may need some special measures. One suggestion would be to train some national servicemen and women in techniques of irrigation as part of their National Service programme. Alternatively school leavers' training courses might be organised. Irrigation is the kind of agriculture that can really benefit from having a literate farmer with a technical orientation and some arithmetic skills.

3. It will considerably help the acceptance of the new techniques required if the irrigated plots are used for the cultivation of 'new' cash crops. Food crops if they are grown under irrigation are often grown in traditional ways which are uneconomic. Looking to the future, irrigation should be linked to the introduction of the new high yielding varieties developed in the so-called 'green revolution'.

4. Nearly all small scale irrigation schemes in the drier parts of the country are likely to suffer years like 1961 when little water is available. Account should be taken of this in the design of the farming system perhaps by accumulating reserves and by using livestock as a reserve for dry years. It might be possible to develop somekind of crop insurance to meet this problem.

5. Irrigation schemes that are not near a main routeway with access to marketing are unlikely to be economically viable unless they are large enough to demand their own infrastructure.

6. It is noteworthy that in the two functioning schemes there has been heavy investment in water distribution, little investment in drainage and no investment by the farmer in fertilizer. In demonstration farms in irrigated areas a whole range of new techniques will need to be introduced. This is not easy and may well prove to be a constraint on the development of irrigation projects. With investment in irrigated land at an average of 2,600/00 per hectare, initial help to the farmer in investment in fertiliser, selected seeds and drainage would be cheap marginal investments but would produce much greater returns than the initial investment alone.

7. The pattern of decision making with regard to the irrigation projects was apparently V.D.C. - D.D.C., R.D.C. - W.D. & I.D. Construction and initial development is carried out by W.D. & I.D. and the schemes are then handed back to local councils or sometimes to the Ministry of Agriculture, Food and Co-operatives.

It is after the handover stage that many troubles occur and that funds are often lacking to continue educational and training aspects of the schemes. It would greatly ease the take-over difficulties if local authorities were integrated with the decision making structure at both technical and administrative levels throughout the development stage. Now that the Ministry of Agriculture, Food and Co-operatives is expanded this problem may be less severe.

8. In general it seems to us that such small schemes are worthwhile as long as they can (a) serve a role in local agricultural and economic development, (b) meet specific market needs within a defined area, (c) serve consciously as a training ground for farmers in techniques of irrigation and, therefore, have a clear educational component, and (d) be integrated into district and regional development programmes. Ikowa and Mgori might be good locations for small pilot training projects as suggested in paragraph 2 above.

9. The points above are mainly concerned with irrigation but other aspects of water resource development also need attention. The possibilities not only of fishing but fish farming are worth consideration wherever dams are constructed.

10. The use of watering centres such as dams in the guidance and control of the livestock industry needs consideration. The possibilities of integration of such investment with other animal oriented investments such as dips, etc. are not always fully utilised.

11. Irrigation projects are transformation projects and need close co-ordination between individuals in the scheme. They should, therefore, in our opinion either be run by the Ministry of Agriculture, Food and Co-operatives on an experimental and educational basis and then gradually transferred into co-operative ujamaa projects, or they should be set up on an ujamaa basis but with provisions for continued help and education in irrigated techniques.

12. Most of the recommendations outlined above are in the direction of greater co-ordination between divisions and between local and central authorities. Many moves in this direction are already being made. It may well be that Regional Development Committees should consider setting up a small technical committee under the Regional Director of Agriculture or the Regional Economic Secretary to deal with the planning and organisation of such schemes. It should be possible for the Regional Planning Division in Devplan or BRALUP in conjunction with W.D. & I.D. to work out guidelines for such sub-committees. One priority for such committees would be to review irrigation and other water control schemes in the regions and make recommendations for their future development.

APPENDIX I: SOME SAMPLE FARMERS

To give some idea of the characteristics of the farmers in the settlements, more detailed information - based on the results of our questionnaires - is given here for one farmer in each. In all cases there is so much variation between farmers that it would be misleading to say that the farmers chosen are typical of their villages. However, the majority do represent relatively "average" conditions.

Mang'onvi:

The sample farmer in Mang'onvi was chosen because he is one of those who have both irrigated and non-irrigated land and so demonstrates the pattern of land use on both types. He is a member of the local Nyaturu tribe and was born in the area. However, he has lived in several other parts of the country and, before he moved back to Mang'onvi a year ago, he was farming in Dodoma. He heard about the irrigation scheme from his brother, who was already there, and decided to return in the hope of obtaining better land.

He is 36 years old and the only other member of the household is his wife. The family is, therefore, smaller than the average. He owns 1.2 hectares (2.9 acres) of land, of which nearly two-thirds is irrigated. The layout of the land at the time of the survey is shown in Map 7. On the unirrigated part there were pure stands of maize and cotton and some mixed crops of maize, beans and potatoes. Almost half the irrigable land

was unused. A pure stand of maize was grown on the remainder, with small areas of sugar-cane and potatoes. The farmer had used no hired or communal labour but had used oxen for cultivating part of the land.

The only livestock owned by the household are two chickens.

Ikowa:

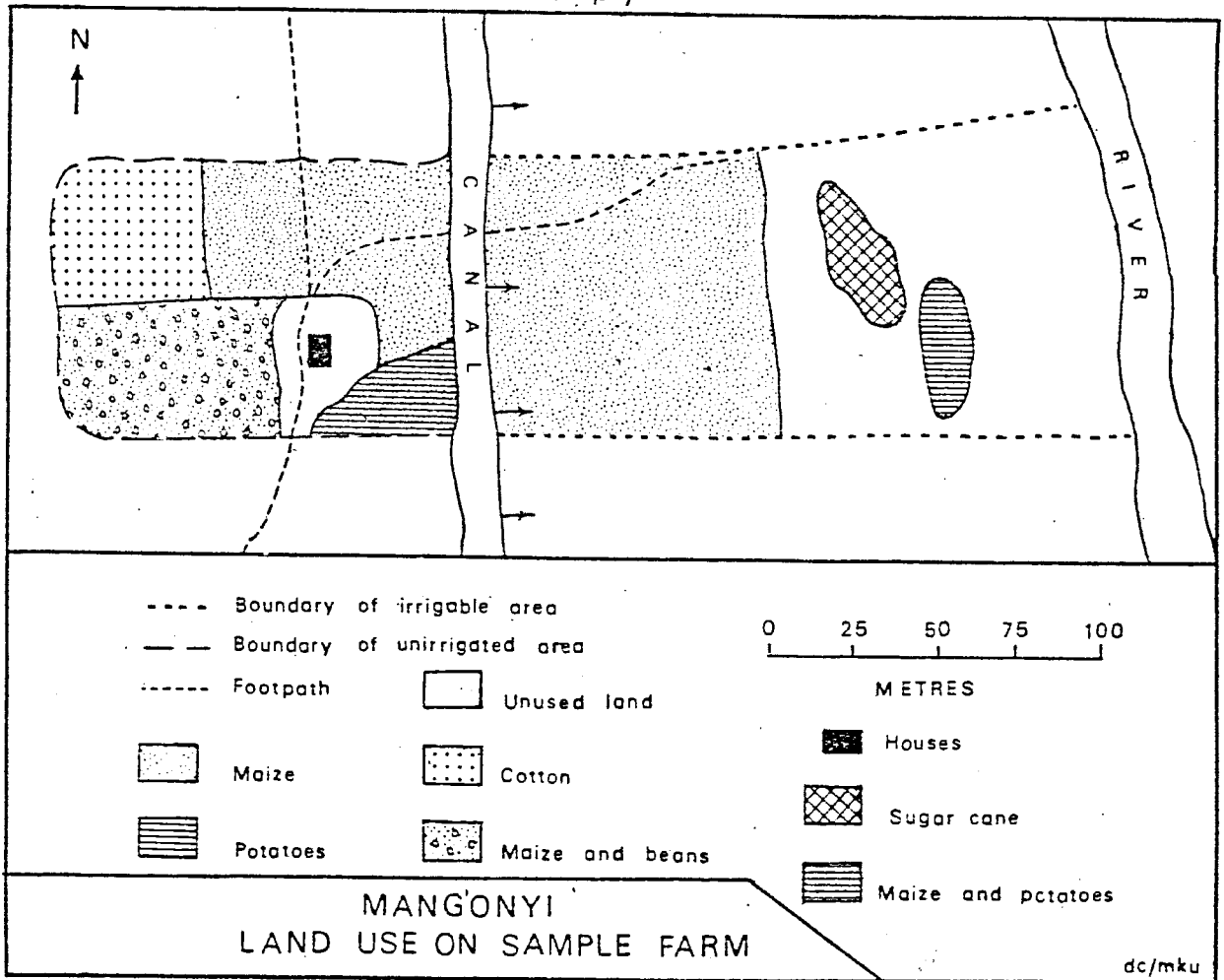
The sample farmer in Ikowa, who belongs to the Nguu tribe, was born in Tanga, where he owned a farm and also earned money by selling tobacco. Five years ago he was travelling past Ikowa, selling tobacco, and was impressed by its fertility and so decided to move there with his family.

He is 26 years old and has a wife and five children, all under the age of ten. He has 2.6 hectares (4.3 acres) of land, of which 0.4 hectares planted with maize, was unirrigated and the remainder irrigated. At the time of the survey he was growing 0.4 hectares each of maize, rice and sugar-cane and 0.1 hectares of onions on the irrigated land. He had marketed some onions and some rice. No hired or communal labour nor mechanical power had been used. Again the only livestock that the farmer possesses are chickens.

Mgori Dam:

Like many of the other settlers at Mgori Dam, the sample householder is both farmer and fisherman. He belongs to the Logoro tribe and was born in Mahenge, but has also lived in Dodoma and Singida Regions.

Map 7



Five years ago he was living 27 kilometres from Mgori when he heard that prospects for both fishing and farming were better at Mgori.

The household consists of the farmer, aged 41, two women between the ages of 19 and 50 and one youth.

At the time of the survey he was only cultivating 0.8 hectares (2 acres) of unirrigated land because part of his income is derived from fishing; but he was planning to expand his land in the future. Two thirds of the area was planted with sweet potatoes and one third with cotton. No additional labour had been used on the land. The only livestock owned by the family are two chickens.

Euma:

The Euma farmer was born in the area and is a member of the Nyaturu tribe. He left home to work in the coffee estates in Arusha but returned to Euma five years ago to see his family, marry and settle down.

He is 31 years old. The household consists of himself, his wife and three children under the age of ten. He has 0.8 hectares (2 acres) of land none of which is irrigated. One third of an acre was planted with castor oil at the time of the survey and the remainder with finger millet. He had marketed some castor oil. Five man-days of communal labour were used for the cultivation of the millet, in return for which beer was provided.

APPENDIX II: BASIC DATA

Table 4: Demography

	MANG'ONYI	IKOWA	PUMA	MGORI	MGORI DAM
Number of households	101	58	77	53	20
Total population	462	285	430	247	80
Average family size	4.6	4.9	5.6	4.7	4.0
Sex ratio (males per 100 females)	92	97	90	71	100

Table 5

Period of Residence in Village

PERIOD OF RESIDENCE	MANG'ONYI		IKOWA		PUMA		MGORI		MGORI DAM	
	No.	%	No.	%	No.	%	No.	%	No.	%
Under 1 year	5	5	-	-	2	3	2	4	1	5
1 year	18	18	1	2	2	3	6	11	-	-
2 years	8	8	10	17	5	7	2	4	3	15
3 - 4 years	26	25	20	35	12	16	4	7	3	15
5 - 6 years	19	19	8	14	11	15	3	6	4	20
7 - 9 years	9	9	8	14	10	13	3	6	3	15
10 -r more years	15	15	11	19	26	35	17	32	6	20
All life	1	1	-	-	6	8	16	30	-	-

Table 6

Origins of People

REGION OF ORIGIN	MANG'ONYI		IKOWA		PUMA		MGORI		MGORI DAM	
	No.	%	No.	%	No.	%	No.	%	No.	%
Singida	89	88	3	5	65	84	46	86	12	60
Dodoma	5	5	30	53	3	4	3	6	2	10
Tabora	3	3	6	10	5	7	1	2	1	5
Tanga	1	1	10	17	-	-	1	2	-	-
Other parts of Tanzania	1	1	6	10	4	5	1	2	2	10
Other countries	2	2	3	5	-	-	1	2	3	15

Table 7

Other Occupations

OCCUPATION	MANG'ONYI		IKOWA		PUMA		MGORI		MGORI DAM	
Fisherman	-		-		-		-		10	
Shopkeeper	4		2		4		1		-	
Trader	-		3		4		1		4	
Craftsman	3		8		4		3		-	
Manual labour	-		-		13		6		-	
Messenger	-		-		1		6		-	
Clerk, etc.	-		1		3		4		-	
Driver	1		1		-		-		-	
Teacher	2		3		1		4		-	
Medical staff	2		1		1		2		-	
Agricultural staff	3		-		-		4		2	
Local Govt./TANU	2		1		1		4		-	
Others	3		-		3		3		-	
No	20		20		35		38		12	
Total	20		35		46		72		60	
No other Occupation	31		38		42		15		8	
	80		65		54		28		40	

Table 8

Reasons for moving to the villages

REASON	MANG'ONYI	IKOWA	PUMA	MGORI	MGORI DAM
Irrigation	4	8	-	-	-
Good for agriculture	7	2	3	-	1
To trade	1	-	-	1	-
To fish	-	-	-	-	4
Because of school	-	-	2	-	-
Near road	-	-	-	-	-
Born there/parents moved	1	2	13	6	-
Relatives there	1	-	-	1	-
Posted there on job	4	-	-	4	-
Wanted to cultivate	2	4	-	-	-
Sought refuge from original home	2	-	1	-	-
Other	2	2	1	1	1

Table 9

Land Use - Sample Farms

ACREAGE	MANG'ONYI	IKOWA	PUMA	MGORI	MGORI DAM
Maize	44.8	47.4	8.7	18.8	4.7
Millet	-	5.0	12.5	0.5	-
Rice	-	19.1	-	-	-
Beans	9.1	-	-	5.5	0.1
Ground nuts	-	1.6	-	8.2	3.2
Cassava	-	-	4.9	0.4	0.1
Sweet potatoes	-	-	2.6	6.2	3.3
Sugar cane	3.3	-	1.5	-	-
Cotton	4.3	-	0.3	6.5	1.8
Mixed cropping	26.2	6.1	-	-	-
Others	0.1	0.8	0.1	-	-
Total	88.3	80.0	30.6	46.1	13.2
No. of sample households	25	17	17	12	5
Average/household	3.5	4.7	1.8	3.8	2.6

Table 10

Land Use - Village Totals

	MANG'ONYI	IKOWA	PUMA	NGORI	NGORI DAM
Total acreage	416	239	194	165	48
Average acreage per household	4.1	4.1	2.5	3.1	2.4
Percentage irrigated	52	41	17	-	-

Table 11

Livestock - Village Totals

	MANG'ONYI	IKOWA	PUMA	NGORI	NGORI DAM
Cattle	483	227	241	146	54
Goats	346	88	185	217	42
Sheep	169	16	120	154	20
Chickens	805	279	306	526	87
Others	7	-	2	-	-
Total livestock units*	587	247	302	220	66
Average units/household	5.8	4.3	3.9	4.2	3.3

Table 12

Agricultural Inputs

PERCENTAGE SAMPLE FARMERS USING	MANG'ONYI	IKOWA	PUMA	NGORI	NGORI DAM
Purchased seed	40	59	42	69	40
Fertilizer	4	-	-	8	20
Ox plough	16	-	-	-	20
Tractor	-	29	-	31	-
Hired Labour	32	53	37	62	60

*1 livestock unit = 1 cattle beast, 5 sheep or 5 goats; chickens are excluded.

APPENDIX III: METHOD OF SURVEY

One of BRALUP's early projects was a comparative study of 12 villages in Tanzania. All villages had some innovative aspects and all were studied by similar methods. A feature of the Bureau's programme is the training and employment of a team of undergraduate research workers and this study was their first major task. The students formed the main team of field investigation and they were supervised and supported by R.W. Kates, L. Berry and J. McKay, all members of the Bureau staff. Twenty student investigators were selected from a large number of applicants and were given one week's special training in field measurement techniques, the use of questionnaires and other problems. They were assigned as far as possible to areas where at least one of the two in the team understood the vernacular.

Student field workers spent about four to five weeks in each of the nearby study sites. They were visited by staff advisors on at least two occasions in this period and problems were then worked out. During their stay the students interviewed all heads of households in the village and filled in a short questionnaire. As a second stage about 20% of households were selected for more detailed study. A longer questionnaire was used which sought details of the farming system and farm layout, some indication of labour and other information related to organisation, monetary expenditure, etc.

In this sample the researchers visited each plot, made a rough survey of it using a compass and noted crops being grown. (In some cases where plots were very distant this was not always possible.) In addition, a general land use map of the whole area was made and a range of observations recorded about the main features of the settlement.

This field study was followed and preceeded by a study of the existing literature, government reports and statistical data. On the completion of their assignment the field workers were asked to complete a questionnaire on the villages studied and to give their impression of the prospects for these settlements.

Data processing by students and staff followed and both general and specific data were obtained. The completion of the data differed with different groups but the overall standard was high. The main failure which was inevitable in view of the time constraints was in the labour budget data which were considered generally unreliable. Additionally in our general approach we had neglected to focus enough attention on the role of livestock in the village economy and our data on this aspect must also be considered inadequate.

The initial studies were made in April/June 1968 and were followed up by further work in most villages in September 1968 at a different stage of the agricultural year. In Ikowa and Mang'onyi further visits were made in September 1969 to check on the effects of the dry year on these two villages.

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* Indicates publication now out of print.