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l Hazimbu/Dakawa, Tanzania The Hague, Netherlands

REPORT ON AN IRRIGATION MISSION TO THE HORTICULTURE PROJECT, DAKANA, TANZANIA

November, 1988

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INTRODUCTION

The purpose of the mission was to assess the possibilities of the establishment of irrigated horticulture at the ANC farm at Dakawa and to make a proposal for donor funding. A more detailed description of consultant's required activities is given in the terms of reference of the mission, Annex 1.

Consultant stayed in Tanzania from the 19th of July till the 4th of August, 1988, half of which time was spent in Dakawa and the remainder in Mazimbu and Dar-es-Salaam. For details reference is made to Annex 2: Itinerary. On the last day of my stay at Mazimbu, preliminary conclusions and recommendations of the mission were discussed with the Chief Administrator of Mazimbu and Dakawa, Mr. Tim Maseko, see Annex 3. During this meeting the Chief Administrator requested including an assessment of the possibilities for irrigated forage crops, which has been complied with.

Although the mission was announced and agreed upon long before, my visit appeared unexpected as no transport was available at Dar-es-Salaam, no accomodation was arranged at Mazimbu and Dakawa, the Farm Manager of Dakawa was away on a course and a number of pertinent reports could not be made available. Nevertheless the mission could proceed more or less as planned thanks to the cooperation and improvisatiqns of a number of ANC comrades, in particular Oswald Dennis and Majoro Nthorane in Dakawa and Peace Tau and Beauty Ngubane in Mazimbu. Furthermore I received valuable information and assistance of Tanzanian wells and Wizara ya Maji (Water Department) in Morogoro and Thrust Engineers International Ltd. in Dar-es-Salaam.

This report will contain some comments on the terms of reference in chapter 2, a review of existing information in chapter 3, the results of the study in chapter 4 and gives proposals including type designs and cost estimates in chapter 5 and recommendations and conclusions in chapter 6.

For those who are not conversant with irrigation and salinity, Annex 4 may be of help to better understand this report.

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2. COMMENTS ON THE TERMS OF REFERENCE

Before my departure to Tanzania I was led to believe that sufficient surface water was available in the Hagole river for at least 50 ha irrigated horticulture;

In a report by F. de Pater of September 1987 was mentioned that for 50 ha most probably sufficient water was available in the Kundi (2 Mkundi : Magole) river.

This is why in the terms of reference is mentioned that quantity and quality of available surface water supplies were to be determined.

At the first day of my arrival at Dakawa it became clear that no surface water is available and I had to concentrate on an assessment of groundwater occurrence, although this is not mentioned in the terms of reference. As groundwater investigations require geo-electrical surveys and/or deep drilling tests, as well as an experienced geo-hydrologist to carry out the tests and interprets the data, the only option open to me was to study existing data and obtain some qualitative information on shallow groundwater (see chapter 3)-

It would have been a much more logical and therefore much better course of action, to carry out a geo-hydrological mission first and; after the well-yield had been tested and the quality had been assessed, to follow-up with an irrigation mission. It would then have been possible to make final designs based on the encountered water supply in a much rshorter time rthan has been necessary now. ’ ’

As the situation stands now, a visit of a geOahydrologist and a test boring will be recommended, which means that a final design and cost estimates as yet cannot be made. Furthermore, even if water is encountered, it may be in such small quantities, that irrigation development will be limited to a few hectares only. This limited development makes part of the terms of reference not applicable such as fasing for future expansion (no expansion possible), marketing, etc. (production for inhabitants only), pattern of cooperation with and influence of production on local population (negligible because of small area).

It is recommended in future to compose a more realistic picture of the situation before a consultant is engaged.

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3. REVIEW OF EXISTING INFORMATION

3.1. Surface water

Review

Irrigation by surface water is mentioned a number of times in the Development Plan for the ANC Development Centre, Dakawa by Norplan A/S (see Annex 8: References: 1). It is stated that "the main source for irrigation water seems to be the Nagole river with sub-surface and pond storage for use during the dry season." (p. 53). It is further stated (p. 64) that irrigation can make up for the low production in the long dry period with the production of crops like potatoes, cabbages and tomatoes, whilst (p. 66) it is also recommended to grow 70 ha of rice in the wet season irrigated with water from the Nagole river. FinallyP in the summary of crop production (p. 77) irrigation is not mentioned, though vegetables are, as part of the production of the area A5 (plot 18). Evidently Norplan had at this stage, 1984, no clear ideas about irrigation.

Unfortunately the Agricultural Development Plan could not be made available at Dakawa, although two copies are alleged to exist. However, volume II: Appendices was available, including an appendix on irrigation water requirements by Johs. Bergedalen (2). This appendix is based on previous reports, including the Norplan report quoted above yand a report "Study for domestic water supply and irrigation purposes? by Dipl.IngJ Rudolf Hupfl (3), a report which also could not be traced. The water availability in the Magole river is based on one-year measurements of the discharge of the Hkundi river, which in 1978-1979 was captured by the Magole river. Although the report mentions that the river may go dry in the dry season, after which some vague remarks are made about a reservoir "in a suitable place in Magole river in plot A10 or somewhere upstream in Hagole, Mkundi or Wami river", it goes on to calculate the water requirements and results in a recommendation for 378 ha under irrigation, including crops such as rice, silage, vegetables and fruits. Evidently this recommendation is not based on a realistic assessment of the water available.

In a further report by the same author in 1987 (4) the possibilities for storage of water in the Mkundi river are explored. A reservoir upstream in the Mkundi river will serve two purposes: supply of irrigation water in the dry season and control of flooding in the wet season. The report gives a positive picture of the possibilities of building a storage reservoir at Hvomero or Hatak in the upstream reaches of the Mkundi river at respectively 25 and 16 km distance from the ANC farm. At the Mvomero site a hydro-electric power station is also possible. Further study is recommended to come to a detailed technical plan and a cost-benefit analysis.

In the volume of hydrology of the Morogoro Domestic Water Supply Plan (5) the Mkundi river is shown as a seasonal river on the hydrological map, whilst the only discharge data are those of 1959 which were also used by Bergedalen. The discharge measuring

station was closed in 1963.

Conclusion.

It is clear that irrigation by surface water for the Dekawa ANC farm is not possible under present conditions, only with a reservoir which stores the water in the wet season to be used in the dry season. The area at and near to the farm is flat and therefore a reservoir at or near the farm is not feasible as the major part of the stored water will be lost to evaporation and infiltration.

The only possibility for storage of water is in the upstream reaches of the Mkundi river, as shown in the report of Bergedalen. Building a reservoir in the river, however, is a much too large and costly undertaking for the ANC farm and must be considered in a much wider perspective, i.e. for supply of irrigation water for a part of the valley of some thousands of hectares. A combined effort of the ANC farm, the Prison farm and other enterprises in the valley might convince the Tanzanian Government of the usefulness of at least a feasibility study into the possibilities of a reservoir and irrigation development of the area.

3.2. Groundwater

Review

The Norplan Development Plan (1) mentions that there are indications of an aquifer of coarse materials at shallow to medium depths (20-30 m) around the river Magole (p. 10, 11). This information is based on the DHV report, The Hupfel report (n.a.) and an unpublished "Swedish report" (n.a.). They recommend that the possible existence of aquifers in the Magole river plain within the ANC area be investigated.

The Hydrogeology Unit of Morogoro region carried out a geo-electrical survey in December 1982 (6). They conclude that the eastern part of the area (range area, plot 22) proves encouraging for (deep) groundwater exploitation. Two points were recommended for drilling, one to 100 m, one to 85 m.

A more recent investigation (1987) by the same Hydrology Unit (7) came to the same conclusion, that the area is geo-electrically favourable for sinking deep wells. It is recommended in the report to carry out test drilling at three locations, 7 km south of plot 18 and one location in the same area, plot 22, as recommended in 1982, 8 km east of plot 18.

A number of soil profiles were made near to the SOC area (plot 18) by Norplan (8). Groundwater was found in fine/medium/coarse silty sand at a depth of 0.2 - 3.6 m. The area is recommended for sinking ring wells, down to a depth of 4.0 m. The yield of the existing well in the area was determined by a pump test at 1 l/sec, but this yield could be improved by constructing a well with a good gravel packed filter and horizontal drains running into the well.

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A deep well was drilled in 1984/1985 by Benwell (9) near to the SOC area (plot 18) near the bank of the river. The quality of the water is good (EC : 0.79 ms). According to the bore-log, the well is 24 m deep and has a water bearing layer of 12 m (from 6.4 to 12.0 m). The yield is reported to be very low. Whether this is due to the low yield of the water bearing layer or due to faulty construction (screen) is not clear.

Extensive geohydrological studies of the Morogoro area were made for the Morogoro Domestic Water Supply Plan. No wells were drilled in or near the Dakawa ANC farm, the results quoted below are obtained by extrapolation;

- Poor prospects for medium depth and deep groundwater: aquifers may be absent, thin and/or saline, depth of wells 20-100 m, yield of wells less than 3 l/sec, EC of groundwater more than 1.5 mS (range 0.5 - 2.5 m5).
- Shallow groundwater present only locally in the higher areas of the farm, limited possibilities for shallow wells (6-12 m) with handpump.
- Shallow groundwater present, salinity moderate in the Magole river bed: unconfined groundwater, wells 7-12 m deep, aquifer 0.5 - 5.0 m, yields 0.2 - 0.4 l/sec, EC:) 5 - 1.5 mS.

Conclusions

There is no doubt that shallow groundwater exists in the river bed;of the Hagole river. The quality of this water is reasonable (see chapter 4). Exploitation of this water may be done by shallow wells. How much of this water may be exploited remains to be investigated.

As far as deep groundwater is concerned, the information available is conflicting and not conclusive. Deep groundwater may be present, but neither quantity (yield) nor quality (EC) can be predicted, therefore further investigation, i.e. test drilling, is required.

It will be proposed, in chapter 5, to arrange for a mission of a geohydrologist soonest, to assess the potentials of both the shallow and the deep groundwater at the site.

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4. RESULTS OF PRESENT STUDY

4.1. Surface water

As was mentioned in the previous chapter, irrigation by surface water for the Dakawa ANC farm is not possible, without additional provisions. The possibility of a reservoir was discussed and it was stated that this is a too large undertaking to be carried out for the ANC farm alone.

An other possibility is pumping from the Wami river, 11 km away, and an attempt will be made here to assess the approximate cost Of the installation and annual cost of pumping. The quality of the Nami river water is excellent (EC : 0.16 ms).

An approximate calculation (Dfl):

15 1/sec 30 1/sec
pipes and couplings 208 400 315 000
pump 3 600 5 000
pumphouse 10 000 10 000
installation pipe 65 000 65 000
reservoir (night storage) 20 000 30 000
transport 145 000 225 000
452 000 650 000
approximate cost per ha 30 000 22 000
using: pipes J diameter 200 mm 250 mm
pump 18.5 kw 30.0 kw
H 60 m 62 m
annual cost (electricity) 30 000 Tsh. 50 000 Tsh.

Since these costs only include the pumps and pipes and exclude the cost of the sprinkling irrigation equipment, it must be considered as prohibitive, i.e. not economically feasible.

4.2. Groundwater

Quality

For an assessment of the quality of the available groundwater in the area, the electrical conductivity (BC) was measured of the existing wells and in a number of holes drilled in the river bed of the Magole river.

The results: E.C.
well at plot 18, SOC area, water supply 1.67 mS
handwell at same site 0.79 mS
well at range area, plot 22 1.28 mS
well at NORCONSULT camp 1.89 mS
well in plot 16 (hospital) 2.87 ms
dug well in river bed 0.88 mS
dug hole near SOC 0.65 mS
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bore hole river bed, near bank 0.95 ms
bore hole in river bed 0.65 ms
outside the ANC farm: Wami Prison Farm 1.59 mS
Wami River Farms 3.6 mS
As a general rule for all crops, crop tolerance levels are given below:
no effect of salinity on crop yields EC (0.75
moderate effect of salinity on crop yields EC 0.75 - 3.0
severe effect of salinity on crop yields EC) 3.0
In general vegetable and fruit crops are more sensitive and field and fodder crops are more tolerant, see Annex 4 for more detailed information. From the measured data it is clear that the water in and near the riverbed has an acceptable quality for all crops and that the water in the wells has some restrictions for vegetable crops.

Quantity

Assessing the quantity of available groundwater for irrigation is a more elaborate exercise involving geo-electrical measurements and test-drilling and -pumping activities which could not be carried out during the present consultancy.
It is clear that water of acceptable quantity is available in the river bed of the Magole river (plot 18) at a depth of about 1 m, which can be extracted by means of open ring wells.
It is’likely that water of reasonable quality is available in the range area, plot 22, to be extracted by means of a deep well to 80-100 m.
It is possible that water of reasonable quality is available in deeper layers in plot 18, to be extracted by a deep well of between 50 and 100 m.
It is necessary for an assessment of the water quantity for irrigation that the following studies are carried out:
- assessment of the quantity of water in the river bed which can be extracted by means of one or more open ring wells
- assessment of the quality and the yield of a deep bore hole in plots 18 and 22.

A proposal for this study will be made in chapter 5.

4.3. Soils

Soil samples have been analyzed for some physical and chemical properties of most of the plots of the ANC farm. Soils of both plot 18 and 22 are suitable for agriculture, the lighter soil of plot 18 being very suitable for vegetable growing.

plot 18: loamy sand, estimatedH readily available water for vegetables; 30 - 40 mm/m’ _

plot 22: sandy clay loam, estimated’) readily available water for forage crops: 60 - 80 mm/m’.

estimated71 infiltration for both soils) 15 mm/hour.

71 estimated from texture, not determined.

4.4. Water reguirements

The water requirements of crops, i.e. the quantity of irrigation water needed for optimum crop growth, is calculated from meteorological data. Unfortunately the data available are very limited (litt. no. 5, Volume III, Hydrology).

Available was:

- temperature data of Wami Prison Farm for 1970-1975
- relative humidity data of Wami Prison, Farm for 1970-1972, 1974, 1975 ,
- radiation data of wami Prison Farm for 1970-1972 and some months of 1973
- wind velocity data of Wami Prison Farm for 1970-1972 and 1974
- sunshine data of Morogoro for 1970-1978.

On basis of these data the evaporation has been calculated according to the FAO method (Irrigation and Drainage Paper No. 24). Since the data are not very recent and probably not very reliable, they have to be used with caution.

The results of the calculation are shown in Table 1.

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Calculation of evaporation by modified Penman method
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The crop coefficients (K-values) have been estimated as follows:
- for vegetables, year round, 0.95
- for pasture, " " 1.0
No daily data on rainfall were available, which is why the effective rainfall was estimated from the USDA-SCS method (FAO paper No. 24) and adjusted for effective storage and irrigation interval:
- for vegetables, rooting depth 0.5 - 0.6 m, effective storage 20 mm, interval probably about 4 days
- for pasture, rooting depth 1.0 - 1.2 m, effective storage 70 mm, interval probably about 14 days.
For efficiency of sprinkling irrigation, finally, a value of 70% was used.
This results in the following calculation (in mm/day):

	Evapotranspir. crop		Effective rainfall		Irrigation requirem.	
	vegetables	pasture	vegetables	pasture	vegetables	pasture
J	5.2	5.5	1.3	3.7	5.6	2.6
F	4.6	4.8	1.0	3.0	5.1	2.6
M	5.2	9.5	1.2	3.5	5.7	2.9
A	3.6	3.8	1.4	3.8	3.1	0
M	3.6	3.8	0.8	2.4	4.0	1.7
J	3.7	3.9	0.2	0.5	5.0	5.0
J	3.4	3.6	O	0.3	4.9	4.7
A	4.2	4.4	0	0.3	6.0	5.9
s	4.5	4.7	o	0.3	6.4	6.3
O	5.5	5.8	0.3	1.0	7.4	6.9
N	6.6	6.9	0.5	1.5	- & z._z	
D	5.6	5.9,	1.4	3.9	6.0	2.9

The irrigation system should be capable of supplying sufficient irrigation water in the top month: November, or have a slight shortage in this month in some years.
Recommended quantities and intervals:
- vegetables: 30 mm every 4 days
- pasture: 100 mm every 14 days
On basis of these recommended figures a design can be made.

5. PROPOSALS

In this chapter a number of proposals will be made concerning necessary further investigations on groundwater, possible irrigation development depending on the results of the investigation, and recommended training.

5.1. Mission geohxdrologist

As has been pointed out in chapter 2’ an assessment of quantity and quality of available groundwater, both shallow and deep, must be made first, before a design of irrigation systems is possible. It is therefore proposed to engage a geo-hydrologist for the following activities (for more details see Terms of Reference, Annex 5):

- assess potentials of shallow groundwater in the riverbed adjoining plot 18, resulting in recommendations for shallow well development including well depth, well diameter, yieldI quality, possible number of wells and interference between them, cost estimates;
- assess potential of deep groundwater at plot 18 and plot 22, resulting in recommendations for deep well development on both sites, including well depth, well diameter, yield, quality, number of wells possible and cost estimates.

On basis of the results of this ihvestigation and on the type’ designs and cost estimates in 5.2. and 5.3. below, final recommendations and cost estimates can be made.

5.2- nge designs for irrigated vegetables in Qlot 18 (Annex 6)

5.2.1. Assuming an open well, 6 m deep, 5 m diameter (storage about 100 m3), producing 1.5 Ilsec,
a small sprinkling irrigation system can be designed covering about 1.7 ha, irrigating in an 18 x 18 m grid, at 5 mm/hour, 2 positions per day of 6 hours each.
In case more wells are installed, more units of 1.7 ha can be purchased.

Costs: equipment including transport: Dfl. 15 500.-
(including a 30% discharge)
well construction and pumphouse " 9 000.-
Total " 24 500.-.

5.2.2. Assuming a deep well, 60 - 100 m deep, 4" diameter, producing 15 Ilseo,
an irrigation system of about 10.5 ha is possible, irrigating in an 18 x 18 m grid, at 3.85 mm/hour, 2 positions per 24 hours of 8 hours each.

Costs: equipment including transport; Dfl. 44 000
(including a 30% discharge)
deep well, screen, pumphouse " 36 000.-
Total " 80 000.-

A larger area may be irrigated, up to some 17 ha, if a

reservoir is constructed, and using a different irrigation lay-out.

5.3- Txge design for irrigated Qasture (Annex 7)

Assuming a deep well, 100 m deep, 10" diameter, producing 15 l/sec, an irrigation system of about 16 ha is possible, irrigating in a 24 x 24 m grid, at 9.2 mm/hr, 2 positions per 24 hours of 11 hours each.

Costs: equipment including transport: Dfl. 39 000.- (including a 30% discharge)
deep well, screen, pumphouse " 35 000.-
Total " 74 000.-

Further assuming 5 - 6 cows per ha, this unit could support some 100 cows, provided good grasses are sown such as Napier grass or Guinea grass with a dry matter production of 15-20 tons/year. Here again, further expansion depends on the availability of deep groundwater. If more tubewells can be placed, more units may be installed.

N.B. The designs given above are meant to show the possibilities for irrigation, given a certain water supply, as well as the order of magnitude of costs. As soon as the water supplies are determined, final designs and more exact cost estimates :may be made and an even larger discharge' in costs may be obtained.

5.4- Training

At Dakawa only the Farm Manager and the Assistant Farm Manager have had agricultural training, but not in horticulture and/or irrigation. Therefore it is proposed to include training in the project.

For the short term it would be extremely useful, both for Dakawa and for Mazimbu, to have a short term consultant to visit the farms once or twice a year for a period of 4-6 weeks. This consultant should be well experienced in tropical irrigated horticulture. As an alternative, it could be considered to appoint a less experienced horticulturist for a period of one or two years.

The task of the long or short term consultant would be to provide on-site training of all personnel involved in the farms and in particular to assist the farm managers in preparing cropping schedules, irrigation operation schedules, fertilizer and spraying programmes, etc.

For the long term, possibilities exist for courses in Tanzanian Agricultural Institutes, which have a curriculum geared to Tanzanian agriculture under conditions similar to large parts of Eastern and Southern Africa. Such courses are much more appropriate and much more practical than courses abroad in Europe.

There are a number of institutes which offer agricultural courses, some of which can be recommended:
ARI Uyole, Mbeya region, general agriculture
ARI Nyegezi, Mwanza region, specialized in land use, including irrigation
ARI Tengeru, Arusha region, specialized in horticulture
ARI nlingano, Tanga region, specialized in farm management.
Courses offered are:
- 1 year course, upgrading and observation; if results possitive follows a
- 2 year course, for a certificate, after which a
- 2 year course, for a diploma, after which students may enter the Agricultural University.
The tuition fees for these courses are Tsh. 90 000 per year, Including books, pocket money and other expenses, some Dflx 2500.- per student per year will be sufficient.

5.5- Stage geriod Dutch students

In support of the Dutch consultant and in particular in the initial stage of the horticulture project at Dakawa, it could be considered to make use of two Dutch students of Wageningen University who could do their stage period of 6 months at Dakawa.
An irrigation student could be charged with installation of the .sprinkling equipment, carrying out trial runs, training the labourers and make an irrigation operation schedule for the two systems.
A horticulture student could be engaged with cropping schedulesy selection of appropriate crops and varieties, fertilizers, soil preparatiod, etc.
Selection of the students could be arranged through the ANS support group at Wageningen University. Accomodation and transport need to be provided at Dakawa.

5.6. Additional suggort

when starting a new activity, such as the horticulture farm at Dakawa, purchase of irrigation equipment does not suffice, as other equipment, implements, tools, etc. are also required as well as seeds, chemicals and fertilizers.
It could be considered including in the project the following items (approximate costs):
- one small (7-10 hp) horticulture tractor with implements Dfl- 10 000.-

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Sprayers
- hoes, Dutch hoes and other small tools
- horticultural seeds
- chemicals and fertilizers, f.e. for one year
- miscellaneous and transport of equipment
Total
5.7. Tentative cost estimates
On basis of foregoing proposals a tentative cost estimate can be given, which has to be adjusted when the results geohydrological investigation are known.
mission geohydrologist 4-6 weeks
2 test drillings to approx. 100 m
irrigation equipment, still to be estimated
(Dfl. 100 000.- - 200 OOO.-)
training, say 4 students, 5 years
consultant (say 4 months total)
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CONCLUSIONS AND RECOMMENDATIONS

No surface water supplies are available at the Dakawa ANC farm for irrigation purposes. Construction of a reservoir in the Ukundi river is a too large and too costly undertaking for the ANC farm and must be considered in a much wider perspective. Pumping from the Wami river for irrigation is economically not feasible.

Limited quantities of reasonable quality shallow groundwater are available in the river bed of the nagole river, whilst deep groundwater may be available in plot 18 and plot 22. This needs further investigation by a geohydrologist, and deep drilling.

Soil and climate at Dakawa are suitable for growing of most irrigated vegetables and of irrigated forage crops.

Irrigation requirements have been calculated for vegetables and forage crops:

30 mm every 4 days for vegetables

100 mm every 14 days for forage crops.

Type designs have been made, including tentative cost estimates, for a;

- 1.7 ha irrigated vegetable plot from shallow groundwater

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.. 16 ha H 7. u Ii n

Definitive designs and cost estimates can be made as soon as the results of the geohydrological study are known.

A proposal has been made for a consultancy of a geohydrologiat to assess quantities and qualities of available shallow and deep groundwater at plots 18 and 22, and for test drilling at both sites.

Further proposals have been made for training, consultancies and additional support.

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ANNEX I
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IS ON HORT CU URE OJ CT AKAWA
. BJECT VES of Consultant's mission 5 to:
1) Assess the posibilities of the establishment of irrigated horticulture
2) Make a proposal for a project document for donor funding.
ACTIVITI S
.1. In close collaboration with designated officials of the ANC the consultant will:
- determine the location, quality and quantity of available surface water supplies.
- determine location and approximate size of possible irrigated area.
- prepare a plan for irrigation development (including soils, water requirements, cropping schedules) including fasing for future expansion -
- assess the requirements for land development (pumps, canals, structures or sprinkling equipment)
- make a construction plan
- make an approximate assessment of the tequired machinery, equipment, implements, stores, etc. ,
- assess the requirements for skilled and unskilled manpower
- assess the requirement for training
- assess the requirement for additional technical assistance
- make approximate cost estimates
- make a simplified cost / benefits analyses.
2. Additional attention will be paid to a number or all of the following items:
- possibilities for marketing, including demand in- and outside the camps, transport and market management potential
- evaluate pattern of cobperation with local population outside the camp
- assess influence of horticulture production in Dakawa on economic position of local population outside the camps (labour, competition in products,etc.).
3. Based on the above, consultant will draft a project document for donor funding which will include but not be limited to: I
- objectives of the project
- possible outputs
- required inputs by donor and by the ANCl
- proposals for training (if required)
- proposals for further technical assistance (if required)
- cost estimates.
ANC -NOVIB
11 July, 1933.
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tiederlandse organisatie voor internationals ontwikkelingssamenwerking
amaliastrw 7 telefoon 010 - 421 621 postgiro 645300
2514 JC den haag Mogramadres novib bank abn 51 9532 813 den haag
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P51

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2. Comments on the Terms of Reference
3. Review of existing information
3.1. Surface water
3.2. Groundwater
4. Results of present study
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4.2. Groundwater
4.3. Soils
4.4. water requirements
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. Type design for irrigated pasture
. Training
. Stage period Dutch students
. Additional support
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Annex 5: Terms of reference consultancy geo-hydrologist (draft)
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ANNEX 2-

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July
August
18th:
19th:
20th:
21st:
22nd:
23rd:
24th:
25th:
26th:
27th:
23th:
29th:
30th:
31st:
1st:
2nd;
3rd;
4th:
5th:

ITINERARY

departure from Amsterdam
arrival at Dar-es-Salaam
arrival at Mazimbu, contacts with Peace Tan and Beauty Ngubane
arrival at Dakawa, contacts with Majoro Nthorana and Jacky Moruki
fieldwork at Dakawa, visit to DHV, Morogoro, stay at Mazimbu
visit to Hazimbu farm, return to Dakawa
Sunday
fieldwork at Dakawa with Majoro, contact with Oswald Dennis
visits to Wami Prison Farm, wami Irrigation Scheme, Mkundi river, with Majoro
fieldwork at Dakawa, contact with Jan Schuthof of Thrust Engineers
to Morogoro and Nazimbu; visits to Tanzanian Wells and Maji, discussion with Chief Administrator Tim Maseko
calculations and study reports
visit to Mazimbu farm, discussions with Mahmood Randeru, farm manager
Sunday
to Morogoro, visit to Tanzanian wells (Mr. van Helden) and Maji (Mr. M.M. Malembeka and Mrs. Jonadhan)
discussion of preliminary conclusions and recommendations with the Chief Administrator Tim Maseko
departure for Dar-es-Salaam
visit to Tanzanian Meteorological Service and Thrust Engineers; departure for Amsterdam
arrival in Amsterdam.

MWEX 3

PRELIMIEARY CONCLUSIONSAND RECOMEENDATIONS

1., The pigbose of consultant’s mission is to asses the possibilities of the establishment of eSrigated horticulture at the ANC farm 5; Dakawa and to a proposal for a project document for donor funding.

Q2. CThe consultant stayed in Tanzania from the 19th of July until the 4th of August 1988, half of which _ time was spent in Dakawa and the remainder in Mazimbu and Dar Es Salaam.

It is clear that no surface water supplies are available at the Dakawa ANC Farm for irrigation purposes gand therefpre that large scale irrigation as envisaged by Norplan is out of the question.

The situation regarding available groundwater supplies is not clear

Limited quantities of shallow ground water are available in the river bed of the river Magole, which borders blocks 18 and 19(Area 5)of the ANC area. The quality of this water is reasonable (EC:O.65 m5:2430 pCpm) for irrigation.

The ground water at all other sites at the Farm is too saline for irrigaticn of vegetables.

It is not known whether ground water bearing aquifers exist at greater dept.

The soil at the progosed site, is block .18, a loamy sand, is saitable fer the growth of vegetables. The internal drainage of soil is sufficience to prevent sulinization when irrigated with Water as encountered in the river bed. The climate at Dakawa is suitable for the growth of mcst vegetables.

9. A proposal will be made to NOVIB for a consultancy of a geo-hydrologist to asses dpntities and qualities of available shallow and deep groundwater.at block 18. The terms of reference for this Consultancy will be included in Consultante report. During or before ’the mission a test drilling will have to be carried out at block 18 to a -depth of 100 m or to an exploit-able deep aguifer, to asses once and for all whether deep ground water is available ti the required quantities and qualities.

19. On basis of this study a definitive design and cost estimate .Tcan be made for irrigaaee horticulture at Dakawa, which may either be 2-4.for irrigated vegezebles from shallow wells, in the river bed or 10-20:irom deep wells.

11. A report on this mission will be prepared in the 7 Netherlands and presented to NOVIB within four weeks after Consultant’ s return. The report will cotain but not be limited to remits of present study1additional activities required, recommendations,proposal for funding and type designs and cost estimateslfor 2-4 ia.from shallow ground water and 10-20 ia.from deep ground water.

12. These preliminary conclusions and recommendations were discussed on the 2nd of Agust 1988 with the Chief Administrator of Mazimbu and Dakawa Camps.

Mazimbu, 2nd August 1988

Jan van der Laan

ANNEX 4- SOME USEFUL TABLES ON IRRIGATION AND SALINITY

Table 34 Average Monthly Effective Rainfall as Related to Average Monthly ETcrgg and Mean Monthlx Rainfall ’ (USDA (SCS), 1969)

Monthly mean rainfall mm	Average monthly effective rainfall in mm
12.5	25
37.5	50
62.5	75
87.5	100
112.5	125
137.5	150
162.5	175
187.5	200
32	39 46
41	48 S6 62 69
35	43. 52 59 56 73 80 87 94 100
125	10 20 30 37 46 54 62 7O 76 85 92 98 107 116 120
150	10 21 31 39 49 57 66 744’ 81 89 97 104 112 119127 133
175	11 23 32 42 52 61 69 78 86 95 103 111 118 126 .1 141
200	11 24 33 44 24 54 73 82 91 100 109 117
7	115

X(Where net depth of water that can be stored 1n the soil at time of irrigation is greater or smaller than 75 mm, the correction factor to be used is:

Effective storage	20
Stem e factor	

EXAMPLE:

Given:

Monthly mean rainfall - 100 mm; ETcrop - 150 mm; effective storage - 175 mm

Calculation:

Correction factor for effective storage . 1.07

Effective rainfall 1.07 x 74 - 29 mm

Table 35 Effect of Irrigation Water Quality on Soil Salinity, Permeablhty

	moderate	severe
Salinity		
ECw (mmhos/cm)		
Permeability		
ECw (mmhos/cm)		
adj. SAR		
Montmorillonite		
lllite		
Kaolinite)		
Toxicig (most tree crops		
sodium (adj. SAR)iI		
chloride (meq/ 1))95 ll		
boron (mg/ 1)		

1 field etc 5 use Table 3.

#17 33:12:31; irrigatign may cause leaf burn when) 3 meq/l. (Ayers and Westcot, 1976)

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Data may not
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26611141523725 11114211111111
8.11171133524576
Crop Salt Tolerance Levels for Different Crops (Ayers and Westcot, 1976)
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n and seedling stage ECe sho_u1
ECe should not exceed 3 mmhos/cm.
dwarf varieties of wheat.
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m .obo
r. nm.u
8 a a
s e nsn
m s m iwi
s/u%)uues M H .W. mmm
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b onerooolri eoou eeraaauemeoap oolaeloareoaarr PPvai eltW /
a HBBBCCCFGRSSSSSW BBBCCCCL PPRSSSTFABBCCHOPSTTTTWFAAAADFGGLOPPS l 2
T.

Table 44
Nozzle
m
Table 38 Relation between Soil Water Tension in bars (atmospheres)
and Available 5011 Water in mm m 9011 d th
(after Rijtema, 19595
Soil water tension 0.2 0.5 2. 5 15
(atmospheres) Available soil water in min
$41
Heavy clay 180
Silty clay 190
Loam 200
Silt loam 250
Silty clay loam 160
Fine textured soils ;O_0_
Sandy clay loam 140
Sandy loam 130
Lonny fine sand 140
Medium textured 3011: 12%
Medium fine sand
Coarse textured soils QQ
OOOOOOOOOOO
Qgerating Figgres for Some Sprinklers (Sguare Pattern)
Pressure Wetxed Discharge 2 Spacing Area
2 Diameter 3 - Irrigated
cm m m m m
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OOH-d M000.) tome.) CD030) WNW OKUIO) UNH
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Precipitation
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NQO qua.) HhN moon U100 OmN HMO
Hg
no..-
535’

Table 39
Generalized Data on Rooting Depth of Full Grown Crops, Fraction of Available Soil Water (p) and Readily Available Soil Water (p.55) for Differem Soil Types in mm m soil de 1h when ETcro 1’s -

Rooting depth (D) available 1/ m soil water-	Fraction (p) of fine
Alfalfa	
Banana 2 /	
Barley27	
Beans -	
Beets	
Cabbage	
Carrots	
Celery	
Citrus	
Clover	
C acao	
Cotton	
Cucumber	
Dates	
Dec. 0 chards	
Flax Z 2/	
Grains small -2/	
winter -	
Grapes	
Grass	
Groundnuts	
Lettuce	
Maize _2_/	
silage	
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O	
0	
9	
S	
0	
5	
5	
3	
0	
O	
Melons	
Olives	
Onions A	
Palm trees	

Peas
Peppers
Pineapple
Potatoes /
Safflower -
Sisal /
Sorghum -
Soybeans
Spinach
Strawberries
Sugarbeet 2/
Sugarcane fl
Sunflower -
Sweet potatoes
Tobacco early
late
Tomatoes
Vegetables
Wheat
rip ening
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Ouxl momwumumOmOhwmmuuw
Hmmmmmwm
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HOO OHOHOOOOHOHOOOOOOHH
HOH
on.
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U1
KOUINBOIQCthNUI
6 mm da
Readily available so)! water (p.5a)
mm/ml
medium coarse
A .A..’..Mm....A-(H: M
1/ When ETcr0p is 3 mm/day or smaller increase values by some 30%; when ETdrg is 8 nim/dp
y
- or more reduce values by some 30%, assuming non- saline conditions (ECe (2 mmhos/cm).
_2_/ Higher values than those shown apply during ripening.
Sources: Taylor (1965), Stuart and Hagan (1972),. Salter and Geode (1967), Rijtema (1965)
and others.

V . A . P. ’ n J
4:. Mm’u . ,1". mag. .’_ra. v q M.
ANNEX 5; TERMS OF REFERENCE CONSULTANCY GEO-HYDROLOGIST Sdraftz
Purgose and duration of mission
To assess the quantity and quality of shallow and deep groundwater resources for irrigation at the ANC Dakawa Farm! Tanzania.
Duration of mission; 3 -4 weeks.
Tasks
1. Assess the availability of shallow groundwater in the river bed of the Magole river at plot no. 18, including:
- depth of water bearing aquifer
- quality of the water (EC values)
- type and size of shallow wells, possible yields
- number of wells possible, interference of wells
- cost estimates,
resulting in a recommendation for poasible shallow well development for irrigation in plot 18.
2. Assess the availability of deep groundwater for irrigation development at plots 18 and 22, including;
- supervision of test drilling to 100 m depth or to good
_ aquifer
’7 - qualities
- yields
_ type and size of deep wells, possible yields
- number of wells possible, interference of wells
- cost estimates,
resulting in recommendations for possible deep well development for irrigation in plots 18 and 22.
Additional information
The drilling can be carried out by Maji, Tanzania, in cooperation with Thrust Engineers International, Dar-es-Salaam.
Reports on groundwater investigation as mentioned in the mission report, are available.
.....1-..t , ,._._,.. q," .7 , v , .. w. .;N.w.._. Hf .Y -w- n, .,

ANNEX 6- TYPE DESIGNS FOR SPRINKLING IRRIGATION OF VEGETABLES

1. Shallow well plot 18

Basic information:

Assumed supply 1.5 l/sec, well 6 m deep, 5 m diameter, 100 m3 storage.

Irrigation water requirement: 30 mm every 4 days, infiltration maximum 15 mm/hr.

Soloctod:

Perrot sprinkler LKA 30/2

nozzle diameter 5 mm, pressure 3 atmosphere, intensity 5.0 mm/hr, discharge sprinkler 1-63 mB/hr, grid 18x18 m, area covered 324 m2.

Calculations:

One irrigation is 30 mm, i.e. 6 hours per position, 2 positions per day.

One irrigation every 4 days, i.e. per day 1/8 area to be irrigated.

30 mm in 4 days : 0.87 l/sec/ha i.e. total area about 1.7 ha.

Therefore per day 2125 m3 i.e. use 6.6 or 7 sprinklers.

1st 2nd 3rd 4th , day

x

x .

x

x x : sprinkler

O : hydrant

x : position

x

x . . . . . .

I main line

0-we11

i.e. 7 x 18 : 126 1 24 : 150m main line

6 x 18 : 108 # 12 : 120 m supply line

7 sprinklers

8 hydrants.

Required pump:

Discharge 7 x 1.63 mz/hr : 11.4 m3/hr.

Required pressure 42 m (4.2 at)

Capacity pump: 46 x 11.4 / 3.67 x 60 : 2.4 kw.

Use for example Perrot electric pump 2 CP 32/200 C (3.0 kw, 12 mzlhr at 4.5 at).

" . ; : L 2.? i 7; 1;.7 2:. W%1w&c&m 52-5 "
Cost estimato:
150 m main line 65 mm diameter, subterranean,
150 x Dfl. 25.-
120 m quick coupling supply line, 70 mm diameter
Dfl. 3 750
120 x Dfl. 19.25 : " 2 310
10 sprinklers LKA 30/2, 5.0 mm diameter " 1 200
10 hydrants ’ " 2 500
spares and accessories " 5 000
pump and suction pipe, couplings " 3 OOO
Dfl. 17 760
discount for large quantity 30% " 5 260
Dfl. 12 500
transport (Europe - Dar-es-Salaam - Dakawa) " 3 000
construction well " 7 000
pumphouse, electric connections, etc. " 2 000
Dfl. 24 500
Operation:
The design is made for the month with the highest demand (November). This means that during months of lower demand (April to June), hours of sprinkling may be reduced and a larger area may be irrigated with 3 shifts per day.
2. Deeg wellI Blot 18
Basic information:
Assumed supply 15 1/sec, well 60 - 100 m deep, 100 mm (4") diameter.
Irrigation water requirement: 30 mm every 4 days.
Infiltration maximum: 15 mm/hr.
Selected:
Perrot sprinkler LKA 30/2:
nozzle 4.5 mm diameter, pressure 3 atmosphere, intensity 4 mm/hr, discharge sprinkler 1.32 mS/hr, grid 18x18 m, area covered 324 m2.
Calculations:
One irrigation is 30 mm, i.e. 8 hours per position, 2 positions per day. Total supply 15 l/sec : 54 m3/hr, i.e. 54/1.32 : 4O sprinklers.
4 lines of 10 sprinklers each:

o u - a
x x x x x x x x x . . . supply lines
x x x x x x x x x
main line
O-well
15 x 18 : 270 1 12 : 282 m main line
4 x 10 x 18 : 720 1 36 : 756 m supply line
40 sprinklers
16 hydrants.
Required pump:
Discharge 54 m3/hr.
Required pressure 52.9 m (5.4 at).
Use in 4" bore hole an electric deep well turbine pump, e.g.
equivalent to Parrot, type Iris 50/3 (15 kw, 62 mE/hr at 6.5 at).
Cost estimate:
282 m main line, 138 m, 100 mm diameter, subterranean
138 x Dfl. 35.- Dfl. 4 830
144 m, 80 mm diameter, subterranean
144 x Dfl. 25.- " 3 600
756 m quick coupling supply line, 70 mm diameter
756 x Dfl. 19.25 " 14 550
40 sprinklers, LKA 30/2, 4.5 mm diameter nozzle
40 x Df1.120.- " 4 800
16 hydrants 16 x " 250.- " 4 000
risers, spares, accessories " 10 000
pump and suction pipe, couplings " 10 000
Dfl. 51 780
30% discharge (for large quantity) " 15 780
Dfl. 36 000
transport " 8 000
construction well, screens " 30 000
pumphouse, electric connections, etc. " 6 000
Total Dfl. 80.000.
Operation:
See remarks with 1: shallow well.
AMmWN A . .

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ANNEX 7- TYPE DESIGN FOR SPRINKLING IRRIGATION OF PASTURE

Deep well Blot 22
Basic information:
Assumed supply 15 1/sec, well 80 - 100 m deep, 150 mm (6") diameter.
Irrigation water requirement: 100 mm every 14 days.
Infiltration maximum: 15 mm/hr.
Selected:
Perrot sprinkler 2K 30;
nozzle 9 mm diameter, 3 atmosphere pressure, intensity 9.2 mm/hr, discharge sprinkler 5.23 malhr, grid 24x24, area covered 576 m2.
Calculations:
Required 100 mm every 14 days with supply of 15 l/sec.
15 1/sec : 54 ma/hr : 54/5.33 : 10.1 sprinklers : about 10 sprinklers.
10 x 576 m2, 2x per 24 hours, 1x per 14 days : about 16 hectares (2 settings/day, 7 days a week).
Possibilities: one line of 10 sprinklers : 240 m or two lines of 5 sprinklers : 2x 120 m.
One line:
240 m x . . . .
one half of lay-out
X
X . . . . . .
1st 2nd 3rd 4th 5th 6th 7th day
14th 13th 12th 11th 10th 9th 8th day
336 m

_. 9: ,_ . J; .4 _,_ A n _ .4 .5133; U. u t, .4. 2 1 ..L._-t . 2.. .,. J_Muxmn A unmet. ’
a I:Rtrximk-gka.-_ ...-, --.,.V-;z,uh.xn. r422. t;
360 m
252 m
main line: 14 x 24 t 24
.,. supply line: 10 x 24 # 12
10 sprinklers
14 hydrants
Required pump:
Discharge 54 mS/hr.
Required pressure: 56.7 m (5.7 at)
Use deep well pump in 6" bore hole, for example:
Parrot, deep well pump SP 75-6 (60 m3/hr at 7 at).
Cost estimate:
360 m main line, subterranean, 125 mm diameter
360 x Dfl. 35.-
240 m quick coupling line, 108 mm diameter
Dfl. 12 600
240 x Dfl. 31.95 : " 7 670
10 sprinklers " 1 000
14 hydrants " 3 500
spares and accessories " 7 500
pump and couplings " 15 000
Dfl. 47 270
discount for large quantity 30% " 14 270
Dfl. 33 000
transport (Europe - Dar-es-Salaam - Dakawa) " 6 OOO
deep well 4 screen " 30 000
pumphouse, electric connections, power line ", 5 000
, Dfl. 74 000.
Operation:
The system is designed for two settings of 11 hours per 24 hours.
This leaves one hour in the early morning and one hour at the end
of the day to move the line in the month with the highest demand
(November). During periods of lower demand (January to May/June)
the hours of sprinkling may be reduced.
, Ww-W _
wrap vv. --1.., 29,21,120 V4.1--.r, .._

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