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**WATER DEVELOPMENT PLANNING
AND SOILS ASPECTS
OF IRRIGATION DEVELOPMENT**

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ROME, 1969



Report to the Government of Tanzania

on

WATER DEVELOPMENT PLANNING

and

SOILS ASPECTS OF IRRIGATION DEVELOPMENT

Based on the work of

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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A B S T R A C T

This report presents the findings of two experts appointed under the Technical Assistance sector of the United Nations Development Programme, to provide assistance in water development planning and soils aspects of irrigation development in Tanzania. The experts, who were appointed by the Food and Agriculture Organization of the United Nations, the executing agency, served in Tanzania from July 1963 to the end of December 1968, and from May 1964 to April 1968.

After short periods of service in other technical offices of the Government, the two experts joined the Investigation and Planning Unit of the Ministry of Lands, Settlement and Irrigation Development. Much of their time was spent in visiting irrigation schemes throughout the country, and the body of this volume is based on the reports written by the experts on these schemes at the request of the Government.

The report stresses the desirability of stage-by-stage development suited to the particular requirements of the area concerned, and emphasizes that, as in the case of Ismani Valley, basic needs, such as the supply of water for drinking and for cattle, must be fulfilled before embarking on irrigation schemes. The need for skilled manpower, with practical rather than academic training, and the importance of management and organization in irrigation schemes, are also brought out. Detailed practical recommendations are given for each of the nine schemes discussed: Bihawana Mission, Kilangali, Anani, Kigoma, Ismani Valley, Mwakijembe, Idowa, Pwaga, and Stiegler's Gorge. In addition to other technical appendices, the report contains a summary of reports on irrigation development written for the Government of Tanzania since 1956, by consultants, missions, FAO and other organizations.

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Chapter 1

INTRODUCTION

1. Government Request and Appointment of Experts

This report is an account of two assignments under the Technical Assistance Sector of the United Nations Development Programme, resulting from requests by the Government of Tanzania for assistance in water development planning and in soils aspects of irrigation development. Owing to the closely overlapping nature of these assignments, the findings and recommendations of the two experts appointed are presented in a single volume.

In accordance with the Government of Tanzania's request, the Food and Agriculture Organization of the United Nations appointed Mr. C.J. Hu, an irrigation planning engineer, to the post of adviser on water development planning, and Mr. D.R. Harris, a soils irrigation specialist, to the post of adviser on soils aspects of irrigation development. Mr. Hu served in Tanzania from 1 July 1963 to 28 December 1968, and Mr. Harris from 3 May 1964 to 14 April 1968.

2. Terms of Reference

The terms of reference for Mr. Hu were as follows:

- i. To advise and assist the Ministry of Agriculture in Irrigation Development.
- ii. To organize the collection of the basic data necessary for the economic appraisal of projects being planned or developed.
- iii. To undertake general appraisals of irrigation schemes.

Mr. Harris' terms of reference were:

- i. To conduct detailed soil surveys of areas under consideration for irrigation and to provide land use classification for potential settlement projects.
- ii. To investigate, as required, seepage and salinity and other problems arising from irrigation development, and to provide advice on measures for avoidance or correction.
- iii. To investigate the water requirements of crops.
- iv. To train local technicians in soil survey and soil analytical work.

3. Summary of Assignments

On Mr. Hu's arrival in Tanzania on 1 July 1963, he was attached to the Ministry of Agriculture, where he served in an advisory capacity until May 1964, when he was transferred to the Ministry of Lands, Settlement and Water Development. On 3 May 1964, Mr. Harris arrived at Dar-es-Salaam, and was stationed at the Water Development Division Project Planning Station, Ubungo, seven miles from Dar-es-Salaam. While at Ubungo, Mr. Harris was engaged in reporting on existing and proposed irrigation schemes. During this period, assistance was also given in the design and equipping of the new Soils Laboratory, Ubungo.

On 21 September 1964, Mr. Harris joined Mr. Hu at the headquarters of the Water Development and Irrigation Division in Dar-es-Salaam. Many joint investigations were carried out and several reports were written on irrigation schemes at the request of the Ministry. Chapters 4 to 13 of this volume are based on these reports. The experts were assisted in many of these studies by another FAO expert on a Technical Assistance assignment, Mr. O.A. Sabry, Rural Institutions Officer.

In December of the same year, the experts joined the newly formed Investigation and Planning Division of the Ministry of Lands, Settlement and Water Development and collaborated with its staff for the remainder of their assignments. The functions of this Division are:

- i. To indicate and organize programmes of research and data collection, either directly or in conjunction with existing research organizations or external Technical Assistance projects.
- ii. To identify, from research findings, the most fruitful areas for development effort.
- iii. From this, to formulate development programmes.
- iv. To prepare feasibility studies and assess the relative rates of return (in terms of cost-benefit analysis) of different projects.
- v. To prepare submissions for external assistance.
- vi. To analyse and evaluate the effectiveness of existing projects, in terms of their economic and social results, so that the lessons of current experience are reflected in the formulation of programmes and policies for the future.
- vii. To translate policy objectives into realistic, phased development programmes.
- viii. To watch the progress of these programmes, and prepare reports on the problems of implementation.
- ix. To maintain liaison with Devplan and Treasury on all problems of forward planning, implementation and control.
- x. To provide general economic advice on the Ministry's work.

During their assignments, the experts also gave advice on the routine work of the office and participated in a working party for setting up an irrigation policy for the second Five-Year Plan.

4. Acknowledgements

FAO is greatly indebted to the many individuals who collaborated with the experts during their assignments, and who offered helpful advice and assistance, and especially to the Honourable Minister for Agriculture, to the Honourable Minister for Lands, Settlement and Water Development, to the staff of both Ministries, in particular their Principal Secretaries, to the Director of the Water Development Division, and to the staff of the Investigation and Planning Division to which the experts were seconded.

Chapter 2

CONCLUSIONS AND RECOMMENDATIONS

1. Prospects and Priorities for Irrigation Development

Investigation of the irrigated and potentially irrigable land in Tanzania indicated that there is abundant land suitable for irrigated agriculture, provided the necessary infrastructure is made available.

The problems of salinity and alkalinity are not widespread, and can be avoided by careful selection of the areas to be developed and by provision of drainage systems.

For the immediate future irrigation development should be concentrated on areas suited to the production of rice, using supplementary gravity irrigation, and on the limited development of areas for the production of high value crops, such as sugar and vegetables.

Development should be based on pilot areas, in which a simple farming system, using well-tried crops familiar to the people of the area, is tested and demonstrated. Development should always take account of local requirements and local farming practices.^{1/}

"Village Irrigation Schemes", usually based on an existing irrigated area, should be developed wherever the local population show a desire to participate in such schemes.

Irrigation development should only be undertaken when other basic needs of the area concerned have been met. In the case of the Ismani Valley (see Chapters 8 and 9), the domestic water supply should be made adequate for the needs of the population and their cattle before any further development is attempted.

2. Financial Policy

It is essential that irrigation schemes should be financially viable. All such development projects have a number of general objectives, with greater emphasis on a specific objective, according to the particular circumstances. Normal objectives are to obtain the highest benefit from natural resources, the highest productivity per unit of land area, and the greatest financial return. In Tanzania, where natural resources are plentiful and there are relatively large areas of land available, the chief aim should be to maximize financial return on investment.

In the interests of sound financial planning, investments in irrigation schemes should be handled by a special body, such as a water resources council. Within this body, responsibility should be centralized, and supervision should be maintained over the financial management of the schemes. A revolving fund could eventually be set up, when a sufficient number of schemes is involved; for the present, however, the essential requirement is to maintain a realistic estimate of the total funds available for such schemes, as a basis for planning.

^{1/} This point is well illustrated in the final report of the Special Fund Project "Survey and Plan for Irrigation Development in the Pangani and Wami River Basins": see also Appendix 1 below, Summary of Reports on Irrigation Development in Tanzania.

3. The Need for Skilled Manpower

The requirement for skilled manpower for irrigation development in Tanzania is considerable. Experienced, trained men are needed not only for irrigation engineering and for the soils and agronomic aspects of the schemes, but for management. At the same time, there is a lack of trained men to fill lower and middle-ranking posts, such as that of foreman or engineer's assistant. There is a need too for trained soil surveyors of graduate level to head soil survey teams.

The Water Development and Irrigation Division is endeavouring to overcome these deficiencies through training programmes. Five students are at present studying for the B.Sc. Earth Sciences degree at Uppsala, Sweden, and they will help to fill the gap. But larger-scale training programmes at all levels are needed. In future training programmes, it is recommended that the following points be considered:

i. Training should never neglect the practical aspects of the work which future trained technicians will have to perform. College and office training should always be supplemented by practical work in the field.

ii. The training programme should be designed to keep pace with planned development, so that the trainees can be employed usefully as soon as their training is completed and so that adequate numbers of trained men are available in time for each planned development phase.

iii. Every effort should be made to ensure that trainees, once trained, continue to work in national irrigation development schemes. The remuneration for the work and prospects for promotion should be sufficient to encourage them to remain. Training involves a considerable investment which will be lost if the pay and conditions of work are poor, and the trained men leave to find work elsewhere.

4. Existing Irrigation Schemes

The expert visited and reported on a large number of irrigation schemes which had been built by Government over the last fifteen years.

Table 1 shows a list of such schemes, and indicates the amount of work to be done and the problems that will have to be overcome if these and similar schemes are to become productive.

In only a few cases are there soil limiting factors. Kalimawe and Naururu are the only sites in Table 1 where the expert considers the soils to be unsuitable for irrigation. In each case, the soils are highly saline/alkaline with the added complications of a high saline water table under much of the Kalimawe area, and shallow soils at Naururu.

In the past the selection of the areas to be developed was probably influenced by the presence of traditional irrigation and the ease with which water could be supplied at command level. Often very little was done in the way of soil investigation during the planning and construction of these schemes, but as the local irrigators were usually good judges of soil, this lack of investigation did not affect the outcome much; but once the increased water supply was misused and wasted, the problems of drainage and risk of salinity build-up became apparent in many places.

In Table 1, it can be seen that almost every scheme is lacking in management. It cannot be stressed too strongly how important management and discipline are going to be in the future development of irrigation in the country.

Table 1
IRRIGATION SCHEMES

Name of Irrigation Scheme	District	Water Supply	Cost to date	Improvement costs	Cost/Acre	Remarks	Acreage
			Sh. T.	Sh. T.	Sh. T.		
1. IKOWA	Dodoma	Gravity below Dam	157 575	20 000	133	Built by W.D. and I.D. in 1957, never properly utilised. Area of good soil limited to 150 acres.	150
2. MLALI	Morogoro	Gravity from Mlali R.	706 300	17 500	100	Built by W.D. and I.D. in '50s. Limited water. Drainage and management needed.	175
3. KALENGA	Iringa	Gravity from L. Ruaha	400 000	540 000	900	Built by W.D. and I.D. in 1960. Area limited to 600 acres. Drainage, flood protection and management needed.	600
4. KISIWANI	Pare	Gravity from Kisiwani R.	82 820	100 000	200	Built by W.D. and I.D. Weir only. Limited dry season flow. Management and distribution system needed.	500
5. KITIVO	Lushoto	Gravity from Umba R.	338 900	400 000	400	Built by W.D. and I.D. in 1960. Distribution system and management needed.	1 000
6. KILANGALI	Kilosa	Gravity from Miyombo R.	N.A.	600 000	600	Built by Agric. in 1948. Headworks, distribution system, flood control and management needed.	1 000 +
7. MLOLO I	Kilosa	Gravity from Mwega R.	-	1 000 000	1 000	Headworks, river stabilization, distribution system and management needed.	1 000
8. MLOLO II	Kilosa	Gravity from Mwega R.	-	600 000	600	Headworks, distribution system and management needed.	

Table 1 (continued)

Name of Irrigation Scheme	District	Water Supply	Cost to date Sh. T.	Improvement costs Sh. T.	Cost/ Acre Sh. T.	Remarks	Acreage
9. NAURURU	Same	Gravity from Pangani R.	-	2 400 000	6 000	Pumping and headworks, distribution system, storage, flood control, drainage and management needed.	400
10. GONJA	Same	Gravity from Itemera R.	-	3 980 000	5 400 ^{1/}	Drainage and distribution system, storage and management needed.	700
11. NYANZWA	Iringa	Gravity from Itemera R.	-	720 000	2 400	Headworks, distribution.	300
12. URU CHINI	Moshi	Gravity from Rau Swamps	N.A.	600 000	600	Built by W.D. and I.D. in 1955. Field layout, flood control, land consolidation and management needed.	1 000
13. MANGOLA	Mbulu	Gravity from Gordon R.	N.A.	700 000	700	New weir, main canal, distribution system and management needed.	1 000
14. MANG'ONYI	Singida	Mianje Mungaa Dam	346 200	200 000	300	Built by W.D. and I.D. in 1957. Abandoned: requires rehabilitation. Management needed.	1 000
15. UTENGULE	Nbeya	Gravity from Mbalizi R.	141 150	400 000	400	Land consolidation, distribution system and management needed.	1 000
16. KALIMAWE	Same	Gravity from Dam	1 134 920	280 000	700	Built by W.D. and I.D. in 1958. Drainage, distribution system and management needed.	400
17. MOMBO	Lushoto	Gravity from Mombo R.	-	600 000	1 500	Under construction by W.D. and I.D. Management needed.	400
T O T A L			Shs.	3 307 865	13 257 500	1.140 - <u>per acre average price</u>	TOTAL 11 625

^{1/} Combined with Hydroelectric generation.

5. Future Soils Surveys for Irrigation Development

The soil land classification system established by the Soil Conservation Service of the U.S. Department of Agriculture and the Irrigation Land Classification of the U.S. Department of the Interior, Bureau of Reclamation, should be followed when evaluating land for irrigation development.

Chapter 3

THE BACKGROUND TO IRRIGATION DEVELOPMENT

1. Climatic Conditions1.1 Rainfall distribution

According to the mean annual rainfall map, based on all data up to 1965 and published by the Government in 1966, mean annual rainfall by area in Tanzania is as shown in Table 2.

Table 2. MEAN ANNUAL RAINFALL BY AREA

<u>Rainfall (mm)</u>	<u>Square Miles</u>	<u>Percentage of total area</u>
Over 2 600	196	0.06
2 200 - 2 600	331	0.10
1 800 - 2 200	1 950	0.57
1 400 - 1 800	5 044	1.50
1 000 - 1 400	60 893	17.80
800 - 1 000	155 976	45.70
600 - 800	59 660	17.40
400 - 600	49 500	14.60
200 - 400	7 600	2.27
T O T A L	341 150	100.00

1.2 The need for irrigation as related to mean annual rainfall

Areas with over 1 800 mm mean annual rainfall could be roughly said not to need any irrigation for the growth of crops. The total area of this category is only 2 477 square miles or only 0.73 percent of the total area of the country, and is mainly high mountain slopes.

The areas between 1 400 mm and 1 800 mm are mostly located on Lake Victoria, in the Kilembero Valley and in the Kilimanjaro and Pare mountains. The total area is 5 044 square miles or 1.5 percent of the total area of the country. Even in this area, there is some drought due to the erratic nature of the rainfall. The major portion of cultivable land falls in the categories between 1 000 - 1 400, 800 - 1 000, 600 - 800 and 400 - 600 millimetres, which represent about 17.8, 45.7, 17.4 and 15.6 percent respectively as shown in the above table.

The area between 1 000 - 1 400 mm of mean rainfall can be cultivated with natural rainfall, but without irrigation; periodic droughts are unavoidable.

The bulk of the cultivable land falls within the limits from 600 - 1000 of mean rainfall. Dry-land cultivation in these areas generally involves some risk, and frequent droughts of varying severity can be expected. Under traditional low-cost production, the effects of such droughts are accepted as part of the peasant's lot. But if he is to increase his capital at risk, by loans for fertilizer, improved seed, equipment etc., the effects of drought may be financially crippling.

1.3 Seasonal rainfall distribution

Dry-land crop production is limited to part of the year over most of Tanzania. Although the actual rainfall pattern varies quite considerably throughout the country, the general rainfall pattern is as follows.

During December, there is in general a short rainy period, followed by a short dry period in February, March. April, May is the season of heavy rains. A long dry period occurs during the months June to November. In very general terms, therefore, the period December-June is the planting period. Cultivators usually plant in December when the first rain comes, and harvest in June or July. But the rainfall is inconsistent. It varies from place to place and from year to year. All the harvests have to depend on the weather. For instance, in the Pare District, on average about once in five years the rains fail to come in time and a drought year results. Irrigation is thus not only able, to put an appreciable amount of additional land into productive use but also eliminates the adverse effects of drought in areas of rainfed cultivation.

2. Early Irrigation in Tanzania

Irrigation has been practiced in Tanzania as far back as history can trace. The now defunct, elaborate canal system on the lower slopes of Oldonyo Longai in Masailand was built by the agricultural Sonjo tribe during pre-European days. The irrigation system practised on the slopes of Kilimanjaro dates back also to pre-European days in this country. The Wambunga system of rice cultivation in the Kilombero Valley is as old as the tribe itself. Other notable irrigation systems have been developed in the Usambaras, Pares, Sukumaland and Tukuyu.

In the lower river basins, people have practised flood plain cultivation by flood irrigation since time immemorial, notably in the Lower Rufiji, Lower Ruvu and Central Wami areas.

3. Government Participation in Irrigation Development

3.1 Early schemes

Recently, about 1955, the former division of Water Development, was expanded to include irrigation under what was then the Ministry of Agriculture. This was the start of Government participation in irrigation development. During the period that the Water Development and Irrigation Division (W.D.I.D.) was attached to the Ministry of Agriculture, quite a few irrigation schemes were constructed: Kalenga, Mlali, Kitivo, Ikowa, Kalimawe, Utengule and Uru Chini are examples. They were built with the notion that irrigation schemes could be properly managed by local authorities or regional agricultural officers who had little or no knowledge of irrigated cultivation. The reasons for the failure of these schemes are multiple. First, there was no coordination between the implementing and managing agencies. The schemes, once implemented, were put into the hands of people without any experience in irrigation. Second, the initiative was always from the farmers themselves. Third, there was no planned

organization. No rules were laid down for settlers. Fourth, there was no Government agent responsible for overall development. Minor reasons were: poor engineering, silt problems, failure to provide for a distribution system, and lack of proper soil investigation.

3.2 Reorganization of responsibility for irrigation development

In April 1964, following a Government reorganization, the W.D.I.D. was transferred to the Ministry of Lands, Settlement and Water Development, and was charged with unified responsibility for irrigation development. W.D.I.D., aware of the failure of most previous schemes, was very cautious about implementing new schemes. In the period from April 1964 to the end of 1968, two main steps were taken, which are described below.

3.3 Reorganization of Mbarali irrigation scheme

This scheme had been run for four years (1960/64) by the Tanganyika Agriculture Cooperative with little success. In April 1964, W.D.I.D. took over the scheme and reorganized it. The scheme is now under the direct control of W.D.I.D. staff, operating as a Government farm, paddy is the main crop, and paid labourers are employed. The yield of crops has improved considerably during this period. A yield of 22 bags of paddy to the acre was obtained in 1966/67. The cultivated area has been constantly increased from about 500 acres in 1964 to 4 000 acres in December 1968.

3.4 Mombo irrigation scheme

Mombo scheme was carefully investigated and designed; 200 acres were constructed during the year 1966/67 and subsequently planted with paddy rice. A yield of 15 bags of paddy to the acre was harvested during the year 1967/68.

4. Organization

Irrigation development in Tanzania may be organized in any one of the following ways:

4.1 Government state farm

The Government is owner and carries all responsibility for failure or success; there is practically no local participation in the farm, except in the context of the employer-employee relationship. The returns as well as the losses will all be directly borne by the treasury. The advantages of state farm management are:

- i. Centralized management is more easily achieved through the Government and managerial problems are reduced to the minimum.
- ii. Improvements in production are more readily attained with central Government support.
- iii. Services and supplies such as seed, fertilizers, mechanization, marketing, extension, etc., needed by satellite settlements around the state farm, can be supplied much more efficiently through the state farm.

However, there are a few problems which should be borne in mind and solved in a practical way. For instance, the general accounting and auditing systems are based on administration and are not viable for farm management. More flexible procedures and regulations are needed to meet the daily requirements in the field.

4.2 Cooperative management

The farmers are organized into a cooperative body at their own will. They are free to operate on their holdings, working out their own farming programmes, formulating their own marketing channels. They would, therefore, carry alone the fruits or burdens of success or failure. The returns and losses will all accrue directly to them and, therefore, will have no effect on the treasury.

This is the method most generally adopted for irrigation development throughout the world. The Government is responsible only for investigation, planning, design, construction, and financing of the scheme, and turns over the running of the scheme to the cooperative who is responsible for management and for repayment of the capital investment, according to the policy laid down by the Government.

The main problem is the difficulty of organizing cultivators into a proper cooperative which can be run efficiently. Recently the Government of Tanzania has devoted its efforts towards social communal development on a village basis.

As far as irrigation schemes are concerned, which require strict discipline and adherence to cultivation schedules, a pre-cooperative transitional period is deemed necessary.

4.3 Satellite settlement

The idea of satellite settlement around the state farm is logical and sound. It should be applied to medium and large irrigation schemes. The ultimate pattern of organization for these satellite settlements should be either cooperative or communal. The participation of the Government during the initial stage is deemed necessary and a joint management for this period is required.

However, the management set-up could be different, as most of the help on experiments, research, extensions, marketing, credit, and mechanization, etc., can be obtained from the nearby state farm. Less managerial staff is therefore needed. The management would consult with the nearby state farm and would be a kind of sub-station of the state farm. Consequently, the managerial cost would be cut down to a strict minimum.

5. Settlement Policy

The five-year development programme for settlement lists 74 new pilot settlement schemes, each costing £150 000 for 250 farmers. These schemes have been distributed over the country, with little regard to the needs and priorities for each region. Cash crops for these schemes were also listed with insufficient consideration for the demand and the economics of their production.

Additional planning and more assessment should be given to the settlement programme, especially with regard to:

- i. Fixing of priorities and numbers of pilot settlements for each region.
- ii. Proper and careful selection of cash crops to be produced on each scheme, with due regard to the economics and the potentialities of production.
- iii. Reconsidering the optimum capital needed for each scheme; and
- iv. The number and the selection procedures of the settlers.

Housing of the schemes should be of the same standard as a normal farmer's house in Tanzania. External capital expenditure on housing should be avoided, and should not compete with production tools, i.e. tractors or other agricultural equipment. Settlers should only earn better housing as they increase their income through work on the scheme. Capital expenditure on housing could be reduced to a minimum as ample local building materials are available near most of the schemes.

Lack of funds proved to be one of the main setbacks to the execution of this year's settlement programme. The C.V.S.^{1/} should seek other sources in cooperation with the Treasury. Loans from the Cooperative Bank, especially in the case of cooperative settlements, would probably make substantial contributions to the programme.

The Cooperative Bank, through its supervision on expenditure on the loans, would check constantly on over-expenditure, and on the economics of the schemes. Advice should be in favour of supplying all financial assistance to the settlement schemes, even if originating from the Treasury through the Cooperative Bank.

The C.V.S. is an advisory board on settlement. Its executive is the Division for Settlement. As settlement schemes will be formed in cooperatives and run on a commercial basis, a special accounting system has to be worked out to clear the demarcation between public (C.V.S. and D.S.^{2/}) and privately owned funds (Settlers'). It is obvious that two accounting systems must be employed:

a. The C.V.S. and the D.S. will operate through the Government accounting system, and would act as an advisory and lending agent to the settlement schemes, debiting to their accounts the cost of services that have been extended to the schemes.

b. The settlements will use the cooperative accounting system and would repay to the C.V.S. and D.S. the cost of the services that have been extended to them. The benefits will be credited to each of the settlers according to his production. It is very important that each settler should always know his financial position and the amount of his debt or credit.

The relationship between the advisory and the lending agent (C.V.S. and D.S.), and the settlement scheme must be clearly defined along the laws of land tenure, and the cooperative rules for settlements.

The Government, in the case of pilot or other settlement schemes, has been extending loans and technical assistance to the settlers, so that production on these schemes will be organized and geared to achieve transformation in agriculture. Therefore it should be ensured, through the laws and rules binding the settlers, that transformation in agricultural production will be achieved and maintained on these schemes until such time as Government loans are repaid.

Plans for most of the pilot settlement schemes have originated and are executed through the H.Q. of the Division of Settlement. Local requests should be given more attention, and the planning of the schemes should normally originate from the regions. Examples of successful local settlements are numerous, and if provided with minimum assistance, might prove more economical than the totally assisted pilot schemes. This calls for a complete economic and technical appraisal for settlement schemes which are presently under development. Subsequently it might be more beneficial for the country if assistance were extended to local settlements rather than to highly capitalised pilot schemes.

^{1/} Commission for Village Settlement

^{2/} Division of Settlement

Chapter 4

BIHAWANA MISSION GRAPE IRRIGATION SCHEME

1. General

Five years ago, the Roman Catholic Mission at Bihawana tried vine growing in the mission-allocated area. It has proved to be very successful. The Mission intends to expand the area. Three wells have been dug on the left bank of the Bihawana River to abstract water; two of them are provided with pumping equipment. The wells are connected with collection pipe lines and, to some extent, provided with filters in the river beneath the ground level. However, the yields of these pumps are rather low; 2 000 gallons per hour for one, and 1 000 gallons per hour for the other during the dry season. Deducting the water used for the whole Mission community (about 1 000 gal/hour), the remainder which could be expected for irrigation purposes is very limited. Up to the present, only one acre of grapes has been planted.

On 9 June 1964, during a conversation between the Roman Catholic Bishop and Mr. Shaw, then the Regional Water Engineer, the Bishop stated that £15 000, Italian funds, were available to provide an Irrigation Scheme at Bihawana. The Mission asked W.D. and I.D. to put forward a Scheme to use this money to the best possible advantage.

2. Water Requirements2.1 Depths of irrigation

The Dodoma District is a dry area with an average rainfall of 20 inches; the limiting factor for irrigation is the availability of water, as the water is precious in the area. The Mission practices orchard irrigation for the vines. The water requirement for one application is 12 000 gal/ac.

$$\frac{12\ 000}{6.25} \times \frac{1}{43.560} \times 12 = 0.53 \text{ inches}$$

2.2 Application

According to Father John, the Mission applied three applications during the dry season only. So the total water requirement is:

$$0.53 \text{ inches} \times 3 = 1.6 \text{ inches}$$

The very low application of water is due to very careful and economic application of water practised by the Mission. The normal application should be based on five applications with 15 000 gal/ac each.

$$16 \times \frac{15}{12} \times \frac{5}{3} = 3.3 \text{ inches}$$

3. Economics of the Scheme

Average production of grapes at Bihawana at present is 2 000 lbs per acre per crop or 180 gallons of wine. For two crops a year, that is 4 000 lbs grapes or 1 600 bottles of wine (1 litre capacity).

4 000	x	2/-	=	Shs. 8 000/-	grape
1 600	x	6/-	=	9 600/-	wine

The planting cost per acre for grapes is estimated at £50 or Shs. 1 000/-.

The benefits to be derived by irrigation of crops such as vines are sufficient to justify considerable capital expenditure, where the supply of water is extremely limited.

On the other hand, any irrigation on peasant crops, such as maize, is not economically recommendable due to very expensive capital investment involved.

4. Topography

The catchment of the Bihawana river above the proposed irrigation area lies to the west of the Dodoma-Iringa road, about seven miles from Dodoma. The steep granite hills rising to 600-700 feet above the river bed to the north and south are drained by a series of gullies into the sandy river bed, forming a catchment of eleven square miles. These hills are covered by low thorn scrub which is used as rough grazing by the local herdsmen.

On the level sites along the north bank of the river, there are several shambas and cattle bomas. Crops include maize and millet (seed eating birds are a big pest).

5. Geology

The area is dominated by the granite hill on which the mission church is built. The proposed irrigation area lies partly on weathered material at the foot of the hill and partly on alluvial materials from the river.

There are several rock outcrops in the river bed and along the banks, mainly a fine gritty caliche with some grey and green talc like schist, exposed by well-digging, lying under the river sand in places.

6. Soils

The soils along both banks have been strongly influenced by the alluvial action of the river in the past. The present bed of the river is full of sand lying on an undulating strata of clay over rock. There may be other older beds of riverine sand nearby which could be used for underground storage if connected to the present river course.

Examination of the many pits and wells on the south bank showed that the soil pattern is very complex and the water tables have a very wide variation in depth over a short horizontal distance.

The area that is used as a vineyard at present is on two soil types. The first which extends over much of the proposed area is a sandy clay loam (7.5 YR 5/4 brown) lying on a silty clay over schist-like material in an advanced stage of decomposition. The other soil seen was a sandy clay (10 YR 5/3 + 5/2 brown) forming in situ from the underlying rock. This could be considered as the extreme shallow phase of the first soil for irrigation purposes. The vines did not show any differences when planted in the different soils types as they are planted in pits 1 metre deep, and back-filled with a made-up soil containing cattle dung.

A profile exposed in one of the pits dug for vines was examined. The soil description is below.

Location: About 100 yds west of the vineyard pump house.

Topography: Almost level. Very light slope to west, 0.2 percent.

Land Use: Dry arable, maize last season.

Vegetation: Nil.

Surface: Ploughed, hard clods and plough-smearred lumps.

Depth:

0-13 cm Reddish brown, (5 YR 4.5/4 dry 1/), sandy loam/sandy clay loam, slightly hard, fine subangular blocky and single grains. Many small pores and dead roots. Absorbs water rapidly. Clear boundary to:

13-37 Dark brown, (7.5 YR 4/4 +4/5 dry), fine sandy clay loam, slightly hard massive with few fine pores and roots. Absorbs water readily. Merging into:

37-85 Reddish yellow-brown (7.5 YR 6/6 + 5 YR 5/4 dry), silty clay loam, hard massive, few roots or pores. Occasional fine vertical cracks. Absorbs water slowly. Merging into:

85-100 Reddish brown, reddish yellow-yellowish brown, (5 YR 5/4, 7.5 YR 6/6, 10 YR 5/4 dry), sandy clay loam, slightly hard, massive with many fine pores. Absorbs water rapidly. Few small iron concretions, not hard.

End of pit, start of auger hole.

100-120 As above.

120-170 Sandy clay. Colours as above but with rusty mottles, moist friable, weak fine subangular blocky and single grain, few small pores. Absorbs water readily.

170-200 Watering rock, moist auger flour, occasional hard pad of sandy clay with dark staining.

Sample Nos. BM1/1 - BM1/5.

Pit No. BM/1 Date: 20 October 1964.

7. Hydrology7.1 RainfallTable 3. RAINFALL AT DODOMA: 1928-1960
(inches)

January	5.74
February	4.77
March	4.93
April	2.07
May	0.21
June	0.04
July	-
August	-
September	.05
October	.19
November	.78
December	.06
<hr/>	
Total:	22.54
<hr/>	

Maximum 3.28 inches on 10 January.

Bihawana Mission
(inches)

1961	24
1962	30
1963	23

Average of three years: 26 inches

7.2 River flow

No hydrological records regarding flows of this Bihawana River exist. The Bihawana River is non-perennial, and flow occurs only ten to twelve times a year during the rainy season; only one or two floods occur annually. According to the Mission:

River Flow during Floods

Duration	6-7 hours
Maximum depth of flow recorded	4 feet
Average depth of flow	3 feet

Approximate discharge of the river during flood

River width average	200 feet
Depth of flood water	3 feet
Velocity of water	6 ft/sec
Discharge $Q = 200 \times 3 \times 6 = 3\ 600$ cusecs	
Maximum discharge = $200 \times 4 \times 8 = 6\ 400$ cusecs	

7.3 Permeability

A sample of river sand taken from a point downstream of the ford had 54 percent voids. Permeability is, therefore, high and a figure of 0.45 ft/hr was obtained in the laboratory.

8. Possibilities of Abstraction of Water for Irrigation from Bihawana River (see Drawing No. 2)

8.1 Deep-well ground water

This may be the future potential in Dodoma District. But for Bihawana Scheme, it is not economic to implement deep-well ground water where surface water is available.

Well point pumping and spider irrigation are not suggested due to the fact that the river longitudinal and cross sections are irregular.

The proposed method of abstraction is by pipeline collector, with perforation facing upstream to collect water. The pipeline should be 9 inches in diameter and placed with a slope of 500 to 1 connected with the existing well. The well would act as a tank to assure the continuity of pumping.

The pipeline collector should be placed 10 ft to 15 ft beneath ground sand level (according to the sand depth of the river) to assure maximum collection from the sand river.

The pipeline collector should be connected with four to six filter pipes, placed along the lower channels of the river. These should be 3, 4, 6 inches in diameter according to the depth installed.

The filter pipeline should be slotted and embedded in gravel or stone to a depth of 2 ft. The length of the filter pipe proposed is 50 ft. long.

8.2 Sub-ground basin (see Drawing No. 3)

Estimated volume of water available. Length of the river between the rock bar upstream and second well is about 8 000 ft.

The width of the sand bed of the river is around 200 ft and the depth is 10 ft average.

So the total volume of sand is:

$$8\ 000 \times 200 \times 10 = 16\ 000\ 000\ \text{ft}^3$$

Assuming 25 percent of the volume within this sand reservoir is water:

$$16\ 000\ 000\ \text{ft}^3 \times 25\% = 4\ 000\ 000\ \text{ft}^3$$

$$\text{Approximately } 4\ 000\ 000\ \text{ft}^3 \text{ of water or } 4\ 000\ 000 \times 6.2 = 24\ 800\ 000\ \text{gal.}$$

Of this volume, how much would be available for abstraction? What is the effective capacity? This is actually a very interesting hydraulic problem. Factors to be investigated include:

- (a) Losses due to immediate evaporation;
- (b) Capillary action of water within sands to bring the water to the surface, consequently evaporation losses;

- (c) Deep percolation losses;
- (d) Seepage losses beneath the sub-ground barrier;
- (e) Moisture-retention capacity of sand which amounts to 6 to 8 percent of the volume of sands;
- (f) Efficiency of the barrier, and efficiency of the filters.

It is very difficult to assess the percentage of effective capacity of the sand reservoir for the present time. Anyway, tentatively we estimate that 30 percent of water in the sand reservoirs could be utilised for irrigation purposes. That is $24\ 800\ 000 \times 30\% = 7\ 440\ 000$ gal.

Estimated irrigable acreage: assume five applications of irrigation of 15 000 gal/ac annually and intervals of application, 30 days.--

The possible irrigable acreage is:

$$\frac{7\ 500\ 000}{75\ 000} = 100 \text{ acres}$$

Pumping capacity to be provided:

$$\frac{7\ 500\ 000}{(150 \text{ days})} = 50\ 000 \text{ gal/day}$$

on 10 hr/day basis 5 000 gal/hr

During the wet season, the sand reservoir is quickly recharged. In order to increase the acreage, and as a safety factor in case of breakdowns, 100 percent additional capacity should be provided, that is 10 000 gal/hr (i.e. 2 x 5 000 gal/hr pumps)

8.3 Storage tanks

In order to increase the acreage of vines under irrigation, storage tanks near the plantation are necessary. The storage tanks could be at the point of abstraction as well as at the plantation. The storage at the point of abstraction is related to flood storage, which is thought to be less efficient and expensive due to the sandy nature of the Bihawana River during floods. For the present time, only the storage in tanks at the plantation is considered.

The storage tanks serve:

1. Additional acreage during the dry season;
2. Safety against any breakdown of pumping;
3. Increase the irrigation capacity by storing the tanks during flood time.

It is assumed that with 50 percent of the water required during the dry season stored in the tank, acreage could be increased accordingly, but as storage tanks are very expensive, low water requirement data are used:

$$3 \text{ applications} \times 12\ 000 \text{ gal} = 36\ 000 \text{ per acre}$$

$$50\% \quad 18\ 000 \text{ gal}$$

In order to irrigate 50 acres, the necessary tank capacity is:

$$18\ 000 \times 50 = 900\ 000 \text{ gal}$$

8.4 Application of irrigation water to vines

In order to economise in the amount of water applied to each vine, the adoption of pot irrigation is advocated. The basis of the pot method is to supply irrigation water to the root zone only. This can be achieved by sinking a clay pipe of suitable length and diameter near the vine or between two or three vines so that when the pipe is filled with water it wets the subsoil around the roots only and there is practically no loss by evaporation or wasteful wetting of soil away from the roots of the plant.

The present rate of water application could be reduced by 25 percent.

$$\begin{aligned} \text{Volume of pipe } 3 \text{ ft } \times 75 \text{ ft} &= 1.32 \text{ ft}^3 \\ 1.32 \text{ ft}^3 \times 6.25 &= 8.25 \text{ gal} \end{aligned}$$

Assuming a planting of 680 vines per acre and an application of 12 000 gal per acre, each vine should receive $\frac{12\ 000}{680}$, 17.6 gal.

As 12 000 gal/acre is rather low, a figure of 22 gal is more realistic. The general opinion at Bihawana is that "little and often" is the best method of irrigating. Thus two applications of 8.25 gallons each by pot methods may be as good as 22 gallons applied at one time and result in the saving of 5.5 gallons per vine.

9. Construction Method

9.1 Sub-ground barrier

The proposed construction method is to place a clay barrier across the Bihawana river.

- (a) Location: few feet downstream from the Mission Well A;
- (b) Direction: normal to river bank;
- (c) Section of the clay barrier. (Drawing No. 4)

(d) Two lines of poles are driven close to the barrier, say one foot from downstream and two feet from upstream. These poles are placed 2 1/2 ft apart from downstream side and 1 1/2 ft from upstream side. Brush wood can be placed behind the poles to prevent the sand from falling in. Dewatering is to be provided during construction. The poles are reinforced, when necessary, by struts from one side to the other. The deepest river section should be constructed first to avoid a concentration of flow in it.

Porous barrier at B.

The barrier at B is for two purposes:

- a. To augment the discharge at well B;
- b. To slow down water movement in the sand reservoir.

The proposed barrier is only two staggered lines of poles driven in with centre to centre distance of 6 inches in one line, the diameter of poles to be 4 inches and length according to the depth of sand. The tops of the poles must be cut off 15 ft below the sand surface.

Blasting of the rock bar 6 000 ft upstream, for a section say 10 ft by 10 ft near the road crossing.

9.2 Storage tanks

As there is a brick factory within the Mission, it will be more economic to use bricks for the construction of storage tanks.

The proposed unit storage tank will be 15 ft by 30 ft and 8 ft depth; built half underground it gives a capacity of:

$$\begin{aligned} 15 \times 30 \times 8 &= 3\,600 \text{ ft}^3 \\ 3\,600 \times 6.2 &= 22\,320 \text{ gal} \quad \text{Say } 20\,000 \text{ gal} \end{aligned}$$

Capacity needed to increase the acreage from 100 acres to 150 acres:

$$\begin{aligned} 3 \times 12\,000 \times 50 \times 50\% &= 900\,000 \text{ gal} \\ 900\,000 / 20\,000 &= 45 \end{aligned}$$

45 units are needed.

These tanks could be built successively, according to financial ability, and with combined units. The proposed unit size offers economic roofing, which is the main cost of storage tanks. The cost of these tanks is estimated at sh 0.3 per gal. That is $0.3 \times 20\,000 = \text{sh } 6\,000$.

10. Phasing of the Scheme

10.1 Phase 1

- (a) Subground Barrier at Section A.
- (b) Porous Barrier at Section B.
- (c) Well re-modelling A.B.
- (d) Equipment.
- (e) Blasting of rock bar 6 000 ft upstream.
- (f) Storage tanks 20 units.

<u>Costs:</u>	a.	£ 500
	b.	100
	c.	100
	d.	300
	e.	200
	f. 20 x 6 000/-	6 000
		<hr/> £7 200 <hr/>

10.2 Phase 2

Storage tanks as many as needed:

$$25 \times 6\,000 = \text{sh } 150\,000 = \text{£7 } 500$$

10.3 Phase 3

Flood storage.

The scheme should be implemented successively.

As the irrigation scheme is expensive, it would be uneconomic to irrigate peasant farms with crops such as maize or beans. Even during the wet season, when a surplus of water is available, the acreage of local farms that could be irrigated is quite limited. It could be used to train the local farmers to plant vines, under the supervision and advice of the Mission.

After the completion of the sub-ground barrier, the water level downstream from the barrier will be lowered, so the abstraction of water by water holes would be more difficult. The sponsor of the scheme should be responsible for the construction of adequate water holes along the river, for the benefit of the local people.

11. Conclusions and Recommendations

During the wet season 1964-65, investigations should be made on the discharge capacity as well as draw downs of the existing well to assess the water movement in the sand river.

The cross section made by R.W.E.¹ of Dodoma should be extended to the limit of sand.

The suggested scheme could be carried out during the 1965 dry season.

The number of storage tanks is flexible, they could be constructed according to the financial ability.

As the economic value of this scheme is very high, any future increase of acreage would be best achieved by constructing a flood storage reservoir.

The best flood storage will be, probably, a sand reservoir near the river.

The abstraction of irrigation water from sandy river is new in this country. The experience obtained in this scheme will be highly valued for similar problems in other areas.

The estimates made in this report are rather on the safe side. It is hoped that better pump yields and a larger acreage could be obtained.

1/ Regional Water Engineer

Chapter 5

KILANGALI IRRIGATION AREA

During a recent visit of the Second Vice-President, the local people asked for help to improve the existing irrigation at Kilangali. As a result, the FAO Team was asked to make an appraisal of the area with a view to starting a "Village Irrigation Scheme".

1. History of the Area

Irrigation was started in 1948 when the Department of Agriculture opened a mechanised rice farm. This project was abandoned in 1951 due to several difficulties, mainly flooding, poor communications, and sticking of equipment in the wet soil.

The Department of Agriculture continued to operate the canal so as to allow local farmers to irrigate rice shambas (farms).

In 1960, the scheme was handed over to the Native Authority and since then several attempts have been made to get the scheme working properly.

In the past years, several officers from the Department of Agriculture and W.D. and I.D. have visited the area. Most of them agreed that the area was promising but all emphasised the past difficulties of maintaining the system and water control discipline; the danger of floods destroying the headworks was frequently mentioned also.

A Farmers Association has been formed at Kilangali. There are 239 members, all residents of the area. In the past, farmers living in Kilosa town used to cultivate part of the area, presumably using local labour. This practice has now stopped and residence is a condition of membership in the Association.

This year the Association, as a communal effort, has cultivated 519 acres of irrigated paddy and 140 acres of dry land cotton.

The "Manager" of the Association is the local Medical Assistant whose salary is paid by the District Council.

2. Description of the Area

2.1 Location

About 16 miles S.E. of Kilosa.

2.2 Altitude

Approximately 1 550 feet above sea level.

2.3 Topography

The area lies between the Miyombo and Mkata rivers. The whole area has been laid down by river action with a general slight slope towards the S.E. Microtopography is quite marked, especially near the present or old river beds.

The bed of the Miyombo river is raised above the surrounding land and is still building up slowly.

2.4 Vegetation

The vegetation of the Kilangani area may be classified as Valley Grassland, trees occupying less than 10 percent of the ground and subject to seasonal flooding. (Gillman Amer: Geographical Review 1949). The air photos of the area show that the trees tend to grow along the lines of present and older, now buried, river courses. The slight ridges between the river courses carry an open grassland with Acacia sp., the most abundant shrub or tree. Of the vegetation along the rivers, the most conspicuous species is the palm Thyphanae.

The wetter areas and those areas now under the influence of irrigation have a thick cover of perennial grasses and herbs with the sedge, Cyperus rotundus; nut grass is very common. This is a troublesome weed especially under irrigation.

The whole area has been modified by the seasonal fires that spread across the area during the dry season, these fires seem to originate from the Mkata swamps and the small area of shambas around Kilangali village.

2.5 Soils

Over the greater part of the area the soil is a deep, dark greyish-brown, cracking sandy clay of alluvial origin having a low permeability and of moderate fertility. There is no evidence of widespread salinity or alkalinity, but small areas are apparent locally. The analysis of nine profiles submitted recently shows that all samples are non-saline (U.S.D.A classification - (E.C. less than 2 millimhos per cm)). See Table 4 for details of analysis. Calcium Carbonate concretions are found at depth, and base exchange results show that both phosphorus and potassium levels are low and crops will benefit from applications of P + K fertilizer.

2.6 Drainage

As the permeability of the soil is low, and the area rather flat, parts will be flooded following rain; other parts will be flooded by the river rising over the river banks. As the fall of the land is S.E. towards the Mkata river, there will be a tendency for the flood water to move in that direction unless prevented by local topography.

2.7 Rainfall

The nearest rainfall station to the Kilangali area is Kilosa, 16 miles to the N.W. The records extend over 40 years 1922-62. See Table 5. The rainfall follows the general pattern in Tanzania: the wet season starts in November and ends in May and the dry season runs from May to October. It is to be noted that with an average rainfall of 1 011 mm and a minimum recorded of 745 mm the area should not be considered arid.

There are two upstream rainfall stations in the catchment of the Miyombo, Madizini Estates and Ulaya, covering a period of 13 years and 4 years respectively.

2.8 Hydrology

A gauging station on the Miyombo was set up in 1951. Records were kept from November 1951 to June 1959, with a gap in readings from October 1953 to April 1954, and during January 1956. The Station was closed in 1959.

<u>Date</u>	<u>Yearly Min. Water level and Flow cusecs</u>	<u>Yearly Max. Water level and Flows cusecs</u>
Nov. 1952	1.60 42	4.5.52 8.10 700
Nov. 1952	1.50 39	5.53 5.10 275
Dec. 1952	1.10 29	8.5.55 7.00 500
Mar. 1953	1.20 32	3.5.56 8.50 750
Dec. 1954	1.40 37	19.4.57 8.80 800
Jan. 1955	1.20 32	31.3.58 9.20 900
Dec. 1956	1.70 37	11.3.59 8.00 700
Nov. 1957	1.90 42	
Nov. 1958	1.60 33	

The flow figures are only approximate, estimated from 5 gaugings: one in 1951, two in 1952, one in 1953, one in 1955. The maximum flows are only for the river channel; they do not allow for flows above the bank level.

The river bank immediately upstream from the off-take is only 8 feet higher than the river bed. It can be assumed that, apart from a few very dry years, the river has spilled over the bank during the rains.

3. Irrigation System

Gravity flow from the Miyombo river.

A short earth cut leads water from the river into a sluice consisting of four 2 foot diameter gated pipes enclosed in masonry. These discharge into a concrete-lined channel section, 60 feet long, leading to the main earth canal about 5 miles long.

A simple weir of stone-filled baskets built across the river just downstream of the lead-in cut is now badly damaged. The present structure of sticks and stones is holding up a very small head of water, and the next high flood will probably wash most of it away.

The main canal does not command the land near the river through which it passes. Some years ago, the river broke into the canal about 140 yards down from the headwork, and the canal was deeply scoured and widened. It now looks more like a small river bed with deep, steep banks. This means that the water does not reach command level for a considerable distance down the canal.

The canal is poorly maintained, heavily overgrown with grass and reeds and badly damaged in places, possibly by cattle, although no cattle were seen at the time of our visit. Some of the breaks in the bank have been repaired by the local farmers.

4. Cultivation Methods used

The rice seed is broadcast over the land following cultivation and watering in November-December, and the crop is watered every 10 days unless the rainfall is sufficient. The water is flooded over the land from crude secondary canals. There are no gates or pipe outlets. The farmers have to break into the bends and replace the soil after each irrigation; as a result there are many wet patches and leaking bunds.

From the appearance of the crop at harvest, it was clear that little weeding had been done and the stand of rice over large parts of the area was poor as a result; also uneven watering led to patchy growth.

Harvesting is by hand, the ears are cut off and the straw left standing. The ears are stacked for drying and thrashing by hand.

There were two self-propelled combines on the area but both were unserviceable. The cost of transporting these machines, to harvest only a part of the acreage, was probably not justified economically.

Following harvest, no other cultivation is done until the next season's land preparation for the paddy. But this year, a small part of the paddy was ploughed after harvest with the idea of growing a dry season crop under irrigation. The land in our opinion was not suitable and the season was too late to make further cultivations on a more suitable area worthwhile.

5. Cotton Cultivation

140 acres of cotton was planted as a communal effort by the members of the Farmers Association. The plant stand was even and the plants healthy. The crop was sprayed eight times from the air at a cost of sh 92/- per acre (Kilosa airstrip is about 10 miles from the area).

The expected yield was stated as 1 200 lbs seed cotton per acre. The late rains this year had delayed ripening and the heavy texture of the soil had aggravated the condition. Consideration should be given to growing the cotton on ridges next season.

6. Problems

i. As the area is located in a swamp area which is frequently flooded by Miyombo river, the main problem in the Kilangali Irrigation Scheme is drainage rather than irrigation.

ii. The present main canal has been partly widened by the spates of the Miyombo.

iii. The present main canal has been silted badly by the river floods. The canal bed grade is now irregular, hence the difficulty of setting the water to the irrigation.

iv. The irrigation area is not properly designed. There are no proper off-takes whatsoever, and no distribution system.

7. Recommendations

As both water and soil are available in the area, the future potential is high and feasible.

As the river spills frequently, only two methods can be envisaged:

i. To protect the area by dyking would cost less, but the maintenance cost is rather expensive.

ii. To regulate the river by upstream reservoir or reservoirs would be ideal, if adequate dam sites are available.

It is estimated that after the river is regulated by upstream reservoirs, then the irrigation area could possibly be extended to 10 000 acres.

7.1 Proposed development programme

For the present time, as the scheme and headwork are already built, it is advisable to develop the scheme in the following phases:

First Phase

i. Remodelling the existing main canal by providing adequate canal bed grade and cross-sections. This should be carried out by self-help, with technical assistance from the Regional Water Engineer (R.W.E.), Morogoro.

ii. A simple off-take structure should be designed by the R.W.E., Morogoro. Five or six such structures should be built along the main canal, wherever it is necessary, to control the irrigation water.

This could also be implemented by self-help, with technical assistance by the R.W.E. The cost of materials (such as cement, stop logs, etc.) should be subsidized by the Government, if financially possible, or through local loan agency.

Second Phase

When first-phase improvements have proved to be useful, the following further improvements are suggested for the second phase:

i. Relocate the widened section of the main canal, where necessary.

ii. Provide the area with a simple irrigation system.

iii. Provide the area with a drainage system.

It is to be noted that, during these two phases, the irrigation area should be limited to 1 500 acres, because the lowest flow in the river is only 29 cusecs and the conveyance losses are considerable.

Third Phase

When economy of the scheme is proved, the whole area could possibly be extended to 10 000 acres by:

i. Dams and reservoirs upstream.

ii. Regulation, control and cleaning of the Miyombo river.

iii. Proper off-take structures to command the whole area.

iv. Properly designed irrigation and drainage systems.

7.2 Estimated costs of the development programme

First Phase

i. Remodelling of the existing main canal (by self-help) 400 Mondays.

ii. Simple off-take structures 6 x 500/- = sh 3 000.

Second Phase

- i. Relocating the widened section of main canal 5 000 ft x sh 10 = sh 50 000.
- ii. Simple irrigation system at sh 200/- per acre.
200 x 1 500 = sh 300 000.

Third Phase

The ultimate development is aimed at 10 000 acres at a cost of £150 per acre. 10 000 x £150 = £ 1 500 000.

A preliminary dam-site investigation should be carried out by Regional Water Engineer, Morogoro, to investigate capacities, embankment volumes, preliminary foundation studies, etc.

Table 4

ANALYTICAL DATA FROM NINE PROFILES AT KILANGALI

Site	Depth (ft)	PH (M/100 CaCl ₂)	(Conductivity) Millimhos/cm	Exchangeable Bases (mill equivalents/ 100 gm Phosphorus PPM.)						
				Ca	mg	Na	K	Mn	Total	Organic
A	1	6.4	0.174	8.8	15.1	1.07	0.37	.79	188	160
	2	6.5	1.244						140	125
	3	6.8	0.552						115	74
	4	6.8	0.102						76	45
B	1	5.7	.073	11.5	8.4	0.77	0.42	.104	183	162
	2	6.1	.244							
	3	6.1	.387							
	4	6.0	.376							
C	1	6.0	.053	8.7	4.3	0.43	0.20	.158		
	2	7.2	.126							
	3	7.8	.563							
	4	7.8	1.937							
D	1	6.0	.078	7.7	6.7	0.81	0.33	.131		
	2	6.6	.282							
	3	7.2	.611							
	4	7.6	1.158							
E	1	5.4	.090	12.1	8.2	0.43	0.42	.079		
	2	5.6	.101							
	3	6.1	.144							
	4	6.1	.522							
F	1	6.1	.082	8.3	5.8	0.76	0.42	.104		
	2	7.2	.215							
	3	7.6	1.549							
	4	8.0	.750							
G	1	5.7	.098	10.3	8.2	0.54	0.33	.158		
	2	6.3	.130							
	3	6.8	.232							
	4	7.2	.314							
H	1	5.7	.076	8.3	6.2	0.69	0.29	.608		
	2	6.6	.124							
	3	7.7	.508							
	4	7.8	.697							
I	1	5.3	.073	7.9	5.8	0.37	0.33	.182		
	2	6.3	.093							
	3	7.3	.236							
	4	7.5	.372							

Water Sample PH 9.1; Conductivity .224 Millimhos/cm; Sodium 4.3 PPM; Potassium 2.5 PPM.

Table 5
RAINFALL RECORDS

Station		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly
Station Kilosa	A	123	124	176	209	78	13	6	13	15	32	90	132	1 011
6° 50'S 37°00'E	H	312	281	364	390	212	61	65	59	68	189	341	312	1 424
1 611 ft 973601 (mm)	L	18	31	49	31	3	1	1	1	1	1	4	13	745
Station Madizini Est,	A	232.8	196.6	298.3	443.7	165	37.1	26.2	37.1	20.8	61.5	171.0	288.3	1 978.4
7°15'5" 36°45'E	H	469.5	436	957.0	1 124	432	116.0	170	260	64	438	802	765	3 249.2
3 000 ft 973601 13 years (mm)	L	57	52	171	126	12.2	0.5	3	3	0	0	4	39	107.1
Station Ulaya	A	177.9	116.5	266.8	148.1	30.8	4.6	9.5	61.5	7.6	27.5	116.6	156.0	1 123.4
7°04'S 36°34'E	H	253.2	181.0	351.7	212.3	48.4	13.5	28.9	216.7	21.2	51.4	261.5	248.4	1 427.2
2 000 ft 973601 4 years (mm)	L	133.3	67.4	116.6	102.9	17.0	0	1.0	1.3	0	9.9	3.0	48.3	871.5

Chapter 6

AMANI TEA SETTLEMENT SCHEME

Following a meeting held on 4 December 1964 in the C.V.S. Office at Dar-es-Salaam, to discuss the development of a Tea Settlement in cooperation with Karimjee Jivanjee Estates Ltd., a visit was made to the proposed area on 7 December 1964 (accompanied by Mr. Nichols, Mr. H. Cooper of Agriculture, and Mr. Waller of Karimjee Estates).

1. Soils

As there are already old established tea plantations in this area, there is no reason why the soils in the proposed new scheme should not be suitable for tea.

The major factors in selecting tea soils are the pH value and the permeability. The pH can only be determined by analysis, but the permeability may be assessed by observation. The soils in the area visited are both permeable and deep.

2. Possible Potash Deficiency

Many bushes have become infested with Armalasia fungus which makes the observation of potash deficiency difficult, but there are signs of what may be potash deficiency. Fertilizer trials, and applications of small amounts of potash fertilizer to the tea plants after they are established is recommended.

3. The Root Fungus-Armalasia

This endemic disease is liable to be a very big problem if the new fields are not cleaned of all stumps and timber fragments prior to planting. Close inspection of all newly cleared areas by qualified officers will be necessary before any planting can be started. This disease, if present on settlement schemes, can be very detrimental to individual farmers as it would affect a large part of the holding and decrease seriously their income for several years.

4. Erosion Hazard

The maximum population of bushes per acre may have to be reduced to allow the planting of Vetiveia zizanioides grass to combat erosion, particularly in the early stages before the tea bush itself protects the soil. The disturbance of the soil during stump removal can lead to irregularities on the surface, and to concentration of run-off and the formation of gullies. The use of a cover crop, such as Oxalis spp., may be of great help in the establishment stage.

5. Clearing

Most of the land in which it is proposed to plant tea has been already cleared by the farmers (squatters) for growing food crops. However, the land has not been properly stumped (see Section 3).

Mechanical equipment could not be used for this work but "monkey" winches will have to be provided to the settlers for removing the stumps.

The clearing costs will be negligible, and the man-hour requirements for planting one acre of tea, as discussed in the meeting on the 4th, could be reconsidered accordingly.

6. Water

The W.D. and I.D. Engineer reported that he did not have instructions to accompany us. Still there are adequate water supplies for domestic uses in the valley bottoms. The conveyance of water to the settlers' houses could be postponed at this stage until the final lay-out of the schemes is decided.

7. Human/Social Aspects

The greatest difficulty in implementing this settlement scheme will undoubtedly be the human factor. The main purpose of the scheme is to find a solution to the squatters' problem on the Karimjee estate. The squatters have been living on the land for a long time. It is true that the estate has on several occasions tried to get rid of them, but it is believed that a sort of relationship exists between the squatters and the estate. Part of the area is still under heavy forest; the costs of clearing are high (estimated at £80-90 per acre). The settlers practise shifting cultivation, partly clear the forest, cultivate food crops for two or three years then move to clear a new area. The estate takes over this cleared and abandoned land, which saves clearing costs, and plants tea.

Most of the squatters are making a considerable amount of money by:

1. Selling timber as they clear the forest.
2. Selling food crops.
3. Obtaining wages for casual work on Karimjee estate.
4. Selling liquor to estate labour (made from sugar cane).

8. The Squatter Problem

It is proposed that the 300 odd families squatting on the estate would be settlers in this scheme. The estate will provide the land, development capital, and technical supervision. The squatters, except for a few that have already reached the edge of the forest, are, as previously stated, making a considerable amount of money and will need very strong incentives to be persuaded to plant tea and participate in a settlement scheme; particularly as the tea bushes take three to four years to produce. Also the presence of a strong feeling of distrust for all projects initiated through the estate must be taken into account. The possibility of the Karimjee estate providing part of the loaned capital in form of developed tea land could be investigated. In turn, the estate can develop an equal area on land they are prepared to make available for the scheme. The squatters will, therefore, have an immediate income and thus an incentive to plant more tea and participate in the scheme.

9. Management

The management of this scheme might pose problems. The relation between the technical manager appointed by the estate, the manager appointed by the commission, and the agriculture tea officer responsible for the area, must be clearly and well demarcated. The costs of technical supervision supplied by the estate must be carefully examined

and should be to a certain extent related to the area under development.

10. Suggested Development Programme

(i) The soils and topography of the proposed area are considered to be suitable for tea production. Analysis to determine pH values is recommended as a final check.

(ii) A programme for fertilizing must be worked out, especially for supplementing potash.

(iii) Proper supervision should be given to clearing, so as to prevent Armalaria fungus from occurring in the tea plantation.

(iv) A programme should be worked out for checking erosion, especially during the development period.

(v) Further investigation should be conducted on the human social problems, preferably by posting a special officer or several officers in the area to collect information on this subject.

(vi) A system for providing strong incentives for the squatters to join this scheme should be established. Investigations should be made of the possibility of the Karimjee Estate to provide part of the capital in form of developed tea land.

(vii) To define the management responsibilities on the scheme, the costs of administrative and technical supervision should be compatible with the planting programme.

(viii) We suggest that, for the time being, and due to various problems involved in the development of this scheme, work should be started on a present plantation basis; and that future expansion and the formation of full-scale settlement schemes should await the outcome of the above.

11. Information Required

It is suggested that the following information is gathered on this area:

- (i) Number of squatters, age and sex of their dependants.
- (ii) System of land tenure practised among the squatters (holdings of each family).
- (iii) Estimated income per family and the various sources for this income.
- (iv) Agriculture practices, rotation and system of cultivation used on the land.

Chapter 7

SETTLEMENT SCHEMES IN THE KIGOMA DISTRICT

1. Introduction

This report was requested by the Commissioner for Village Settlement for investigating the possibilities of assistance for four settlement schemes - Ilagala, Kasaba, Mayenge and Mkuti - which were started in 1964 by the Kigoma local authorities.

Assistance for these schemes could be extended either in the form of food supplies, which are granted to the Government under the Freedom from Hunger Campaign (FFHC), or by providing capital for these schemes as for other assisted settlements.

Mr. Sabry and Mr. Harris of the Investigations and Planning Division, and Mr. Vincent of C.V.S., visited these projects, as well as, at the request of the Kigoma Area Commissioner, an additional project, Bulombola, which is in the same area. The group also had discussions with the Regional Commissioner of Kigoma, the Area Commissioner and the Agriculture regional staff there. The trip to Kigoma took place on 24, 25 and 26 March 1965.

As these settlement projects have different aspects, this report will deal with each scheme as an independent unit.

2. Bulombola Settlement

2.1 Location

About 19 miles from Kigoma on the earth road to Ilagala, at an altitude of about 2 700 ft.

2.2 Soils

The area under cultivation was previously covered by wooded grassland and has a deep, dark brown clay loam soil with a high organic matter content. The present fertility status of the soil is high, but rotations, and fertilizers or manuring will be necessary to maintain yields.

2.3 Rainfall

The nearest station with a record of rainfall is at Ujiji, about six miles distant. The rainfall at Bulombola is probably similar in amount and distribution.

The average annual rainfall at Ujiji (altitude 2 250 ft) is 34.85 inches (1922-58).

The average monthly rainfall in inches (1922-58) is as follows:

<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>	<u>Sept.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>
4.50	4.45	5.89	4.95	1.80	0.16	0.06	0.08	0.08	1.80	4.51	5.85

2.4 Domestic water supply

The nearby lake is one unfailing supply of water for this scheme, but from a health point of view, a properly constructed well or tapped spring would be the best solution.

2.5 General description of the scheme

This scheme is based on cotton production. Fifty people with their dependents have been settled on unoccupied land; most of the settlers were originally from Ujiiji village and from areas affected by last year's flooding. Land was occupied in October 1964 and the settlers, although arriving late in the season, were able to cultivate and plant 64 acres of cotton - an average of a little over one acre per settler.

2.6 Local assistance to the project

The local authorities were responsible for the selection of the settlers. They were transported to the project site free of charge. They were also assisted by weekly free issues of 7 pounds of maize flour, and undetermined quantities of salt, beans, palm oil and curry flour. Assistance was provided from the funds of regional committees or through donations from the local population.

Cotton seed was supplied free of charge through the Lint and Seed Marketing Board, and loans were available for pest control equipment and chemicals, as well as chemical fertilizers.

No mechanical assistance was given for cultivation and work on the fields is carried out manually. Technical assistance is available in the form of one agricultural field assistant serving this project and another nearby scheme, as well as through technical supervision up to regional agriculture level.

No assistance for housing was given to the settlers. They were able to put up temporary houses near the scheme, using local building materials.

2.7 Programme of development

It is proposed that this scheme would reach full development in 1965. It is planned that the number of settlers would reach 100 during the coming planting season. It is also hoped that each settler would cultivate 3 acres of cotton and 2 acres of subsistence crops. But this area could certainly be increased if mechanical assistance were provided.

At present the settlers are organized as a farmers' association, and it is hoped that in future a cooperative society among the settlers would be formed; the scheme will then be able to take care of itself. The plan provides for giving to each settler a right of occupancy over the area he is cultivating.

2.8 Assistance requested

2.8.1 Immediate assistance

External assistance in the form of food, or funds so that food could be purchased locally, is needed due to the exhaustion of local funds. Otherwise settlers would lack support until harvest time.

The period during which this assistance is to be extended would be till 31 May 1965 for settlers already on the scheme, and to carry the new settlers for one year until they harvest their own crops by May 1966.

2.8.2 Long-term assistance

This type of assistance would also be provided through the central government to cover the purchase and supply of capital commodities, and could be extended in the form of loans and in some cases as grants for planning, communications, improvements, and for drinking water supply, etc.

2.9 Discussion

This project was started with the least possible assistance, yet, when the fields were visited, the cotton crop was healthy and it was obvious that cultivation was maintained up to the normal standards by the settlers. It is safe to state that the settlers' fields were mostly in a better condition than other cotton planted nearby.

The settlers had also constructed temporary accommodations, using their own resources and local materials, and all indications prove that settlement on this scheme is successful.

The present situation calls for quick action in assisting the settlers who are already on the scheme by providing them with subsistence rations, either in kind or in cash, until their cotton is harvested; for it is economically unsound to abandon at this stage the maintenance and care of their fields until harvest time, which is near.

As for further assistance, the matter calls for additional examination for the following reasons:

i. The scheme, if continuing to rely on manual labour for cultivation and for clearing, might barely reach the proposed plan for developing 3 acres of cotton and 2 acres of subsistence crops per settler. Assuming that each settler will eventually manage to plant such an area, the direct returns from cotton would be:

$3 \times 800 \text{ lbs (average yield)} = \text{sh } 1\,200/-$

Cost of production per acre (the settler would provide labour), including spraying, would be sh 150/-, or for three acres sh 450/-.

Each settler will net sh 650/-, or about sh 200/- above the average income in Tanzania, without including returns from his subsistence crops.

ii. It is obvious that in the event that the settlers cannot manage the proposed acreage, this scheme will not be viable, as there will not be enough incentive to encourage the settlers to remain on the scheme.

iii. It is up to the regional agriculture officers to see that production per acre is maintained above the estimated average. This could be achieved by constant supervision over the settlers to ensure that agricultural practices are executed up to the required standards. Also careful and constant examination of soil potentialities in this area is essential as yields would tend to decrease as the land is repeatedly tilled. The Agriculture staff should be in a position to advise on the most economical methods for maintaining the soil's production, either by rotating or by fertilising, or through combined measures.

iv. In view of these problems it is advisable that the present number of settlers on this scheme should not be increased, unless indications are strongly in favour of its success.

2.10 Recommendations for Bulombola settlement

i. That immediate assistance in the form of food commodities be extended to the settlers of this scheme until their cotton is harvested.

ii. New settlers should not be introduced to this project unless production averages are achieved by the existing settlers. Therefore, no further assistance (subsistence) should be extended to new settlers unless the settlers which are already on this project achieve their goal.

3. Ilagala Settlement

3.1 Location

Ilagala lies at the end of the earth road, about 33 miles from Kigoma, on the north bank of the Malagarasi river.

3.2 Soils

The soils of the area have been investigated by the Land Planning Officer, Western Region, and are described in his report of 28 March 1965 (Folio 64 File VSV 20/2).

3.3 Rainfall

The nearest rainfall station is at Ujiji, some 18 miles to the N.W. of Ilagala; and it is assumed that the figures at Ujiji relate to conditions at Ilagala.

For rainfall figures at Ujiji see Section 2.3 above.

3.4 Domestic water supply

At present, the river is used as the main supply. For the future a pumped, filtered supply will be needed at the settlement. The whole object of the exercise at Ilagala will be the improvement of the standard of living, and the health aspect cannot be ignored. Construction of a pipeline and pumped supply will cost in the region of £1 700 per mile of pipe, and about £1 000 for a tank and pump to deliver 500 gal/h.

3.5 General description of the scheme

Ilagala has two main types of farming land:

- i. Land in the delta of the Malagarasi river.
- ii. Higher land surrounding the village.

The land in the Malagarasi delta is subject to flooding of varying intensity. Last year's flood was an exceptionally high one. As a result, about 400 people had to be moved to higher land, and some of their crops were destroyed.

The regional administration has a plan to urge the people to abandon cultivating in the delta, and to shift their shambas to the higher grounds and grow cotton, sisal and other crops. Some reports and correspondence on Ilagala exist from 1963. The object was to start a village settlement scheme in this area, but up to now nothing has materialised. In all, 300 families are living in Ilagala. The total area under cotton is about 368 acres. A cooperative society of 200 members exists in this village.

3.6 Assistance to the project

The victims of the floods (100 people) were assisted by the local administration by free issues of maize flour, salt, palm oil, etc., as was done in other schemes.

Cotton seeds were supplied free of charge through the Lint and Seed Marketing Board; also loans were available (in kind) for pest control equipment and chemicals, etc.

No mechanical assistance was given for cultivation, and work in the fields is carried out manually. Technical assistance is available through local regional agricultural staff.

Some assistance in housing was provided. The flood refugees erected their new houses in the village on higher ground.

3.7 Programme of development

The regional administration is hoping that a pilot village settlement scheme would be started at Ilagala by the Commission for village settlement. Correspondence on this matter exists since 1963.

A Russian delegation which visited the area suggested that a state farm should be started instead of a settlement scheme.

3.8 Assistance requested

3.8.1 Immediate assistance

Immediate assistance in the form of subsistence food for 100 flood refugees. The need for this assistance is also due to the exhaustion of funds and other assistance which was provided locally to the settlers.

The period to which this assistance is to be extended would be until harvest time.

3.8.2 Long-term assistance

Long-term assistance was requested to start a village settlement scheme in Ilagala.

3.9 Discussion

The present agricultural development that is taking place at Ilagala cannot be considered as settlement work. The efforts of the regional administration are more in the nature of diversification of agricultural production which is practised in this village. The main purpose of this work is to cope with future flood problems as well as to increase and diversify production.

The requested immediate aid would be mainly to relieve flood refugees and support them until their new crops are harvested, and should be supplied through other organizations which are responsible for this type of assistance. The Commissioner for village settlement is mainly responsible for assisting land settlement.

As for the proposed plan for a pilot village settlement scheme near Ilagala, it is up to the C.V.S. to make a decision on this matter without allowing for further delays, so that local administration should be informed of the Commission's intentions as soon as possible. The present agricultural situation in Ilagala is not in favour of starting new pilot settlement schemes as there is no reason for resettling people of this village. Such a measure will lead to needless expenditure for developing new institutions for services which are already available in this village. Other areas in Kigoma region would be more suitable for organised village settlement schemes.

3.10 Recommendations for Ilagala

- i. Immediate assistance to the flood victims at Ilagala should come from other agencies in the Central Government and not from C.V.S.
- ii. Agricultural development under way at Ilagala is more in the nature of improvement than settlement or transformation.
- iii. An immediate decision must be reached and the Regional Administration advised about the proposed plans for developing a Pilot village settlement at Ilagala. Conditions at Ilagala are not up to the requirements for this type of settlement.

4. Kasaba Settlement

4.1 Location

This settlement is close to the point where the Kigoma-Ilagala road crosses the Kigoma-Tabora railway. It is about 4 miles from Luiche station and 13 miles from Kigoma by road.

4.2 Soils

The soils on this settlement scheme are red loams to sandy loams. For cotton growing these soils are rather coarse, that is, they do not have a very high water-retaining capacity. Neither do they have a very high nutrient status or organic matter content, but as the land is recently cleared, the present crop is healthy. But these soils will not yield like the soils at Bulombola; fertilizers or manuring will be necessary if satisfactory yields are to be obtained in the future. On the other hand, these soils are fairly easy to work.

4.3 Domestic water

At present the settlers are making use of a nearby spring which they said was supplying their needs. Capping this spring would improve the quality of the water, and perhaps the building of a night storage tank will increase the quantity of water available for daily use.

4.4 General description of the scheme

The scheme is based on cotton production. Sixty-six women from Ujiji have planted an acre of cotton each; they have been settled on the scheme since October 1964.

4.5 Local assistance to the project

The local authorities have been responsible for urging the settlers to leave their village at Ujiji and settle at Kasaba; by joining their efforts they would help increase the country's production. The settlers were transported without charge to the project site, and were assisted with free weekly issues of 7 pounds of maize flour, plus salt, palm oil, etc., which were supplied from the local population. Cotton seeds were supplied free of charge through the Lint and Seed Marketing Board, and loans in kind were available for pest control and fertilizers.

No mechanical assistance was given for cultivation, and work in the fields is carried out manually. Technical assistance was extended through the Agricultural regional staff.

No assistance for housing was supplied. The settlers have erected temporary houses on the scheme by using local building materials.

4.6 Programme of development

It is proposed to fully develop this scheme during this year; the number of settlers would remain as it is, but it is hoped that the men at Ujiji will join their women when they have proved the success of the scheme. It is hoped that during the next planting season each settler will cultivate three acres of cotton and two acres of food crops. It is hoped also that this settlement scheme would receive a tractor.

At present, the settlers are organised in the form of a farmers' association; in future, they would form a cooperative society.

It is also planned that each settler would be given a right of occupancy over his holding.

4.7 Assistance requested

i. Immediate assistance - in the form of food commodities available through external assistance (FFHC) or in funds for its local purchase. The need for this assistance resulted from the exhaustion of local funds; and there is a need to continue assisting the settlers until they harvest their crops.

ii. Long-term assistance - would be provided to cover the purchase of capital commodities which are essential to the project. This assistance could be supplied in the form of loans, and, in some cases, grants for planning, communications improvements, and for the supply of domestic water.

4.8 Discussion

This project was started with a minimum of assistance when compared with some other settlement schemes; yet it is noted that the settlers are using their full strength to ensure the success of their scheme. Cotton fields are well tended and the crop is healthy, although not comparable to the other schemes. This is due to the type of soil which is somewhat coarse for cotton. This soil characteristic might be beneficial in this particular case as the settlers are women and the coarser soils are easier to work than the finer ones, but production is not expected to reach the average set in other schemes.

The settlers have cleared the land and constructed temporary accommodation, and all indications prove that settlement in this scheme is successful at this stage.

Quick action must be taken to assist these settlers and provide them with subsistence food rations until their cotton is harvested. It is not feasible to abandon the maintenance and the care of the fields after the cotton has reached this stage of growth.

As for long-term assistance, it is felt that some further achievement will have to be fulfilled.

i. The scheme is relying on manual labour. The settlers are women, usually single, and it is doubtful if the planned acreage could be reached unless the settlers are helped by the rest of their families. When considering the soil and fertility of this area, net returns per settler might prove to be low for providing incentives for working another year.

ii. Based on this year's harvest, a plan could be worked out, either for assisting this scheme in the use of mechanical equipment and/or through fertilising, or, if not, another more suitable area should be found before the settlers are discouraged.

iii. Therefore, provision must be made so that, in the event that the settlers have not enough from their present acreage and are not able to reach the development goals, they should be supported and moved to a more suitable area, probably adjacent to the present scheme where more suitable conditions for cultivation exist.

4.9 Recommendations for Kasaba

i. Immediate assistance for the 66 settlers until harvest time.

ii. Consider methods for reaching high yields, through mechanical assistance and fertilising, if this year's average cotton yields are favourable.

iii. In case yields are not favourable, and yields increases could not be realised by technical and mechanical assistance, settlers should be moved to a suitable area and provision made to support them for one more year.

5. Mayenge Settlement Scheme

5.1 Location

On the west side of the Kigoma-Kasulu road, about half mile north of the Mkuti river road bridge, about 18 miles from Kigoma.

5.2 Soils

The soils at this scheme are very good. Developed on basalt, they are deep and free draining, having been under modified miombo forest prior to clearing. The soils have a very high nutrient status. The pH of the soil may be slightly acid but this is outweighed by its physical condition.

The site is almost level, apart from the occasional ant-hill.

5.3 Rainfall

From a study of the vegetation in the area, the rainfall is probably a little higher and slightly better distributed than at Ujiji.

5.4 Domestic water

At present the domestic water comes from the nearby river, but a supply could be obtained from a ram-driven spring supply at the Mkuti settlement scheme, (see Section 6.4).

5.5 General description of the scheme

This scheme is based on cotton and sisal production; 150 settlers, all old people, have been moved to this project since October 1964, mostly from the town.

Vegetation in this area is much thicker than at the other schemes. The settlement was able to clear about 54 acres which were planted with groundnuts - 12 acres, cotton - 30 acres, sisal nursery still under planting - 12 acres.

5.6 Assistance to the project

The local authorities were responsible for the selection and free transport of the settlers. The settlers were also assisted with free issues of maize flour, salt, beans, palm oil, etc. as in other schemes in this area.

Cotton seeds were supplied free of charge through the Lint and Seed Marketing Board. Loans were available for pest control equipment, chemicals and fertilizers.

No mechanical assistance was given; work in the fields is carried out manually.

Technical assistance was available through the regional agricultural staff.

No housing assistance was provided. The settlers have put up temporary houses on the scheme, using local materials.

One hundred National Servicemen are helping in land clearing.

5.7 Programme of development

It is hoped that the scheme will reach its full development during 1965. It is planned for the number of settlers to reach 200 during the next planting season. Each settler would cultivate 2 acres of cotton, 3 acres of sisal, and 2 acres of subsistence crops.

The settlers are presently organized in a farmers' association and it is hoped that in future a cooperative society will be formed among the settlers.

It is hoped that each settler will be given a right of occupancy over the area he is cultivating.

5.8 Assistance requested

i. Immediate assistance - in the form of food commodities, which are available through external assistance (as in FFHC), or in funds so that food could be purchased locally. The need for immediate assistance is due to the exhaustion of local funds, and, therefore, settlers would lack support until harvest time.

ii. Long-term assistance - to be provided to cover the purchase of capital commodities which are essential to the project. This assistance would be supplied in the form of loans, and, in some cases in grants for planning, communications improvements, and for the supply of domestic water. Local authorities hope that the Central Government would consider developing this scheme as a village settlement project.

5.9 Discussion

This project was also started with little assistance. It is noted that the settlers are fully engaged in making their project a success. All the fields are well kept and the crops are particularly healthy in this scheme, due to favourable soils and other conditions. It can be safely assumed that production per acre will top the average production in the area.

The settlers have cleared heavy bush, constructed their temporary accommodation, and have properly planted and tended their crops. Here too, all indications prove that the settlers are willing to farm and occupy this area.

In this scheme also, action must be taken to assist these settlers by providing them with subsistence food until their crops are harvested.

Long-term assistance for this scheme cannot be advised at this stage unless its development programme is carefully reconsidered.

i. The scheme is situated in heavy bush which needs great effort for clearing. Careful supervision must be imposed on the settlers to speed up the programme for clearing. They should not rely on the National Servicemen for all the work. If clearing continues at the present pace it will be difficult for the scheme to reach its objectives according to the programme.

ii. It is obvious that cotton will realise high production standards in this area, and it is advised strongly that it should be the main crop in the project. The area for each settler would be as proposed in the other schemes, i.e. 3 acres of cotton and 2 acres of subsistence crops.

iii. Sisal is a new crop in this area, and is being introduced in the scheme. Cotton and sisal are not workable in a rotation without careful planning, especially with regard to labour requirements; this is particularly true for sisal. The introduction of a new crop in an area should follow certain procedures. It is unfair to make the settlers bear the consequences of trials on the adaptability of new crops in an area. We advise strongly that a technical and economic opinion for planting sisal on this project should be sought from the authorities responsible in this field.

iv. At present sisal that has been planted in the nursery could be used as hedges for the project, and could be processed manually. Large scale planting should not occur except after careful planning.

v. As for additional settlers (to reach 200), due to the particularly favourable conditions on this area, they could be introduced to the scheme and supported during clearing and planting until they harvest their crops.

5.10 Recommendations for Mayenge

- i. Supply immediate assistance to 150 settlers until harvest.
- ii. Proper supervision and stepping up the programme of land clearing.
- iii. Re-examine the merits of introducing sisal on this project, economically and technically.
- iv. Introduce 50 more settlers as planned. Assistance through issues of food commodities should be contemplated for them until their land is cleared, planted and harvested (12 months).

6. Mkuti Settlement Scheme

6.1 Location

Mkuti is the east side of the Kigoma-Kasulu road, about one quarter of a mile north of the Mkuti river road bridge, and about 18 miles from Kigoma.

6.2 Soils

The soils are very similar to these at Mayenge but the site slopes towards the river. There is a good depth of soil of high nutrient status due to its having been under miombo-riverine forest.

Great care must be taken to avoid erosion on the sloping land. Any natural drainage lines are best left uncleared, forming a strip of vegetation 200 feet wide.

6.3 Rainfall

The rainfall pattern is similar to that at Mayenge.

6.4 Domestic water

The settlers get water from a spring close to the present camp. The Mkuti river is quite close and this would seem to be an ideal site for a hydraulic ram driven by the river pumping the spring water to both Mayenge and Mkuti settlements. Such a system has the great benefit of negligible running and maintenance costs.

6.5 General description of the scheme

This scheme is based on cotton and sisal production; 164 T.A.N.U. ^{1/}Youth settlers were moved to this project towards the end of December 1964. The settlers arrived late for the cotton planting season but they cleared about 35 acres, of which 20 acres have been planted with sisal.

6.6 Assistance to the project

The local authorities selected the settlers and transported them free of charge to the scheme. They were also assisted with free issues of maize flour, salt, beans, palm oil, etc. as in other schemes of this area.

Technical assistance was available through the regional agricultural staff.

^{1/} Tanganyika African National Union

Sisal transplants were supplied to the scheme. No housing assistance was provided. The settlers have put up temporary houses on the scheme, using local materials.

6.7 Programme of development

It is hoped that the scheme will reach its full development during 1965. The number of settlers is planned to reach 200 during the next planting season. Each settler would cultivate 2 acres of cotton, 3 acres of sisal and 2 acres of subsistence crops. The settlers are presently organized in a farmers' association, but it is hoped that in future a cooperative society will be formed among the settlers of the scheme.

It is hoped that each settler will be given a right of occupancy over the area he is cultivating.

6.8 Assistance requested

6.8.1 Immediate assistance

External assistance in the form of food, or funds to enable food to be purchased locally, is needed due to the exhaustion of local funds. Assistance should be continued to the settlers until they harvest their crops.

6.8.2 Long-term assistance

Long-term assistance should be provided to cover the purchase of capital commodities, which are essential to the project. This assistance would be supplied in the form of loans, and, in some case, in grants to cover such items as planning, improvement of communications, and for the supply of domestic water.

It is hoped that the central government would develop this scheme in conjunction with Mayenge as a pilot village settlement project.

6.9 Discussion

This project was started with little assistance and it is noted that the settlers are quite active in their jobs, although they were not able to plant a crop this season. The soils in this scheme are variable, and, if proper production is to be achieved, some careful planning has to be carried out for this area.

Bush is also heavy in this scheme, and clearing should be stepped up so that enough land is cultivated.

Considering the present stage of development it is difficult to decide whether this scheme will be economically viable in future, but settlers already on the site will have to be assisted until they are able to harvest a crop, i.e. for a period over one year.

Long-term assistance for this scheme cannot be advised at this stage, unless its development programme is carefully re-considered.

- i. Clearing should be supervised so that enough land is cleared in time.
- ii. Planting of sisal on this scheme is not recommended, as has been discussed on Mayenge.
- iii. Additional settlers should not be introduced unless conditions prove favourable to this scheme.

iv. Starting a pilot village settlement in Mayenge and Mkuti might be a recommendable project. But it should be understood that this would happen only after careful planning and after capital and running costs are available. Plans for a pilot scheme might also be in conflict with the programme presently under execution.

6.10 Recommendations for Mkuti

- i. Supply of assistance for 164 settlers until harvest time.
- ii. Proper supervision and stepping up the programme for land clearing.
- iii. Re-examine the plan for the development of this scheme.

iv. More settlers should not be introduced until indications prove that the scheme will be economically viable.

7. Summary of Recommendations

7.1 Bulombola settlement

Immediate assistance in the form of food commodities or funds for the local purchase of food for 50 people till 31 May 1965. New settlers should not be introduced to this project unless it is proved that the project is viable.

7.2 Ilagala settlement

Assistance to flood victims should be sought from appropriate authorities. A decision on the possibilities of starting a pilot village settlement scheme at Ilagala should be reached and advised to the local authorities as soon as possible.

7.3 Kasaba settlement

Immediate assistance to 66 settlers in the form of food commodities or funds for food to be purchased locally should be extended up till 31 May 1965. Provision must be made for further food supplies for one more year if the project needs adjustment due to the soil or labour factors. No further assistance should be supplied unless yield standards prove that the project is viable.

7.4 Mayenge settlement

Immediate assistance to 150 settlers in the form of food commodities, or funds for food to be purchased locally, to be extended till 31 May 1965. Similar assistance for 50 new settlers from the date they are introduced to the project till their first harvest on 31 May 1966. Proper supervision and programming for land clearing. Re-examine the agriculture development plan of the scheme.

7.5 Mkuti settlement

Immediate assistance to 164 settlers in the form of food commodities, or funds for food to be purchased locally up till 31 May 1966. Proper supervision and programming for land clearing. Re-examine the agriculture development plan of the scheme, with due regard to variations of soil. More settlers should not be introduced, unless indications prove that this scheme will be economically viable.

7.6 General recommendations

Assistance to settlers even in the form of foodstuffs for subsistence, should not be handed out free of charge. Settlers must never become accustomed to relying on free support as this will develop into a continuing habit of asking for free help.

The price of subsistence food, or at least its handling and transport costs, should be debited to each settler's account and collected when his crops are harvested.

In agriculture settlement, as in pure agriculture production, work done in the fields is different in nature. Some jobs in agriculture are best suited to women, others to men or children. Therefore agriculture is based economically and technically on the work of family units. If local authorities are seeking efficiency on these projects, settlers should be allowed to form family units as soon as possible. The division of settlements into separate units for old people, for women, or for youths, should be reconsidered.

Long-term assistance, in the form of loans, tractors and other assistance measures is essential to these projects. The formation of a supervised agricultural cooperative society will facilitate the access to bank and government assistance. Supervision is essential so that assistance is used in a proper manner and paid for.

Planning of production in the settlements should be based on proved technical methods. Innovations which are not based on concrete trials should never be used for increasing production. The settlers' future should not rely on agricultural practices that are not yet fully proved.

Chapter 8

ISMANI VALLEY DEVELOPMENT: PART I-BACKGROUND

1. Introduction

The study team consisted of Mr. O.A. Sabry and Mr. D.R. Harris (FAO)², the Regional Water Engineer, Mbeya; the Regional Agricultural Officer, Iringa;³ the Area Commissioner, Iringa; and the Regional Medical Officer, Iringa. Mr. A.J. Hu (FAO) joined the study team at a later stage.

The terms of reference for the team were broadly to examine the economic and social benefits of the Ismani Water Development Project, on long and short-term basis, with reference to water for domestic and irrigation purposes, respectively. In detail, the team's terms of reference were as follows:

- i. The team shall determine the most advantageous form of settlement for the Ismani Area.
- ii. On the basis of soil suitability, the team shall determine the areas where people should be settled permanently, the size of village, water distribution system and the social services required.
- iii. The study shall also include crop and livestock husbandry and soil conservation programmes to prove the economic justification of the project.
- iv. To examine, in general terms, the suitability of soil for irrigation, particularly in the Lambilele Mbuga area; and to assess the future potential for irrigation, assuming that up to 300 cusecs of water could be made available by diversion from the Little Ruaha River.
- v. To prepare proposals for meeting the water supply requirements of the Area, either by means of a diversion tunnel from Little Ruaha and a piped gravity distribution system, or from any other source considered more expedient.
- vi. The data collected and the report to be prepared should be in the form of a well integrated and well phased development plan of the whole of Ismani Valley which can be sold to a financial authority.

2. General Information

Ismani is an area of some 200 square miles that lies to the north of the Little Ruaha river; a hill range on the east separates it from the Morogoro-Iringa main road. The town of Iringa is built on the south-western end of this range. The great north road, Iringa-Dodoma forms a loose boundary along the western margin. To the north, flowing in an easterly direction is the Great Ruaha river (topographical sheet 215/III 1:50,000 Appx.I).

The surface drainage from the western part of the area is collected by the river Mbungu, while rivers Ifolya and Mgera gather the run-off from its eastern part. The two latter rivers merge into the large Lambilole Mbuga. Through the gap between Uhambengetu and Kipangala Hills, the overflow from this Mbuga is directed to the river Mbungu which ultimately joins the Great Ruaha. The rivers Mbungu and Ifolya flow only in wet seasons. The Mgera river in its upper reaches supports perennial water which until recently has been dissipated over the Mbuga plain; but now is being directed by

two man-made shallow cut ditches to the Lambilole and Mafifira areas, both located on the northern side of the Mbuga.

The general topography can be described as broken and undulating with a good soil cover. The altitude varies from 4 700 to 4 000 feet, very little of the area is flat, except within the Mbugas, but the slopes are not steep and the greater part of the area is suitable for cultivation.

Soil erosion is not apparent, except near the steeper edges of the drainage lines where the cultivators have tried to use every inch of land. The area has been cultivated for a long time and the natural vegetation has been destroyed or strongly modified.

Rainfall at Iringa Airport, 1960-64

Annual total in inches:	<u>1960</u>	<u>1961</u>	<u>1962</u>	<u>1963</u>	<u>1964</u>
	18.9	24.7	30.7	24.4	19.2

Rainfall at Ismani, 1956-62

<u>1956</u>	<u>1957</u>	<u>1958</u>	<u>1959</u>	<u>1960</u>	<u>1961</u>	<u>1962</u>
27.9	25.8	23.65	---	43.8	24.8	24.7

The rainfall season lasts from Mid-December to the end of April. During 6-7 months, Ismani area has practically no rainfall.

The valley itself is made up predominantly of rocks belonging to gneissic family, which can be divided into two main types. Quartz - Feldspar-chlorite - Sericite Schists and Hornblende - Biotite Gneisses. The former are in general of lighter colour, less resistant to weathering; hence the hills which they form are usually round-topped. These types of rocks seemed to occur under the greater part of Lambilole Mbuga, i.e., approximately south of the line running through Lambilole-Dungaya settlement, along its eastern margin and extending to the south as far as the Nyambiriti - Mkalangetu hills and to Ilole mission. The western part, between Nyumbanitu and Kigara settlements, the whole stretch of Mbungu river and beyond the Iringa-Dodoma road are underlain by the second type: Hornblende - Biotite Gneisses, dark to black in colour. As these rocks are less prone to weathering and richer in iron content, their soils coverage is distinctively deep red in colour and shallow.

The prominent hills and ridges enclosing the valley to the east and south are made up of Granite and Granochlorite type rocks. Faulted granodiorites occur immediately on the western side of the Uhambigetu hills and run to the west where they cut across the Hornblende - Biotite Gneisses at Kigaza village. Their extension under blanketing red soils to the north-western limits of Lambilole is possible.

The rocks forming the valley are of metasedimentary origin. During the past ages, all these rocks were subjected to various geological forces, mainly to metamorphism and faulting, as a result of which they became, as observed now, substantially deformed, jointed in places, shattered and inclined in general south-easterly direction at angle between 30 to 90 degrees.

The extent of jointing, degree of weathering, relief disposition and recharge are some of the factors which have considerable bearing on accumulation of groundwater within the rocks and on their yielding capacity. From this point of view the Quartz-Feldspar-Chlorite-Sericite Schists appear to be better aquifers than the Hornblende - Biotite Gneisses. Their joints' system is more open and reaches to a considerable depth. The zones of weathering are usually deeper too, more consistent and of wider lateral spread. However, because of deep jointing, groundwater within these rocks tends to be

disposed at depth; and its movements seem to be hindered by fine materials derived from the decompositions of Chlorite Sericite, which clog the system of inherent fissuring, thus reducing their yielding capacity.

The Hornblende - Biotite Gneisses as a unit are much more massive and harder rocks, and less susceptible to weathering. Close and tight jointing is a typical feature of these rocks, and groundwater is confined at depth to an irregular, scattered pattern of narrow zones of more pronounced shattering or more open jointing.

3. Land Use at Ismani

Generally, Ismani area should be classified agriculturally into five distinctive zones.

3.1 The Nduli area

This zone is in the south-western end of Ismani, around the Airport. It occupies an area of about 15 000 acres of well drained sand-loam soils.

Flue-cured tobacco is the main cash crop in this area; it is grown by native and non-native farmers. Yields are, at present, good but leave much to be desired. During 1964/65 season, yields are expected to average about 800 pounds of cured tobacco leaf per acre. Although fertilizers are used intensively, total dependence on rain has been the main limiting factor toward better production. It is believed that if planting time could be advanced by one month to November, this being only possible by irrigating until rain starts in December, yields might reach 1 300 pounds of cured tobacco leaf per acre. These figures are based on actual yields achieved by some farmers in Nduli, and on findings from experiments at Seaten-dale Research Farm.

3.2 The central Ismani

This zone includes all the areas on either side of Iringa Dodoma road, from Kisinga to Nyangoro, and including areas around Kihorogeta. This zone is about 100 000 acres and carries the greatest concentration of both human and livestock population. Development of this area has started about fifteen years ago, and particularly after the construction of the Dodoma-Iringa road. Maize is the main cultivated crop in the area and covers about 80 percent of the total arable land. The estimated average yield of maize per acre in Ismani is 5 bags or 1 000 pounds. When calculated by Tanzania standards, the yield is about double the average in the country (0.45 tons per acre compared to 0.215 (1960). Still the problem of utmost importance to the economy of the area is the gradual declining in maize yields. Records point out that in the period between 1950 to 1955 maize yields were about 9 to 12 bags per acre. By 1963, in a period of less than 10 years, maize yields had fallen to the present average of 5 bags per acre. This very rapid decline is attributed mainly to the following factors.

i. Large scale agricultural development has started in this area following the construction of the Dodoma-Iringa road. Most of the development was initiated and supported financially by non-residents, most of whom were not farmers by profession. Their interest was in getting quick returns from the land. Therefore, agricultural practices in this zone can be described as mainly of the soil-mining type; with no consideration given to the preservation of the soil's fertility.

ii. A long dry season, with no proximity to adequate domestic water supplies that could be developed within the financial and technical means of the growers, dictated monoculture cropping. Therefore, production was mainly oriented to a short growing, and low labour-consuming crop so as to minimize domestic water use by farm labourers, especially during the dry season.

For the same reason cattle husbandry and consequently grass rotations could not be adopted.

3.3 The Igula -Mkulula

This zone lies eastwards from Igula to Mkulula. It is about 60 000 acres and a relatively recent area of development, some parts of which are still unoccupied. Here the level of soil fertility is fairly high; and yields of maize, which is virtually the only cultivated crop, are comparatively high, about 8-9 bags per acre. Farmers are still acquiring new plots in this zone at a rate that would put all good land under cultivation within 3 years.

3.4 Lambilole Mbuga

This zone is situated to the east of the central Ismani zone and has an acreage of about 23 000 acres. The Mgera and two smaller rivers and several streams flow into this area which remains flooded for the greater part of the year. It dries up completely toward the end of the dry season.

Presently this zone supports a large number of cattle, about 50 000 head-11 000 of goats, 7 000 of sheep (for cattle distribution in Ismani see Appendix II). It is mainly utilised for grazing, but if supplementary irrigation was available, the zone could have high potentialities for intensive agricultural uses.

3.5 Area north of Nyangoro village

This zone covers an area of about 10 000 acres of sandy loams and is very suitable for flue-cured tobacco; yet only one farmer (800 acre farm) grows tobacco. The greatest part of the zone is unoccupied and is under thick bush. Some subsistence maize is cultivated by the local population but yields are very poor. Because of the unsuitability of the soils, a better practice would be to rotate maize and tobacco, the latter being more suitable for this type of soil. Maize would then benefit from the residual effect of the fertilizers that would be applied heavily to the tobacco. On the other hand, lack of domestic water supplies has again hindered tobacco production in this zone.

4. The Development of Ismani: General Considerations

The Tanzania Government is interested in the development of Ismani, mainly because it is one of the major maize producing areas in the country. In 1964, 19 676 tons of maize were marketed for cash from this area. This amounts to 60 percent of the total maize deliveries to Tanzania Millers Ltd. from Iringa and Mufindi districts. But it is feared that production per acre in Ismani will continue to decrease gradually, as has been the case for the last fifteen years; it has been often mentioned that the whole area would sometime revert to subsistence cultivation. This would waste all investments so far. Therefore, it is important to plan transformation agriculture in Ismani, with the aim of laying down more stable foundations for production. The main objectives would be to increase productivity as well as to maintain the fertility of the soils. Several complicated problems would face development, and, if production figures are to be restored to the 1950 averages, it is important that all aspects of the problems should be examined. These problems are described in the following sections.

5. Water Supply

Whether for domestic, cattle, or for irrigation purposes, water is a major factor that dictates the agricultural pattern and land utilization in Ismani. If changes and improved practices are to be introduced, the solution to the problem of water supply

should precede any other considerations, as pointed out in the following chapter.

Scarcity of domestic water supplies, especially during the dry season, makes maize cultivation the best alternative in this area. Maize is a wet season crop and, therefore, requires minimum water supplies.

In addition, water affects the distribution and the intensity of the population, labour force, and cattle in the area. Providing an adequate supply of domestic water would immediately improve conditions, particularly for labour, and would thus help to increase production, and create better possibilities for land utilization.

6. Agricultural Practices

6.1 Tobacco cultivation

The two tobacco-growing areas, at Nduli and north of Nyangoro village, are not at present of top concern to the Government. Agricultural practices in the two areas follow the general pattern for tobacco cultivation in Iringa. Development of new farms and settlements is under way especially in the Nduli area. There is a marked shortage of domestic water supplies in the Nduli areas, but the need is greatest in the area north of Nyangoro village. Improvements to the supply of irrigation water for the tobacco farms should be undertaken only after a more detailed feasibility study that would include trials and demonstrations.

6.2 Maize cultivation

Decline in maize production per acre in Ismani is the most immediate problem. Comparative yields in the Ilanga experimental substation in central Ismani, for fertilizer and grass ley trials, and production averages in the newly opened lands in the Igula-Mkulula area, demonstrate effectively that the soils in the central area have been mined for many years; and that unless proper agricultural practices are introduced maize yields will keep on declining as more pressure is exerted on the land. Several recommendations have been put forward to solve this problem and are included in the working programme of the experimental substation. These are mainly:

- i. To introduce a proper crop rotation that would involve other crops than maize, namely: groundnuts, beans, pulses, castor, sun-flower or grass.
- ii. To encourage fertilizing, manuring, and the introduction of better maize varieties.
- iii. To encourage animal husbandry.

6.3 Labour requirements

Still some physical factors prohibit a full-scale improvement in the region. In the case of introducing new crops in rotation, this could entail higher labour requirements. Comparisons in labour requirements between maize and groundnuts (the latter being the most promising alternative crop) clearly demonstrate that, when considering labour costs, maize would be more rewarding to an Ismani farmer, especially since farming is done generally on a family-unit basis. The comparison is as follows:

- i. Maize: Average yield per acre 500 lb or about 200 kg at sh $\frac{-}{27} = 54/-$.

A family could easily care for 10 acres of maize (see labour requirements Appendix 3). The gross revenue of a farm unit would be sh $54/- \times 10 \text{ acres} = 540/-$.

ii. Groundnuts: average yield per acre 650 kg at sh -/85 = 552/50.

A family can only cultivate (if not employing additional labour units) 0.75 acres (see Appendix 4). Therefore, the gross revenue of a family would be sh 552/50 \times 0.75 = 414/38.

It is normal practice in the area to select planting seeds from last year's crop; and as labour is supplied free by the farmer family, it can be assumed, therefore, that other costs of production are negligible, and that the gross income per family unit could be well considered as a net income. It is apparent then that returns from maize are higher than from groundnuts. Additionally, maize cultivation, on a family-size unit does not put extreme pressure, through excessive labour requirements, on the family as compared to groundnuts. The whole picture would change if cheap labour was available in Ismani. So until then, it would be a difficult job to introduce new crops to farms in that area.

Other measures of agricultural development, including the use of fertilizers, improved varieties, etc. would also result in an increase in labour requirements; for if successful, they would result in bigger yields and, therefore, more labour to handle the crop. Eventually, agricultural improvements in Ismani would result in more pressure on water resources as additional labour is introduced. Therefore, development will be delayed as long as the water problem has not been solved.

6.4 Pasture and animal husbandry

It has been suggested that grass ley alternating with maize would be a good agricultural practice for Ismani. From purely technical considerations this might be so but farmers do not yet realize that a long term increase in fertility to their soils would compensate for the loss of half their maize production to grass, especially since, at present, annual production can be maintained at no cost on the Mbugas where feed is plenty and free.

Cattle are kept mainly on the Mbugas during the wet season. The main object of animal husbandry is beef production, yet some cattle are brought to the maize areas to graze clear the maize fields; then they are driven off to the Mbugas as the water shortage becomes acute. Thus the improvement of animal husbandry too is dependent on solving the water problem.

7. Marketing and Credit

The marketing of maize in Ismani is done through marketing cooperative societies which are part of the Iringa Farmers Cooperative Union. Deliveries are made to Tanzania Millers who are the main agents of the National Agricultural Products Board.

There are five cooperative societies in Ismani, namely: Igula, Ndevelwa, Mkaunguga, Kisinga, Kitapilomiva. The role of these cooperatives is mainly confined to collection and marketing. No credit is extended to the farmers through these cooperatives. Yet by examining deductions in the price paid to the farmers (see Appendix 5), it will be seen that cooperatives subtract a shT -/02 levy per kg of maize. This actually amounts to 1/80 per 90 kg bag net, or to about 400 000/- from the whole Ismani area.

The value of the service extended by the cooperatives to the growers or to its members was not considered in this report. It is suggested though to examine the marketing of agricultural products in the area with the aim of making better use of these cooperatives; and make sure that more assistance is extended to its members (i.e. farmers) in aspects of agriculture production, especially in extending credit which should be made available for the purchase of fertilizers and good seed, as well as for payment of labour. Therefore, among other technical measures recommended for Ismani, the problem of improvement of cooperatives and credit facilities should be given high priority.

8. Population

The population in Ismani fluctuates depending on the season. It is divided in two distinct groups:

i. Ismani locals

	<u>Ismani Area</u>		<u>Mbungu Valley</u>		<u>Total</u>
	<u>Adults</u>	<u>Children</u>	<u>Adults</u>	<u>Children</u>	
Wet season:	14 213	7 253	3 618	2 012	27 096
Dry season:	12 223	4 112	2 916	2 001	21 252

ii. Seasonal Labourers

Wet season: = 24 513

Dry season: = Nil.

The total population in the wet season is about 52 000; in the dry season it decreases to 25 000. This position is attributed to the unfavourable conditions, especially with regard to domestic water supplies. For this reason labourers are only available during the wet season; they come in from distant places seeking employment in Ismani. The average pay for one labourer per day is sh 3/35, including housing, plus some assistance in ration supplies which are offered free by the employer. In the dry season, labourers migrate back to their homes. This seasonal fluctuation has affected, in a detrimental manner, the economy of the area, in that:

(i) most of the labour-consuming jobs, such as harvesting, are achieved in a very short time, i.e. before the depletion of the water supplies. Consequently, the marketing is confined to a short period, putting a lot of strain on transport and storage.

(ii) off-season labour-demanding crops could not be introduced favourably in the area in a proper rotation with maize.

(iii) a large portion of the labourers' earnings are wasted on transport to and from Ismani.

9. Land Tenure

Most of lands in Ismani are held under customary rights. Allocations have been made by the local chiefs during the early settlements. Presently, allocations are made through the district council. Records of the rights are not kept officially, which means that the situation regarding land tenure does not instill confidence or give an assurance to the farmers on the future of their holdings. Recording and acknowledgement of right would indeed give more stability in the area and would encourage injection of capital and efforts on long term development. Additionally, procedures involving the implementation of tenure policy, could be effectively used for initiating valuable reforms to the farms of this area.

Chapter 9

ISMANI VALLEY DEVELOPMENT: PART II-WATER DEVELOPMENT

1. Introduction

At the request of the Director, W.D.I.D., the FAO Investigation Team visited the Ismani Valley area on 8-9 January 1965, to investigate and report on the Ismani water supply projects.

From a study of the correspondence on the above subject the following facts emerge:

On 29 January 1964, a request for a pipeline was made by the local authorities Iringa/Ismani to the W.D.I.D. so as to ease the domestic water supply to the Ismani area.

On 18 February 1964, a rough estimate for supplying piped water from the Little Ruaha was made; prepared by the R.W.E. Mbeya (Officer-in-charge Iringa). It quoted a cost of £150 000 to supply 250 000 gallons per day.

On 7 March 1964, the Officer-in-charge, Iringa, W.D.I.D., stated that the people at Ismani had collected 30 000 shillings for an improved water supply. They did this by collecting one bag of maize from each farmer. He also reported that the possibility of connecting the proposed Ismani supply to the present Iringa town pumped supply had been discussed with the local people, on the understanding that the water would be sold to them from kiosks. The Officer-in-charge, Iringa, quoted the Extension Officer, Agriculture, as saying the yield of maize was falling to 5 bags per acre (1 000 pounds?). The Tanesco water-right to generate electricity was mentioned at this stage (140 cusecs at Tasamaganga from L. Ruaha).

On 16 May 1964, under the Title, Land Utilization - Ismani, Iringa District, the R.W.E. Mbeya proposed:

- i. A 2-mile long tunnel through the Cherigimono hill to bring water from the Little Ruaha into the Ismani Valley via the Mbungu river drainage.
- ii. The building of the dam at Iringa on the Little Ruaha (FAO - Rufiji Basin Survey 1961).
- iii. To divert 300 cusecs into the Ismani valley via the tunnel and to generate en route 50 000 000 kwh/year; and to use the bulk of this 300 cusecs for irrigation in the Ismani valley.

Cost of tunnel	£50 000	first phase
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Cost of dam	£1 200 000	second phase
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On the proposal to pump and pipe water from the Little Ruaha, the R.W.E. quoted 20 miles of 6 inch pipe, costing £150 000 and pumping charges of £8 000 per year.

On 24 August 1964, it was stated that up to £1 500 was to be allocated to surveys of the proposed tunnel at 1/10 000 (Head Office, W.D.I.D.).

On 16 September 1964, the R.W.E. Mbeya received a letter stating that the preliminary investigations of the Ismani Water supply would be under the direction of the C.D.R.E. ¹/_(Ubungo).

1/ Chief Design and Research Engineer

On 14 October 1964, in a report on the Ismani Water Supply, the Director of Planning (D. of D. and P.) gave his views on the tunnel v. pump scheme, and favoured the idea of pumping from the Little Ruaha. He further mentioned the easing of the problem if the population was "pulled in" to villages or settlements. Then followed several letters between interested parties in which the real object of supplying drinking water to the people of Ismani became lost in a welter of technical data and costs and estimates covering a major irrigation development and power production scheme.

On 7 January 1965, an aid application for Ismani Water Supply, Land Survey No. 46, prepared by W.D.I.D., gave the cost of the construction of a tunnel from the Little Ruaha river and 20 miles of pipeline, with a second branch of 15 miles, as £265 000 spread over three years; and left the construction of the 60 megawatt generating station, the development of 20 000 acres under irrigation and the building of the Little Ruaha dam to the future.

The pump scheme was dismissed as having too high a recurrent cost.

On 9 January 1965, a map giving the areas of "good" soil for development and some estimated population figures, as and when the area is fully developed, was forwarded by R.W.E. Iringa to the Regional Agricultural Officer who is undertaking an "Agricultural Feasibility Study of the Ismani Area with Reference to a Water Supply from the Little Ruaha River".

The R.W.E. comments that the proposed development could lead to a demand of 1.5 million gallons a day, which at the Iringa township price of sh 3/- per 1 000 gallons would cost £80 000 per annum.

The question of financing the development of the area is also covered by the correspondence and minutes of file WD 302.

The Ministry of Lands, Settlement and Water Development had promised the inhabitants of the Ismani Valley area that £100 000, which was estimated as the cost of the works, was available for starting the scheme.

2. Description of the Area

The Ismani Valley area of some 200 square miles lies to the north of the Little Ruaha river, separated from it by a range of hills. Iringa town is built on the western end of this range. The Great North Road Iringa-Dodoma forms a loose boundary along the western margin, and the north and east is bounded by low hills.

The area is drained by the non-perennial Mbungu river, which flows east into the Great Ruaha. There is no record of flows in this river. Drainage is interrupted by a series of mbugas which eventually drain into the river system.

The general topography can be described as broken and undulating, with a good soil cover. The altitude varies from 4 700 to 4 000 feet; very little of the area is flat, except within the mbugas, but the slopes are not steep and the greater part of the area is suitable for cultivation. Soil erosion is not apparent except near the steeper edges of the drainage lines where the cultivators have tried to use every inch of land. The area has been cultivated for a long time and the natural vegetation has been destroyed or strongly modified.

Rainfall at Iringa airport, 1960-64.

Annual total in inches	<u>1960</u>	<u>1961</u>	<u>1962</u>	<u>1963</u>	<u>1964</u>
	18.9	24.7	30.7	24.4	19.6

Rainfall at Ismani, 1956-62

Annual total in inches	<u>1956</u>	<u>1957</u>	<u>1958</u>	<u>1959</u>	<u>1960</u>	<u>1961</u>	<u>1962</u>
	27.9	25.8	23.62	-	43.8	24.8	24.7

3. The Ismani Water Supply Scheme3.1 General

Looking into the relatively short history of the "Ismani Water Supply Scheme", it seems that the original and rather urgent target to be achieved, namely a satisfactory water supply (which had been requested by the local population), had undergone considerable transformation when the technical side of the problem was undergoing discussion and examination.

From a limited rural water supply scheme intended to meet the immediate needs of the local people in the Ismani area, it became a large multipurpose water development project, with the idea of digging a tunnel through the Cherigimono hill range to divert 300 cusecs from the Little Ruaha, with the possibility of irrigation development over some 320 square miles.

In such a multi-purpose scheme, the return from the domestic water supply would form only a minor part of the returns from the whole, and undoubtedly the feasibility of the scheme has to be based on the full-scale development of the area. For this reason alone, realistic consideration must be given to the prospects of irrigated crops and electric power consumption in the Iringa Plateau/Ismani Valley area in the future.

3.2 Irrigation of the Ismani Valley area

So far, irrigation is not required by the unsettled population of the Ismani Valley area. Should a reliable water supply and other community facilities build up better living conditions in the area and, therefore, urge a greater part of the population to become more stable and to practise husbandry on a more permanent basis, irrigation would most likely become a necessity to palliate the long dry season. But because of the undulating land, gravity irrigation can hardly be envisaged. Overhead sprinkler irrigation would be the best system, so development of irrigation at Ismani will have to wait until the region is much more advanced.

3.3 Present agriculture in the Ismani Valley area

Some 78 000 acres are under rain-fed cultivation at present, the greater part of which is used for maize; some beans and tobacco are grown, and the usual food crops are grown near the houses. A few cattle are kept in the area, but the number that can stay throughout the dry season is small; like the farmers they have to leave once the dry season starts and local surface water supplies dry out. Cotton is not grown in the area due to the regulations imposed by the Ministry of Agriculture, Tanzania.

3.4 Agriculture output

The yields of maize are put at 5 bags/acre or 1 000 pounds per acre. Total output of maize in Tanzania is some 600 000 tons. The area under cultivation of crops, including maize, is 16 400 000 acres. The total output of cereal starches is 3 520 000 tons. So it is possible to say that the output of the Ismani valley area is about double the average for the whole country.

3.5 Soils

After only a brief examination of the area, the general soil pattern suggests that the bulk of the area that is suitable for dry arable farming has been developed for a long time; some of the eastern areas and the mbugas are still not used. The level of fertility is not high but compared with other parts of the country is above average.

The only way to improve the fertility level of the soil without using artificial fertilizers is by introducing rotations, including legumes; and by introducing mixed farming and returning the animal manure to the land, something that is rarely practised at present in Tanzania; and it seems that this is something the farmers are strongly opposed to doing. The labour of moving the manure is considerable without the help of some form of transport; and the manure tends to collect near the dwellings which are not usually in the centre of the arable plots.

4. Population of the Area

The number of people in the Ismani valley area is estimated at between 7 000-8 000 during the height of the maize growing season, but falls considerably in the dry season, perhaps to 2 000. The main population areas are: Ilole, Nduli, Lambilole, the Ismani village area along the Great North Road, the Mbungu valley and Ukaninemo area. It is estimated (R.W.E.) that after development the population density will be 380 per square mile (110 000 on 184 000 acres), as opposed to 26 for the whole of Tanzania. If the area is developed to 184 000 acres, and each family of five persons farms five acres, the population will be 640 per sq. mile (1 per acre).

5. Utilization of the Generated Power

Taking into account the power requirements of an overhead irrigation system and domestic demand, the 50 megawatts quoted previously is considerably in excess of the anticipated future demand.

Of the three main purposes of the Ismani Valley scheme - irrigation, hydro-electric power and water supply - only the last requires immediate consideration, as the real shortage of water is hindering permanent and organized settlement in the area.

6. Domestic Water Consumption in Rural Communities

The feasibility of tapped water supply schemes in rural Africa is frequently based on a daily consumption of 10 gal/human. Provision for cattle also amounts to some 10 gal/head/day. This is more than is necessary.

Tapped water, supplied from reliable and permanent sources, delivered at kiosks is needed in the following amounts in the Ismani area.

Humans:	Dry season (8 months):	6 gal/day/person
		25 gal/day/family of 6.
	Rainy season	3 gal/day/person
		12 gal/day/family of 6.

(additional supply from surface water)

8. Exploitation of Water Sources

8.1 Permanent sources

Water could be extracted from the Little Ruaha by pumping it over the lower saddle of the hill range, 150 ft above the river bed; by a hydraulic ram (through a gabion-made weir 8 ft high); by a tunnel. A delivery system, would be required for all three alternatives.

In many parts of the Ismani Valley, extracting groundwater by wirepump would be an adequate way of supplying domestic water to small groups of families. Wind records at Iringa Airport (Nduli area) show that a 20 ft diameter wind-wheel, properly located, could lift to 130 ft more than 800 000 gallons during the year (see Appendix 6), i.e. the annual consumption for a community of 250 people plus cattle, in due proportion (assuming an additional supply from rain and/or surface run-off during the rainy season).

8.2 Non-permanent sources

8.2.1 Catchment and storage of rainwater

Assuming a 20 inch rainfall in an ordinary dry year, one and a quarter ft of rainwater can be collected during the three rainy months (March, April, May). Assuming also that the use of stored rainwater would be restricted to humans (water requirements of cattle being met by other means), the quantity of rainwater to be caught for the annual requirements of one individual is 1 440 gallons or 231 ft³. Therefore, the area of watertight catchment (for one individual) should be 185 ft², and the capacity of the cistern 1 200 gallons or 200 ft³ (per person). The minimum catchment area for a family of six should be 740 ft², and the capacity of the cistern 2 800 gallons or 800 ft³.

8.2.2 The family-type rainwater cistern

A 10 x 10 x 8 ft underground cistern, is required, lined with bricks and floor bricks, covered with aluminium corrugated sheets supported by a light bamboo frame.

The roof of the house (of corrugated sheets) and the roof of the cistern itself form an appreciable fraction of the rainwater catchment.

$$\text{cistern roof} = 10 \times 10 = 100 \text{ ft}^2$$

$$\text{house roof} = 20 \times 10 = 200 \text{ ft}^2$$

$$\underline{\underline{300 \text{ ft}^2}}$$

$$\begin{array}{r} \text{Area of the "apron"} \\ 740 - 300 \end{array} = \underline{\underline{440 \text{ ft}^2}}$$

The apron is lined with floor bricks.

For future housing, the cistern and apron should be planned to be combined with the dwelling.

8.2.3 The community-type rainwater cistern (50 to 100 people)

Cisterns of 50 000 and 100 000 gallons, with appropriate aprons (7 700 and 15 400 ft³) would be needed. Although they should be cheaper (smaller area of lining and roofing per gallon stored), the types of roof-framing become different for larger spans, and require more costly materials.

Whatever the type the cistern is, drastic measures should be taken in order to avoid pollution of water; fencing around the aprons, separate wells to extract water from the cisterns.

8.2.4 Storage of temporary runoff

Due to the high evaporation (and seepage), the capacity of shallow reservoirs created by erecting small earth dams at selected places on minor non-perennial water courses has to be four or five times larger than the estimated requirements.

On the Ismani Plateau four such "charcos" have been in service for several years. Their yield is not very satisfactory. However, this means of storing water cannot be neglected, especially for cattle. In every case, careful investigations have to be carried out in order to select suitable sites controlling water catchments of limited area, not subject to intensive erosion.

9. Cost Estimates

It is possible by examining figures and estimates worked out by W.D.I.D. to anticipate the development costs, running costs, and finally the cost of water supply to this area.

9.1 Permanent sources

9.1.1 Little Ruaha River

i. Pumping. Pumping costs were worked out (File WD 302 Folio 54) at sh 2/25 per 1 000 gallons on the basis of a delivery of 233.6 million gallons per year. We estimate that the needs for Ismani will not exceed 28 million gallons per year. The estimated figure should, therefore, be increased as the capital, installation and running costs do not vary in proportion to the delivery, but will tend to increase as the total delivery of the scheme is decreased. This figure, if brought to sh 2/50, will be adequate for comparison.

ii. Hydraulic Ram. No previous study has been undertaken for the supply of water to Ismani by using this system. The use of hydraulic rams in this scheme might be worth investigating, especially as the operation and running costs would be minimal.

iii. Tunnel. Estimates for the construction of a tunnel are given in File WD 302 Folio 54. A minimum possible tunnel structure with distribution system will cost £743 000. The entailed capacity of 300 cusecs (300 cusecs = 59 000 million gallons/year) is dictated by the technical considerations of tunnel construction, and there is no relationship between that capacity and the actual water requirements of the Ismani Valley. As only 28 million gallons are needed, the cost of delivery of 1 000 gallons by the tunnel would be:

$$\frac{743\ 000 \times 20 \times 1\ 000}{30 \times 28\ 000\ 000} = 17/70 \text{ cents}$$

Therefore, supposing that water for the Ismani Valley is supplied from the Little Ruaha, it is obvious that pumping, either by pumping units or hydraulic rams, would be the most economical system.

Pumping for Ismani could be developed in stages, as the need arose, through the increase of water consumption in the area.

However, it must be noted that the supply of pumped water would only serve areas where population is concentrated. Long distances between the areas of concentration and places where the population is scarce would overburden the construction and the operation of a complete water distribution system.

9.1.2 Groundwater

Reference is made to the Ukaninemo borehole, equipped with a windmill. The construction costs were as follows (1957):

Borehole (300 ft deep)	£ 950
Surface works and equipment	£1 650
	<hr/>
<u>Total</u>	<u>£2 600</u>

The tested yield was 300 gal/hour, and the estimated yearly output 800 000 gallons. The cost of the supply of 1 000 gallons by pumped groundwater (windmill) would be about sh 5/-.

9.2 Non-permanent sources

Cost estimates for the supply of runoff storage water which are based on the water catchment tank built at Segera indicate that water would cost about sh 27/- per 1 000 gallons. This figure is very high. However, it could be reduced in the following ways:

- i. Development costs could be decreased by an estimated 40 percent if proper attention is given to the design and the choice of material used in the building of these tanks.
- ii. Most of the costs are local costs involving only a small portion of foreign currencies. Labour costs could also be met by voluntary contribution, or by the farmers when unemployed in cultivation.

Moreover, the topography of Ismani is particularly suited to the development of such tanks.

10. Conclusions and Recommendations

The Ismani Valley area has been recently developed as a result of the construction of the Dodoma-Iringa road. The valley is part of the Rufiji Basin and drains north to the great Ruaha river. Its general topography can be described as broken and undulating. The altitude of Ismani varies from 4 700 to 4 000 feet. There is no evidence of important soil erosion. The average rainfall is between 20-27 inches and the rainy season is from mid-December to the end of April. During 6-7 months the area does not receive any rainfall.

The rocks of the valley belong to the Gneiss family. These can be divided into (a) Quarts-Feldspar-Chlorite Sericite Schists and (b) Hornblende Biotite Gneisses. The rocks were subjected to various geological forces; and as a result they became substantially deformed, jointed in places, shattered and inclined in a south easterly direction.

The Hornblende-Biotite Gneisses are the more massive and harder rocks. Close and tight jointing is a typical characteristic of these rocks, and groundwater could be

confined at depth in an irregular and scattered pattern.

Ismani can be divided into five main zones according to land use in the valley.

- (a) The Nduli area.
- (b) The Central Ismani.
- (c) The Igula - Mkulula area.
- (d) The Lambilole Mbuga.
- (e) North of Nyangoro.

The Nduli and north of Nyangoro are mainly tobacco growing areas, while the Central Ismani and Igula - Mkula areas are maize growing areas; the Lambilole Mbuga is chiefly grazing ground for cattle.

The immediate interest in Ismani lies in the maize-growing areas of central and Igula-Mkululu, where 60 percent of the Iringa and Mufindi's maize is produced. Yields have been gradually decreasing. Reasons for the drop in production are mainly:

(a) Lack of domestic water supplies, especially in the dry season, which results in the decrease of the labour force and cattle in the area. This favours maize production while it excludes other possibilities in land utilization, especially in the case of labour-demanding crops.

(b) Other measures which might result in the adjustment of farm utilization in the area, such as use of fertilizers, improved marketing, land tenure reforms, animal breeding, etc., would eventually result in increasing labour requirements.

It is obvious that the first step toward any readjustment or development in agriculture production at Ismani is to provide a reliable supply drinking water to the people of Ismani. Any major irrigation development and power production scheme should be postponed until this basic need has been fulfilled.

So far no agricultural work has been started in this area, for the purpose of determining the economic, technical and human problems involved in an irrigation scheme. The time needed for this study, the design, and the construction of an irrigation scheme in this area, will easily exceed four to five years before any irrigation project can be started. The following investigations are still required.

- (i) Soil and topographical surveys.
- (ii) Tunnel investigations and accurate construction estimates.
- (iii) The determination of suitable crops.
- (iv) Proper irrigation methods and costs of development.
- (v) Water consumption of the crops in relation to the regime of the Little Ruaha, taking into account the dry season, and Tanesco water rights, etc.
- (vi) Running costs and expected returns.
- (vii) Settlement of the population and system of operation.

Other problems related to the proper economical use of power would also have to be examined by the agencies responsible.

The total requirement for water in this area is about 28 million gallons per year. This figure is based on the actual population and cattle numbers in this area.

A tunnel to bring water from the Little Ruaha river is not recommended, not because of technical considerations, but because economically a tunnel would not be viable unless large amounts of water are actually required.

It is recommended that:

- (a) Pumping of water from the Little Ruaha should be developed for water supply to the main concentration centres at Ismani. The development of the pumping scheme should be gradual and in accordance with the requirements of the population.
- (b) Pumping from underground water using windmills should also be investigated to supplement the water distribution system in the area. This method might in future compete with the system in (a) if areas are remote and the population is low.
- (c) The construction of runoff storage tanks is expensive when compared with other methods, but such tanks will find their uses as the methods of construction are improved; and especially where families and small numbers of cattle and people are located in remote areas. This system also has the advantages of absence of foreign currency requirements, use of local materials, and high labour costs that could be cut by proper organization and by voluntary contribution, and by spreading construction over a number of years.

The cost for development would be:

- (a) piped water supply - £76 000
- (b) development of existing water supply - £ 34 000

It is difficult to assess the exact figures of benefit Ismani Valley would get as a result of this scheme, but the most obvious results would be:

- (a) A yearly economy in the cost of transporting a minimum 50 000 persons to and from Ismani during dry season.
- (b) The permanent settlement of the migratory population would not involve extra costs in accommodations and other services as the temporary accommodations used during dry season would be also used permanently.
- (c) More earning would be expected on farms as labour-demanding high producing crops are introduced gradually to the area. This would result in the diversification of production and a better distribution of labour requirements.
- (d) It will solve a marketing problem resulting from the need of bringing in and handling the harvest in a short period, i.e. before the commencement of the dry season.
- (e) Introduction of stability on the farms, more capital and a long term conservation policy.

Possibilities for the utilization of the generated electricity should be examined by the Ministry of Industries and Power. If information later proves that there are good possibilities for the development of the Little Ruaha scheme than more detailed studies could be initiated towards that end.

Chapter 10

MWAKIJEMBE IRRIGATION SCHEME

1. Location

The village of Mwakijembe is on the south bank of the Uмба river, about 40 miles upstream from the Tanzania-Kenya border. Access to the village is an 18-mile long earth road from Mtandikeni, which is about 40 miles from Tanga on the Mombasa Road. Traveling would be difficult on the earth road after heavy rain.

2. Topography

The houses of the village are situated on slightly undulating land above the river. This land extends to the south and east. North of the village the land slopes steeply towards an alluvial terrace of variable width above the river bed. The terrace is flooded for short periods during maximum river flows (i.e. April 1964).

There is a contoured topographic map of the area, scale 1 in to 200 ft.

3. Population

There are about 200 persons in the area as far as could be established. The majority are farming the land along the river terrace, but a few own livestock.

4. Cultivation

The main crops are maize, cassava and beans, with a few bananas and coconuts; all relying on rainfall. Crop failures are common. It is believed that each person has 0.5 acres of shamba.

5. Rainfall

The rainfall, as in many other areas of Tanzania, is erratic and unreliable.

Rainfall at Mwakijembe 1951-1955. Average inches per month

January	1.11	
February	2.49	
March	1.84	
April	3.59	
May	4.58	
June	0.40	
July	0.74	
August	1.74	
September	0.87	
October	2.32	
November	2.80	
December	2.26	
	<u>24.74</u>	Maximum in one day: May 1951, 3.36

Rainfall at Moa Estates, 25 miles from Mwakijembe and nearer the coast, was an average of 40.47 inches per year 1941-1962. Daily maximum 6.21 inches 26 September, 1948. Lowest annual rainfall 1941-1962 was 1949 with 26.01 inches.

6. Hydrology

The Uмба river is perennial with a wide fluctuation in flow. Gaugings from January-December, when the gauge was destroyed by a flood, gave a minimum flow of 8 cusecs on October 31, 1963, and a maximum of 6 000 - 10 000 cusecs on 26 December, 1963.

In April 1964, there was an even higher flood which rose higher than any of the local people could remember. This new high-flood level was recorded during the recent survey.

There is an agreement between the Governments of Kenya and Tanzania that allows Tanzania to abstract 5 cusecs for irrigation at Mwakijembe.

7. Soils

From an irrigation point of view, there are three soil types at Mwakijembe that are potentially irrigable. These are:

i. The soils of the river terrace. At present these soils are fully cultivated under rainfall. The soils vary in texture from clays to coarse sands due to their alluvial origins. They have a high level of fertility and show no signs of salinity or of poor drainage, except in a few places where the topography assists the wet conditions; An ideal site for pumped irrigation.

ii. The soils of the sloping land between the river terraces and the village. These are generally brown and red clay loams, with occasional rock outcrops and patches of shallow soil. The slopes are too steep for any practical irrigation system.

iii. The soils of the undulating land around and to the south and east of the village are deep, bright red, clay loams carrying a thick cover of commiphora bush. Very suitable for irrigation but for their topographical position 80 - 90 ft above the river, which excludes the possibility of pumping on economic grounds.

8. Proposals for Irrigation Development

8.1 Three methods for extracting water from the Uмба river have been proposed for irrigating area listed in Section 7. iii. These are:

i. Damming the Uмба river so as to obtain reservoir regulation at a point $3\frac{1}{2}$ miles above the irrigation area and supply canal on the south bank of the river.

ii. Building a weir at the same point as the dam but running the canal along the north bank for 1.7 miles and then bringing the water across the river by an inverted syphon.

iii. Installing a pump or pumps to lift the water from the river to a commanding level for the whole area; the lift will be about 90 ft.

We believe that the building of a large and expensive scheme along the methods proposed hereabove cannot be recommended at present for the following reasons:

i. The area is remote and the population is low compared with the requirements of the scheme.

- ii. Marketing difficulties will be encountered if the scheme is to produce in excess of local requirements.
- iii. Detailed investigations are required so that a proper economic appraisal can be conducted.
- iv. Damming the Umba river at the proposed weir site is not feasible due to the steep slope immediately upstream from the weir.
- v. Any upstream reservoir construction is considered not economically feasible for the present time.
- vi. The proposed pump irrigation, abstracting water from the Umba river, to command the area described in Section 7 (iii) is considered not economic for the present time due to the very high running costs of pumping.

9. Recommendations for Development

The immediate requirement of this village is to secure a reliable agriculture crop on the area presently under cultivation and described in Section 7, 1 .

A pumped supply from the Umba river to command these 115 acres is sufficient at present.

Water would be distributed to open furrows via short lengths of pipe from the pump.

The area to be irrigated is about 115 acres and the quantity of water required would be about $\frac{115}{60} = 1.92$, or 2 cusecs. Assuming a water duty of 60 acres per cusec.

Power required to lift 2 cusecs to 15 ft from the river to the irrigated area would be $HP = \frac{QWH}{550}$
 $2 \times \frac{62.5}{550} \times 15 = 3.4$ Say 5 HP to include losses.

It would be possible to fit the pump to a tractor so that water may be extracted at several points along the river and thus reduce losses due to long runs of earth furrows. Also by this method water distribution will be easier and there would be an economy in lift.

10. Implementation of the Scheme

Additional field information will be needed to complete the study and the planning of this irrigation scheme. The Water Development Office in Tanga could be instructed to collect this information as soon as possible.

The detailed project could then be drawn along the requirements of the farmers. It would then be possible for the designers to specify the number of pumping points, the delivery of the pump, the power of the tractor and other specifications for this project.

The Water Development Regional Engineer should have frequent contacts with local authorities, especially with the village committee so as to explain the scheme to them and to inform them of the development stages that are already under way.

Farmers of this village must have some form of organization enabling them to make proper use of this scheme as well as of the equipment involved. We suggest that the possibility of forming an Agricultural cooperative society, grouping the farmers willing to

join the scheme should also be investigated. The rules for this cooperative society could be similar to what has been proposed for the Mombo irrigation scheme.

The following information is needed before more definite plans can be made:

1. Number of farmers having shambas on the land proposed for development.
2. Acreage and layout of each shamba (to be marked on the existing map).
3. Present pattern of cultivation of various crops and average yields:
 - a. Planting season
 - b. Land preparation
 - c. Harvesting
 - d. Intercropping
 - e. Average yields
 - f. Pests on plant diseases affecting the area.
4. Land tenure rights.

Chapter 11

REPORT ON IKOWA IRRIGATION SCHEME

1. Introduction

Reference is made to this scheme in previous reports - FAO Report on Flood Control in the Kinyasungwe-Mkondoa River Basin; Report on Ikowa Irrigation Scheme W.D.I.D. 1955; Report on Irrigation and Land Use at Ikowa 1958, Land Planning; and Ikowa Irrigation Scheme, proposal for possible revival, by L. Horst, FAO Irrigation Engineer.

2. Existing Situation

The situation on this scheme is well explained in Mr. Horst's report. However, at present the 40 acres that were cultivated by 26 tenants are not in evidence. The area under irrigation has decreased to a few plots of banana trees. Waters from the reservoir and the dam are now used only for:

- i. Flood control.
- ii. A part of the domestic water supply for about 3 000 inhabitants of this area.
- iii. Cattle watering for about 4 500 head of cattle.

Agricultural development in the Ikowa area is now centered on settlement schemes that are composed of three distinct groups:

- (i) A group of T.A.N.U. Youth League volunteers.
- (ii) Women settlers who originated from Dodoma township.
- (iii) A group of farmers, elders, who have been selected from around the area.

Each of the groups were allocated about 40 acres of land planted with rain-fed crops, ground nuts, sim sim and maize. No irrigation is practised on these settlement schemes.

Several surveys of the soils within the Ikowa scheme have been made in the past and many analyses carried out.

From a study of the past work, present field observations and analyses, the conclusions reached are:

The soils ("red soils") nearest to the main canal are suitable for irrigation but are not very fertile and have a low water holding capacity. Drainage is adequate and the land falls gently from the main canal. There are about 40 acres of this land under command of the present canal system.

Lying next to the "red soils" is a narrow band of fine clays of about 14 acres, imperfectly drained and having a slight salinity and alkali hazard. These soils can be irrigated, but with care. Below this narrow band of clays lies a larger area of some 95 acres of dark clays of high inherent fertility. These soils are the problem soils of the scheme. In many places the analyses show high salt and pH readings at both surface and depth, with high exchangeable Na %; whilst in other places the readings are not unduly high. This follows the usual patchy pattern of saline/alkali soils.

These alluvial clays are very difficult to irrigate and require effective drainage and leaching to keep the soil in production. In fairness to the early soils survey, it should be noted that the recommendation to irrigate this type of soil was of an experimental nature in order to assess the possibility of reducing soluble salts in such a soil by leaching with irrigation water alone, or even treating with gypsum.

Very little experimental soil work was carried out once irrigation started, particularly on the build-up of saline-alkaline conditions and water tables.

The layout of the irrigation and drainage scheme for this project, although designed and planned, was not completed.

3. Discussion

The Ikowa dam was built in 1957 for the purpose of flood control and irrigation.

No proper attention was given to the agricultural and economic side of irrigation, especially concerning the choice of suitable crops, farming rotation, the organization of the farmers, the marketing of their products, etc.

The rapid pace of silting in the reservoir would discourage any future undertaking, for it is estimated that in a period of 8 - 10 years the reservoir will be silted. Presently, the reservoir does not always contain enough water to meet the needs of irrigation and other water supplies, especially in dry years.

Checking silting, through watershed management, would be extremely costly and would not produce any marked effect in the near future.

Some attempts at soil conservation, especially in the vicinity of the reservoir, should be envisaged. Fencing of the reservoir and the proper distribution of cattle watering points might solve some of the immediate problems. However, the beneficial effects of this work on the future of the reservoir have to be examined from the economic side.

The proposals put forward by Mr. Horst in his report have our full support, and we further stress that no further step or additional expenditure should be started on this project for promoting irrigation, unless an agricultural solution to the problems involved is duly worked out. Emphasis and stress should always be considered on the value of the organization, and in the administrative and technical operation of the scheme.

In case it is decided to go ahead with irrigation on this scheme, and in the event of proper tackling of its agricultural problems, it should always be borne in mind by the planners that the life of this scheme, even if revised as recommended in Mr. Horst's report, would not be more than 20 - 30 years because of the silting problems in the reservoir.

4. Recommendations

The recommendations in Mr. Horst's report for the revival of this project are strongly endorsed.

Irrigation on this scheme should not be considered unless -

1. The proper organization of the farmers and the administration of the scheme is worked out according to a comprehensive agricultural plan which would take into consideration the nature and the life of the existing water supply.

ii. The basic agricultural development should, therefore, be concentrated on growing rainfed crops in the areas of good soils which surround the irrigation scheme.

iii. In case it is decided that irrigation should be included in the pattern of land settlements that are developed around Ikowa, we recommend that, provided the farmers have been well organized and funds are available, any plan should always consider the irregularity and gradual decrease expected from the water supply. Crops to be grown in the irrigation scheme must be either hardy, drought-resistant plants, or deep-rooted trees, that would survive the possible variations in quantity, and eventually the lack of, irrigation water during the dry season. Also the choice of the crop should be linked with the economic value and marketability of the produce to justify expenditure on irrigation.

Nevertheless Ikowa dam, if properly maintained to provide flood protection, domestic water, and cattle watering for this area, would contribute in a marked way to the improvement of the living standards and in the income of the people in this area. The dam would therefore contribute a great deal to development, other than agriculture, and the dam should be maintained in operation as long as possible.

Chapter 12

PAWAGA IRRIGATION SCHEME

1. Introduction

It has been proposed to supply irrigation water to an area of land on the east bank of the Little Ruaha river by means of a low weir and canal. Another proposal was to incorporate a road bridge with the weir to improve local communications.

2. Location

The area in question covers about 2 000 acres on the right bank of the river, between Segerere and Chamaba. The proposed weir site is at 7° 28' S, 35° 28' E, altitude about 2 700 ft.

The area is served by an earth road running north from Iringa to Izazi, a village on the Great North Road. From Iringa to the weir site is 36 miles and from Dodoma 142 miles.

3. Topography

The area is part of the flood plain of the Little Ruaha and is bordered by the Uhenge escarpment to the S.E. and an undulating plain to the N.E.

The river flows N.N.E. on an aggraded bed which shows signs of frequent and recent changes of river course with associated cut-off meanders and point-bar deposits.

Just below the confluence of the Hoho river with the Little Ruaha there is a rock bar, and it is this rock bar that has led to the proposals for a weir at this site. The rock bar has been surveyed and examined in some detail by W.D.I.D. There is a river gauging station at this site.

The area that would be commanded by a weir at the rock bar is level or gently undulating, dissected by old river courses and sandy cross drainage channels flowing down from the high land to the east, but it is not subject to flooding by the river.

4. Present Irrigation Works

Below the northern end of the proposed area there are two main off-take channels used by local irrigators to irrigate land downstream, and traces of many older furrows.

One "old" furrow has now become an important arm of the river and causes heavy flooding downstream during the rains.

A newer furrow, the so-called "Italian furrow", dug in the 1940's, has now captured a large proportion of the stream and is out of control during high river flows, flooding some of the irrigated area.

Due to the aggraded state of the river and the lack of proper regulators, the irrigators have had very little control over the water and have "lost" their supply wherever a furrow has been captured or the river changed its course.

The cost of bringing such a furrow system under control is very great and would be far above the economic level; and this is one of the reasons for considering the proposed area.

5. The Proposed Area

The proposed area is virtually unoccupied, and apart from a few rainfed shambas is used for grazing.

The area under command of the low weir has the following vegetation cover - acacia woodland of mature trees on the young alluvial soils; and acacia scrub on the sandy clays, and acacia-commiphora scrub on the red soils and sandy soils.

Rainfall at Kimande - 14 years 1949 - 1963. Altitude 2 900 ft. Average annual rainfall 14.36 in.

Average Monthly Rainfall in Inches

<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>	<u>Sept.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>
3.32	2.83	2.72	1.49	0.16	0.01	0.0	0.0	0.04	0.34	0.53	2.87

As in other parts of Tanzania, the rainfall is very erratic and poorly distributed, so a system of agriculture based on rainfed crops is precluded and the only alternative is a system based on irrigation.

6. Soils of the Proposed Area

Several reports on the soils along the banks of the Little Ruaha have been made in the past, but the only one to cover this area in any detail is a report by the A.O. Land Planning, dated 25 May 1958. (Folio 156 File 58/2 CR.210). The soil survey was done with the help of air photos, and soil pits were dug at intervals along traces cut in the bush. But the results of the analyses of samples taken from these pits are not available here. Analyses, however, do appear to have been carried out.

The reconnaissance soil map produced with the above report shows that the soil pattern is quite complex and from an irrigation point of view made difficult by areas of intractable soils, alkaline soils and buried sand channels. Some of the area was too complex to map at reconnaissance level.

The report recommended that the alluvial soils are suitable for irrigation and that the area should be investigated in greater detail, but this was not carried out.

The area commanded by the proposed new channel was estimated as 2 660 acres, but following a more detailed topographic survey of the area it was found necessary to alter the line of the proposed channel. This reduced the area under command to some 2 160 acres.

Of these 2 160 acres, over 400 acres were mapped as "areas completely unsuitable for irrigation due to unfavourable topography, presence of numerous sand bars, and isolated from main area by gullies".

The remaining 1 760 acres is divided in two by a large sand channel running through the centre of the area, parallel to the river.

A detailed soil survey of the above 1 760 acres could downgrade another 40% of the area to leave only 1 000 acres of really suitable soils, and these would not be in a compact block.

7. Construction of Weir and Channel

The length of the channel, as shown on H.Q.SK No.267/3, is approximately six miles. The first 1.5 miles would be a non-irrigating channel and considerable excavation would be necessary, some of it rock.

The weir would be a mass concrete structure with a crest level of 497.6 ft, that is 5.44 ft above the lowest recorded flow level in 1956 - 1957 (flow of 229 cusecs) and 7.59 ft below the highest recorded flow level (flow of 5738 cusecs) April 1957. Invert level of off-take would be at 495.0 ft. The high flow would mean a water depth of 9.4 over the weir crest.

File WL.27 Folio 2 gives a description of the rock bar at the weir site, also Folio 189 File 58/2 C.R.210.

8. Costs of Construction

In November 1958, the cost of construction of the weir, headworks, main and distributary channels and main drainage channels was quoted as £35 000. There was also a plan to incorporate a road bridge with the weir. But it is not clear if the £35 000 included the cost of such a bridge-cum-weir.

The £35 000 quoted above does not include the costs of land clearing, land preparation, or minor field channels.

Development costs per acre, assuming 1 000 acres irrigable are:

$$\frac{35\ 000}{1\ 000} \text{ construction} + \frac{15\ 000}{1\ 000} \text{ clearing and levelling} +$$

$$\frac{5\ 000}{1\ 000} \text{ minor field channels, roads, etc.} = \text{£55 per acre.}$$

$$\text{£55} \times 1\ 000 = \text{£55 000 or 1 100 000 shillings.}$$

To the above figure there should be added the costs of improving the road to Iringa and other agricultural and social services, which would range around £25 000. Therefore total capital costs for developing this scheme would be about £80 000.

9. Recommendations

The future of Pawaga scheme as proposed by W.D.I.D. will depend mainly on the potentiality of production, marketing and other economic and social factors, compared with the present land utilization by farmers.

The factors involved in that scheme indicate that its development in a single stage would be a hazardous achievement. Planting trials for irrigated crops in the project area should be conducted as a base for proper appraisals and planning of the scheme.

Social factors have also to be considered. The farmers are presently living in environments which are much different from the proposed new area.

Therefore, as an alternative to this scheme consideration should be given to the

irrigation of a small area by pumping from the river about 1.5 cusecs initially, and to increase the area gradually as the demand for irrigation water increases.

The land classification survey shows that there is considerably less land for irrigation than was expected. Pumping water will be the only solution to satisfying local needs.

A pumped irrigation scheme will not prejudice the eventual building of the weir if the design of the pump scheme is flexible and its water could be supplied from the weir in the future.

Chapter 13

THE DEVELOPMENT OF STIEGLER'S GORGE AS A MULTI-PURPOSE PROJECT

1. Introduction

The Rufiji River system drains an area of 68 500 sq. miles, almost one fifth of Tanzania, and discharges to the Indian Ocean some 80 miles south of Dar-es-Salaam.

Stiegler's Gorge, situated 100 miles up-stream from the mouth of the River, is one of Tanzania's most important natural resources and its development would be a major step towards full development of the Rufiji River Basin. The construction of a dam at the gorge would be a multi-purpose project, the benefits of which would be:

- i. Power Generation
- ii. Flood Control
- iii. Irrigation
- iv. Navigation
- v. Fisheries
- vi. Recreation and Tourism

The Gorge was identified during the German administration. In 1955-60, the FAO Rufiji Basin Survey team in the course of their studies investigated various dam sites. Two alternatives were put forward; the main features of these alternatives are:

<u>Dam</u>	<u>Alternative I</u>	<u>Alternative II</u>
Type	Concrete gravity	Concrete gravity
Roadway Elevation	530 000 ft	600 000 ft
Total Crest length	1 150 ft	1 900 ft
Maximum height above river bed	308 ft	378 ft
Full supply level	510 ft	580 ft
Total Reservoir Capacity	6 370 590 A ft	18 500 000 A ft
Maximum useful storage	6 369 530 A ft	18 498 940 A ft
Cost of Dam (1960)	£10 267 000	£17 110 000
Installed Capacity	362 Mega Watts	430 Mega Watts
Firm Power	1 260 Million Kwh	3 359 Million Kwh

The FAO proposals were preliminary in nature, and emphasized the irrigation aspects of the project. More investigations are necessary before definite plans could be laid down. As stated in the U.S.A.I.D. report "Rufiji River Basin" of 1967, the average flow for the eleven year period from 1954-65 was 25 000 000 ac feet as compared with an average of about 18 000 000 ac feet measured during the five years starting in 1954-55 and quoted in the FAO report. This would increase considerably the original estimate of the power output of the project.

The forecasted power demand increase in the near future reported on by A.S.M.I.S. (1967) is 12 percent annually. There are only three hydro-power sites within short transmitting distances of the central/coastal system namely: Pongwe on the lower Wami, Kidatu on the Great Ruaha, and Stiegler's Gorge on the Rufiji.

The cost per kwh generated for Stiegler's is estimated at 2.8 cents when fully consumed; the cost from other two power sources has been calculated at between 5-6 cents per kwh. On the other hand, the heavy initial investment needed for dam construction will possibly result in about the same unit cost in the first development stage. It is, therefore, desirable to investigate whether Stiegler's Gorge project could be implemented in stages.

In view of the predicted increase of power demand at 12 percent annually, the construction of Stiegler's dam should be started around 1975. The feasibility studies, detailed design and financial arrangements are all time consuming. To meet this timetable the feasibility study should be started immediately.

2. Recommendations Proposal for a Feasibility Study

2.1 Preliminary investigations

2.1.1 Surveys

- i. Aerial survey of the river stretch where possible sites may exist. (This work is in hand).
- ii. Reconnaissance soil and topographic survey over the potential irrigation area, together with provision of necessary equipment.
- iii. Detailed topographic surveys for possible dam sites.

2.1.2 Access roads

Access roads are necessary even during investigation stage for the facility of transport of equipment, personnel, etc. The access road system should be well planned and readily upgraded to meet the heavy duty requirements for dam and power, house construction.

Equipment needed for investigation will include soil testing apparatus and diamond drilling rigs. Field accommodation for the study team will also be required. Improvement of the present air strip will be necessary.

2.2 Studies for the dam and reservoir

2.2.1 Dam site

There are six dam sites mentioned in the FAO report, Volume VI parts 1 and 2. The dam site proposed by the FAO team in 1961 is located at 7°48'06"S and 37°51'00"E. This site is about 71 river miles upstream from Utete. For each of the prospective dam sites a detailed topographic survey and preliminary design should be carried out with due consideration given to the foundation problems, material requirements and availability, water management studies, power generation costs, to evaluate relative merits.

2.2.2 Type of dam

The FAO report suggests a concrete gravity dam with by-pass tunnels. Various types of possible dam construction should be investigated such as rock-fill,

concrete arch or earth dam. Suitable sources of concrete aggregates and spillway conditions would present considerable problems and will influence the decision on the type of dam structure selected.

2.2.3 Hydrology and water management

More data has been collected since FAO submitted its report in 1961. The average flow according to the latest information exceeds the 1961 estimated flow by nearly 40 percent. This increases considerably the capacity of the reservoir and power generation potential. Detailed investigations on hydrology, peak flood evaluation and water management for power generation, flood control and irrigation are necessary.

2.2.4 Determination of economic height of the proposed dam

This should be based on the water management studies, cost analysis on types, height and spillway considerations; and take into account the power generation aspects, generating costs and consumption.

2.2.5 Advisability of establishment of a cement factory

When the type of dam is decided, and if a concrete dam is adopted, due to the large volume of concrete involved it might be desirable to establish a temporary cement factory for the exclusive use of the project.

2.3 Power generation

Stiegler's Gorge is most attractive as a power scheme, and the preliminary investigations show that power can be produced at a very low unit cost. Due to the relatively small power consumption in Tanzania at the present time, and large capital investment needed for the dam itself, a thorough investigation on staged development should be undertaken. This is straight forward as far as it concerns the power house and generating equipment, but for the dam construction, due to the elevation of intakes, penstocks and spillway, it is more complicated.

The proposed feasibility study should therefore include :

- i. Possibility for a phased development covering dam construction and alternatives.
- ii. The preliminary design of the power station plant and transmission lines in order to draw up quantities and a cost estimate.
- iii. An outline of the necessary transmission system and a feasibility analysis based on the unit cost per kilowatt hour of firm power delivered to Dar-es-Salaam.

2.4 Irrigation

2.4.1 General

The average discharges from the reservoir suggested in the FAO report are 21 200 cusecs for Alternative I and 22 436 cusecs for Alternative II; sufficient to irrigate about 1 000 000 acres of land, which is probably in excess of the available land in the area. The irrigation potential in the lower Rufiji area has been estimated at 300 000 acres and with this area the costs of investigation and design will be very high. A large body of skilled personnel will be required, such as land surveyors, soil scientists, professional engineers and technicians. The area below the proposed dam can be divided into four sections, described below.

2.4.2 Areas north of Rufiji river

North of the Rufiji River, immediately downstream from the Gorge, there is an area with a gross acreage of 30 000 consisting of soils of uniform alluvial clays. The average rainfall is of the order of 40 inches annually. This area could be developed for the irrigation of rice. Unfortunately, the FAO soils map stops four miles from the river due to the relative inaccessibility of the area.

2.4.3 Areas south of Rufiji river

The area south of the river, immediately downstream from the damsite and upstream from Utete, is characterised by soils of variable texture ranging from clays to sandy soils. The average annual rainfall is about 30 inches. Irrigation will be required when the flooding has been controlled. A mixed cropping pattern could be planned for this area which extends to some 180 000 acres gross.

2.4.4 Utete area

In the area north of the river in the vicinity of Utete, the soils are quite uniform and comparable to other soils north of the river. The major portion of the soils in this area are alluvial clays with minor intrusion of sandy soils; the average annual rainfall is about 30 inches. Irrigation will be necessary when flooding has been controlled. This area, with a gross acreage of 36 000, is served with the best communications in the lower Rufiji area, and should therefore be developed first if no contrary indications are found during detailed investigations. A pumped pilot irrigation scheme with a flood protection works should be established in this area at an early date. The area on both banks of the river downstream from Ndunda to the sea coast is characterised by very uniform soils; especially on the north bank where extremely uniform clay soils extend over a very large area. The gross acreage is estimated at about 180 000 acres, with average annual rainfall of about 40 inches. The area is partly affected by tides, and detailed study of tidal effect will have to be conducted to assess the total availability of land. The soils, climate and rainfall all indicate an area favourable for rice production once flooding is controlled and irrigation facilities provided.

It must be stressed that, although the most attractive benefit from the project is power generation, the controlling of the flood flow of the Lower Rufiji river makes it essential that irrigation be established, since the livelihood of the area is currently dependent on the floods for cultivation, which would cease once the dam is built and the water stored for power generation. The development of irrigation schemes in the Lower Rufiji must therefore be undertaken simultaneously with the Power Scheme.

The proposed feasibility study should, therefore, cover:

- i. A pedological survey of the lands considered topographically suitable for irrigation to produce soil maps to 1:20 000 scale.
- ii. An agronomic survey of the irrigable lands to determine suitable cropping patterns and rotation based on the soil survey findings.
- iii. A sociological enquiry into the problems which will arise with change of agricultural techniques following the construction of the dam.
- iv. A general layout of irrigation system and detailed typical irrigation design for a representative area in order to draw up quantities and cost estimates.
- v. The establishment of an adequate hydro-meteorological network for the area.

2.5 Navigation

The broad lines of the river training work required for the irrigation schemes, and to allow for navigation on the river, should be established and the cost of this training estimated.

2.6 Other aspects

The feasibility study should cover the following additional aspects:

- i. Fisheries
- ii. Recreation and tourism.
- iii. An economic evaluation of the scheme as a whole and a preliminary apportionment of the cost of construction to its different components.

2.7 Estimated time requirements and costs

The feasibility study will inevitably require at least 3 years for completion, and the report which emerges should include a time-table for the development of the Lower Rufiji Basin. With 1975 as the target date for starting construction, the feasibility study should begin not later than January 1969 since a further 3 years will be required for design work and the arranging of finance.

The cost of a feasibility study is tentatively estimated at sh 10 000 000/-.

Appendix 1

SUMMARY OF REPORTS ON IRRIGATION DEVELOPMENT IN TANZANIA

1. Lake Victoria Drainage Basin

This area has been surveyed by Sir Alexander Gibb and Partners and report of investigations submitted in December 1956. As the Nile Basin covers such a big area in Tanzania, the survey is of a very preliminary nature. However, the Nile Basin in Tanzania was sub-divided into three distinct areas:

1.1 East Lake Region

Areas under investigation by Sir Alexander Gibb and Partners are as follows:

Mara Valley	Majita Bay
Mori Valley	Baumann Gulf
Suguti Valley	Guta
Grumeti River	Mbalageti River
Raamagongo	Near the ferry of Ukerewe Island
Ikungu Bay	Near Kibara.

According to Sir Alexander Gibb and Partners' report, the first five areas are more suitable for implementation, whereas the rest of the schemes are less favourable, for the following reasons:

Ikungu Bay	Soils and Topography both unsuitable
Majita Bay	Soils and Topography both unsuitable
Baumann Gulf	Drainage
Mbalageti River	Salinity
Guta	Salinity
Ukerewe (near ferry)	Liable to flooding
Area north of Kibara	Liable to flooding
Near mouth of Grumeti River	Salinity
Mara Swamp	Liable to flooding.

These conclusions are preliminary in nature; more detailed investigations could possibly affect the feasibility. However, Sir Alexander Gibb and Partners' report indicates clearly that only five areas should be concentrated on for future investigation. The areas and possible irrigable acreage are listed as below:

Mara Valley	15 500 acres
Mori Valley	1 500 acres
Suguti Valley	3 800 acres
Raamagongo	250 acres
Grumeti	2 400 acres

1.2 Sukumaland Region

Possible areas to be developed, according to Alexander Gibb's report, are:

Magogo Valley
Simiyu/Duma Valley
Isanga Valley
Bukeme Bay

Sima (Several areas)
Nassa Flats and Magu Bay
Nungwe Bay
Nzera Bay

The first four areas are considered to be more feasible, whereas the other areas are not recommended in the report due to the following reasons:

Nungwe Bay	Unsuitable soil and topography
Nzera Bay	Unsuitable soil and topography
Nassa Flats and Magu Bay	Unsuitable soils
Sima Area	Unsuitable soils

Of the areas proposed by Gibb's report, the following are listed:

<u>Name of Scheme</u>	<u>Gross Irrigable Area (Acres)</u>
Magogo Valley	8 200
Isanga Valley	5 100
Simiyu/Duma Valley	1 400
Bukome Bay	1 300
Other small areas	<u>1 000</u>
Total	<u>17 000</u>

Of these proposed Schemes, Simiyu Scheme is proposed only on flood-protection basis. No dam was proposed in the report, the gross area to be irrigated is rather limited, only 1 400 acres.

In 1963, a Yugoslav Team made another survey of the same scheme. Later, Dr. Dolfi of FAO wrote a report proposing to build a dam to command an area of 20 000 acres.

In 1965, Gibb was asked to investigate the same scheme. Pending the submission of the report, it seems the difficulty of foundation and unfavourable topographic conditions are the main problems of the project.

1.3 West Lake Region

According to Gibb's report, eight areas have been investigated, namely:

Ngono/Ikumba Swamps
Kashasha Valley (including Kabala Valley)
Ruiga Bay
Kishanda Valley
Kitangule Plain
Busenya Area
Diverere Swamp
Nsonsoi Valley

Of these eight areas, only the first three areas are considered by Gibb as more feasible for development:

	<u>Gross Area (Acres)</u>
Ngono/Ikumba Swamps	17 340
Kashasha Valley	14 200
Ruiga Bay	<u>500</u>
Total	<u>32 060</u>

On the remaining five areas, Gibb's report considered the following areas not suitable for the following reasons:

<u>Area</u>	<u>Reason for unsuitability</u>
Kishanda Valley Kitangula Plain, and Busenya Plain	High pumplift, poor topographic conditions, and excessive soil acidity
Diverere Swamp	Unsuitable soils
Nsonsoi Swamp	Poor soils and difficult drainage conditions.

It is to be noted that the West Lake Region is rather a remote area in Tanzania. The proposals made by Alexander Gibb are of a very preliminary nature. More investigations are needed within these regions to decide which areas should be started for irrigation. However, recently the Water Development and Irrigation Division made some proposals for the development of the Kagera River, which is the largest tributary of the Lake Victoria within the Tanzania territory. A multi-purpose dam has been proposed for the power generation, flood control and irrigation. Preliminary studies show very high potential of this scheme as it involves such a big area to be developed. However, the high initial capital cost and remoteness of the area with regard to the other part of the Tanzania territory would possibly limit the immediate implementation of the scheme.

The Nile Basin within Tanzania covers an area of 30 500 square miles.

The amount of water flowing into Lake Victoria from sources in Tanzania is estimated approximately at 3 922 000 acre-feet a year. With such an amount of water and land at our disposition, it would be rather difficult to draft a general plan for development in the whole area without more detailed investigations. The first thought for development would be to abstract the water from the lake within fair range of pumping lift.

Several locations along the coast have been selected for pumping irrigation. Agridev is actually working on field basis for the agricultural development along the Lake coast.

If the pumping lift and pumping running cost could be analysed through Agridev performances, and pumping irrigation layout could be made along the various areas on the coast, this should be considered as the most feasible scheme that can be proposed for the present time as it would involve less expensive and flexible initial costs for development.

In the West Lake area, in early fifties, the Bhagwant Sugar Estate was established and the refinery was in operation by 1955. Irrigation is practised by overhead sprinkler, pumping water from the Kagera River.

The Estate is still in the developing stage and is prosperous. The Missenge Sugar Scheme was proposed to increase sugar cane production by outgrowers in the area; the scheme is considered economically feasible as the initial capital requirement is rather low.

Due to difficulty of communication, the West Lake Region is rather separated from other regions. However, there is a tremendous potential for water resources development. The Gibb's report is considered too brief. It is recommended that more detailed survey should be made to assess the future development, especially the Kagera River Dam and its commanding areas.

1.4 Smith Sound Scheme

The Smith Sound Scheme was originally proposed during the German Administration. The idea is to convey water from Smith Sound at the southern extremity of Lake Victoria over the southern watershed of the Nile Basin to irrigate land in the Manonga Valley and the Wembere Plain.

It was originally estimated that 570 000 acres of land were irrigable in the Manonga Valley and Wembere Plain, and that in addition some 7 400 acres in the Isanga Valley could be irrigated from the main canal between Smith Sound and Isaka. The estimated flow of water needed for irrigation was 3 250 cusecs.

From the engineering point of view, there were two proposals to convey the required water through a 56 mile long trans-basin canal. One is by multi-staged canal system along the main canal to reduce the excavation. All the power required to operate the three pumping installations could be produced at a plant near the outlet of the main canal. The other alternative is to excavate a gravity canal with a maximum cut of 93 ft.

Cost estimates made by Gibb show that there would be little difference in capital cost between the two alternatives.

The total cost of the Smith Sound Scheme, excluding the cost of reclaiming the lands, was estimated to be in the order of £25 - £30 million at the prices of 1956.

At the present rate it should be estimated at £40 000 000.

Furthermore, Alexander Gibb in his report mentioned that original estimates of land available of 570 000 plus 7 400 = 577 400 acres were not available. Only 220 000 acres of saline and alkali land could be found in the proposed area.

This scheme should be considered only for future potential.

1.5 Possible action to be taken within the next Five-Year Development Plan on the Lake Victoria Area

- i. a. Pumping Irrigation along the Lake Coast.
- b. Missenye Scheme.
- ii. Detailed investigation. Simiyu Scheme is now under investigation.
- iii. More preliminary investigations needed in the near future.
 - a. Kakono Dam.
 - b. Mara Valley.
 - c. Magogo Valley.

2. Lake Tanganyika Drainage Basin

2.1 Luiche Delta near Kigoma

Mr. Mary of FAO submitted a report entitled "Investigations for flood control in the Luiche Delta" in 1964. This report gathers together the basic data available in 1961 and outlines possible schemes of water control, flood protection and drainage. He suggests that Nyangofa Dam be built to control the flood, and floodway to improve the drainage.

In 1966, Sir William Halcrow and Partners submitted a feasibility report entitled "Report on the Economic Feasibility of Flood Control, Irrigation and Hydro-electric Works in the Luiche River Delta".

In this report two schemes have been proposed:

Scheme A: No dam but replaced by proposed Big Bend flood control diversion.

Scheme B: With Nyangofa Dam.

The Halcrow report favours Scheme A:

Both these reports mention the high silt content in the river and no effective desilting devices have been suggested to dispose of the silt, which is surely the main technical problem to be solved before the total scheme area is started. As a step-by-step development was proposed in the Halcrow report, the proposed preliminary drainage works, involving clearing the Shepstone Channel and rehabilitating the old western and eastern Luiche Channel, with a total cost of £16 000 could be implemented immediately. The proposed second step is to provide internal drainage works in some of the developed areas within a total cost of £142 000. The implementation of irrigation facilities should be very cautious as the silt content is so high for both Schemes A and B. It should be implemented only when more studies on silt deposition are made and proved to be feasible.

3. Pangani Valley

3.1 Historical background

In 1961, Dr. Dolfi of FAO submitted a report entitled "The Nyumba ya Mungu Storage Scheme on the Pangani River".

Proposals were made, apart from the generation of power, to use part of the basin water resources in the upper reaches of the basin, where favourable conditions exist for agricultural development, for irrigation, and part of the balanced water to be used in chosen areas downstream from the reservoir in the same district. However, according to a report prepared by Dr. Dames, FAO Soil Expert, only limited areas of the mid-valley can be considered as having soils of good quality from the point of view of irrigation farming.

In 1962, Halcrow and Partners submitted a report on "The Development of the Pangani River Basin". In this report, the irrigation development in the basin has been divided into three areas, namely:

- "(A) Lower Moshi
- (B) Middle Pangani
- (C) Mkomazi Valley."

The Lower Moshi area has been sub-divided into:

- "(1) Rau Area
- (2) Miwaleni Spring and Kahe Area
- (3) Soko River Area
- (4) Himo River Area."

In the Middle Pangani Valley, two areas have been mentioned in Halcrow's report:

- "(1) Marwa
(2) Naururu,"

In the lower Pangani, the Mkomazi Valley has been suggested.

All these schemes have only been investigated in a preliminary way. Further feasibility studies are needed to confirm the viability of the development.

3.2 The Special Fund Project

In 1964, a United Nations Special Fund Project commenced to investigate the potentials of the Pangani and Wami Valleys. This project ended in February 1968, and its findings are given in Report FAO/SF: 42/TAN 4, 1969.

Proposals are submitted for irrigation development in the Pangani River Basin at Kahe Miwaleni upland and Naururu, and for pilot schemes on the Wami coastal plains.

4. Wami Valley

Dr. Dolfi of FAO submitted a preliminary report on the Wami Valley in 1963. In this report he suggests that a large-scale irrigation development can be implemented in two areas:

- i. The alluvial plain in the Central Plateau
- ii. A strip of the coastal plain.

In the central plain areas, the report suggested six reservoirs to be built to control the whole river flow. More detailed investigations are needed before any realistic and phased development could be laid down. A suitable pilot scheme is surely the first step for development.

More detailed surveys were undertaken by the United Nations Special Fund Team, and the results of these surveys are given in the final report mentioned above.

5. Ruvu River

Mr. Chablani of FAO submitted a report entitled "An outline plan for the Development of the Ruvu Basin". The main suggestions made by Mr. Chablani are:

i. That a total of 23 dams be built to control the flood and to provide required irrigation water for development.

ii. The following three areas could be developed for irrigation:

Area I	168 000	Gross	110 000	Net.
Area II	234 000	Gross	160 000	Net.
Area III	29 000	Gross	20 000	Net.

It was stated that first priority should be given to Area I, followed by Areas II and III, with emphasis on the development of the Mgeta Area first. The proposal to construct the group of 23 reservoirs is also put into three phases:

Phase 1. Dams 1 to 7 concentrated in the Mgeta Catchment.

Phase 2. Dams 8 to 10 including Kidunda Dam in the Middle Ruvu.

Phase 3. Dams 11 to 23 for the development of lower reaches of the Ruvu River.

In 1962, a French technical Mission submitted another report in greater detail. In this report, emphasis has been given to the building of the Kidunda Dam as the controlling structure for the development of the Ruvu Valley. They suggest that the seasonally flooded area along the Ruvu between Kidunda and the Indian Ocean is the most suitable for agricultural development. Nevertheless, this development is in connection with the flood control of the Ruvu River and its boundaries; the building of the Kidunda Dam, essential for flood control, seems to be the first condition for a land development programme. When this will be built, most soils now lying fallow will be able to be developed, irrigation becoming possible with water stored in the reservoir.

The costs of the 23 dams have been prepared by Mr. Chablani as listed in Table VIII of his report. From this table, we can see that the Kidunda Dam is much more favourable than the others as the cost per ac. ft. of reservoir capacity is only shs. 33/- ac. ft. to compare with the second lowest of shs. 280/- ac. ft.

The favourable condition for building the Kidunda Dam is not only to compare with other proposed dams in the Ruvu Valley, but also to compare with any other dam in the country. The cost of ac. ft. of capacity or the cost of regulated flow or the cost of unit area of land development under the command of the Kidunda is so low compared to any other proposed dam in this country that further economic comparison is considered unnecessary.

The power potential in the Ruvu Valley is not high, principally due to topographical conditions. The development of Ruvu Valley is mainly agricultural. Also there has been a recent proposal to grow a large area of soft wood for pulp production, with a plant near the Ruvu Bridge.

The Kidunda Dam is now under detailed investigation by the Chinese Aid Mission. Pending the results of the investigation, soil surveys should be carried out in the areas for future development of land. The French Mission listed the priority as Areas, C, D, and E in the No.3 Drawing of their report. All these areas are big. A preliminary soil survey will be necessary, to find:

- i. Total suitable land for irrigation, and
- ii. Priority for development and phases.

Detailed soils survey and topographic surveys are expensive. They should be concentrated in the most promising areas for development.

The Mgeta plain is more fertile than Lower Ruvu, but the communication and marketing conditions are less favourable. However, the M'vuha pilot scheme as proposed by the French Mission should be implemented as soon as possible to ascertain the economic value of development.

Besides the M'vuha pilot scheme, recommendations for a pilot scheme called Kwala, located near the Ruvu railway station, have been submitted by another French Mission. This is a most important scheme, and the report is very complete, giving all bills of quantities for construction. The scheme has been shelved as it was feared that it would duplicate the State farm proposed by the Chinese Mission.

The Mgeta Plain, according to French Mission's report, should be developed under the following priority:

- a. The western Kiraki area and the Mgeta Mugazi area.
- b. The Migazi - Bwakira areas.

- c. The Bwakira Dutumi area.
- d. The eastern Dutumi area and the Kilengwe area.

6. Rufiji River Basin

6.1 Potential for development

The potential for land development in this vast river basin is enormous. The FAO report "Preliminary Reconnaissance survey of the Rufiji Basin" indicates that 155 000 acres of land could be developed. In a vast river basin such as the Rufiji, all considerations - social, technical, human, organizational, economic and financial indicate clearly that development should proceed by successive stages.

The basin presents opportunities for multi-purpose development of land, power generation, flood control, and navigation, in that order of priority.

All these developments are more or less inter-related. Furthermore, the basin is divided into three regions: Usangu, Kilombero and Lower Rufiji.

As far as land development is concerned, the FAO preliminary reconnaissance survey of the basin suggests that the development should proceed in three stages (p.50, Vol.I).

i. First Stage

This comprises the development possible with the minimum of capital expenditure. Water is to be taken from streams as they now are - unregulated. No storage dams are included, whether for water supply or for flood protection. Only relatively minor works of protection against flooding, river diversion, or drainage, are assumed.

ii. Second Stage

This is intermediate between the first and third stages. It is visualized as including the construction of larger works only on a moderate scale, technically not difficult and financially not too costly, either in actual amount or in relation to their prospective benefits.

iii. Third Stage

This comprises the full control of river flows both for provision of irrigation water and prevention of flooding, and the extension of irrigated cultivation to the maximum ultimately possible.

Although there is no clear division between these three stages, the general programme is quite clear.

6.2 Economic aspects

The 1960 FAO report was written with the emphasis on the engineering side. The economy is based on figures of engineering costs and of the value of the products to be expected. The expected yields and prices of the various crops however depend on so many basic factors, such as skill of cultivators, efficiency of the organization, methods and means of transport, marketing or export of cash crops, methods of collecting revenue, taxation, etc.

Irrigation is an expensive investment. Irrigation schemes must be viable. Cash crops should be included in a scheme plan. Marketing and means and costs of trans-

port usually affect the financial return. At present the costs of transport across the Kilombero River are high and uncertain; this jeopardizes the development of the area south of this river unless the bridge across the Kilombero is built. The development south of the Kilombero is, therefore, rather limited for the present time.

The total land development potential is listed as follows:

Usangu	519 000 acres
Pawaga	12 000 acres
Kilombero	824 000 acres
Lower Rufiji	<u>200 000 acres.</u>
Total	<u>1 555 000 acres</u>

6.3 First-stage development

6.3.1 Usangu

Nembara R. (Madibira)	5 000	Soils very good, land clear.
Halali R.	8 000	Soils good.
Mbarali R.	25 000	Soils medium to good. 1 000 acres already developed.
Kimani and Great Ruaha R.	25 000	Soils good.
Chimala R.	5 500	Soils good. Some river diversion and local drainage necessary.
Usangu N.W. and N.	1 000	Pasture management with some irrigation.
Dry Valley Idunda Valley		Trial. Earth dams.
Total:	69 500	

6.3.2 Kilombero valley

Luri R.	1 340	Soils very good.
Rufiri R.	2 500	Soils very good.
Mdulipa R.	1 250	Soils excellent.
Furua R.	2 500	Soils good.
Mpanga R.	1 250	Soils excellent.
Mgeta R.	1 250	Soils suitable.
Lumemo R.	2 500	Soils quite good, systematic irrigation.
Lumemo R.	1 250	Polder Scheme extension of trial farm area.
Total:	13 840	acres.

6.3.3 Little Ruaha

Development of little Ruaha (or Pawaga) is a minor one when compared with Usangu or Kilombero.

6.3.4 Lower Rufiji

The lower Rufiji development depends mainly on the construction of Steigler's Gorge Reservoir which is estimated (in 1961) to cost, dam only:

Alternative 1: £10 267 000

Alternative 2: £17 110 000

The main purpose of the Steigler's dam is power generation rather than irrigation development. The implementation will be economically justified only when the market for power favours. Many dam sites have been proposed in the FAO Rufiji Report (general report, P.43). The merits of these proposed dam sites are listed as follows:

1. For power generation.
 - A. Steigler's
 - B. Mtera Dam.
2. For land development (or partial power generation).
 - A. Mkasu
 - B. Taveta
 - C. Msana
 - D. Ngalenge
 - E. Iringa
 - F. Doliya
 - G. Mbarali
 - H. Kimani "

This priority list of dams is very tentative in nature. It should be revised according to information collected from time to time. However, it gives some idea where to concentrate investigations needed in the near future. The selection was based on unit cost of reservoir, locations and lands commanded.

7. Msangasi River Basin

This is a river basin between the Pangani and Wami. The development of this basin is interesting because of its small size, which is about 1/4th, 1/6th and 1/8th respectively of those of Ruvu, Pangani and Wami.

Dr. Dolfi, FAO Irrigation Engineer, submitted a report entitled "Msangasi River Basin". A storage dam was proposed with an impounding capacity of 60 000 ac. ft. to irrigate an area of 10 000 to 15 000 acres in the plains.

The total cost of this river basin development was estimated at £2 750 000.

The project is favourable due to the small amount of capital requirement compared with any other river basin in this country; and the overall capital requirement is surely within the financial capacity of the Government.

However, the report is very preliminary in nature. More detailed investigations are needed for feasibility studies. Main problems involved are hydrology and soil surveys. It is essential that gauging stations are installed.

8. Lukuledi Basin

This basin is located at the southern part of Mtwara Region. The total catchment area is 1 850 square miles, draining into the Indian Ocean at Lindi.

Mr. Mary of FAO submitted a report entitled "Lukuledi Basin" in 1962. In this report he proposed to develop the basin by improving the drainage of the river.

Detailed surveys are necessary. However, the following are suggested:

i. Survey and design of the present Mahiwa Experimental Farm as an irrigation pilot scheme, by the Water Development and Irrigation Division's own engineers.

ii. If the investigation proves favourable it would not be difficult to implement the scheme, as it covers only a few hundred acres of land development. As the diversion weir is already built only drainage and field canals are necessary.

iii. If the Mahiwa scheme is proved to be successful, the same pattern could be applied to the land available within the basin.

Appendix 2CATTLE CENSUS IN ISMANI AREA CONDUCTED BY THE
MINISTRY OF AGRICULTURE, FORESTS AND WILDLIFE

<u>Village</u>	<u>Cattle</u>	<u>Goats</u>	<u>Sheep</u>	<u>Donkeys</u>
Misinga	5 172	1 117	385	38
Iveno	1 432	330	197	12
Ndolela	1 436	312	70	-
Itagutwa	2 310	627	245	38
Uhambingeto	6 454	1 203	348	149
Kitapilimwa	2 344	545	312	24
Dunguya	4 449	367	64	-
Mafifila	2 051	254	155	14
Ilambilole	4 712	1 246	1 342	88
Matembo	364	99	98	18
Manyambuma	257	54	82	8
Mgiha	2 596	340	98	18
Ikengeza	726	193	310	19
Malenga-Makal	277	98	148	23
Nyangoro	521	88	113	2
Chadindi	303	24	34	-
Mangawe	428	74	31	-
Hollo	272	20	4	-
Muwimbi	1 122	439	259	16
Mkungugu	342	53	18	12
Kihorokota	1 406	308	165	95
Kisilu	871	58	16	-
Igula	629	111	54	-
Malenga-Makali	134	65	15	-
Makundupa	78	35	50	-
Mhawana (Muhwana)	265	132	89	-
Ngege	201	150	70	2
Nyakavangula	185	110	105	6
Lukalasi	203	165	101	5
Masega	107	62	15	2
Mwanzagala	205	106	111	8
I timbo	309	109	208	11
Mkulula	345	385	42	1
Nyakabema	245	92	-	-
Ihumbilisa	237	128	69	-
Mpalagaga	178	28	6	-
Balali	352	1 871	120	10
Mseke	301	83	104	5
Mawalewela	2 166	502	262	10
Nduli	3 755	1 032	876	42
Mlangali	2 130	262	381	5
TOTAL	51 866	11 592	7 137	680

Appendix 3

LABOUR REQUIREMENT FOR ONE ACRE OF MAIZE

Maize	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Ploughing (oxen plough)												1.5
Planting												0.5
Cultivating (weeding)			2 x 4									
Harvesting						3						
Shelling and bagging							6					

Total man day per acre 19: With a peak demand of 0.15 man per day during March, April, June, and July and August. This would limit an average family of 2 labour units (assuming 1 unit the husband, $\frac{3}{4}$ wife and $\frac{1}{4}$ child) to about 10-15 acre plots.

Appendix 4

LABOUR REQUIREMENT FOR ONE ACRE OF GROUNDNUTS

Groundnuts	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Ploughing and ridging (oxen ploughs)												5
Planting												1
Cultivating (weeding)			2 x 4									
Harvesting						45						
Drying shelling and bagging						60						

Total man day per day per acre 118: With an average demand of 1.3 man per day during May, June, July and a peak of 2.3 in June. This would limit an average family of 2 labour units (assuming 1 unit for the husband, $\frac{3}{4}$ the wife and $\frac{1}{4}$ a child) to about 0.75 of an acre, if no additional labour is employed on the farm. 4

Appendix 5

PRICE OF MAIZE IN IRINGA DISTRICT - 1965/66 MARKETING SEASON

Grade	Board's Price f.o.g. (free on Cooperative Unions Godown)	Deductions from Price per kg (in cents)					Price to Grower per kg	
	Price per bag of 90 kilo net (in sh)	Price per kilo (in cents)	Coop. Union's Levy	Coop. Society's Levy	Transport Charges	District Council's CEss 4%	Total de- ductions	
I and II	34/20	-/38	-	-/02	-/04.5	-/01.6	-/08.1 Approx.-/08	-/30
III	31/50	-/35	-	-/02	-/04.5	-/01.5	-/08	-/27
IV	26/10	-/29	-	-/02	-/04.5	-/01.2	-/07.7 Approx.-/08	-/21

Notes

- (a) Board prices are fixed for the season.
- (b) Cooperative Society's Levy amounts to sh 1/80 for 90 kilo bag net.
- (c) Transport charges amount to sh 4/05 for every standard weight of 90 kilo bag net.
- (d) District Council Cess is calculated at the rate of 4 percent ad valorem of the fixed price of the maize per 90 kilo bag net as per the grades of maize. Under the produce Cess Act published in the Tanzania Gazette Supplement No. 17 of 2 April 1965 G.N. No. 171, such cess must be payable to the nearest 5 cts. or multiple of 5 cts. to the cess so calculated. Under these conditions, therefore, the amount of cess recoverable from the price of a standard 90 kilo net (i.e. sh 34/20 for grades I and II etc.) when recovered at the rate suggested in the table per kilo, will amount to Grades I and II - sh 1/40 Grade III - sh 1/30 and Grade IV sh 1/05.

Appendix 6POSSIBILITIES OF RAISING WATER BY WIND POWER IN THE
ISMANI/IRINGA AREA

Duration of wind velocity in excess of 6 knots during the period 0430 - 1930 hours east at Iringa Airport, and duration of wind velocity at over 21 knots, 1957-59.

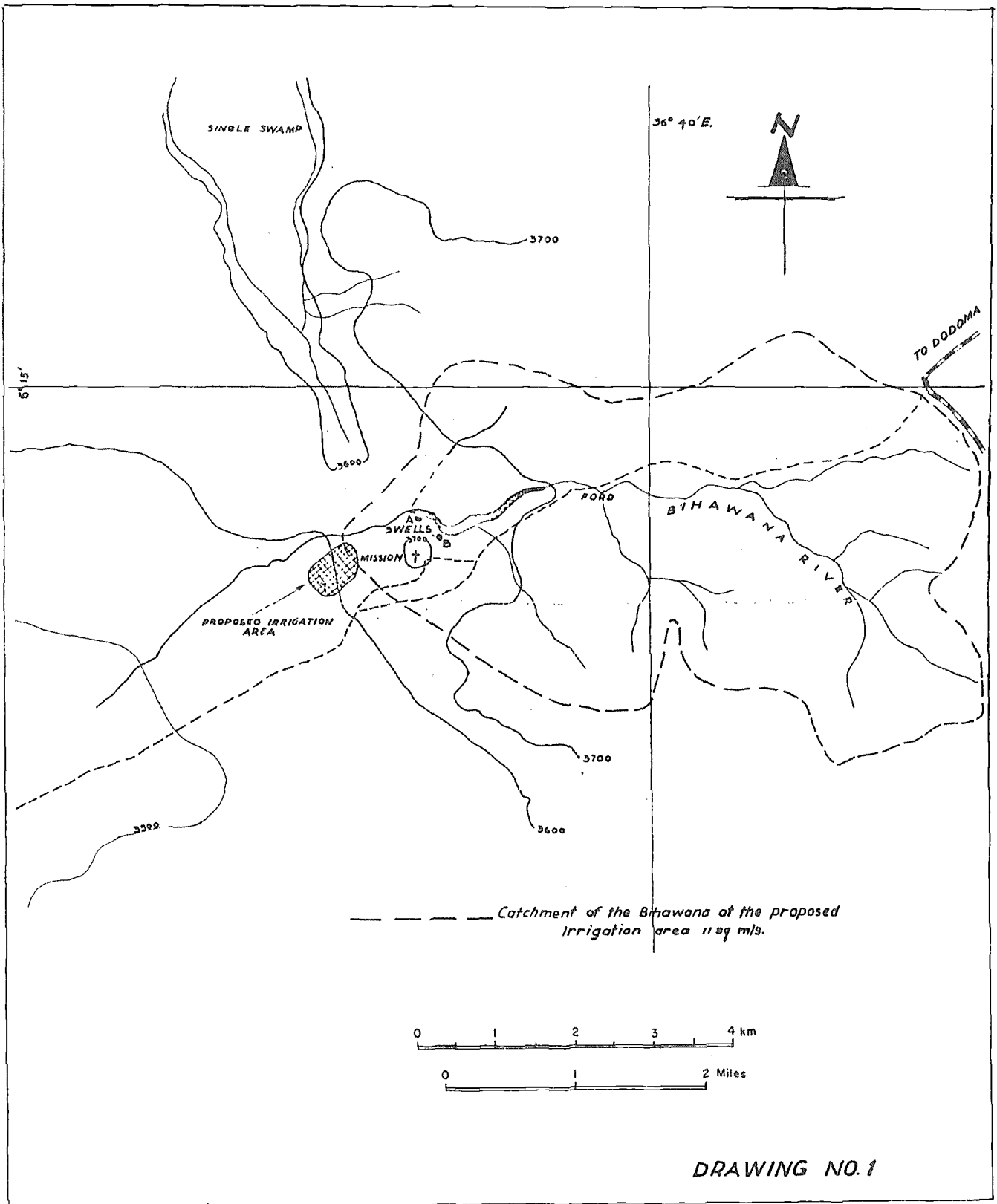
	<u>6 - 21 knots</u>	<u>over 21 knots</u>	<u>0 - 6 knots</u>
January	39.6 hrs	0 hrs	
February	46.0 hrs	0 hrs	
March	33.3 hrs	0 hrs	
April	109.0 hrs	0 hrs	
May	138.0 hrs	0 hrs	
June	160.0 hrs	16.2 hrs	
July	138.0 hrs	1.8 hrs	
August	163.0 hrs	2.7 hrs	
September	170.0 hrs	0 hrs	
October	136.0 hrs	0.9 hrs	
November	74.8 hrs	0 hrs	
December	24.2 hrs	0 hrs	
	<hr/>	<hr/>	<hr/>
	1 231.9 hrs	21.6 hrs	4 146.5 hrs
			<hr/>
		<u>Total</u>	5 400 hrs

Assuming an efficiency of 20 percent.

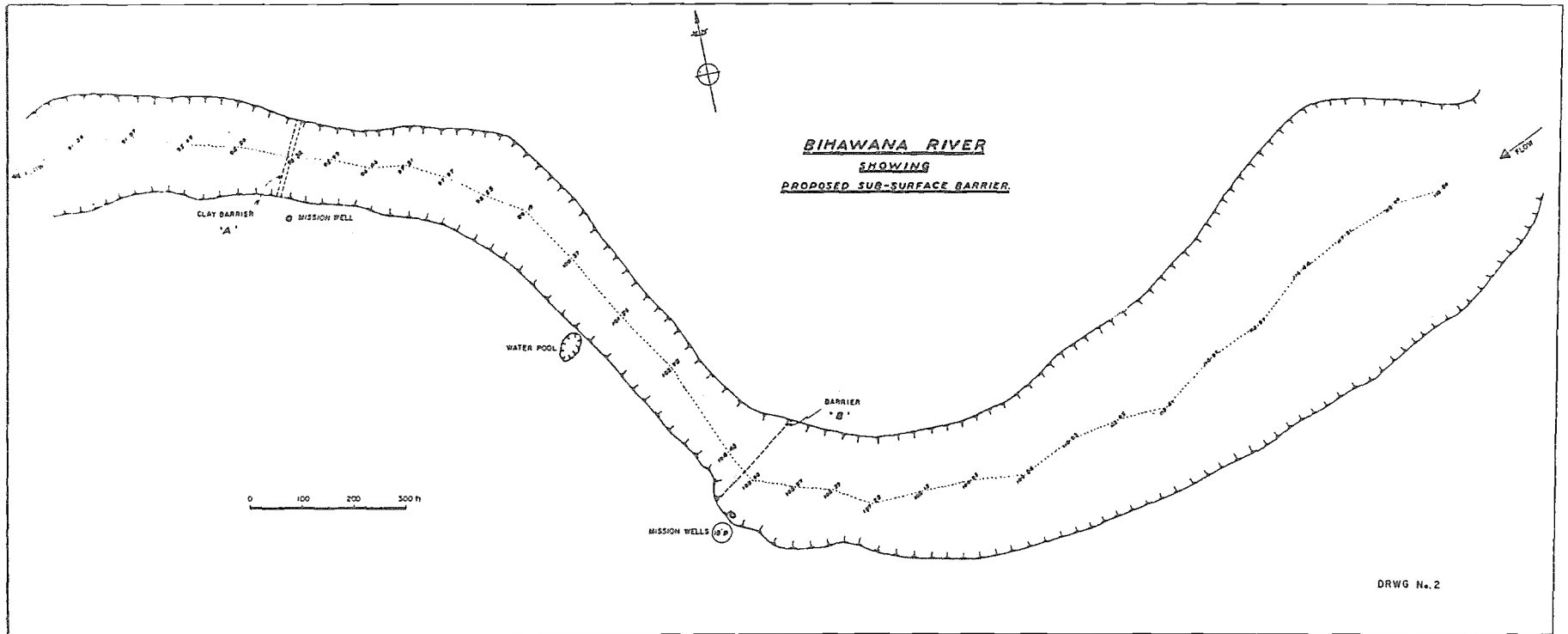
With a wind wheel of 6.1 m diameter and a pumping head of 40 metres the output should be:

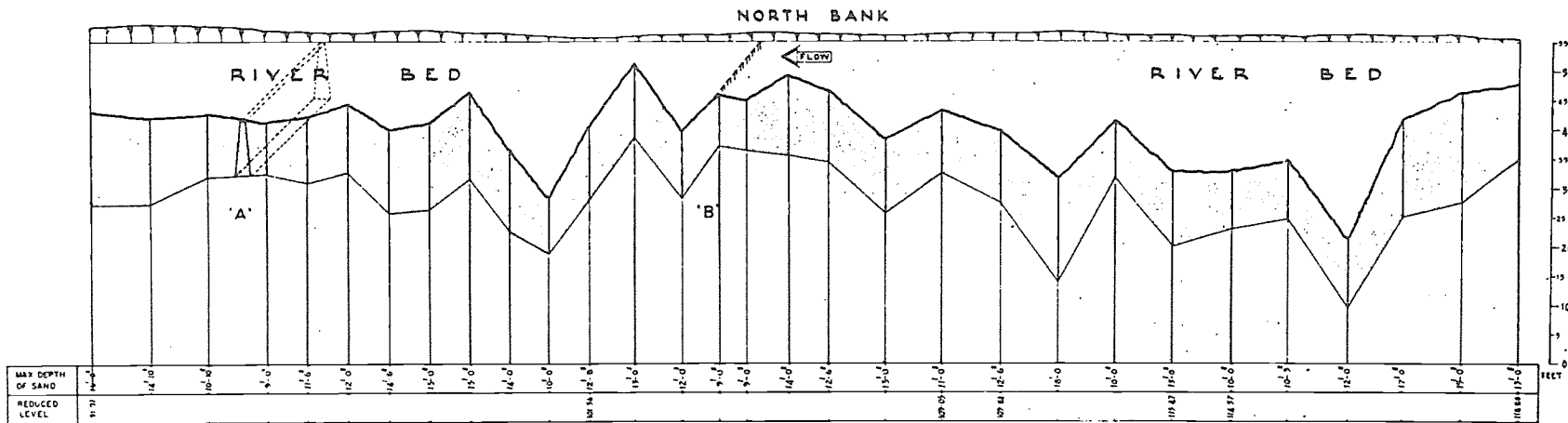
$$6(1\ 231.9 + 21.6) \text{ m}^3 = 3\ 760.5 \text{ m}^3 = 831\ 070.5 \text{ gallons.}$$

Over 5 400 hours per year. This figure has been taken i.e. 15 hours per day, as there are no records of wind velocities at Iringa from 1 800 hrs - 0060 hrs. As the general pattern of winds at night in the tropics is similar, the wind velocities at Dar es Salaam have been referred to. There is almost complete calm during the night at Dar-es-Salaam Airport, so the output from the night time winds, if any, has been ignored.



DRAWING NO.1





BIHIWANA RIVER
L.S. SHOWING POSITION OF MAXIMUM SAND BED DEPTH

DRWG. No. 3.
H.O. SK. No. 517.

HORIZONTAL SCALE 0 100 200 ft
VERTICAL SCALE 0 10 20 ft

DRAWN BY H.J. MARSHALL, OCT. '54.

