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CAPM IRRIGATION SCHEME REHABILITATION UPGRADING PROGRAM AND IDENTIFICATION OF IRRIGATION COMPANIES AND FIRMS IN THE AREA

COMMERCIAL AGRICULTURAL PRODUCTION
AND MARKETING PROJECT

Contract Number 645-0229-C-00-9019

Prepared in Association with:

The Ministry of Agriculture and Cooperatives
Mbabane, Swaziland

and

The United States Agency for International Development
Swaziland Mission

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TABLE OF CONTENTS

		Page
LIST OF ACRONYMS		i
SECTION I	INTRODUCTION	
	A. Stated Objectives	1
	B. Expected Outputs	1
	C. Statement of Work	2
	D. Methodology	2
SECTION II	PHOPONYANE IRRIGATION SCHEME REHABILITATION PROGRAM	3
	A. Irrigation Scheme Selection	3
	B. Irrigation Scheme Rehabilitation	3
SECTION III	EMBEKELWENI IRRIGATION SCHEME DRIP IRRIGATION PROGRAM	5
	A. Drip Irrigation System Design	5
	B. Drip Irrigation System Layout	6
	C. Installation of the Drip Irrigation System	8
	D. Water Source	9
	E. Irrigation Training	9
	1. Drip Irrigation	10
	2. Irrigation Training	11
	F. Establish a Maintenance Fund	12
	G. Irrigation Scheduling	12
SECTION IV	ADDITIONAL IRRIGATION SCHEME REHABILITATION AND UPGRADING UNDER THE CAPM PROJECT	13
	A. Scheme Selection	13
	B. Vusweni Irrigation Scheme	13
	C. Madubeni Irrigation Scheme	14
	D. Additional Studies	14
	E. Other Alternatives	14
SECTION V	IRRIGATION CONSULTING AND TRAINING COMPANIES AND FIRMS	16
	A. Company/Firm Identification	16
	B. Responses	17
SECTION VI	OTHER CONSULTING IRRIGATION ACTIVITIES	19
SECTION VII	SUMMARY RECOMMENDATIONS	20
ANNEX A	EMBEKELWENI DRIP IRRIGATION EQUIPMENT LIST	A-1
ANNEX B	EMBEKELWENI DRIP IRRIGATION PRICE QUOTATIONS	B-1
ANNEX C	SOILS, PLANTS AND IRRIGATION/ IRRIGATION WATER MANAGEMENT ON THE FARM	C-1
ANNEX D	IRRIGATION CONSULTING COMPANIES/FIRMS	D-1

LIST OF ACRONYMS

CAPM	Commercial Agricultural Production and Marketing Project
CIE	Consulting Irrigation Engineer
GPM	Gallons Per Minute
GPH	Gallons Per Hour
GOS	Government of Swaziland
ha	Hectare
IFAD	International Fund for Agricultural Development
l/h	Liters Per Hour
l/s	Liters Per Second
m	Meter
mm	Millimeter
MOAC	Ministry of Agriculture and Cooperatives
SNL	Swazi Nation Land

SECTION I
INTRODUCTION

A. Stated Objectives of the Consultancy

The objective of the Irrigation Engineering Consultancy is to provide technical assistance for the Commercial Agricultural Production and Marketing (CAPM) team as well as the Swaziland Ministry of Agriculture and Cooperatives (MOAC) in the rehabilitation of irrigation schemes, training of farmers in the use of specific irrigation systems and in general irrigation practices, and in developing a priority list of potential irrigation rehabilitation objectives for the future.

B. Expected Outputs

The expected output from the Consulting Irrigation Engineer (CIE) are as follows:

- Oversee the installation of piping and related components of complete upgrading of one irrigation scheme in the Northern Rural Development Area (RDA). This will include assisting in securing of required inputs, supervision of the work, and assuring that work is done accordance to set standards.

- Assist in securing equipment and supervise the installation of a drip irrigation system within an irrigation scheme. This will include assisting individual farmers in the installation.

- Train farmers in general irrigation practices to include: scheduling of irrigations (this will require the development of a method which is both efficient and workable with farmers), system maintenance, and the development of a cooperative approach to water management. The focus of the training must be directed toward the use of drip irrigation (farmers have had limited experience with drip irrigation).

- Identify additional schemes that have good potential for the installation of drip irrigation, using a list of criteria provided by the project production section.

- Identify regional/local irrigation engineering and irrigation training expertise with the capability of providing intermittent technical services and training on behalf of the CAPM Project in the future.

C. Statement of Work

The CIE will incorporate the basic CAPM concept of "sustainability and programmed production" into all phases of the consultancy. The consultant will report to the CAPM Chief of Party or his designee. Technical direction and day to day supervision will be provided by the CAPM Horticultural Specialist. Most of the work will be performed at selected irrigation schemes in Swaziland with the CAPM Matsapha Project Office serving as a base of operation.

D. Methodology

The CIE arrived in Swaziland on November 5, 1992 and completed his assignment on December 11, 1992. Throughout the assignment the CIE met frequently with Kim Kennedy, CAPM Chief of Party for a brief period during the CIE's assigned time; Dan Bradbury, CAPM Chief of Party designate; Doyle Grenoble, Horticultural Specialist and Acting Chief of Party; Robert Thwala, CAPM Project Coordinator; Rueben Myeni, MOAC Irrigation Officer and Patrick Khumalo, MOAC Agricultural Officer - Irrigation. The purpose of the meetings were for the CIE to review the progress of his assignment and to obtain advice and at times guidance on how to proceed. The following schedule for the CIE was agreed upon:

- Oversee the installation of the piping and related components to complete the upgrading on the Phoponyane Irrigation Scheme in the Northern RDA.

- Assist with the securing of irrigation equipment for installing a drip system on the Embekelweni Irrigation Scheme in the Central RDA. The CIE was to supervise the installation of the drip irrigation system.

- Train the Embekelweni Irrigation Scheme farmers in the use and management of the installed drip irrigation system including irrigation scheduling, times and amounts of water to apply and maintaining the drip irrigation system.

- Identify addition irrigation schemes (schemes where selected farmers are now engaged or will be significantly involved in vegetable production under the CAPM Project) needing rehabilitation for optimum production.

- Identify local and/or regional irrigation engineering and irrigation training expertise with the capability of providing intermittent technical services and training as required by the CAPM Project in the future.

SECTION II
PHOPONYANE IRRIGATION SCHEME REHABILITATION PROGRAM

A. Irrigation Scheme Selection

During the CIE's assignment with CAPM in March of 1992, the CIE in cooperation with members of the CAPM Team and MOAC Administration officials identified the Phoponyane irrigation scheme as one having excellent potential for vegetable production under the CAPM Project if rehabilitation of the scheme where undertaken.

The Phophonyane irrigation scheme is a private farmer operated scheme. The scheme is 28 hectares in size with 14 farmers. The original irrigation water supply was pumped from a stream source into a storage reservoir. Some 4 or 5 years ago the farmers decided to stop pumping water due to high electric power costs, thus shutting down the irrigation scheme. In the meantime, another water source has been located from another stream from which the water can be supplied to the storage reservoir and scheme by gravity flow. In most years, indications are that this new water source will be sufficient to meet irrigation requirements for the scheme without having to supplement the irrigation water supply by pumping from the original water source. The new water source is encouraging since it has continued to flow water during these present drought times in Swaziland.

B. Irrigation Scheme Rehabilitation

In March, 1992, it was estimated by the CIE that 3500 meters of 110 mm (4 inch) PVC pipe and a concrete diversion weir was all the rehabilitation required to develop the new water supply source at an estimated cost of approximately E70000. This cost included the hiring of trenching equipment, materials and supplies and the putting a cost on the farmers labor contribution.

The MOAC Land Use Section finalized the design of the Phoponyane proposed rehabilitation following the CIE's March assignment. A shorter distance was located from the stream water source to the night storage then originally anticipated. The pipeline length was reduced from 3500 meters to 1800 meters. This reduced the cost substantially from the original estimate.

Also, the Phoponyane farmers volunteered to dig and backfill the entire pipeline trench by hand. The farmers have hand dug the 1800 meter trench, 1 meter in depth; laid the pipeline and backfilled the trench under the supervision and direction of the MOAC Irrigation Section construction staff. This phase of the project was just being completed upon the CIE's arrival for this assignment. A field inspection was made of the pipeline installation. The pipeline installation has been found to be done in an excellent manner.

The farmers, again under the supervision and direction of the MOAC Irrigation Section construction staff, are now constructing the diversion weir and desilting basin. This phase of the project was being completed during the last days of this assignment of the CIE. Field inspections of the weir installation were made and found to be done very well. Upon completion of the weir, the system should be ready for operation after a couple of weeks for curing of the concrete.

The Phoponyane farmers have demonstrated how farmers can contribute much towards the rehabilitation of an irrigation scheme by providing their labor. The Phoponyane farmer volunteer labor to dig the pipeline trench in addition to laying the plastic pipe and refilling the trench, is estimated as an E15000 to E16000 contribution on their part. In addition, I'm sure, the farmers feel as having an ownership in this irrigation scheme and not feeling like someone gave them everything. They helped earn it.

SECTION III
EMBEKELWENI IRRIGATION SCHEME DRIP IRRIGATION PROGRAM

A. Drip Irrigation System Design

The CAPM Project is currently working with several selected Embekelweni Irrigation Scheme farmers on irrigated vegetable production. This irrigation scheme has some very good farmers plus has excellent soils and climate for year around vegetable production. However, the irrigation scheme often experiences irrigation water shortages.

The recent drought in Swaziland has brought about discussions on possibilities of introducing drip irrigation on Swazi Nation Land (SNL) to "stretch the water" so to speak. Before the arrival of the CIE, CAPM and MOAC officials concluded that more of the funds contributed by the Government of Swaziland (GOS) for the irrigation scheme rehabilitation program in the amount of approximately E280,000 be used for financing drip irrigation systems. This decision was based on the water saving capabilities of drip irrigation as well as the other important production benefits (i.e. yield increases, improved produce quality, less disease problems, etc.). See CAPM and MOAC report, 4 August 1992.

The Embekelweni irrigation scheme was selected as the initial scheme for installing a drip irrigation system by CAPM and MOAC. As indicated above, the Embekelweni irrigation scheme has a history of water shortages. The use of drip irrigation as a possible water savings practice was one of the reasons for selecting this scheme for drip irrigation (again, see CAPM and MOAC report, 4 August 1992).

A drip irrigation equipment list for the Embekelweni Irrigation Scheme was compiled by members of the CAPM team and price quotations were requested from irrigation dealers in the area. The selection of the Embekelweni irrigation scheme, drafting of the drip irrigation equipment list and requesting of equipment price quotations were all made before the arrival of the CIE. The drip irrigation equipment list was put together without having field data information available such as field elevations, field sizes, etc. This was done for a reason. It was hoped that the drip equipment would be available for installation before or soon after the arrival of the CIE. Because of this urgency, the MOAC Irrigation Section staff, however; was unable to provide the necessary field data due to prior commitments. The CAPM team members proceeded the best they could putting together the equipment list and requesting price quotations, hoping it would meet the needs of the Embekelweni irrigation scheme.

Upon the arrival of the CIE, it was soon realized that it was extremely important that the proposed Embekelweni drip irrigation system would be key to demonstrating the success of such irrigation in this country. The first step towards a

successful irrigation system, whether it be drip or any other irrigation method, is that an adequate system be designed to fit the land area to be irrigated. For Embekelweni, an extensive field survey was necessary to do an adequate drip irrigation design. With the assistance of the MUAC Agricultural Officer - Irrigation, Patrick Khumalo (an opportunity used by the CIE to conduct brief field training of Khumalo) a detailed field survey was made of the Embekelweni irrigation scheme to establish surface elevations and to determine if sufficient gravity pressure was available to operate a drip irrigation system. There are several advantages to utilizing gravity pressure, if the elevation difference is available, instead of using an irrigation pump to provide the pressure. One being, not having to pump the water can result in a substantial savings in costs of operating a drip irrigation system. Using the field survey data, a review of the initial drip irrigation system design was made. Major design changes had to be made to the original drip design and new price quotations were requested from the irrigation dealers in the area.

B. Drip Irrigation System Layout

Figure 1 is a layout of the drip irrigation design as proposed by the CIE. The total acreage is right at 6 hectares. The land area is divided into 27 panels. Twenty six farmers, each assigned 1 panel, are involved on the Embekelweni irrigation scheme. One panel, number 28, is used for establishing bedding plants.

On the figure is shown the size and length of the mainline piping and filter location.

The head available (pressure) at each panel from two water sources is also shown. The original design had proposed the night storage as the irrigation water supply. The field survey indicated that sufficient gravity pressure was available for only panels 17 through 28 from the night storage. Ten meters or 34 feet of head is required to operate a drip system. Figure 1 shows that such pressure is available beginning at panel 15 and 16. However, there will be some pressure losses in the delivery mainline, thusenough pressure will not be available until the beginning of panels 17 and 18.

Through the field survey, sufficient pressure to operate the drip irrigation system for the entire irrigation scheme was located. By extending the mainline pipe from the night storage to the weir outlet, as shown in Figure 1, (one of the stream water sources), the entire scheme can be irrigated using gravity pressure. The design is such that both the weir and the night storage water sources can be utilized. Figure 1 also shows a storage dam water supply. Sufficient gravity pressure is not available at this water source. However, the water from the storage dam can continue to be delivered into the night storage making it available for drip irrigation on a portion of the irrigation scheme.

The drip irrigation system is designed to deliver 12.6 liters/second (l/s) or 200 gallons/minute (gpm). Each panel is divided into 3 blocks, drip lines spaced 1.2 meters, emitters spaced 30 cm along the drip lines, each emitter to discharge 2 liters/hour (l/hr) or 7.6 gallons/hour (gph).

Peak crop water requirements in the Embekelweni area occur during the months of October through March, averaging 5 to 6 mm/day (0.20 to 0.25 inches/day). However, generally during these months, the area receives sufficient rainfall such that in most years very small amounts of irrigation is even need. During drought years such as this past year, almost all the crop water requirement had to be applied through irrigation. The drip irrigation system as designed, will meet the high crop water requirement.

During the winter months when rainfall is very limited, the peak crop water requirements average 4 to 5 mm per day. Essentially all of the crop water requirements must be applied through irrigation during this time of year. If the farmers irrigate 6 hours each day, 12.6 l/s will meet the daily crop water demands of 5 mm/day on 5 hectares, assuming a water application efficiency of 90 percent. It is highly unlikely that 100 percent of the land area will be in production at one time or all crops being at peak water use at the same time. It will be more likely that about 70 percent of the area will be in full production at all times, or about 4 hectares out of 6. Thus, there will be sufficient irrigation water to meet the crop water needs on the acreage planted at all times.

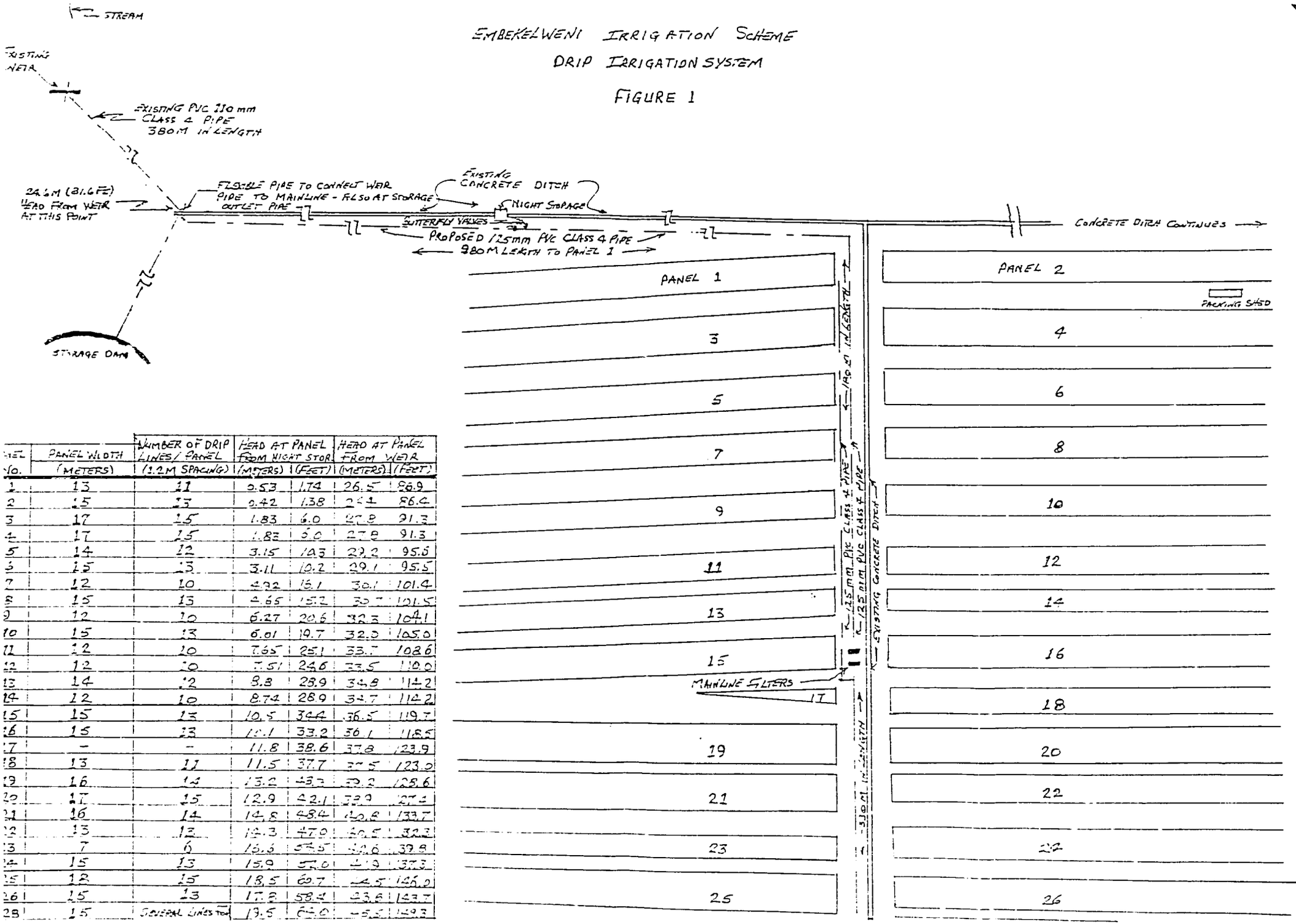
With the drip lines spaced 1.2 meters and emitters spaced along the drip line, each emitter discharging 2-l/hr per emitter, a total of 10 or 11 blocks out of a total of 78 blocks can be irrigated at one time. A six-hour irrigation will apply a total of 24 mm (essentially 1 inch) of irrigation water at 90 percent application efficiency. This is assuming that the total soil area is wetted. However, with the drip lines being spaced 1.2 meters, approximately 60 percent of the soil area will be wetted. Irrigation water applied to the crop root area will be approximately 40 mm (1.6 inches) during a 6-hour irrigation set. At a daily consumptive use rate of 5 mm per day, a 6-hour irrigation will be enough water to last about 8 days (40 mm applied/5 mm peak use per day). Again, with less then 100 percent of the area in production, irrigations can easily be scheduled on a 7 day or weekly cycle on all the planted acreage.

Figure 2 shows a typical panel layout with the necessary drip irrigation equipment required. Each panel as indicated above, is divided into 3 blocks, 30 meter drip line lengths with each line spaced 1.2 meters.

Figure 3 shows the mainline filter system.

Figure 4 shows the connection of the mainline to the weir and night storage water sources with necessary valves and connections.

EMBEKELWENI IRRIGATION SCHEME
DRIP IRRIGATION SYSTEM
FIGURE 1

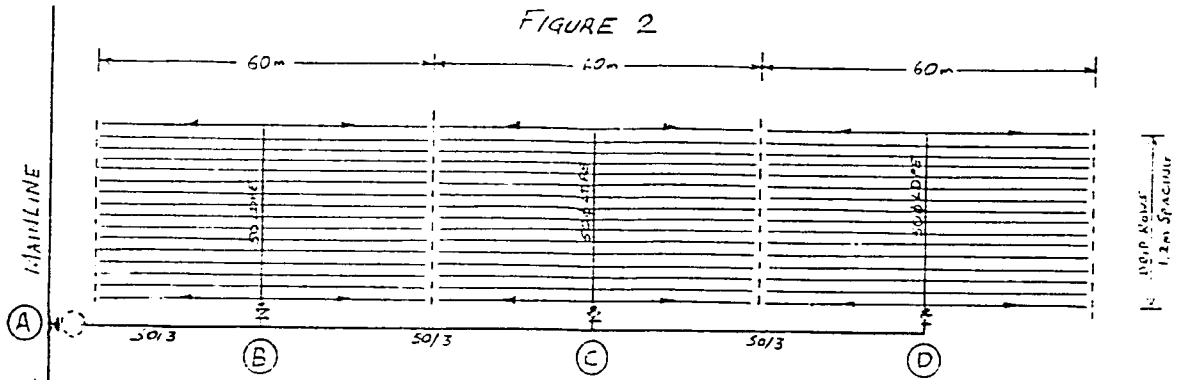


PANEL NO.	PANEL WIDTH (METERS)	NUMBER OF DRIP LINES/ PANEL (1.2M SPACING)	HEAD AT PANEL FROM NIGHT STOR (METERS)	(FEET)	HEAD AT PANEL FROM WEIR (METERS)	(FEET)
1	13	11	0.53	1.74	26.5	86.9
2	13	11	0.42	1.38	26.4	86.4
3	17	15	1.83	6.0	27.8	91.3
4	17	15	1.83	6.0	27.8	91.3
5	14	12	3.15	10.3	29.2	95.5
6	15	13	3.11	10.2	29.1	95.5
7	12	10	4.92	16.1	30.1	101.4
8	15	13	4.65	15.2	30.7	101.5
9	12	10	6.27	20.6	32.3	104.1
10	15	13	6.01	19.7	32.0	105.0
11	12	10	7.65	25.1	33.7	108.6
12	12	10	7.51	24.6	33.5	110.0
13	14	12	8.8	28.9	34.8	114.2
14	12	10	8.74	28.9	34.7	114.2
15	15	13	10.5	34.4	36.5	119.7
16	15	13	10.1	33.2	36.1	118.5
17	–	–	11.8	38.6	37.8	123.9
18	13	11	11.5	37.7	37.5	123.0
19	16	14	13.2	43.3	39.2	128.6
20	17	15	12.9	42.1	39.0	127.4
21	16	14	14.8	48.4	40.8	133.7
22	13	12	12.3	47.9	40.5	132.3
23	7	6	16.6	54.5	40.6	33.9
24	15	13	15.9	52.0	41.9	137.3
25	12	15	18.5	60.7	44.5	146.0
26	15	13	17.8	58.4	43.6	143.7
28	15	SEVERAL LINES TOO	13.5	44.0	45.5	149.3

PROPOSED PANEL LAYOUT

EMBEKELWENI IRRIGATION SCHEME

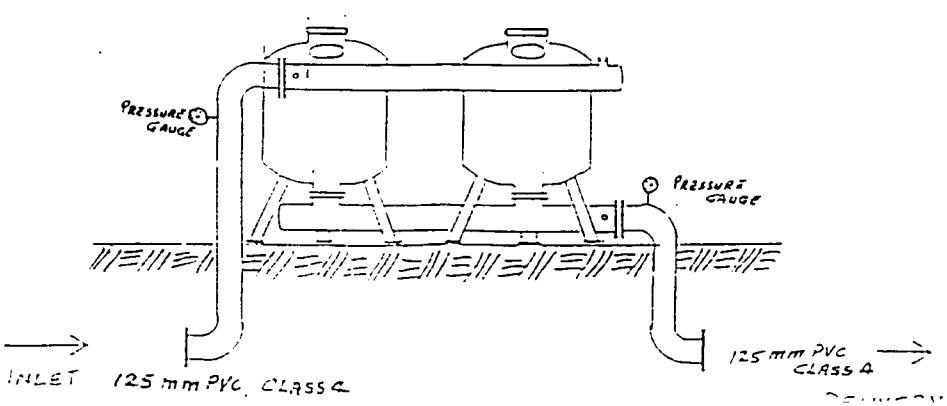
FIGURE 2



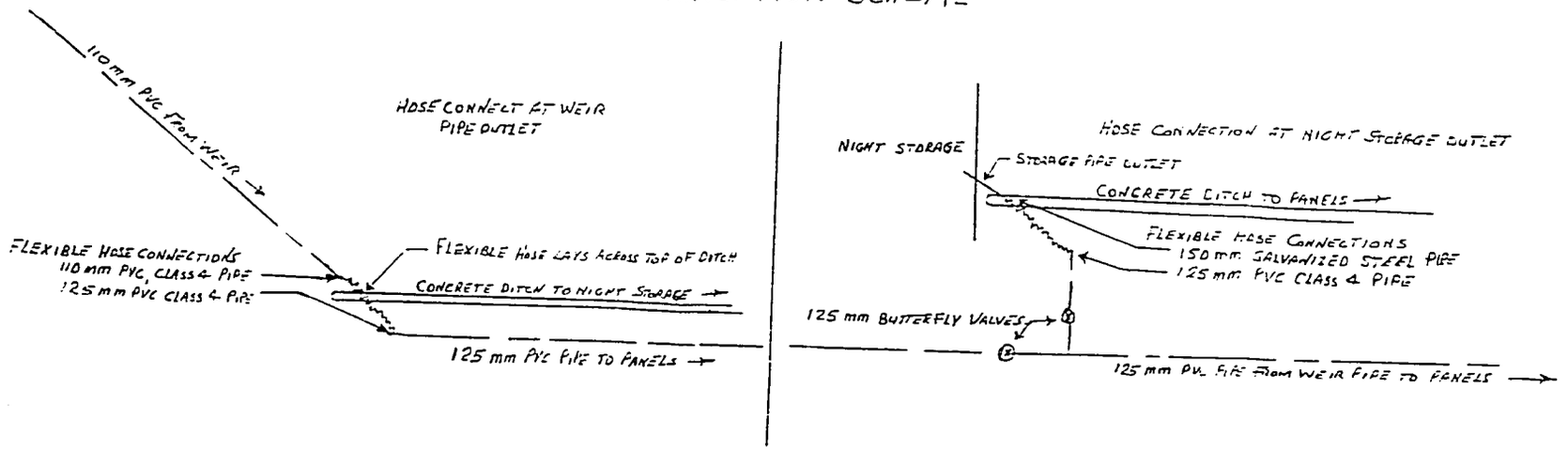
1. EACH PANEL LENGTH 180M - WIDTH VARIABLE - PANELS EACH DIVIDED INTO 3 BLOCKS
2. EACH BLOCK SIZE - WIDTH OF BLOCK x 60M IN LENGTH - EACH BLOCK SPIT 50 DRIP LINES 30M IN LENGTH
3. FROM POINT A TO POINT D - 50mm POLYETHYLENE PIPE, CLASS 3 LDPE
4. POINT A: 125mm x 50mm TEE COUPLING FROM PVC, CLASS 4 TO POLYETHYLENE, CLASS 3
   - 1 - 50mm VALVE
   - 1 - DISK FILTER - MAXIMUM FLOW OF 2 l/SEC. - 30 GPM
5. POINTS B, C AND D:
   - SUBLATERIAL PIPE - 50 mm POLYETHYLENE, CLASS 3 LDPE
   - 1 - 50mm VALVE
   - 1 - PRESSURE REGULATOR - 110 KPa PRESSURE - 15.7 PSI

MAINLINE FILTERS

FIGURE 3



EMBEKELWENI IRRIGATION SCHEME



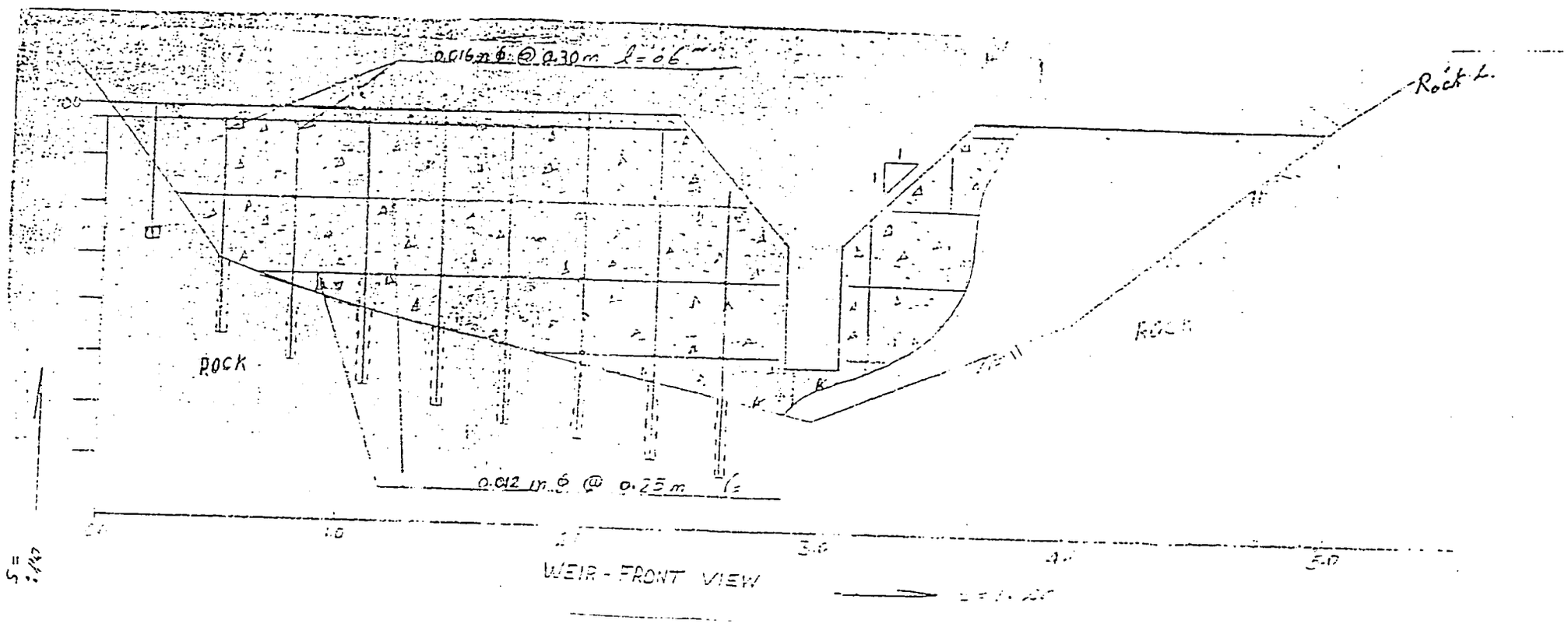
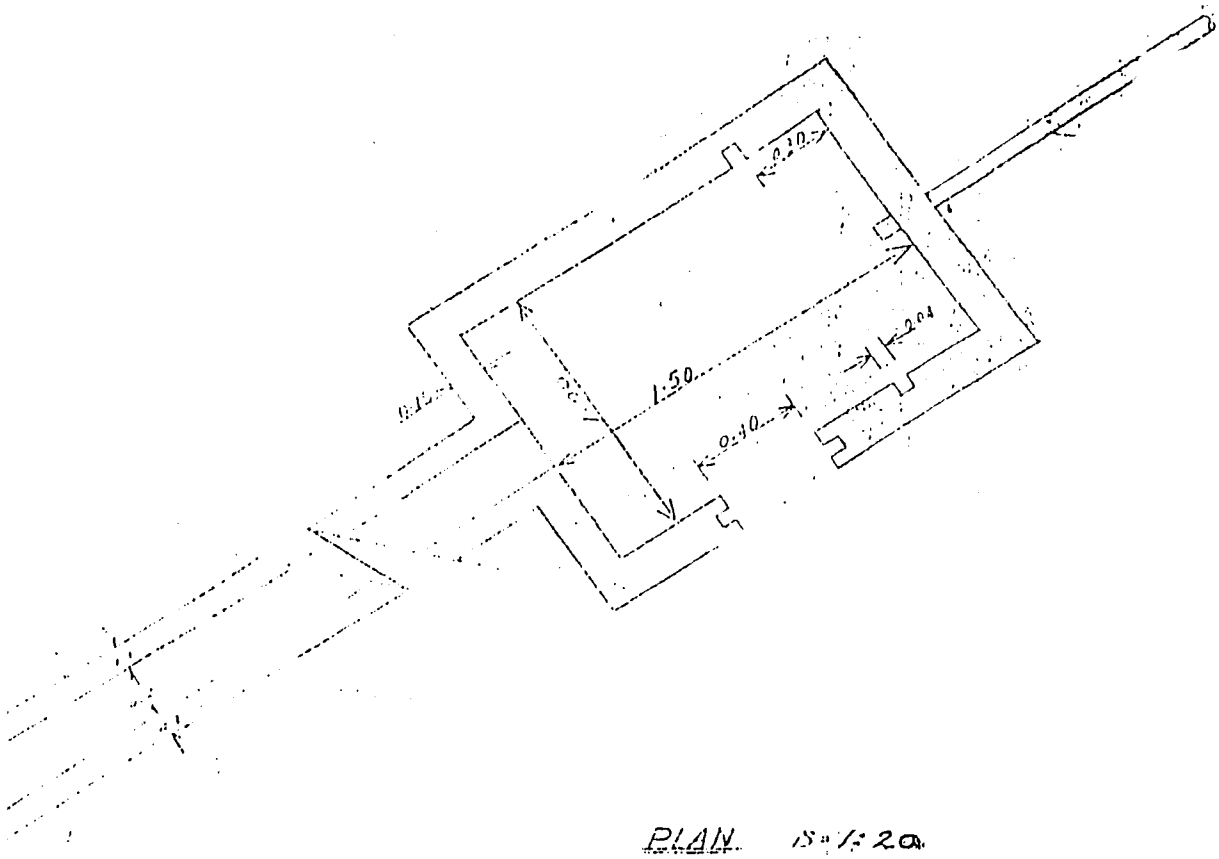


FIGURE 3



PLAN 1:20

EMBAKEMENT IRRIGATION SCHEME
WEIR - TOP VIEW
FIGURE 4

Annex A shows a detailed drip irrigation equipment list as submitted to irrigation equipment dealers in the area for price quotations. A price quotation was requested from the following irrigation dealers:

- o Capro Irrigation - Manzini
- o Swazi Agri Plan - Manzini
- o Bozongo Irrigation - Manzini
- o Mike Taylor Technical Services - Manzini
- o A.J. Nyman, Swaziland - Mbabane & Barberton
- o Tal Pal - Johannesburg
- o Nelspruit Irrigation Engineers - Nelspruit

Annex B shows copies of the price quotations received. The price quotations ranged from a low of R101,339 to a high of R133,206. After a comparative review of the quotations, Mike Taylor Technical Services, Manzini, the low quotation of R101,339 was selected to provide the drip irrigation equipment. However, working with Mike TAylor on several changes such as decreasing the pipe sizes in several places, his price quotation R101,339 waas lowered to R98,782.17.

C. Installation of the Drip Irrigation System

The completion of the Embekelweni irrigation scheme drip system project was not completed during the CIE's assigned time as requested in the scope of work.

As indicated earlier, field surveys had to be made and a completely revised drip system design was required from what was available upon the CIE's arrival. Neither of these tasks were anticipated. These tasks caused a delay such that the drip equipment could not be delivered in time for the CIE to supervise and direct its installation.

There are several alternatives available to CAPM for getting the drip system installed. The MOAC Land Development Section and the MOAC Irrigation Section has staff available for supervising, directing and possibly providing some or all the necessary installation equipment (trencher, transport, etc.). The Irrigation Section construction staff has satisfactorily supervised and directed the necessary construction in cooperation with the Phoponyane Irrigation Scheme farmers (see Section I of this report). It is recommended that the MOAC Irrigation Section be designated to supervise and direct the installation of the Embekelweni drip irrigation system. It is also recommended that the Embekelweni farmers volunteer their labor to dig all trenches, lay all pipelines and back fill all trenches as their contribution to the cost of installing the drip system. The farmers contribution in labor could amount to E20000 to E25000.

The CIE conducted a field session with the MOAC Irrigation Section engineers and construction staff informing them of the design and installation details.

Another alternative is to hire a technician such as identified in Section V of this report. Or, for a cost, the irrigation dealer supplying the drip equipment may be available to supervise and provide the necessary equipment to install the drip system. A combination of the above may also, be an alternative.

Suffice to say, the present CAPM staff does not have the personnel nor the time to supervise the drip system installation, as they are committed to carrying out their present tasks.

Figures 1 through 4 should have the necessary details for those supervising and directing the installation.

D. Water Source

The weir water source for the irrigation scheme (location shown in Figure 1) was located and installed about two or three years ago. This CIE at that time was a member of the Penn. State Cropping Systems Team (July 1989 to July 1991). At that time, this CIE assisted the MOAC Land Use Section in determining what kind of weir would best work for diverting the water from the stream. Figures 5 and 6 drawings are what was proposed as a design for the weir to be installed. Streams in Swaziland often carry heavy loads of silts. This weir was designed with a desilting basin to settle out the silts in the water carried in the stream. However, the MOAC Land Development Section, who did the construction portion of irrigation schemes, for some reason or another did not construct the desilting portion of the weir as shown in Figure 6. The weir was constructed after the CIE had left Swaziland in July of 1991. The weir as now constructed is silting up to the point where the diversion becomes completely clogged. The Embekelweni farmers have been informed by the CIE and MOAC Irrigation Section engineers that they must check and clean the weir of silt deposits often.

It is recommended that as part of the drip project, the desilting basin be added to the existing weir. The approximate cost for materials would be E4000 with the Irrigation Section construction staff doing the supervision and directing, again with labor assistance from the Embekelweni farmers.

More detailed drawings of the weir in addition to figures 5 and 6 are on file and available at the MOAC Land Use Section office.

E. Irrigation Training

Since the drip irrigation system was not installed during the time of the CIE's assignment, it was not possible to conduct a comprehensive training session for the farmers in using and managing the drip irrigation system. However, the CIE with assistance from the MOAC Irrigation Officer, conducted a two-hour information session with the Embekelweni irrigation scheme farmers. Eight farmers attended the meeting (5 women and 3 men, the most active farmers on the scheme). The proposed drip irrigation design and operation of the system was discussed in detail with them (i.e., panels divided into 3 blocks, developing

and managing an irrigation schedule because not all farmers will be able to irrigate on the same days because of design limitations, keeping the weir cleaned of silt, maintaining the drip irrigation system, etc.). The farmers were very enthusiastic and said they would look forward to the installation of the drip irrigation system and learning how to use and manage it properly.

Once the drip irrigation system has been installed, an extensive training of the farmers must be conducted. The CIE is convinced that the farmer training must include more then a one or two day session with them, but include working with the them in the field on a daily basis for at least 3 or 4 months. The trainer will need to teach, observe and guide them until the farmers know the system well and have confidence in operating the system on their own. After the 2 or 3 month period, weekly follow up visits will need to be made to assist wherever needed.

It may be well if an irrigation field supervisor(s) also be trained in irrigation during the same time of the farmer training, to serve as an irrigation assistant to the farmers such as the present CAPM field people do in the production area. The irrigation field supervisor(s) could visit the CAPM farmers at least on a weekly basis to make sure they are using proper irrigation practices for vegetable production.

An International Fund for Agricultural Development (IFAD) team is in Swaziland at this time meeting with the MOAC Administration on what is needed to strengthen MOAC's irrigation assistance program in the country. The CIE was asked to meet with the Irrigation Section engineers to discuss with them my thoughts on how MOAC could strengthen the irrigation section. Preliminary plans proposed by the Irrigation Section for strengthening their section included adding an Irrigation Field Supervisor in each of the 4 Regions. Training of the Embekelweni farmers would be an opportune time to also train these 4 Irrigation Field Supervisors at the same time. If this takes place, Swaziland would be taking a big step forward in providing irrigation water use and management training and assistance for its irrigation farmers which is badly needed at this time.

A farmer, extension worker and/or field supervisor irrigation training may include the following:

1. Drip Irrigation

Where drip irrigation is being used, management requirements are high. A critical delay in operation decisions may cause irreversible damage to crops. It is difficult to "catch up" so to speak when using a drip irrigation system. Thus, where a number of farmers are involved as on an irrigation scheme, it is very important that everyone understands the system and understands their responsibilities in order to make the irrigation system a success for all scheme participants. The training must include:

a. Water Source

It is important to keep as much of the silt out of the water as possible at the water diversion point (weir), where surface water supplies are used, resulting in less problems at the filter points within the system. Therefore, a desilting basin is a must as part of the drip system and the farmers need to keep it flushed out.

b. Valves

The function of all valves must be pointed out: how the two water sources (weir and night storage) can be most efficiently used by use of valves, operation of the valves for back flushing the filtering systems, turning on and off of the water to each panel block, etc.

c. Flushing of the Filtering System

Emphasis should be placed on reading inlet and outlet pressure gauges often on the mainline filters and when pressure deferential becomes around 50 to 70 kPa (7 to 10 psi), the filters must be flushed for system to operate properly. This is the heart of the drip irrigation system and without proper flushing procedure, extreme clogging problems can result throughout the system.

d. Flushing of the Lateral Filter Screens

These filters should be flushed or washed out after each irrigation or even during irrigation if necessary.

e. Flushing the Drip Lines

Drip lines should be flushed about once a month when in use.

f. Proper Handling of Drip Lines

Removing, storing and reinstalling the drip lines with care after the crop has been harvested and preparing the field for the next crop is very important for length of life for this equipment.

g. Maintenance

Watching for leaks in the system and repair immediately when such is detected, example - rubber gaskets on the filters need replacing about every 3 to 5 years, etc.

h. Developing an Irrigation Schedule

Developing an irrigation schedule for each farmer on the scheme and the importance of strictly adhering to such schedule for having a successful operating system (see irrigation scheduling section).

2. Irrigation Training

Proper training for any type of irrigation system requires the knowledge of the principles of plant - soil water relationships. Farmer, extension worker and field supervisor training materials where developed by CIE during his association with the Cropping Systems Project in 1989 to 1991 and is included in the Farmers Handbook developed at that time. These materials are included in this report as Annex C.

F. Establish a Maintenance Fund

The major maintenance costs on the Embekelweni drip system will be the replacement of the drip lines every 8 to 10 years. In ten years, this may be a E40000 expense. This amounts to E675 per hectare (ha) per year (E675 x 6 ha x 10 years = E40500). There will be other maintenance costs involving the replacement of filter rubber seals, valve repairs and replacements, etc. It is recommended that the farmers establish a maintenance fund of E700 per ha per year.

G. Irrigation Scheduling

During the months of October through March, in most years not much irrigation is required. On the average, sufficient rainfall is received in the Embekelweni area to meet the crop water requirements during these months. However, there will be years when rainfall may be short such as is being experienced in Swaziland this past year. During the summer months, the farmers need to use the "feel method" as described in Annex C, Irrigation Water Management on the Farm section. When to irrigate can be determined very accurately using this method. How many hours irrigation water should be applied short of 6 hours, can be determined by using the iron rod as discussed in the section entitled Soils, Plants and Irrigation in Annex C (applying sufficient water to fill the crop root zone).

During the winter months of April through September it is recommended that a weekly irrigation schedule be developed for each planted block. Again, the hours required for applying irrigation water to the land area, short of 6 hours, can be determined using the iron rod as discussed in the section entitled Soils, Plants and Irrigation in the Annex C (applying sufficient water to fill the crop root zone). In many of the cases, a full 6 hour irrigation may be required during the winter months for most all vegetable crops.

SECTION IV
ADDITIONAL IRRIGATION SCHEME REHABILITATION AND UPGRADING UNDER THE CAPM PROJECT

A. Scheme Selection

The financial contribution by GOS for irrigation scheme rehabilitation and upgrading is approximately E280000. Costs to rehabilitate the Phoponyane and Embekelweni irrigation schemes will cost about E135000 leaving funds of somewhere around E145000 for additional rehabilitation projects.

During the drought that Swaziland is now experiencing, several streams have been identified that still are flowing water. It would seem practical to rehabilitate irrigation schemes located along such streams to take the most advantage of the water resources particularly during drought periods (CAPM's concept of sustainability). A couple of the irrigation schemes the CIE visited where CAPM is working with the farmers on vegetable production are near such streams. Relocating and/or upgrading the water diversion points would provide a more stable water supply for these schemes. The two irrigation schemes are the Vusweni scheme in the Northern RDA area and the Madubeni scheme in the Sitobila RDA area.

B. Vusweni Irrigation Scheme

The Vusweni irrigation scheme is a farmer developed scheme, located in the Northern RDA area in the Hhohho Region. It is a 5 ha irrigation scheme with 7 farmers. These farmers have been producing some of the finer vegetables for the CAPM Project.

A stream within 50 meters of the irrigation scheme has been the irrigation scheme's water source. The water is pumped directly to the irrigation scheme with a very small lift involved. There is no night storage available. Just in the last week, this water source has now dried up. However, the irrigation scheme is located about 450 meters from the Lomati River which still has a strong flow of water. It is recommended that a new water source from the Lomati River be developed for the Vusweni irrigation scheme. This would strengthen the CAPM Project in having an irrigation scheme that can produce vegetables during extreme drought periods during a time when many irrigation schemes in the country are completely out of water.

The development of the new water source would require a 450 meter PVC pipeline, a new pumping plant and a night storage dam. The approximate costs of this project would be E40,000.

In visiting with the Vusweni farmers, they indicate they would install the necessary pipelines at their cost from the night storage dam to each of their fields in the irrigation scheme. It is estimated that their costs for the pipes and their labor for installation would be E30,000. This would be the farmers share in rehabilitating the scheme.

The annual diesel fuel required to operate the pump will be approximately 3,000 liters (atE1.00 per liter, this equals E3,000 per year for fuel) to pump the necessary water required in an average year. Another approximately E300 per year will be required for maintenance costs (oil, replacement of the engine in 10 years, etc.). The annual costs per ha will be approximately E660 (E3,000 plus E300 divided by 5 ha = E660/ha).

The MOAC Irrigation Section engineers are prepared to do the necessary design work and the construction section to supervise and direct the installation.

C. Madubeni Irrigation Scheme

The Madubeni irrigation scheme is located in the Sitobela RDA area in the Shiselweni Region. Madubeni is a farmer developed irrigation scheme presently 5 ha in size with only 1 farmer. It is planned to increase the size of the irrigation scheme to 15 ha involving 8 farmers. The irrigation scheme is located along the Mhlatuze River which too, has a good flow of water available at this time. The present farmer is involved with the CAPM vegetable production program. The proposed enlargement of the irrigation scheme to 15 ha and 9 farmers would be a benefit to the CAPM Project by concentrating the vegetable production program within a concentrated area involving more then one producer.

The water supply for the present irrigation scheme is pumped from the Mhlatuze River to a storage tank. The present pumping plant and storage tank are not of sufficient size to serve the proposed enlarged scheme. It is proposed to add a new pumping plant, a PVC plastic pipeline from the water source to a night storage dam and construct a new night storage dam at an estimated cost of E60,000. The farmers agreed that they would purchase the necessary pipeline to deliver the water from the night storage dam to their respective fields. The estimated cost and farmer contribution for purchase of their portion of PVC plastic pipes and utilizing their labor for installation of the rehabilitation equipment, is E40,000.

The annual diesel fuel required to operate the pump will be approximately 16,000 liters (E1.00 per liter equals E16,000 per year for fuel) to pump the necessary water required in an average year. Another approximately E1,000 per year will be required for maintenance costs (oil, replacement of the engine in 10 years, etc). The annual cost per ha will be approximately E1,133 (E16,000 plus E1,000 divided by 15 ha = E1,133/ha).

D. Additional Studies

For both the Vusweni and Madubeni irrigation scheme, time permitted only a preliminary field survey for determining rehabilitation and upgrading cost estimates. More detailed field surveys and designs will be required to arrive at actual construction, operation, and maintenance costs to do the projects. The MOAC Irrigation Section engineers are qualified and equipped to do the field studies and necessary designs.

E. Other Alternatives

Many of the irrigation schemes in Swaziland run short of water even during the good water years. Better water use and management by the irrigation farmers would go a long ways towards solving some of these water shortages. When the Embekelweni drip irrigation is proven a success demonstrating the efficient use of a limited water supply, drip systems may be installed on other water short irrigation schemes.

The CIE is familiar with many if not most of the irrigation schemes in Swaziland. The CIE knows of no other irrigation scheme where there is sufficient gravity pressure available to operate the drip system. However, a small pump as part of the drip system is the only additional equipment required where gravity pressure in not sufficient.

Irrigation schemes where drip irrigation may be considered are Mashobeni and Mavulandela in the Northern RDA, Hhohho Region. Or, the Ntamakuphila irrigation scheme in the Ngwempisi RDA area, Manzini Region and Mgonfelweni irrigation scheme in the Mahlangatsha RDA area, Manzini Region. Similar irrigation schemes in the Lubombo and Shiselweni Regions.

Also, inadequate diversion weirs are now used on a number of irrigation schemes to divert the water unto the respective schemes. Several of such schemes include Ndlalambi and Lomshiyo in the Northern RDA area, Hhohho Region and Asiphilisane and Vulamehlo in the Ngwempisi RDA area, Manzini Region. Such irrigation schemes can be identified in the other two Swaziland Regions.

A major criteria is selecting rehabilitation projects on irrigation schemes that CAPM will be concentrating their vegetable production programs.

SECTION V
IRRIGATION CONSULTING AND TRAINING COMPANIES/FIRMS

A. Company/Firm Identification

To assist the CIE in locating local and/or regional consulting firms and companies having irrigation engineering and irrigation training expertise, the Swaziland, Durban and Johannesburg telephone directories yellow pages were used. Consulting Engineers, Agricultural Management Consultants, Agricultural Agencies and Agricultural Services Consultants listed in the yellow pages were noted and contacted by the CIE. Additional companies and firms were identified through conversation and contacts with Swaziland agricultural leaders. Seven contacts in Swaziland and 18 contacts in the South Africa areas of Durban, Petermaritzburg, Nelspruit, Johannesburg were made by the CIE. Communication with the companies and firms included the following:

> The Commercial Agriculture Production and Marketing Project (CAPM), a U.S. Agency for International Development (USAID) program in cooperation with the Swaziland Ministry of Agriculture and Cooperatives (MOAC) is in Swaziland to assist with the enhancement of horticultural crop production and marketing. The project is directed to small scale farmers on Swazi Nation Land (SNL). CAPM is interested in identifying local and/or regional irrigation consulting companies and firms who could be hired by CAPM to design irrigation systems of all types (flood, sprinkler, drip, etc.), advise farmers on irrigation system and equipment selection, assist farmers with the installation of the selected irrigation system(s) and conduct farmer training in the proper use of the respectively designed irrigation systems(s). In addition, consulting will also be needed in the area of farmer and extension worker training on plant-soil-water relationships (basic principles and fundamentals of irrigation water application and management).
>
> The purchase of the irrigation equipment relating to the irrigation system designs on the CAPM irrigation schemes will need to be selected and accepted from competitive bidding from local and/or regional irrigation equipment dealers.
>
> If your company or firm is capable of providing the above outlined services and are interested in being considered by the CAPM Project, please return the following requested information to our office (return requested by December 3, 1992).
>
> Name of Company/firm _____
> Address _____
> Telephone no. _____ Fax no. _____

Does your company/firm provide for hire

____ yes ____ no Irrigation Engineering Consulting including surveying, design of irrigation systems, installation of irrigation systems, etc.

____ yes ____ no Irrigation training (operation and management of irrigation systems, basics of irrigation - water application and management, etc.).

Please provide a brief description of your consulting services, recent services and a couple of references.

B. Responses

Eight companies/firms responded positively to the communication (5 from Swaziland and 3 from South Africa). All the responses indicated that they had the expertise to do both irrigation engineering and conduct farmer training programs. A number of the responses received indicated that they had no irrigation or training expertise. The positive responses are included in this report as Annex D.

There are now 5 irrigation dealerships in Swaziland as far as this CIE is aware. Two of the 5 companies responding indicated that they were available for hire to do irrigation design work (necessary field surveys, data collecting, actual design of the irrigation system, etc.). Matter of the fact is that all of the irrigation dealers (companies) located in Swaziland are available for irrigation system designing at no cost to the farmer or CAPM. Competition is keen in this country for irrigation companies to sell equipment.

Thus, CAPM and/or the farmers interested in a price quotation for specific irrigation projects, all that the interested party needs to do is advise the Swaziland irrigation companies and they will do the necessary design of the irrigation system for them and provide a price quotation for the necessary irrigation equipment. The CIE see no need to hire any company or firm to do irrigation design work. This service is available at no cost.

Most irrigation equipment dealers whose equipment has been selected through the price quotation, will also provide assistance to the farmer(s) during the installation of the irrigation system. Also, these same dealers will provide a minimum training for the farmer in the operation and management of the irrigation system purchased. All this at no cost. Capro Irrigation Company and Swazi Agri Plan, both located in Manzini are this kind of company. Even though A. J. Nyman, Mbabane and Nelspruit; Bozongo Irrigation, Manzini and Mike Taylor Technical Service did not respond to the communication, they too provide the above services at no cost.

ZMCK Consulting Engineers, Mbabane; Bicon Consulting Engineers, Mbabane; Loxton, Venn and Associates, Sandton, South Africa; Murray Biesenbach & Bradengorst Engineering, Nelspruit, South Africa; and S.A. Farm Consultants, Petermaritzburg responded to the communication indicated designing and installation technical services were available through them at a cost. These same companies/firms all provide extensive irrigation training programs which CAPM project farmers and field supervisors are in need of.

ZMCK Consulting Engineers, Mbabane would work in conjunction with a company known as Agricarmel (joint venture consulting company between Agridev of Israel and the Gerber Goldschmidt Group of South Africa) for conducting an irrigation training program. They have had vegetable production projects in Ciskei, Bophuthatswana, Zambia and Venda. They have been in Swaziland for a number of years running the Nkaleshane Cotton Estate.

Bicon Consulting Engineers, Mbabane, are not directly involved with irrigation systems but do work in pumps, civil engineering structures, pipelines, etc. This company would not be qualified to do extensive irrigation training.

S.A. Farms Consultants, Petermaritzburg, is a general agricultural management consulting firm. According to the information sent, they are more an agriculture development feasibility study group then a training group.

Loxton, Venn and Associates, Sandton, is currently managing two irrigation schemes in the Transkei. One scheme 3000 ha in size with 1800 farmers and another scheme of 2300 ha. The company has managed South African smallholder irrigation schemes ranging in sizes of 475, 800 and 570 ha. The company has experience in the design of irrigation systems, installation and supervision of contractors thereof, as well as the training and development of smallholder commercial farms.

Murray, Biesenbach & Badenhorst Incorporated, Nelspruit, is a company of consulting engineers in the fields of agricultural engineering, hydro-engineering and development of natural resources and rural areas. The company offers a management service to assist clients in the scientific utilization of available water by means of irrigation from the most simple irrigation system to the most sophisticated computerized sub-surface drip irrigation systems.

More details are available on each of these companies/firms in Annex D.

It appears from the information supplied by the companies or firms, that ZMCK Consulting Engineers, Mbabane; Loxton, Venn and Associates, Sandton; and Murray Biesenbach & Badenhorst, Nelspruit are all viable companies/firms for CAPM to contact for hire of farmer, extension worker and field supervisor irrigation training.

SECTION VI
OTHER CONSULTING IRRIGATION ENGINEERING ACTIVITIES

The CIE assisted CAPM in several farm visits to assist with advising farmers in the selection of irrigation equipment. Field visits were made to the following farms:

A. Saul Dlamini

Siphofaneni area - advise on the design and selection of a new sprinkler irrigation system and pumping plant.

B. Norah Earnshaw

Siphofaneni area - advise on the design and selection of new sprinkler irrigation system and pipeline for the expansion of her irrigated land area.

C. Brian Stein

Malkerns area - advise on the design of a pipeline size for a proposed sprinkler irrigation system.

D. Steve Goertx and Dan Bradbury Field Trip

1. USAID/CAPM Officials

The CIE spent a day with Steve Goertz, CAPM Project Manager/USAID, and Dan Bradbury, CAPM Chief of Party, on a field trip to the Northern RDA, Hhohho region, visiting irrigation schemes.

2. USAID Director

The CIE assisted the CAPM team in conducting a field trip of CAPM project activities for USAID Director Ms. Valarie Dickson-Horton; Steve Goertz, and Jack Royer.

SECTION VII
SUMMARY RECOMMENDATIONS

- The rehabilitation works on Phoponyane irrigation scheme are essentially completed. Except for a few minor tasks, water should begin flowing through the system during the week of December 14, 1992.

- Mike Taylor Technical Services, Manzini, has been selected to supply the drip irrigation equipment for the Embekelweni irrigation scheme. His company's price quotation was the lowest of the 5 quotations received.

- It is recommended that the Irrigation Section engineers and construction staff be designated to advise and direct the drip irrigation system installation on the Embekelweni irrigation scheme. The CIE has conducted an information field session with them reviewing the system design and installation procedures. The Embekelweni farmers are to be encouraged to contribute to the installation of the drip system by digging the pipeline trenches, laying of all the pipelines and drip lines and back filling all the trenches.

- It is recommended that a desilting basin be constructed at the weir takeout point as part of the rehabilitation program on the Embekelweni irrigation scheme.

- A maintenance fund of approximately E700 per hectare per year must be set up by the Embekelweni irrigation farmers to meet the annual maintenance costs.

- It is recommended that an irrigation training consultant be employed by CAPM for a time period of 3 to 4 months after the drip irrigation system has been installed to extensively train the Embekelweni farmers in the operation of the drip system and in the basic principles of irrigation water use and management. The consultant should work with the farmers in the field on a daily basis during this entire time advising and teaching proper irrigation methods.

- During the time when the training of the Embekelweni farmers is taking place, it is recommended that CAPM in cooperation with the MOAC select several extension workers and/or field supervisors to take the opportunity to train full time MOAC workers. The training of such extension workers and field supervisors can be the final step towards the MOAC having the technical assistance available to advise irrigation scheme farmers throughout the country on irrigation practices without having to continually employ outside consultants to perform this task.

- An irrigation schedule on the Embekelweni irrigation scheme will include irrigating each panel block once a week during the winter season which is normally the low rainfall time of the growing season. During the summer months, irrigations are not normally needed on the scheme, however, farmers should plan on occasional irrigations as required.

- In addressing the CAPM concept of sustainable vegetable production, it is recommended that rehabilitation considerations be given on the Vuswen1 irrigation scheme in the Northern RDA, Hhohho Region (estimated MOAC costs of E40000 and farmer contributions of E30000) and the Madubeni irrigation scheme in the Sitobela RDA area, Shiselweni Region (estimated MOAC costs of E60000 and farmer contributions of E40000). The annual operation and maintenance costs for Vuswen1 irrigation scheme is estimated to be E660 per ha and for Madubeni irrigation scheme E1,133 per ha.

- Irrigation designs are available to the CAPM Project and Swazi farmers at no cost through local irrigation dealers.

- Irrigation training for hire has been identifies as being available through ZMCK Consulting Engineers, Mbabane, Swaziland; Loxton, Venn & Associates, Sandton, South Africa; and Murray, Biesenbach & Bandenhorst, Nelspruit, South Africa.

ANNEX A

EMBEKELWENI DRIP IRRIGATION EQUIPMENT LIST

COMMERCIAL AGRICULTURAL PRODUCTION AND MARKETING PROJECT
(CAPM)

OCEANIC BUILDING
9 USUTU CRESENT
MATSAPHA INDUSTRIAL SITES
MATSAPHA, SWAZILAND

TELEPHONE: (268) 86210 FAX: (268) 86213

DATE: NOVEMBER 24, 1992

FROM: DOYLE GRENOBLE, PRODUCTION HORTICULTURIST

TO:

FAX:

The CAPM Project is seeking price quotations on the following drip irrigation equipment. The equipment will be purchased by the Swaziland Ministry of Agriculture and Cooperatives (MOAC). Quotations must reach the CAPM office by the afternoon of December 2, 1992 at the above address or fax. Quotations should include delivery price to the CAPM office in Matsapha. Also, indicate how soon equipment can be delivered after receipt of final order.

DRIP IRRIGATION EQUIPMENT LIST

1 x 110 mm x 4 m flexible plastic type hose (Kana-flex or equivalent) with all the necessary fittings - inlet of the hose to attach to 110 mm PVC pipe, class 4, male end and outlet of hose to attach to 125 mm PVC pipe, class 4, female end. All PVC pipe with rubber ring couplings. Pressure at attachment point 250 kPa of 35 psi.

1 x 110 mm x 4 m flexible plastic type hose (Kana-flex or equivalent) with all the necessary fittings - inlet of the hose to attach to 150 mm galvanized steel pipe, male end and outlet of the hose to attach to 125 mm PVC pipe, class 4, female end, rubber ring coupler. Pressure at the attachment point 250 kPa or 35 psi.

1500 m x 125 mm PVC pipe, class 4, rubber ring couplers.

2 x 125 mm x 125 mm x 125 mm Tees for PVC pipe, class 4, rubber ring couplers.

2 x 125 mm butterfly valves with proper fittings to install onto 125 mm PVC pipe, class 4, rubber ring couplers.

2 x 125 mm x 125 mm 90 degree elbow for PVC pipe, class 4, rubber ring couplers.

1 x 125 mm end plug, PVC pipe, class 4, rubber ring couplers.

23

2 filters (sand or disc), 130 to 140 mesh, manual back flush, for a total flow of 12.6 l/sec. or 200 gallons/minute, with the necessary fittings and valves and pressure gauges, both inlet and outlet to attach to 125 mm PVC pipe, class 4, rubber ring couplers.

53000 m drip tape, 30 cm emitter spacing with 2 l/hr.emitter flow rate (Queen Gil 10 or equivalent).

4000 m x 80 mm polyethylene, class 3, LDPE, non SABS.

27 x 125 mm x 125 mm x 80 mm Tees - 125 mm PVC pipe, class 4 to polyethylene, class 3, LDPE, non SABS.

27 x 80 mm brass valves with fittings to install unto polyethylene pipe, class 3, LDPE, non SABS.

27 x 80 mm end plugs for polyethylene pipe, class 3 LDPE, non SABS.

27 disk filters with the necessary fittings to install onto 75 mm polyethylene pipe, class 3, LDPE, non SABS with maximum flow of 2 l/sec. or 30 gallons/minute.

81 x 80 mm x 80 mm x 50 mm Tees to fit polyethylene pipe, class 3, LDPE, non SABS.

1400 m x 50 mm polyethylene pipe, class 3, LDPE, non SABS.

3000 drip tape connectors for 50 mm polyethylene pipe, class 3, LDPE, non SABS.

81 x 50 mm end plugs for polyethylene pipe,class 3, LDPE, non SABS.

81 x 50 mm brass valves with the necessary fittings to install unto 50 mm polyethylene pipe, class 3, LDPE, non SABS.

81 pressure regulators, 110 kPa pressure or 15.7 psi, with the necessary fittings to install onto 50 mm polyethylene pipe, class 3, LDPE, non SABS.

COMMERCIAL AGRICULTURAL PRODUCTION AND MARKETING PROJECT
(CAPM)

OCEANIC BUILDING
9 USUTU CRESENT
MATSAPHA, SWAZILAND

TO: FIRMS REQUESTED FOR PRICE QUOTATIONS ON DRIP IRRIGATION EQUIPMENT

FROM: DON BROSZ, CONSULTING IRRIGATION ENGINEER

DATE: NOVEMBER 25, 1992

MY FACE IS RED WITH EMBARRASSMENT!! There are several errors on the drip irrigation equipment list for which you are being asked for price quotations. It is not the fault of Doyle Grenoble, whose name appears on the letterhead. The mistake is mine and please accept my deep apology.

First page - the globe valves should be butterfly valves.

Second page - 2nd line should read 12.6 l/sec. not l/hr.

Second page - 2nd paragraph should read 53000 m of drip tape not 5300.

Second page - 7th paragraph should read 2 l/sec. not l/hr.

A corrected copy is attached - please destroy the initial copy you received.

EMBEKELWENI DRIP SYSTEM
CAPM PROJECT

1. 4m x 100mm ID Kanaflex IS755 Hose
   2 x 100mm Swaged Nipples (Galvanised)
   2 x 110mm x 100 LM6 Female Adaptor
   2 x 100mm Stainless Steel Hose Clamps

2. 4m x 100mm ID Kanaflex IS 755 Hose
   1 x 125mm x 100mm LM6 Female Adaptor
   2 x 100mm Swaged Nipples (Galvanised)
   1 x 130mm x 100mm Galvanised Reducing Bush
   2 x 100mm Stainless Steel Hose Clamps

3. 1500mm x 125mm Class 4 UPVC Pipe with integral lyng rubber joint ring

4. 2 x 125mm LM6 Equal Tees

5. 2 x 125mm Varix Type V.A. Butterfly Valve
   2 x 125mm LM6 Flange Adaptors

6. 2 x 125mm LM6 90° Elbows

7. 1 x 125mm LM6 End Cap

8. 2 x Sand Filters 130 - 140 mesh with manual backflush and flow of 12,6 l/sec complete with Flanged valves and pressure guage.
   (price excludes silica sand)

9. 53000m x 12mm 2 L/H Drip-in regular with 30cm emitter spacing (10 YR. PLUS LIFE)

10. 4000 x 80mm LDPE pipe (non SABS)

11. 27 x 125mm x 80 BSP LM6 Riser Tees
    27 x 80mm Insert Male Adaptors
    27 x 80mm Stainless Steel Hose Clamps

12. 27 x 80mm Brass Gate Valves
    52 x 80mm Male Adaptor Inserts
    52 x 80mm Stainless Steel Hose Clamps

/Cont.....

13. 27 x 80mm Male Adaptor Inserts
    27 x 80mm End Caps BSP Galvanised
    27 x 80mm Stainless Steel Hose Clamps

14. 27 x 40mm Disc Filters, flow rate 10 cubic m of water per hour.

15. 81 x 80mm x 80mm Equal Tee Inserts
    81 x 80mm x 50mm Reducer Coupling Inserts

16. 1400 x 50mm L.D.P.E. Class 3 pipe (non SABS)

17. 3000 x 12mm Combination Saddles and Nut

18. 81 x 50mm End Plug Inserts

19. 81 x 50mm Brass Gate Valves
    162 x 50mm Male Adaptor Inserts
    162 x 50mm Stainless Steel Clamps

20. 81 x 110 KPA Pressure Regulators

ANNEX B

EMBEKELWENI DRIP IRRIGATION PRICE QUOTATIONS

CAPRO
SWD (PTY) LTD
P.O. Box 112
MANZINI
Tel: 53418 Fax: 53418

Stockists of:

INDOC PAINTS
INTERIOR & EXTERIOR PAINTS

ASTORE
INSERTS & COMPRESSION FITTINGS

ANN PLASTICS
H.D.P.E & L.D.P.E PIPES

MEGA FLEX
HYDRAULICS PIPES & FITTINGS

POLYCOP
THE PLUMBERS PIPE

ALL TYPES OF SPRINKLERS

04/12/92

C.A.P.M. PROJECT
9 USUTU CRESENT
MATSAPA

ATT : MR DOYLE GRENOBLE
CC: MR DON BROZ

DEAR SIRS

THANK YOU FOR YOUR ENQUIRY REGARDING SUPPLY OF EQUIPMENT FOR DRIP IRRIGATION FOR 27 PARTICIPATING FARMERS. PLEASE FIND HEREUNDER OUR QUOTATION.

1)	1 X 4 MT KANAFLES 100MM PIPE	239.00
	1 X 110 MM X 4" MA3 SOCKET	100.00
	1 X 4" SWAGE GALV NIPPLE	22.92
	1 X 125 TO 110 MR1 REDUCING SOCKET	95.00
	1 X 110 GALV SWAGE NIPPLE	22.92
2)	1 X 4 MT X 100 MM KANAFLEX PIPE	239.00
	1 X 100 MM GALV SWAGE NIPPLE	22.92
	1 X 100 MM X 150 MM GALV REDUCING SOCKET	36.00
	1 X 125 MM TO 100 MR1 RED SOCKET	95.00
	1 X 100 MM GALV SWAGE NIPPLE	22.92
	4 X 100 MM KANAFLEX CLAMPS	74.88
3)	1,500 MT X 125 MM CLASS 4 PVC PIPE AS 250 X 6MT LENGHTS (16.87/m = 101.22/6m)	25305.00
4)	2 X 125 MM X 125 MM X 125 MM TEE	182.76
5)	2 X 4" BALL VALVES DOUBLE UNION	1800.00
	2 X 125 MM X 4 MALE ADAPTOR AM 3 125-4)SW	186.00
6)	2 X G01 90 DEG ELBOW SOLVENT WELD 125 MM	334.00
7)	1 X 125 MM SOLVENT WELD END PLUG	133.00

CAPRO
SWD (PTY) LTD
P.O. Box 112
MANZINI
Tel: 53418 Fax: 53418

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MM PLASTICS
H.D.P.E & L.D.P.E PIPES

MEGA FLEX
HYDRAULICS PIPES & FITTINGS

POLYCOP
THE PLUMBERS PIPE

ALL TYPES OF SPRINKLERS

8)	2 X SAND AND DISC COMBINATION FILTERS 50.000 LTR / HR OR 13.63 LTR / SECOND 3" INLET OUTLET WITH 500 KG SILICA SAND. 8 X 3" SINGLE UNION BALL VALVES AND RELEVANT PIPES MANUAL BACK FLUSH AND 125MM PVC TO 75MM REDUCER SOCKETS	12326.00
9)	53 X 1000 MT QUEEN FILL 10 TYPE DRIP TAPE 30CM EMITTER SPCAING 2LTR PER HOUR (0.53/m)	28090.00
10)	4000 MTR X 80 MM CLASS 3 LDPE PIPE (5.82/m = 582/100m)	23280.00
11)	27 X 125 MM X 125 MM X 80 MM TEES PVC FEMALE	2467.26
	27 X 80 MM INSERT MALE ADAPTORS	183.06
	27 X 80 MM GATES S/S HOSE CLAMPS	183.60
12)	27 X 80 MM BRASS GATE VALVES	3606.66
	54 X 80 MM INSERT MALE ADAPTORS	366.12
	54 X 80 MM GATES S/S HOSE CLAMPS	367.20
13)	27 X 80 MM X 50 MM INSERT REDUCING COUPLING	384.48
	27 X 50 MM END PLUGS	90.18
	81 X HERBIE CLAMPS	202.50
14)	27 DISK FILTERS 3" INLET / OUTLET MANUAL FLUSH 120 MESH	8640.00
	54 X 80 MM MALE ADAPTORS	366.12
	54 X 80 MM GATES S/S HOSE CLAMPS	367.20
15)	84 X 80 MM X 80 MM X 80 MM INSERT TEES	1620.00
	81 X 80 MM X 50 MM INSERT REDUCING COUPLING	1153.44
	324 X 80 MM GATES S/S HOSE CLAMPS	2203.20
16)	4 X 100 MTR X 50 MM CLASS 3 LDPE PIPE (291.80/100m)	1167.20
17)	3000 DRIP TAPE HEAD CONNECTORS	4800.00
	3000 HEAD CONNECTORS WIRE TIES	180.00
	1 X WIRE TIE TOOL	134.00
18)	81 X 50 MM END PLUGS FOR LDPE PIPE	270.54
	81 X 50 MM GATES S/S HOSE CLAMPS	392.04

CAPRO
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P.O. Box 112
MANZINI
Tel: 53418 Fax: 53418

Stockists of:

INDOC PAINTS
INTERIOR & EXTERIOR PAINTS

ASTORE
INSERTS & COMPRESSION FITTINGS

ANN PLASTICS
H.D.P.E & L.D.P.E PIPES

MEGA FLEX
HYDRAULICS PIPES & FITTINGS

POLYCOP
THE PLUMBERS PIPE

ALL TYPES OF SPRINKLERS

19)	81 X 50 MM BRASS GATE VALVES	4659.12
	162 X 50 MM INSERT MALE ADAPTOR	923.40
	162 X 50 MM GATES S/S HOSE CLAMPS	550.80
20)	81 PRESSURE REGULATOR VALVES	5022.00
	81 X 50 MM GALV NIPPLES	298.89
	TOTAL	133206.33

HOPING THIS QUOTATION MEETS WITH YOUR REQUIREMENTS. SHOULD YOU HAVE ANY FURTHER QUERRIES PLEASE DO NOT HESITATE TO CONTACT US.

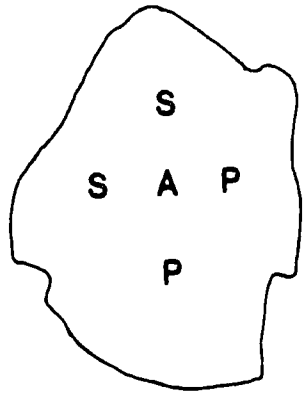
YOURS FAITHFULLY

P HORNSBY
PROJECTS MANAGER

5400 m x 50 mm @ 291.80/100 m = 15 757.20
- Minus 400 m x 50 mm = 1167.20
- Minus 4000 m x 80 mm = 23 280

133206.33
- 1167.20
- 23280.00
108 759.13
15757.20
124516.33

21



SWAZI AGRI - PLAN (PTY.) LTD.

P.O.Box 2830
Manzini
Swaziland
Tel: (09268) 55053
Fax: 55053

07/12/1992

CAPM
OCEANIC BUILDING
9 USUTU CRESENT
MATSAPHA

ATT: MR. DON BROSZ

Dear Sir

We thank you for the opportunity to quote on the Embekelweni

Drip System.

Please hereby accept our quotation.

Yours Faithfully

T. F. CHANGUION

EMBEKELWENI DRIP SYSTEM
CAPM PROJECT

1.	4m x 100mm ID Kanaflex IS755 Hose 2 x 100mm Swaged Nipples (Galvanised) 2 x 110mm x 100 LM6 Female Adaptor 2 x 100mm Stainless Steel Hose Clamps	E 376 82
2.	4m x 100mm ID Kanaflex IS 755 Hose 1 x 125mm x 100mm LM6 Female Adaptor 2 x 100mm Swaged Nipples (Galvanised) 1 x 150mm x 100mm Galvanised Reducing Bush 2 x 100mm Stainless Steel Hose Clamps	E 419 3
3.	1500mm x 125mm Class 4 UPVC Pipe with integral lyng rubber joint ring (13.4/m = 80.4/6m)	E 20 100 0
4.	2 x 125mm LM6 Equal Tees	E 16 0
5.	2 x 125mm Varix Type V.A. Butterfly Valve 2 x 125mm LM6 Flange Adaptors	E 1286 9
6.	2 x 125mm LM6 90° Elbows	E 47 9
7.	1 x 125mm LM6 End Cap	E 39
8.	2 x Sand Filters 130 - 140 mesh with manual backflush and flow of 12,6 l/sec complete with Flanged valves and pressure guage. (price excludes silica sand) ?	E 2455 17
9.	53000m x 12mm 2 L/H Drip-in regular with 30cm emitter spacing (10 YR. Plus Life) - (1.27/M)	E 67 310 0
10.	4000 x 80mm LDPE pipe (non SABS) ?	E 2021 0
11.	27 x 125mm x 80 BSP LM6 Riser Tees 27 x 80mm Insert Male Adaptors 27 x 80mm Stainless Steel Hose Clamps	E 2097 1
12.	27 x 80mm Brass Gate Valves 52 x 80mm Male Adaptor Inserts 52 x 80mm Stainless Steel Hose Clamps	E 4406

/Cont.....

SWAZI AGRI-PLAN (PTY.) LTD.
P.O. BOX 2830
MANZINI
TEL. 55053

13.	27 x 80mm Male Adaptor Inserts 27 x 80mm End Caps BSP Galvanised 27 x 80mm Stainless Steel Hose Clamps	E 669 09
14.	27 x 40mm Disc Filters, flow rate 10 cubic m of water per hour.	E 9647 5
15.	81 x 80mm x 80mm Equal Tee Inserts 81 x 80mm x 50mm Reducer Coupling Inserts	E 1065 96
16.	1400 x 50mm L.D.P.E. Class 3 pipe (non SABS) (225.60/100m)	E 3158 40
17.	3000 x 12mm Combination Saddles and Nut	E 5040 7
18.	81 x 50mm End Plug Inserts	E 104 69
19.	81 x 50mm Brass Gate Valves 162 x 50mm Male Adaptor Inserts 162 x 50mm Stainless Steel Clamps	E 4948 15
20.	81 x 110 KPA Pressure Regulators	E 2141 44
	GRAND TOTAL:	E 127598 3[illegible]

SWAZI AGRI-PLAN (PTY.) LTD.
P.O. BOX 2830
MANZINI
TEL. 55053

4000 x 50mm @ 225.60/100m = 9024

Minus 4000 x 80mm = 2021

127598.39
2021.00
125577.39
9024.00
134601.39 (Some Savings on Fittings, Also)

A. J. NYMAN SWAZILAND (PTY) LTD.

Irrigation Supplies
No. 3 Commercial Centre, Johnson Street, MBABANE

DARBERTON 1300
Fax (01314) 24198
Telex 33-5698

SAPM
Oceanic Building
9 Usutu Cresent
MATSAPHA
SWAZILAND

4 December 1992

RE: QUOTATION FOR IRRIGATION EQUIPMENT

We thank you for the opportunity to quote on the above and submit herewith our quotation.

DETAIL OF QUOTATION

1.	1 x 100 mm Kena-flex hose as per specification	R	385-00
2.	1 x 100 mm Kena-flex hose as per specification	R	590-00
3.	1500 m x 125/4 PVC pipes (79.00/6M)	R	19 740-00
4.	2 x 125 mm LM6 Equal Tees	R	193-00
5.	2 x 125 m Butterfly valves with flange adaptors	R	824-00
6.	2 x 125 mm x 90° LM6 bends	R	180-00
7.	2 x 125 mm LM6 End plug	R	35-00
8.	2 x Sand filters with secondary disc filters with fittings and valves as specified	R	9 920-00
9.	53 000 m Typhoon drip tape, 300 mm spacing and 1,8 l/h (0.42/M) (LIFE?)	R	22 200-00
10.	4000 m x 50/3 LDPE pipe (618.75/100 M)	R	24 750-00
11.	27 x 125 mm x 50mm Tees as specified	R	2 340-00
12.	27 x 50 mm Brass gate valves as specified	R	3 280-00
13.	27 - 50 mm End plugs	R	1 110-00

B-7

75

14.	27 - 40 mm Amiad Disc filters with fittings and vlaves as specified	R 12 330-00
15.	81 - 50mm x 50mm Tees as specified	R 1 380-00
16.	1400 m - 50/3 LDPE pipe (68.21/100m)	R 955-00
17.	3000 Combination saddles	R 2 250-00
18.	81 - 50 mm End plugs	R 135-00
19.	91 - Brass gate valves as specified	R 4 200-00
20.	91 - 40 mm Pressure regulating valves	R 20 200-00
	TOTAL	R126 997-00

ALTERNATIVE PROPOSALS

1. We propose that the 27 x 40 mm Disc filters under item 14 be left out of the system as we have already provided for disc filters at the main filtration plant under item 8. This will have a saving of R12 330-00 on the project.

2. We propose that item 10 be changed to the following:
1000 m 65/3 LDPE
2000 m 50/3 LDPE
1000 m 40/3 LDPE

TOTAL R 9 650-00

With each line starting with 65 mm and going down to 40 mm it would be sufficient even if they irrigate all three blocks at once.

The saving with this alternative would be:
R 15 100-00

3. The total for the quotation with the alternative offers will be R99 967-00.

+ 2385-00
102,252-00

4000 X 50mm @ : 2728.40
MINUS 4000 X 80 mm = 24750.00

126 997,00
- 24750,00 2
104975.40 (Some SAVINGS IN FITTINGS ALSO)
- 12,330.00 (SAVINGS OF Disc Filters)
92 645.40

We trust the above quotation will meet with your approval and we assure you of our best service at all times.

Yours faithfully

K. MINNAAR
2175CA.KWO

BOZONGO IRRIGATION (PTY) LTD

REG NO 280 OF 1992

TELEPHONE: 30276
53359

P O BOX 40
NSOKO

7 December 1992
C A P M Project
P O Box 2015
MBABANE
Swaziland

QUOTATION: DRIP IRRIGATION SCHEME

We have pleasure in submitting a quotation on the supplying of the irrigation equipment listed below:-

1 x 110mm x 100mm LM6 Flanged Adaptor T/D		
1 x 100mm S/O Flange T/D		
2 x 100mm S/O Swaged Nipples		
1 x 100mm x 125mm W/O Concentric Reducer		
1 x 125mm W/O Flange T/D		
1 x 125mm x 125mm LM6 Flanged Adaptor T/D		
8 x M16 x 50mm Bolts and Nuts		
1 x 100mm R/Packing		
1 x 125mm R/Packing		
4m x 100mm Kanaflex Delivery Hose		
4 x 100mm Heavy Duty Clamps	**E**	**494.97**
1 x 150mm W/O Flange T/D		
1 x 150mm S/O Flange T/D		
1 x 150mm S/O Swaged Nipple		
4m x 150mm Kanaflex Delivery Hose		
4 x 150mm Heavy Duty Clamps		
1 x 150mm W/O Swaged Nipple		
1 x 150mm x 125mm W/O Concentric Reducer		
1 x 125mm W/O Flange T/D		
1 x 125mm x 125mm LM6 Flanged Adaptor T/D		
8 x M16 x 50mm Bolts and Nuts	**E**	**900.55**
1500m x 125mm Class4 u-PVC Pipe with Rubber Joints (per m ?)		
2 x 125mm LM6 Equal Tees		
2 x 125mm Butterfly Valves (Lever Type)		
4 x 125mm x 125mm LM6 Flanged Adaptors T/D		
8 x M16 x 150mm Bolts and Nuts		
2 x 125mm x 90deg LM6 Bend		
1 x 125mm LM6 Endcap	**E**	**22 855.40**
1 x Bank of 2 x 80mm MULTIFLO SAND FILTERS with Hydraulic Valves, In- and Outlet Manifolds, Shastomits, Pressure gauge and fittings for washing of Filtration-unit.		
2 x 125mm x 100mm Concentric Reducer		
2 x 125mm W/O Flanges T/D		
2 x 100mm W/O Flanges T/D		
2 x 100mm Butterfly Valves (Lever Type)		
16 x M16 x 50mm Bolts and Nuts + 6 x 100mm R/Packing		
8 x M16 x 150mm Bolts and Nuts + 2 x 125mm R/Packing		
20 x Pockets Filter Sand	**E**	**14 339.33**

C A P M Project (continued)

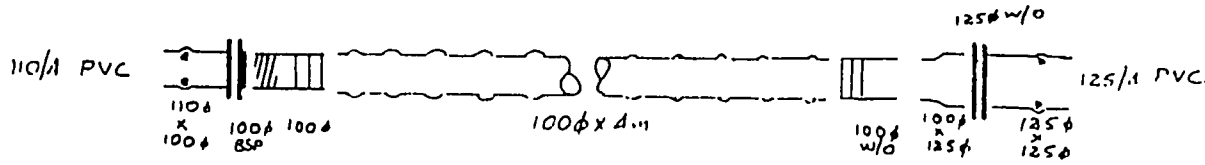
53000m x 2 l/h x 300mm Drip-In Light Dripperline (5yr warranty)	E	43 062.50
		(0.81/m)
5400m x 50mm LDPE Class 3 Polyethylene Pipe Non SABS	E	14 033.00
		(259.87/100 m)
27 x 125mm x 50mmBSP LM6 Riser Outlet Tee		
54 x 50mm x 40mm Galv Reducing Bush		
27 x 40mm x 1000mm Galv Standpipe		
27 x 40mm Galv F/F Bend		
27 x 40mm X 300mm Galv Stand pipe + 20mm socket welded		
27 x 20mm Galv Nipple		
27 x 20mm Ball Valve		
27 x 40mm Brass Gate Valve		
27 x 40mm Galve Barrel Nipple		
27 x 40mm Galv Conical Union		
27 x 40mm Disc Filter with Pressure Gauges		
27 x 50mm Hydraulic Pressure Regulating Valves		
27 x 50mm x 300mm Galv Standpipe		
27 x 50mm Galv Socket		
27 x 50mm Galv M/F Elbow		
27 x 50mm x 1000mm Galv Standpipe		
27 x 50mm Galv F/F Bend		
27 x 50mm Nylon Adaptors		
54 x 50mm/3 Wire Clamps		
20 x Rolls PTFE Sealing Tape	**E**	**28 692.00**
54 x 50mm Nylon Combination Tee		
27 x 50mm Nylon Combination Elbow		
81 x 50mm Nylon Insert Endplug		
81 x 50mm Nylon Adaptor		
600 x 50mm/3 Clamps		
81 x 50mm Galv Barrel Nipples		
81 x 50mm Brass Gate Valve		
3000 x 16mm x 12mm Combination Saddle and Nut	**E**	**6 596.44**
TOTAL QUOTATION VALUE.....		**E 130 974.19**

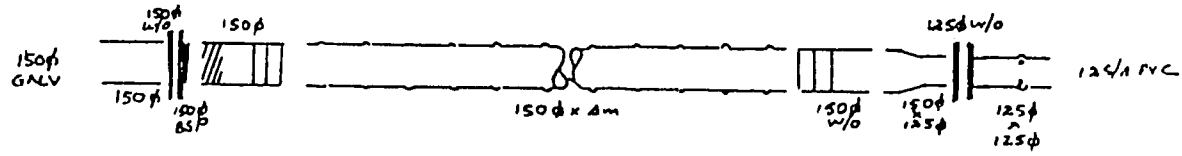
Delivery at CAPM Matsapha Swaziland 4 to 6 Weeks after date of order.
(Please allow an extra 3 weeks if order is placed before the festive season)
TERMS OF PAYMENT: Payable on date of delivery or as per arrangement.
All goods carry the normal manufacturers warranty.
Trenching and installation is not included but can be quoted for.

We once again thank you for allowing us to render a quotation.

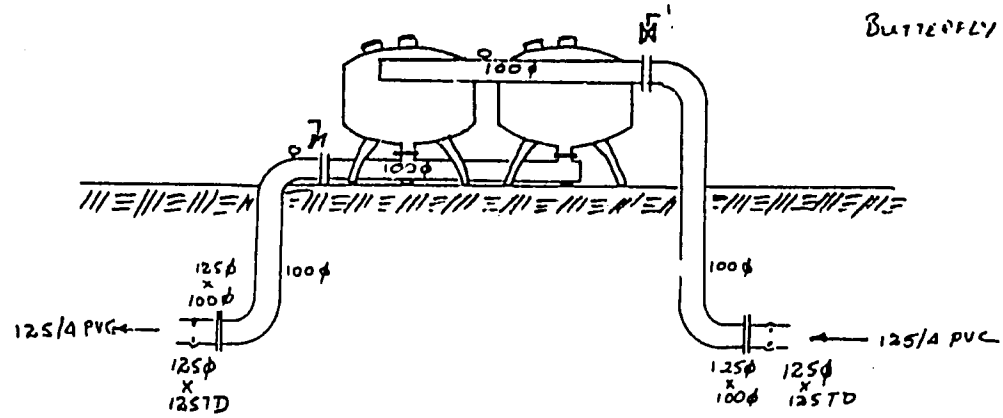
Yours Faithfully

ALWYN KRUGER (M.S.A.I.I.
for Bozongo Irrigation

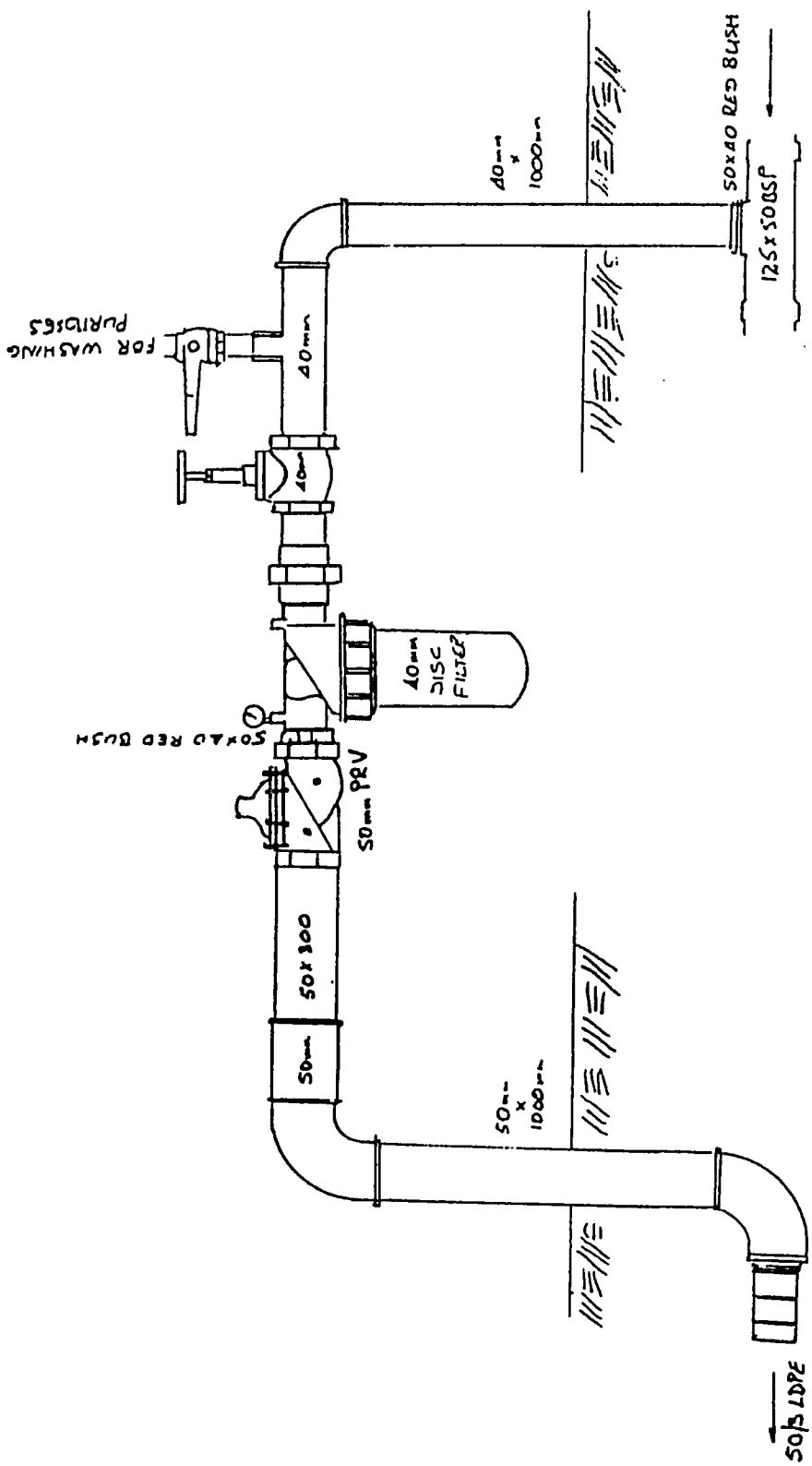




BANK OF 2 x 80mm SANDFILTERS + 2 x 100mm BUTTERFLY VALVES



TAKE-OFF POINTS FROM 125mm MAINLINE



Mike Taylor Technical Services (Pty) Ltd

P.O. Box 2953
Manzini
Swaziland

Tel: (09268) 52729
(09268) 85310
Fax: 85112

MT/jht

4 December 1992

Commercial Agricultural Production and Marketing Project
(CAPM)
Oceanic Building
9 Usutu Crescent
Matsapha Industrial Sites
Matsapha
Swaziland

For the attention of Mr D Grenoble
Production Horticulturist

Dear Sirs

Please find attached our tender for drip irrigation equipment.

All prices quoted are nett delivered to CAPM, Matsapha.

Due to manufacturers closing for annual shutdowns, delivery will be mid-January.

We hope that our quotation meets with your approval. Should you have any queries do not hesitate to contact us.

Yours faithfully,
for MIKE TAYLOR TECHNICAL SERVICES (PTY) LIMITED

M TAYLOR
Director

Enc.

4/7

		E	
1.	4m x 100mm ID KANAFLEX IS755 Hose	169,48	
	2 x 100mm swaged nipples (galvanised)	20,18	
	2 x 110mm x 100 LM6 Female Adaptor	71,16	
	2 x 100 Stainless Steel Hose Clamps	6,90	
			267,72
2.	4m x 100mm ID Kanaglex IS 755 Hose	169,48	
	1 x 125mm x 100mm LM6 Female Adaptor	38,43	
	2 x 100mm Swaged Nipples (Galvanised)	20,18	
	1 x 150mm x 100mm Galvanised Reducing Bush	69,21	
	2 x 100mm Stainless Steel Hose Clamps	6,90	
			304.20
3.	1500mm x 125mm Class 4 UPVC Pipe with integral lyng rubber joint ring	16448,72	
4.	2 x 125mm LM6 Equal Tees	148,17	
5.	2 x 125mm Varix Type V.A. Butterfly Valve	522,49	
	2 x 125mm LM6 Flange Adaptors	101,86	
6.	2 x 125mm LM6 90° Elbows	138,14	
7.	2 x 125mm LM6 End Caps	53,28	
8.	2 x Sand Filters 130 - 140 mesh with manual backflush and flow of 12,6 l/sec complete with Flanged Valves and Pressure Gauge . Price excludes silica sand.	6692,16	
9.	5300m x 12mm 2 L/H Drip-in regular with 30cm emitter spacing (10yr plus life)	39756,81	
10.	4000 x 50mm LDPE pipe (non SABS)	8903,00	
11.	27 x 125mm x 50 BSP LM6 Riser Tees	1630,16	
	27 x 50mm Insert Male Adaptors	53,39	
	27 x 50mm Stainless Steel Hose Clamps	72,73	
12.	27 x 50mm Brass Gate Valves	1402,80	
	52 x 50mm Male Adaptor Inserts	102,81	
	52 x 50mm Stainless Steel Hose Clamps	140,04	

/Cont.....

		E
13.	27 x 50mm Male Adaptor Inserts	53,39
	27 x 50mm End Caps BSP Galvanised	392,39
	27 x 50mm Stainless Steel Hose Clamps	72,73
14.	27 x 40mm Disc Filters, flow rate 10 cubic metres of water per hour. (130 mesh)	9135,90
15.	81 x 50mm x 50mm Equal Tee Inserts	273,44
16.	1400 x 50mm LDPE Class 3 pipe (non SABS)	2670,90
17.	3000 x 12mm Combination Saddles and Nut	1310,91
18.	81 x 50mm End Plug Inserts	70,37
19.	81 x 50mm Brass Gate Valves	4008,00
	162 x 50mm Male Adaptor Inserts	240,18
	162 x 50mm Stainless Steel Clamps	415,63
20.	81 x 110 KPA Pressure Regulators	1399,85
		967,82.17

ANNEX C

SOILS, PLANTS AND IRRIGATION
AND
IRRIGATION WATER MANAGEMENT ON THE FARM

Soils, Plants, and Irrigation

Soils

In irrigation, the soil's most important function is to store water and nutrients for the plant. A soil's texture and structure are major factors affecting how much water it can hold for plant use. "Available water" refers to the amount of water that a soil can store and that is accessible for plant use. Not all the water stored in the soil is available for the plant to use. Available water is the difference between field capacity (the most water the soil can hold) and permanent wilting point (soil condition reached after the plants have taken all the water they possibly can from the soil; the soil is not completely dry but plants are unable to take it).

A simple way to determine soil texture or soil type in the field can be done as follows. Place some soil in the palm of the hand. Add a little water to the soil and gently rub the palms of your hands together. Soil type can be determined by consulting Figure 1.

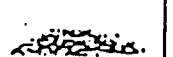
Soil cannot form a stick.		very sandy	Stick can be bent half-way round.		loam
Soil forms a stick. Will break when bent.		sandy	Stick can be bent more than half-way.		clay loam
Stick will bend a little before breaking.		sandy loam	Stick can be bent into a ring.		clay

FIGURE 1. Determining Soil Type

The following table shows the available water of different soil types.

Soil type	Available water for plant use mm/cm	inches/foot
Sandy	0.4	0.5
Sandy loam	0.8	1.0
Loam	1.3	1.6
Clay loam	1.7	2.0
Clay	2.1	2.3

Plants

The roots of the plant are in contact with the soil and feed the plant with water and nutrients as available in the soil.

Root depths vary by crop. The following table shows the approximate root depth for various fully grown crops. These depths indicate where the major numbers of the roots can be found in the soil. Restricting layers (hard pan, high groundwater table, rocks, etc.) within these soil depths may limit how far the roots can penetrate.

30-40 cm	40-60 cm	60-75 cm	75-100 cm	100-125 cm
Lettuce	Cabbage	Carrots	Tomatoes	Maize
Radishes	Cauliflower	Eggplant	Asparagus	Cotton
Spinach	Peas	Potatoes	Melons	Sorghum
Onions	Green beans	Cereal crops	Parsnips	Sunflower
Broccoli	Cucumbers	Cantaloupe	Turnips	Raspberries
Brussels sprouts	Peppers	Groundnuts	Pumpkins	Fruit trees
Celery	Red beets		Squash	
Garlic	Swiss chard		Sweet potatoes	
Strawberries				

To illustrate the difference in crop root depths, a few different plants and their root depths are shown in Figure 2.

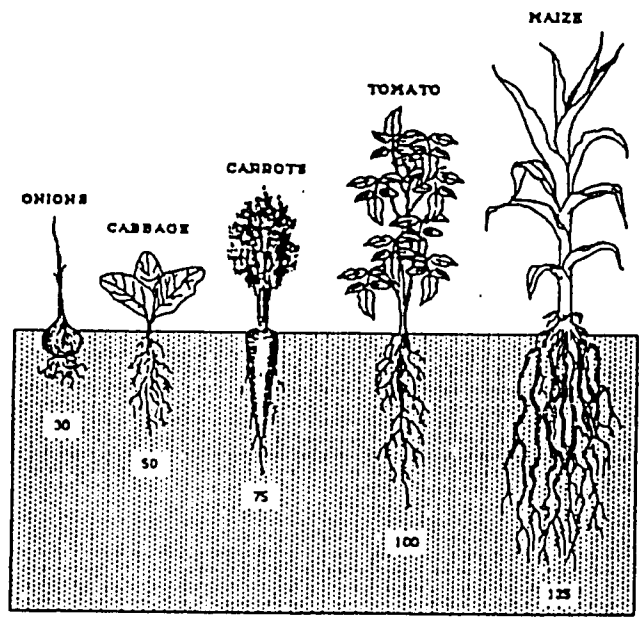


FIGURE 2. EXAMPLE OF CROP ROOT DEPTH DIFFERENCES

Penetration of roots into soil will increase as plants grow from seedlings to maturity. A rough estimate can be made on sight. The height of the plant above the ground is roughly equal to the root depth as shown in Figure 3.

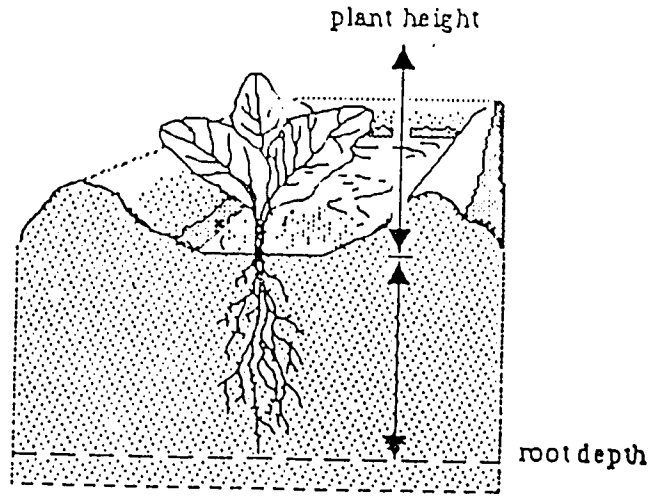


FIGURE 3. ROOT DEPTH ROUGHLY EQUALS PLANT HEIGHT

To determine how deep the irrigation water has gone into the soil, an irrigator can use a small iron rod. In wet soil the rod will push into the soil very easily. When the bottom of the rod reaches dry soil, it needs to be pushed much harder to continue going deeper into the soil. The point at which the rod begins to push harder is the line between the wet soil and dry soil. Use the small iron rod when irrigation water is being applied, as shown in Figure 6.

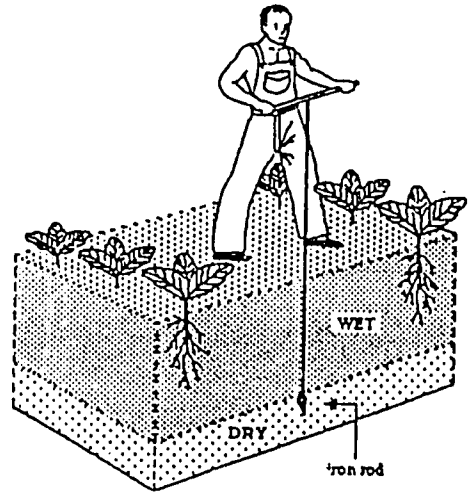


FIGURE 6. USING THE IRON ROD TO DETERMINE DEPTH OF IRRIGATION WATER

Irrigation should be stopped a few centimetres before the water reaches the bottom depth of the plant roots. After irrigation is stopped, there will be enough water in the already wetted soil for it to continue moving down to the bottom of the plant roots.

When using the iron rod, within limits, the irrigator does not need to worry whether or not irrigations are scheduled too frequently. The iron rod should be used for every irrigation. Some irrigations may take only a few hours to fill the soil with water to the plant root depth, while other irrigations may require water to be applied for many more hours. The iron rod is an excellent tool for the irrigator to determine how long the irrigation water should be applied for each irrigation.

Soil type	Plant root depth (cm)	Available water for plant use (mm)
Sandy	30	12
	60	24
	90	36
	120	48
Sandy loam	30	24
	60	48
	90	72
	120	96
Loam	30	39
	60	78
	90	117
	120	156
Clay loam	30	51
	60	102
	90	153
	120	204
Clay	30	63
	60	126
	90	189
	120	252

If equal amounts of water are applied to different soils, there will be different wetting depths for the various soils, as shown in Figure 7.

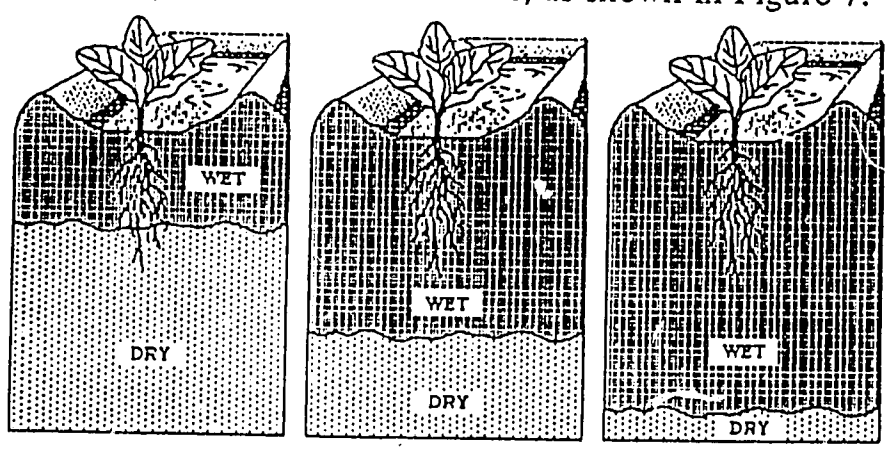


FIGURE 7. APPLYING EQUAL QUANTITIES OF WATER RESULTS IN DIFFERENT WETTING DEPTHS FOR VARIOUS SOIL TYPES

Again, the iron rod can be used as a guide to determine depth of irrigation for various soil types.

Knowing the soil type and the plant rooting depth, the available water to the plant is approximately as shown in the above table.

Furrow Length

The choice of furrow length depends on soil type, size of stream of water flowing down the furrow, irrigation depth, field size and shape, slope, and farming practices.

On sandy soils water infiltrates rapidly. This means furrows must be short (100 m or less), so that water in the furrow can flow quickly to the far end of the field. If the furrow is too long for the irrigation stream size, too much water will be lost in deep percolation near the head end of the field.

On clay soils water infiltrates more slowly, and so furrows can be longer than on sands (up to 800 m or more), even when only small irrigation stream sizes are available. If the furrows are not long enough for the irrigation stream size, excessive run-off can occur. This is because water cannot be ponded in furrows for a long enough time to irrigate the soil to the desired depth. Thus, water must be left flowing in the furrow until enough of it has been absorbed into the soil which may require excessive run-off.

Furrows can be longer on the same soil when a large irrigation stream size is available. This is because water will advance more rapidly down the furrows as the flow is increased. However, there is a limit to the size of stream that can be used because of the risk of soil erosion.

Applying larger irrigation depths also means that furrows can be longer because there is more time to spread the flow down the furrows. When furrows are used on steeper sloping land (up to 0.3%) they can usually be longer. This is because water moves more rapidly down the furrow as the slope increases. However, on sloping land there is always the risk of soil erosion. As the land becomes steeper than 0.3, smaller irrigation stream sizes are used in order to prevent erosion. This means that shorter furrow lengths must be used.

As in the case of basins and borders there are no simple ways to calculate the best furrow length for different conditions. It is usual to rely on local experience or the experience of others.

Using the following table, for example, on a clay soil with a slope of 0.1% the maximum irrigation stream size is 3.0 l/s and the best length of furrow is 340 m for an irrigation depth of 75 mm. If the application depth is increased to 150 mm the furrow length can also be increased to 440 m.

Suggested furrow lengths (m):

Slope	Maxi. irrig. stream size	Average irrigation depth (mm)							
		Clay		Loam			Sand		
(%)	(l/s)	75	150	50	100	150	50	75	100
0.05	3.0	300	400	12	270	400	60	90	150
0.1	3.0	340	440	180	340	440	90	140	190
0.2	2.5	370	470	22	370	470	120	190	250
0.3	2.0	400	500	280	400	500	150	220	280
0.5	1.2	400	500	280	370	470	120	190	250
1.0	0.6	280	400	250	300	370	90	150	220
1.5	0.5	250	340	220	280	340	80	120	190
2.0	0.3	220	270	180	250	300	60	90	150

FIELD SIZE AND SHAPE

Field size and shape may be a practical limit to furrow length. In small fields, furrows may be as long as the field. Larger fields may be divided into two or more equal lengths. This makes it easier to deliver the same amount of water to each furrow.

FARMING PRACTICES

From a farming point of view, furrows should be as long as possible. Fewer farm channels and drains are needed, less land is taken up by the channels, and mechanization is easier. Short furrows require a lot of attention because the flow must be changed frequently from one furrow to the next.

The use of tractors on the farm can also affect furrow length. Furrows are often compacted by tractor tyres and this can reduce soil infiltration rates. Compaction may be of benefit on sandy soils, as furrow lengths can be increased without extra percolation loss. However, all the furrows would then require similar compaction; otherwise, water would advance at different rates in different furrows.

Ideally furrows should have a uniform slope. A minimum slope of 0.05% is needed to ensure that water will flow down the furrow and any excess water can be drained. The maximum slope depends on the risk of soil erosion, a factor that is more critical in furrows than borders because the flow is confined to a small channel and so it can erode the soil more easily. In arid regions, the maximum furrow slope should be about 2.0%. In more humid regions with a risk of intensive rainfall the maximum slope should be about 0.3%.

The maximum allowable slope is usually related to a nonerosive irrigation stream size, as shown in the above table. This is the maximum stream size that will not cause erosion in the furrow. Furrows on slopes of 0.05% and 0.1% could safely carry flows greater than 3.0 l/s from the viewpoint of erosion. In practice, however, this amount could be beyond the capacity of most furrows and overtopping would occur.

SWAZI NATION LANDS

Field sizes of small farms, such as those on Swazi Nation Lands, are usually very small. Irrigation furrows are often less than 50 metres in length. In short furrows, such as on Swazi Nation Lands, the length of time irrigation water is in the furrow is not long enough to completely fill the plant root zone. The irrigation stream needs to be changed back and forth between furrows during each irrigation until sufficient water has been applied to fill the plant root zone area for each respective crop.

Irrigation Water Management on the Farm

When to Irrigate

PLANT INDICATION

When the plant can no longer obtain enough water from the soil to satisfy its need for water, it will begin to show signs of wilt, particularly during the hottest part of the day. Waiting for the plant to show signs of wilting is not recommended, however, because this may mean lower yields.

"FEEL" METHOD OF DETERMINING SOIL MOISTURE

A common method for determining when to irrigate is to feel the soil and to observe its appearance. This method is relatively accurate. Soil samples are taken using a soil auger, shovel, etc., as shown in Figure 8.

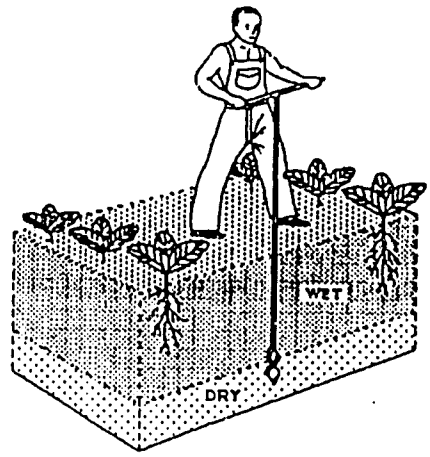
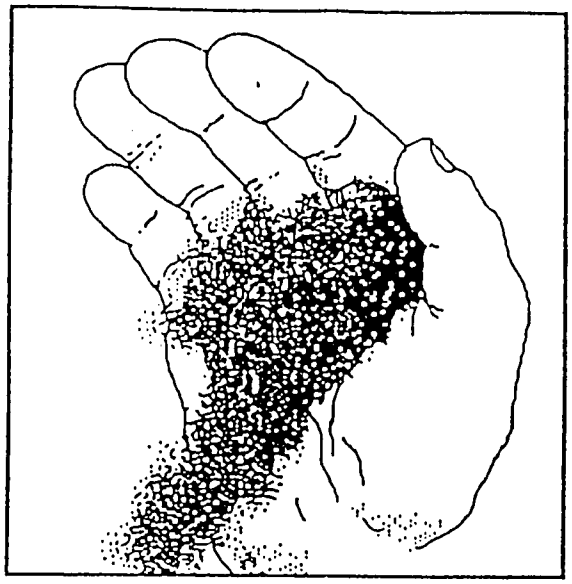


FIGURE 8. DETERMINING SOIL MOISTURE USING A SOIL AUGER

Once the soil texture has been determined (see "Soils, Plants, and Irrigation," this chapter), the soil sample is squeezed in the palm of the hand, as shown in Figures 9, 10, and 11.

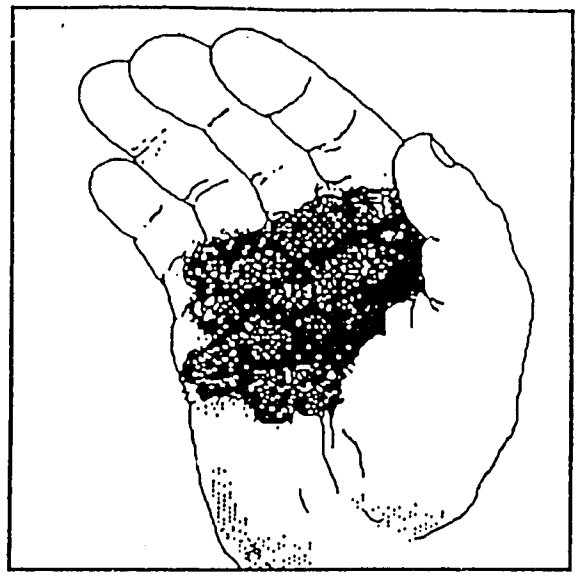
Irrigation should be started when the feel and appearance indicates that about 50% of the available moisture has been taken from the soil at about the middle of the plant root area. This will mean that the top half of the plant root area is quite dry, while the bottom half is still somewhat wet. Another guide for determining when to irrigate is shown in the following table:

Coarse Texture - sandy loams and loamy sands



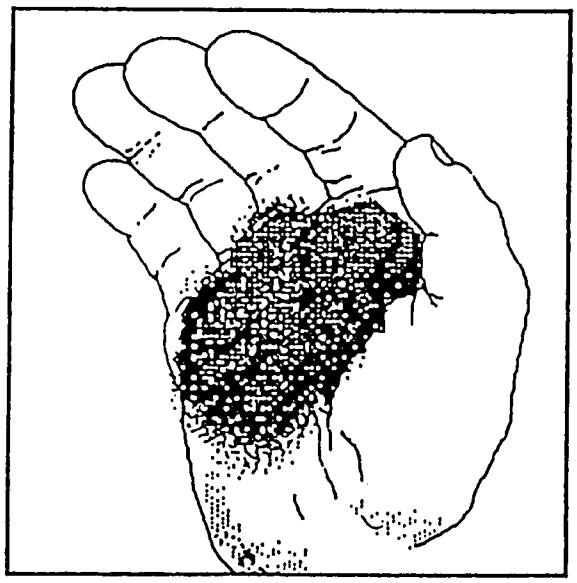
(1)

* 0 to 25% Available Moisture - Dry, loose, flows through fingers.



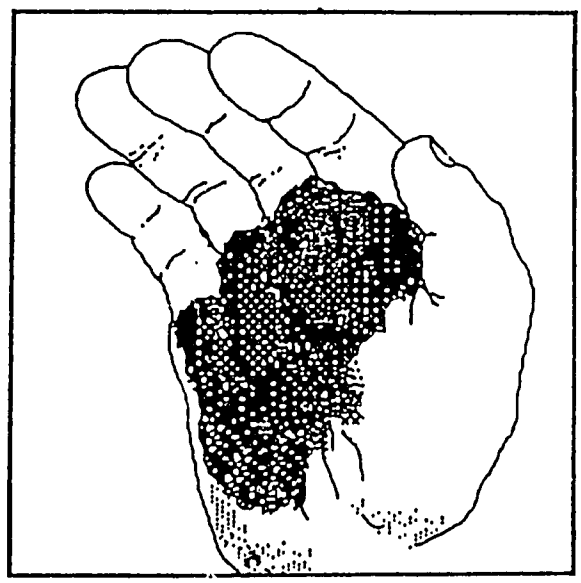
(2)

* 25 to 50% Available Moisture - Looks dry, will not form ball with pressure.



(3)

* 50 to 75% Avalable Moisture - Will form loose ball under pressure, will not hold together even with easy handling.

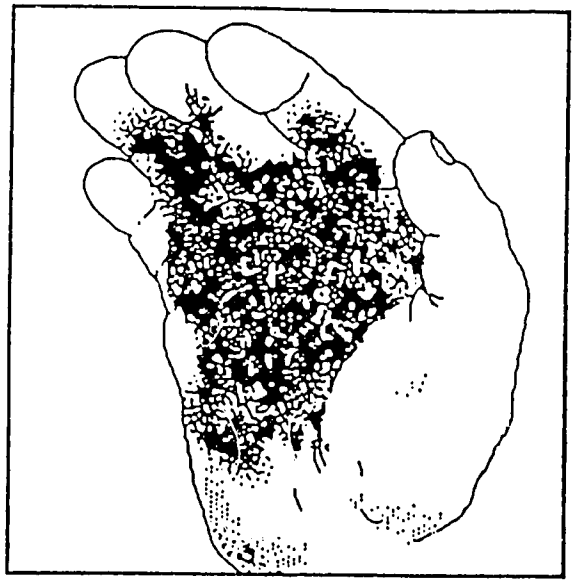


(4)

* 75 to 100% Available Moisture - Forms weak ball, breaks easily, will not "stick".

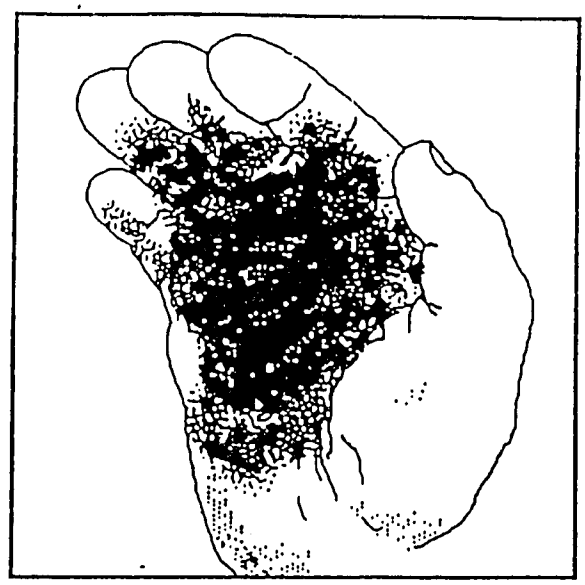
FIGURE 9. USING THE FEEL AND APPEARANCE METHOD TO ESTIMATE AVAILABLE SOIL MOISTURE

Medium Texture - loams and silt loams



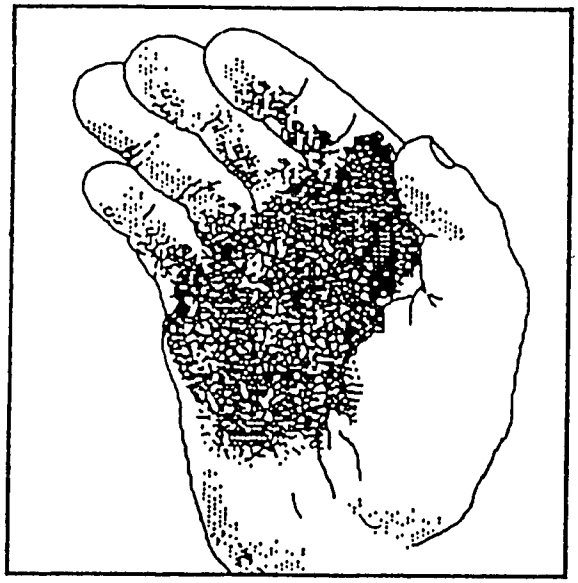
(5)

* 0 to 25% Available Moisture - Crumbles easily, tends to hold together from hand pressure.



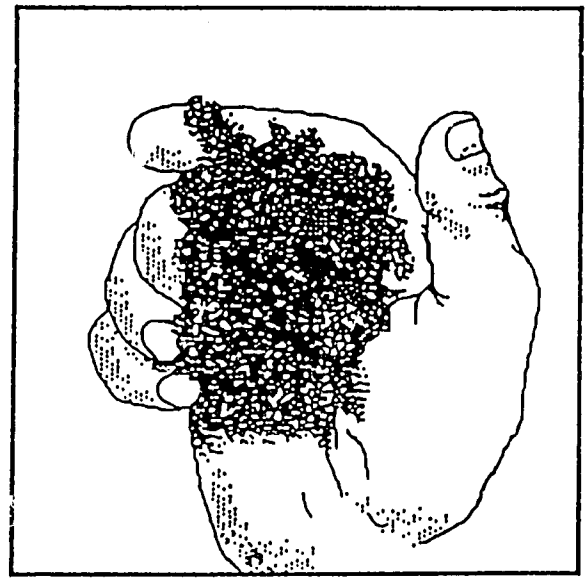
(6)

* 25 to 50% Available Moisture - Somewhat crumbly, will hold together in hand with pressure.



(7)

* 50 to 75% Available Moisture - Forms "ball" readily, will "slick" slightly with pressure.

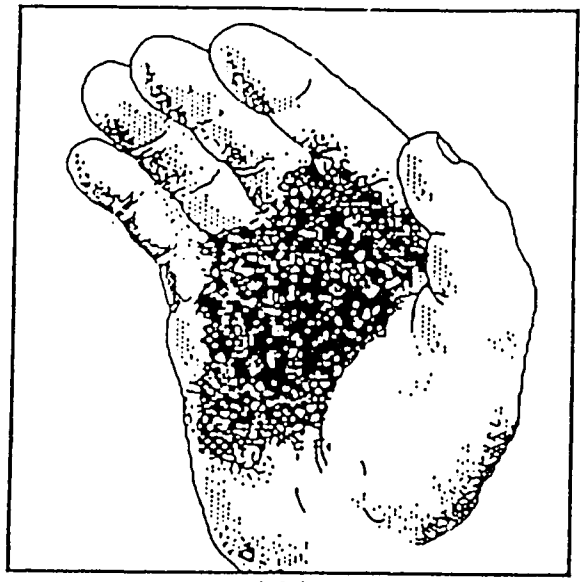


(8)

* 75 to 100% Available Moisture - Forms "ball" easily, fairly friable, "slicks" readily.

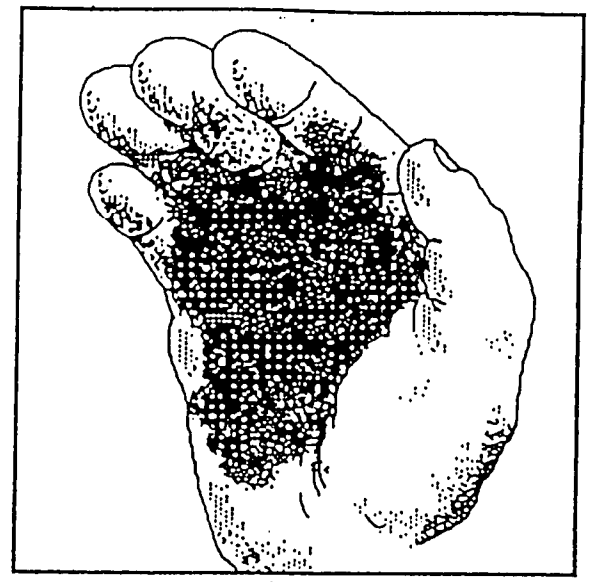
FIGURE 10. USING THE FEEL AND APPEARANCE METHOD TO ESTIMATED AVAILABLE SOIL MOISTURE

Moderately Fine Texture - clay loams and silty cly loams



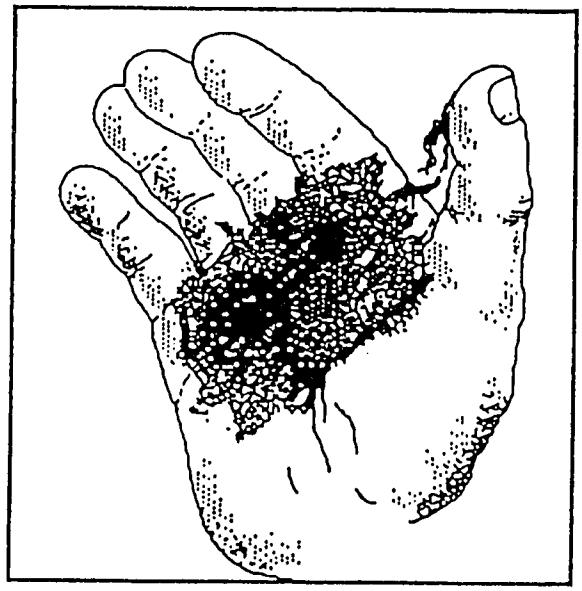
(9)

* 0 to 25% Available Moisture - Crumbles readily, will but "balls" with difficulty and breaks easily.



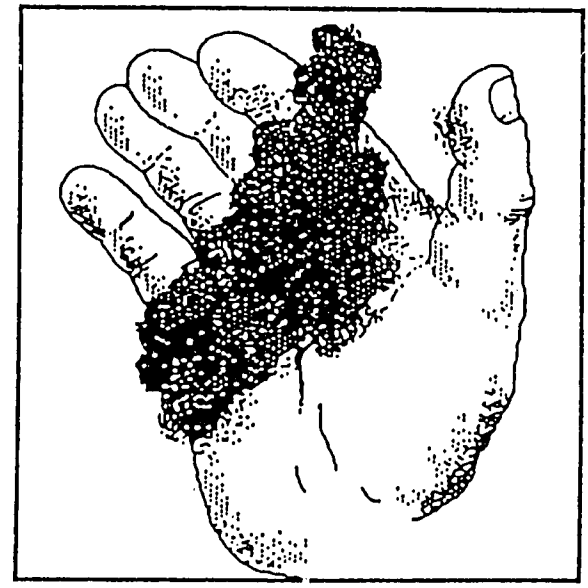
(10)

* 25 to 50% Available Moisture - Does not crumble, easily, forms readily, will "ball" with pressure.



(11)

* 50 to 75% Available Moisture - Forms "ball" readily, will "ribbon" out between thumb and forefinger. Somewhat slick feeling.



(12)

* 75 to 100% Available Moisture - Easily "ribbons" out. Has slick feeling.

FIGURE 11. USING THE FEEL AND APPEARANCE METHOD TO ESTIMATE AVAILABLE SOIL MOISTURE

GUIDE FOR ESTIMATING THE AVAILABLE WATER BY THE "FEEL" AND APPEARANCE OF SOIL

Comment and action	Coarse-textured soils (sandy-sandy loam)	Med.-textured soils (sandy clay loams)	Mod. fine textured soils (clay loams-clays)
Too late	Dry and loose, flows through the hand	Lumpy but easily breaks down into powder	Hard, solid, baked lumps difficult to break
ACTION	Irrigate at once: You may be too late. Crop should have been irrigated days ago, it is just about dead.		
Late	Just dry: will not form a ball in palm of hand	Will break up but may also form a ball	Soft but not sticky; will form a ball
ACTION	Start irrigating now (not tomorrow). Your crop will suffer with another day's delay.		
Just right	Damp: forms a ball which collapses when bounced in the hand	Easily forms a ball; is plastic or pliable; may stick to hand under pressure	Will ribbon out when rubbed in the palm: has a sticky feeling
ACTION	Irrigate tomorrow or the next day. Do not leave too long or soil will dry out.		
Early	Soil very moist—no free water but tends to stick to hand when rolled		
ACTION	No need to irrigate for a week but check again in 4 to 6 days.		
Ruined	Free water on surface for more than 24 hours		
ACTION	Overirrigated—you may lose your crop; drain off water and wait.		

EVAPORATION MEASUREMENTS USED FOR PREDICTING WHEN TO IRRIGATE

The evapotranspiration (Et), or the amount of water the plant uses daily and daily evaporation from the soil, is related to evaporation from an open water surface. The daily evaporation (Eo) is being measured at various meteorological stations throughout Swaziland using the U.S. Weather Bureau Class A pan. Average daily evaporation measurements (mm/day) for various stations in Swaziland are as follows:

Month	Malkerns	Big Bend	Mbabane	Mananga	Mhlume
January	5.5	7.5	4.1	7.4	7.1
February	6.1	7.1	4.3	6.7	6.7
March	5.2	6.5	3.7	5.7	5.7
April	4.2	4.9	3.1	4.8	4.7
May	3.8	4.0	3.1	4.1	4.0
June	4.1	3.3	2.7	3.8	3.5
July	4.1	3.5	3.0	4.4	3.8
August	4.6	4.7	3.6	5.3	4.8
September	4.9	5.6	3.8	6.1	5.5
October	5.3	6.5	4.3	6.4	6.0
November	5.0	6.3	4.3	6.2	6.0
December	5.2	7.4	4.0	7.4	6.8

The ratio of evaporation (Et) to the actual amount of water evaporation (Eo) varies with the stages of plant growth. The demand for water by crops is not evenly spread over the growing season. At the beginning of the season when the crop is planted, the need for water is low. The need for water increases as plant foliage develops, reaches its peak during flowering and fruit formation, and rapidly decrease during ripening. For most crops, the evapotranspiration and actual plant water use (Et/Eo) for different growth stages is as follows:

Stage of growth	Et/Eo
Emergence to early growth	0.3-0.5
During vegetative growth	0.5-1.0
During flowering	1.0- 0.8
During wet fruit stage	0.8-0.6
During dry fruit stage	0.6-0.0

For example, the average daily evaporation (Eo) in the Malkerns area for the month of May is 3.8 mm per day as shown in the previous table. If the crop is in the early growth stage, the Et/Eo ratio is between 0.3 to 0.5 (above table). The actual water use by the crop can be determined by multiplying 3.8 x 0.3, which equals 1.14 mm/day, or 3.8 x 0.5, which is equal to 1.9 mm/day. Thus, the water taken out of the soil by the plant is between 1.14 and 1.9 mm/day during the early plant growth stage.

If the crop is in the vegetative growth and flowering stage, the Et/Eo can reach 1.0 (above table). Again, if this stage occurs in May at Malkerns, the actual water used can be as high as 3.8 mm/day (3.8 x 1).

Knowing the water available in the soil for plants (see the table showing available water for various soil types, "Soils, Plants, and Irrigation"), an irrigator can determine the number of days between irrigations.

For example, if the soil is a loam texture and the plant roots are 60 cm deep, the available water for plant use is 78 mm. However, it is recommended that irrigation take place when 50% or half of the available water is used up. In our example, irrigation water should be applied after 39 mm (78 x .50) is used. If the plant uses 3.8 mm of water per day during this time, irrigation should take place within 10 days (39 / 3.8 = 10).

Critical Periods for Plants to Have Adequate Water

It is especially important that the water supply to the plant is adequate during critical periods of the plant's growth. The first critical period is during germination of the seed, in order to ensure a desired plant population. Adequate plant numbers are essential for achieving high yields. Another critical plant growth period is during the flowering to the wet fruit stage. At this point, large quantities of water are needed to carry nutrients throughout the plant's system. Careful irrigation management is required at this stage of growth if high yields are to be attained.

Rainfall

Rainfall plays an important role in irrigation water management. Water added to the soil by rainfall generally does not have to be applied by irrigation. After each rainfall, the small iron rod can be used to determine how deep the rainfall has penetrated the soil, as described earlier. Whether the irrigation scheme is a group scheme or an individual one, there should be at least one rain gauge to record rainfall. Farmers who irrigate soon learn how many days of a certain rainfall amount will meet the needs of the crop on their scheme.

ANNEX D

IRRIGATION CONSULTING COMPANIES/FIRMS

INFORMATION SHEET

COMMERCIAL AGRICULTURAL PRODUCTION AND MARKETING PROJECT

IRRIGATION CONSULTING POSITION REQUEST

NAME OF COMPANY/FIRM ZMCK Consulting Engineer

ADDRESS P.O. Box 2594 Mbabane, Swaziland

TELEPHONE NO. 61058/61665 FAX NO. 61058

DOES YOUR COMPANY/FIRM PROVIDE FOR HIRE

✓ YES _____ NO Irrigation Engineering Consulting (surveying, design of irrigation systems, installation of irrigation systems, etc).

✓ YES _____ NO Irrigation training (operation and management of irrigation systems, basics of irrigation - water application and management, etc.)

Please provide a brief description of your consulting services, recent services and a couple of references.

ZMCK CONSULTING ENGINEERS

P O Box 2594 MBABANE SWAZILAND

Roberts Complex Ezulwini | Telephone 61058 / 61665 | Telex WD 2245 (for ZMCK) | Fax 61058

Our Ref: A036

2 December 1992

Commercial Agricultural Production
and Marketing Project
Oceanic Building
9 Usutu Cresent
Matsapha
Swaziland

Attention: Mr D Brosz

Dear Sir

IRRIGATION CONSULTING POSITION REQUEST

Thank you for your fax of 26 November 1992 inviting ZMCK Consulting Engineers to register an interest in providing consulting services to the CAPM project.

We would like to confirm our capability and interest in providing the service envisaged on the forthcoming project.

ZMCK have considerable experience available throughout their regional offices on all engineering aspects of irrigation projects.

To supplement the engineering capabilities of ZMCK and offer as comprehensive a service as possible on the project we would propose where required to work in conjunction with Agricarmel.

Agricarmel is a joint venture consulting company set up some 10 years ago between Agridev of Israel and the Gerber Goldschmidt Group of South Africa. They are involved in many agricultural areas in Southern Africa, such as the growing and canning of pineapples, asparagus and deciduous fruits. In most of these products there is a well developed marketing organisation with Gerber Goldschmidt offices in some 20 odd cities throughout Europe and the far East.

Project have been undertaken and operated in Ciskei, Bophuthatswana and Venda involving products such as vegetables and citrus.

In Zambia a vegetable growing project was initiated for a private company with the bulk of production being exported to the UK and Europe.

We were involved in Swaziland for a number of years with the running of the Nkaleshane Cotton Estate.

I enclose for your information a brochure on ZMCK Consulting Engineers detailing the services we can offer and some projects undertaken recently. I also enclose a brochure from Agridev and the Gerber Goldschmidt group.

We would like to take this opportunity to thank you for inviting ZMCK to express an interest in this project and hope we can be of further assistance to you.

Please do not hesitate to contact us if you require any further information.

Yours faithfully

N.J. Mortimer
ZMCK Consulting Engineers

bicon
CONSULTING ENGINEERS

INFORMATION SHEET.

COMMERCIAL AGRICULTURAL PRODUCTION AND MARKETING PROJECT.

IRRIGATION CONSULTING POSITION REQUEST.

NAME OF COMPANY/FIRM: BICON CONSULTING ENGINEERS.

ADDRESS: P.O. BOX A233, SWAZI PLAZA, MBABANE.

TELEPHONE NO. 42227/23956 FAX NO. 42227/23956.

DOES YOUR COMPANY/FIRM PROVIDE FOR HIRE.

.....PARTLY..... Irrigation Engineering Consulting (surveying, design of irrigation system, installation of irrigation system, etc.)

.....PARTLY..... Irrigation training (operation and management of irrigation systems, basics of irrigation, water application and management, etc.)

Please provide a brief description of your consulting services, recent services and a couple of references.

We are civil structural, electrical and mechanical engineers. We do not directly work on irrigation systems but are involved in many aspects of that type of work from pumps, treatment works, pipelines etc. to electrical supply lines.

We are also involved in certain training work here in Swaziland and also elsewhere in the Southern Africa region (particularly in Namibia where we are working on labour intensive projects)

We are able to work with various other organisations to fulfil the requirements that you may need and accordingly we enclose a copy of a CV. of someone with whom we are in contact and would be able to work for us.

References: Principal Building Officer,
Ministry of Works & Construction - P.O. Box 58,
Mbabane.

Mr. R. Skipsey,
Ngwane Mills; P.O. Box 1169, Matsapha.

Mr. M. Farinha,
Manager Works, Swaziland Railway.

INFORMATION SHEET

COMMERCIAL AGRICULTURAL PRODUCTION AND MARKETING PROJECT
IRRIGATION CONSULTING POSITION REQUEST

NAME OF COMPANY/FIRM CAPRO PTY LTD (IRRIGATION DIVISION)

ADDRESS P. O. Box 112 MANZINI

TELEPHONE NO. 53418 FAX NO. 53418 ASK FOR FAX

DOES YOUR COMPANY/FIRM PROVIDE FOR HIRE

✓ YES ___ NO Irrigation Engineering Consulting (surveying, design of irrigation systems, installation of irrigation systems, etc.).

✓ YES ___ NO Irrigation training (operation and management of irrigation systems, basics of irrigation - water application and and management, etc.)

Please provide a brief description of your consulting services, recent services and a couple of references.

MAINLY CONCENTRATING ON SMALL IRRIGATION SCHEMES HOWEVER IT IS HOPED THAT IN EARLY 1993 WE WILL HAVE AT OUR DISPOSAL THE SERVICES OF A FULLY TRAINED WATER TECHNITION. AT PRESENT WORKING IN NATAL.

MR. MESHACK SHIBA. (SPRINKLER IRRIGATION)
P. O. Box 89
KWALUSENI. TEL 84455

MR ROBIN DIBDEN
P. O. Box 279 (DRIP IRRIGATION)
HOBAMBA. TEL. 45707 ASK FOR 469. (RADIO PHONE)

MR [illegible]
P. O. Box 184
TEL KWALUSENI
NI

TOTAL P.02

SAFC
S.A. Farm Consultants (Pty) Ltd
Development and Management Consultants
in Agriculture. Property Broking.
Reg. No. 69/1548/07

M E M O R A N D U M

30 NOVEMBER 1992

FROM: Chris Dodson

TO: Don Brosz
Commercial Agricultural Production and Marketing Project
Oceanic Building
[illegible]
Metsapha
SWAZILAND

Enhancement Of Crop Production

The attached sheet summarises the requested replies to your preliminary questionnaire. We are very keen to be of service to you.

A short company profile is also attached.

CHRIS DODSON

121 Loop Street. P.O. Box 1145
Pietermaritzburg 3200
Telephone: (0331) 452507
Fax: (0331) 452015

INFORMATION SHEET

COMMERCIAL AGRICULTURAL PRODUCTION AND MARKETING PROJECT

IRRIGATION CONSULTING POSITION REQUEST

NAME OF COMPANY/FIRM ..S.A. FARM CONSULTANTS.....

ADDRESS .....PO BOX 1145, PIETERMARITZBURG, 3200, 121 LOOP STREET

TELEPHONE NO. 0331-452507..... FAX NO. 0331-452015.....

DOES YOUR COMPANY/FIRM PROVIDE FOR HIRE

.... YES	.... NO	Irrigation Engineering Consulting (surveying, design of irrigation systems, installation of irrigation systems, etc.)
..✓.. YES	.... NO	Irrigation training (operation and management of irrigation systems, basics of irrigation - water application and management, etc.)

Please provide a brief description of your consulting services, recent services and a couple of references.

We are general agricultural management consultants. We have a subsidiary called LHA. We are in regular touch with suppliers of irrigation equipment and will tackle this project in partnership with Bosch and Associates who are Consulting Engineers with a long history of association with various agricultural projects.

Relevant tasks:-

A. STUDIES/REPORTS

Kangwane Agricultural Development Corporation(Irrigated tobacco)- Small farmer development study, Mswati area, Kangwane, 1987.

Kwazulu Department Of Agriculture - Mhlatuze Cash Crop Project: establishment of a small farmer irrigation scheme in the Biyela area of Kwe Zulu, 1989.

R.S.A. Region D (Development Bank Funding) - Market potential for irrigation crops in Region D (Ciskei/Transkei), 1988.

Water Resource Development Study For Mooi River Irrigation Board, 1990

Identification Of Sugar Estate/Smallholder Project In Namibia - for the Administration of Caprivi in association with Lonrho Sugar Ltd.

S A FARM CONSULTANTS (PROPRIETARY) LIMITED

COMPANY PROFILE

1. INTRODUCTION

We are a progressive South African based consultancy established in 1969 under the auspices of the then Union Lugg ? Gould mainly due to the motivation of Gordon Lugg a well known British Agricultural Consultant. For a number of years the consultancy operated throughout the Southern African continent with representation in Swaziland and Zambia until political isolation restricted the extent of our involvement on the sub continent.

Our main objective is to provide a quality service to the agricultural sector in Africa with special emphasis on professional management, consultancy and property broking in an appropriate and practical manner.

2 WHAT WE DO

2.1 DEVELOPMENT

Despite over-production of many farm products, the need for sound agricultural development is paramount in much of the Third World. We have been involved in the preparation of development plans in many territories. Numerous national development programmes involving farming have failed because of a failure to identify limiting factors, such as marketing, lack of training, technical problems and the necessity for long term controls. Our successful experience in the development field is well documented and will inspire confidence in the new developer.

2.2 PROJECT MANAGEMENT

The Company has been responsible for completing a large number of feasibility studies for development organisations in Africa. On a number of occasions these have been followed by the award of management contracts for the implementation of the recommendation and on-going management. Project management involves appointment of staff, full technical and financial control, provision of training services and handling all aspects of marketing. The best reference for any consultant must be that of implementing his proposals successfully, and in this respect the Company enjoys an enviable record.

2.3 CONSULTANCY SERVICES

Our consultants most of whom have practical farming experience, have a strong underlying Agribusiness/Economic bias but have specialised experience in the following areas:-

Budgeting
Budgetary Control and Management
Management Accounting & Management Services
Labour Management & Negotiation
Economic and Financial cost benefit analysis.
Marketing Research & Analysis
Grassland & Pasture Management
Livestock Management
Timber Development / Management
Social Development in Emerging Farming Communities

We have a large reserve of associates willing to combine with us in fields as divergent as poultry husbandry, industrial relations, pedology and irrigation design. We recognise the need to recruit specialists on an ad hoc basis for certain specific consultancies and have at times co-ordinated multi-disciplinary assignments involving a significant input from external specialists and associates.
Over the years we have serviced several hundred farmer clients but the financially significant clients tend to be Companies, Co-operatives, Associations, Governments and Quasi Government organisations.

2.4 PROPERTY BROKING

Recognising the synergy between consultancy project management and real estate transfer our Company is diversified into the field of Agricultural property broking. In the last three years we have negotiated the sale of agricultural property to the value of some R50m. Our success is attributable to our unique combination of skills, experience and professionalism.

2.5 SECRETARIAL SERVICES

Through our involvement with the Southern African Tea Industry our company played a major role in initiating 'The Tea Council of Southern Africa' a body representing tea growers and concentrating on market development, research and promotion.

We are official secretaries to the Tea Council, providing accounting and administrative services.

2.6 PERSONNEL PLACEMENT

Many farming organisations find problems in recruiting the right people for specific employment situations. We are often appointed to recruit management, ensuring that clients find suitable candidates and in assisting clients to clarify their thinking in relation to employment strategy.

C) MAIZE/BEEF

Also at our initiative a commercial maize/beef operation known as Lambasi Farms (Pty) Limited has been established. This comprises, 700 hectares of maize for human consumption and smaller areas of dry beans and soya. The farm comprises a good arable area above an escarpment and a large area of natural grazing and pasture between the escarpment and the coast. We are building up a herd which will ultimately comprise more than 1 000 breeding cows. Numbers currently are around 400 breeding cows.

Lambasi employs a workforce of 300. It provides valued employment and saves the district considerable additional expenditure through replaced maize "imports". Plans are underway to convert the project into a farmer support centre.

D) TIMBER

Through North Pondoland Sugar (Pty) Limited we are responsible for the establishment and management of 1 000 hectares of timber plantation and envisage the development of a further 1 000 hectares.

We supervise the management of 15 timber farms for investment syndicates comprising of an afforested area of 9 000 hectares. The consultants have personal investments in timber and timber management.

C) MAIZE/BEEF

Also at our initiative a commercial maize/beef operation known as Lambasi Farms (Pty) Limited has been established. This comprises, 700 hectares of maize for human consumption and smaller areas of dry beans and soya. The farm comprises a good arable area above an escarpment and a large area of natural grazing and pasture between the escarpment and the coast. We are building up a herd which will ultimately comprise more than 1 000 breeding cows. Numbers currently are around 400 breeding cows.

Lambasi employs a workforce of 300. It provides valued employment and saves the district considerable additional expenditure through replaced maize "imports". Plans are underway to convert the project into a farmer support centre.

D) TIMBER

Through North Pondoland Sugar (Pty) Limited we are responsible for the establishment and management of 1 000 hectares of timber plantation and envisage the development of a further 1 000 hectares.

We supervise the management of 15 timber farms for investment syndicates comprising 9 000 hectares. The consultants have personal investments in timber and timber management.

CLIENT	REPORT TITLE	DESCRIPTION	DATE	CONTRACT VALUE (nominal terms)
Kangwane Agricultural Development Corporation	Small farmer development study - Farm Semingkup - Mawati area, Kangwane	Detailed planning of proposed small farmer settlement scheme with specific reference to tobacco as a main enterprise	July 1987	R35 000
United Plantations (Pty) Limited	A livestock programme for Riverbank - Tendelova	A detailed livestock and cropping plan for a newly acquired property, the objective being an assessment of financial returns from commercial beef and dairying	May 1987	R10 000
Rumavite Farms (Pty) Limited	A farm study with recommendations for Rumavite Farms (Pty) Limited	Resource assessment and recommendations to improve the viability of beef and seed enterprises	Aug 1987	R15 000
Regional Development Advisory Committee - Region D	Marketing Potential for irrigation crops in Region D	Regional marketing study with special reference to the irrigation potential of Region D (The Eastern Cape & Southern Transkei)	April 1988	R100 000
Dept. of Development Aid	Planning data for settlement of small Commercial Farmers on Sadt Land at Highflats and Texas Valley	Socio - Economic and marketing appraisals for a joint study involving the planning of 10 000 hectares of land for small farmer settlement	May 1988	R10 000
E S De Kock & Sons (Pty) Limited	An evaluation of E S De [illegible] with reference to the impact of crop farming on company viability.	Detailed enterprise analysis and financial projections with special reference to risk aspects of a continuation of annual cropping	Nov 1988	R7 000
Kwa Zulu Department of Agriculture & Forestry	Mhlatuze cash crop project	Detailed project ledger for proposed irrigation scheme to improve socio economic standing of some 300 rural households	Jan 1989	R60 000
Department of Water Affairs	Investigation into proposed Paris dam - also economic study	Assessment of land use capability, valuation of land and infrastructure for areas to be farmed by proposed dam and of compensatory areas	Nov 1989	R40 000
Kroonvrug Landgoed (Pty) Ltd	Damages suffered as a result of a chemical hormoning treatment on 45 hectares of pineapple	A detailed assessment of losses incurred by a pineapple producer, resulting from Chemical Hormone treatment	July 1989	R10 000
Administration for Caprivians	Development of Caprivi Agriculture	Identification of a suitable agricultural enterprise to develop the eastern Caprivi, assessment of market potential with a view to attract a major investor	March 1989	R90 000
Paddock Tea Planters Association	A brief assessment of the viability of the proposed Paddock Tea Planters scheme	An analysis of production and marketing aspects and long term financial projections for a proposed Tea Project	July 1989	R6 000

SOME RECENT CONSULTANCY ASSIGNMENTS

CLIENT	REPORT TITLE	DESCRIPTION	DATE	CONTRACT VALUE (nominal terms)
Kangwane Agricultural Development Corporation	Small farmer development study - Farm Homingkop - Mawati area, Kangwane	Detailed planning of proposed small farmer settlement scheme with specific reference to tobacco as a main enterprise	July 1987	R35 00
United Plantations (Pty) Limited	A livestock programme for Riverbank - Tendekwa	A detailed livestock and cropping plan for a newly acquired property, the objective being an assessment of financial returns from commercial beef and dairying	May 1987	R10 00
Runavite Farms (Pty) Limited	A farm study with recommendations for Runavite Farms (Pty) Limited	Resource assessment and recommendations to improve the viability of beef and seed enterprises	Aug 1987	R15 00
Regional Development Advisory Committee - Region D	Marketing Potential for irrigation crops in Region D	Regional marketing study with special reference to the irrigation potential of Region D (The Eastern Cape & Southern Transkei)	April 1988	R100 00
[illegible]	[illegible] of small Commercial Farmers on Sadt Land at Highflats and Texas Valley	[illegible] appraisals for a joint study involving the planning of 10 000 hectares of land for small farmer settlement	May 1988	R10 00
E S De Kock & Sons (Pty) Limited	An evaluation of E S De Kock & Sons (Pty) Ltd with reference to the impact of crop farming on company viability.	Detailed enterprise analysis and financial projections with special reference to risk aspects of a continuation of annual cropping	Nov 1988	R7 00
Kwa Zulu Department of Agriculture & Forestry	Mhlatuze cash crop project	Detailed project ledger for proposed irrigation scheme to improve socio economic standing of some 300 rural households	Jan 1989	R60 00
Department of Water Affairs	Investigation into proposed Paris dam - also economic study	Assessment of land use capability, valuation of land and infrastructure for areas to be farmed by proposed dam and of compensatory areas	Nov 1989	R40 00
Kroonvrag Landgoed (Pty) Ltd	Damages suffered as a result of a chemical hormoning treatment on 45 hectares of pineapple	A detailed assessment of losses incurred by a pineapple producer, resulting from Chemical Hormone treatment	July 1989	R10 00
Administration for Caprivians	Development of Caprivi Agriculture	Identification of a suitable agricultural enterprise to develop the eastern Caprivi, assessment of market potential with a view to attract a major investor	March 1989	R90 00
Paddock Tea Planters Association	A brief assessment of the viability of the proposed Paddock Tea Planters scheme	An analysis of production and marketing aspects and long term financial projections for a proposed Tea Project	July 1989	R6 00

CLIENT	REPORT TITLE	DESCRIPTION	DATE	CONTRACT VALUE (nominal terms)
Agricultural Development Corporation of Bophuthatswana	Macro Agricultural Development guide plan eastern region	A desk top study to identify, collect and analyse Agricultural resource information for the Eastern region of Bophuthatswana	Sept 1989	R37 000
Mooi River Irrigation Board	A water resource development survey	A survey of farms in order to assess irrigation potential and demand for irrigation in view of the proposed building of a dam.	Oct 1990	R30 000
Department of Water Affairs/Bosch and Associates	Cost benefit analysis and macro - economic impact study - Pongola Government Water scheme	Enterprise analysis and costings for agricultural component of the cost benefit study involving supplemant water to an existing irrigation scheme	Aug 1990	R12 000
The Agricultural Development Corporation of Bophuthatswana	Bophuthatswana eastern region - information for agricultural planning	A compilation of information on the agricultural resource potential of the eastern region of Bophuthatswana. The study embraced the production of 45 maps at a scale of 1:1 000, depicting land capability , land use and climatic parameters	Jan 1991	R330 000
Stewart, Sviridov & Oliver	Neure dam project study	Cost benefit analysis for a major study - irrigated sugar cane	Nov 1991	R45 000

MURRAY BIESENBACH & BADENHORST INC/INC
Fax: 012 - 471193/Tel: 012 - 471166 Bus/Box 11157, Brooklyn, 0011

FAKSIMILEE-VERSENDINGSBLAD/FACSIMILE TRANSMISSION SHEET

AAN/TO : CAPM - CONSULTING IRRIGATION ENGINEER

VAN/FROM : MR KOBUS VAN RENSBURG ONS VERW./OUR REF.: V1193

DATUM/DATE : 1 DECEMBER 1992 U FAKS/YOUR FAX :

AANTAL BLADSYE VERSEND (Insluitende hierdie dekkingsblad):
NUMBER OF PAGES TRANSMITTED (Including this cover page) 1 + 12

INSAKE/REGARDING: SMALL SCALE FARMERS ON SNL

Your enquiry to Capricorn Africa Economic Associates was directed to us by Mr Bruce Page.

We take the opportunity to forward information regarding our company to you.

The project is of interest to us and we believe that we can make a contribution.

Please advise if we can forward additional information or if it will be opportune to visit you to discuss the project.

Regards
MURRAY BIESENBACH & BADENHORST INCORPORATED

DJ VAN RENSBURG Pr Eng
Managing Director

DJVR/svdw/F-V1193

COMMERCIAL AGRICULTURAL PRODUCTION AND MARKETING PROJECT

IRRIGATION CONSULTING POSITION REQUEST

NAME OF COMPANY/FIRM MURRAY BIESENBACH & RADENHORST INCORPORATED

ADDRESS PO BOX 11157, BROOKLYN - 0081

TELEPHONE NO. 012 - 471166 FAX NO. 012 - 471193

DOES YOUR COMPANY/FIRM PROVIDE FOR HIRE .

X YES ___ NO Irrigation Engineering Consulting (surveying, design of irrigation systems, installation of irrigation systems, etc.).

X YES ___ NO Irrigation training (operation and management of irrigation systems, basics of irrigation - water application and and management, etc.)

Please provide a brief description of your consulting services, recent services and a couple of references.

INCLUDED PLEASE FIND:

APPENDIX A: A brief description of our company.

APPENDIX B: Project descriptions of three irrigation projects.

On Ndumu Estates MBB is presently busy with the design of a 120ha scheme for 12 individual farmers.

Dragline type of sprinkler irrigation will be used. A new pumpstation on the Pongola River will be designed.

MBB is heavily involved in research on irrigation, as well as the design of all types of irrigation. This is both for commercial and developing farmers. More information can be provided if required.

APPENDIX C: References who you may contact.

MBB

Murray, Biesenbach & Badenhorst Incorporated is an established company of consulting engineers which has served the agricultural and related sectors since its inception in 1973. The company, founded by Johann Murray in Stellenbosch, has its origin in the Cape wine industry. Expansion has since taken place to include the fields of agro-industry, agricultural engineering, hydro-engineering and the development of natural resources and rural areas.

MBB provides services in the disciplines of agricultural, civil, mechanical and industrial engineering. Projects often demand that MBB engineers liaise with related professions such as pedology, agricultural economy, sociology, agronomy and engineering geology. This expertise is provided by a panel of proficient and experienced associates.

Many of MBB's projects are multidisciplinary. This has contributed to the development of expertise in the management of a multiprofessional team as well as proficient functioning within such a team.

At present MBB operates on a countrywide basis from six strategically situated offices. Projects have also been completed in Malawi, Mauritius, Namibia, Swaziland and Portugal, paving the way for MBB to make an increasing contribution to the development of the entire Southern African region.

Apart from the conventional consulting engineering services of design and construction supervision, MBB is also actively involved with research, product development, the management of water resources and the acquisition and processing of data. Project management forms an integral part of the service spectrum offered by MBB.

The constructive approach and responsible attitude of MBB towards the environment is evident from active involvement with integrated environmental management projects (IEM) such as the management of solid waste material, soil conservation planning and studies on natural resources.

OUR MISSION

We render innovative and excellent consulting engineering services which contribute towards the creation of prosperity and a competitive advantage for our clients, shareholders and employees, while we fulfil our responsibility towards the community and the environment.

AGRICULTURAL ENGINEERING

Agricultural engineering applies the principles of engineering science and technology to agricultural practices, thereby optimising the development of agricultural opportunities. MBB combines knowledge of natural and biological sciences with engineering skills to address specific demands for development.

Within the MBB division for agricultural engineering we focus on the development of natural resources for primary agricultural production. A study of the climate, soil, water and vegetation forms the basis of planning and designing each project and system aimed at enhancing animal, plant and fish production.

MBB undertakes the planning of complete farming developments. A master plan for such an enterprise develops by assimilating basic information and integrating this with comprehensive technical, financial, economic and human resources data. From the master plan specific projects ensue.

MBB can render detailed services of planning and design as well as on site supervision during the implementation of projects. In this respect MBB has undertaken projects on farms and in developing areas covering soil conservation, dams, irrigation systems, animal housing, farm buildings and mechanisation projects.

DATA ACQUISITION AND PROCESSING

Since 1976 MBB has, at the request of a state department, been involved with the acquisition and processing of agricultural data in certain river catchments.

The notable success achieved can be attributed to the experience gained over the years by a team of field and office personnel versed in recording procedures, aerial photography and interpretation of deeds, as well as the computer processing of this information. This capability is currently enhanced by the implementation of computerised geographic data processing and the use of sophisticated GIS software.

MBB's experience of data acquisition, the processing of this data and extensive knowledge of the agricultural sector, provide a unit which can gather and process information rapidly, economically and reliably and prepare this information for use on several computer systems.

IRRIGATION

The specialised expertise of MBB's agricultural and civil engineers and technicians covers the full spectrum of irrigation technology. The philosophy of MBB is to view irrigation development as an integral part of a wider development plan. All aspects of the soil, climate and crops are considered in conjunction with financial and management resources when determining norms for designing and implementing irrigation systems. This philosophy has been successfully applied in irrigation projects involving micro, drip, flood, sprinkler and mechanical systems from the Western Cape to Malawi.

From the most simple irrigation system to the most sophisticated computerised sub-surface drip irrigation systems have been designed and implemented by MBB. Irrigation systems are also designed and planned for landscaping recreational and sport developments.

A management service is offered to assist clients in the scientific utilisation of available water by means of irrigation. MBB strives for the most effective utilisation of water to ensure optimal irrigation advantages.

MBB has developed the IDES computer program which is used in the irrigation industry for the design and evaluation of static irrigation systems. This powerful program includes a fully digital terrain modelling (DTM) and drawing program (CAD).

The development of the IDES computer program is a contribution by MBB's engineers to the irrigation industry, and the ongoing development of this program bears evidence of our long-term commitment to the irrigation industry.

DRAINAGE

The drainage of land is often necessary to make crop cultivation feasible. Surface and sub-surface drainage systems are planned and designed by MBB and irrigation management is adapted to control the accumulation of salts and to effect optimal production conditions.

The company is also involved with research on scheduling, water quality and problems with brackish water.

FARM BUILDINGS AND STRUCTURES

MBB plans and designs specialised farm structures such as silos, silage bunkers, storage sheds and workshops, and undertakes the expert and scientific layout of farm yards and buildings. The company has been commissioned by various farming enterprises and agricultural development organisations to construct labour housing complexes which can include sport and recreational facilities.

ANIMAL HOUSING AND RELATED SERVICES

The expertise of MBB and our co-operation with animal scientists, grazing scientists and nutritionists have resulted in the design and construction of buildings and facilities for cattle handling and feeding, dairy systems, pig and poultry production and sheep shearing and handling. Interesting new developments are a housing system for ostrich chicks and facilities for aquaculture.

Services such as the design of animal handling facilities, fodder storage and milling or mixing facilities are seen as an integral part of designing animal housing systems.

MBB has the expertise and experience to solve the problem of handling waste materials resulting from intensive animal feeding systems which can be a potential pollution danger. This is evident from projects such as the scientific disposal of liquid waste by irrigation and bio-gas generation.

AGRICULTURAL MECHANISATION

Mechanisation systems in the agricultural sector are planned and optimised by incorporating knowledge of the requirements resulting from soil types and cultivation methods, with managerial demands and financial restrictions. Cost estimations and investigation of alternative mechanisation systems are conducted and recommendations are made regarding the choice of machines or implements. MBB handles the direct or tender purchases of agricultural machinery on behalf of our clients.

SOIL CONSERVATION

The conservation of soil as a natural resource is a speciality field of agricultural engineering. MBB renders a service for the planning and design of control systems for surface water, the combating of erosion as well as donga control and stabilising. Apart from applying these skills in agricultural development projects, the company offers a supportive service to town developers and transport engineers.

PROJECT

LAVUMISA IRRIGATION PROJECT

Location	Lavumisa, Swaziland
Services provided	Consulting services pertaining to agricultural development, irrigation planning, socio-economic and economic services
Associated Organisation	University of Natal, Durban and University of Natal, Westville
Project cost	R35 000 (study)
Completion date	May 1992
Client	Department Agricultural Development Sub-directorate: Irrigation Engineering Pretoria

Project description

Murray Biesenbach & Badenhorst Incorporated (MBB) were commissioned by the Department Agricultural Development on 18/12/91 to proceed with the preliminary feasibility study for the Lavumisa Irrigtion Project in Swaziland, using information from previous studies as a point of departure. The proposed scheme involves a central farming estate with numerous satelite farmers. The total development was estimated at 400 ha.

2/....

LAVUMISA IRRIGATION PROJECT

At a very early stage in the study, it became obvious that the proposed central estate development model would not be suitable to the area due to the prevailing land tenure and farming practices. Further to this, the Swaziland Government have indicated their reluctance to become involved in estate farming. As a result, the consultants adjusted their focus to the establishment of a broad based development plan in line with the local community's needs and preferences. The local community was consulted at a preliminary level via a socio-economic study and four proposed development scenarios were discussed with them. An economic analysis of each of the proposed development scenarios was undertaken and recommendations for the proposed development made. Issues requiring attention at the next study level were identified.

PROJECT

UTILISATION OF THE WATER RESOURCES AT NDUMU ESTATE FOR IRRIGATION DEVELOPMENT

Locality	Ndumu Estates, Makhatini, Natal
Services provided	Hydrological analyses Agricultural Engineering
Project cost	R3 800 000
Completion date	November 1988
Client	South African Development Trust Corporation

Project description

The investigation considered the agricultural potential of Ndumu Estates, situated on the Northen border of the Ngwavuma District on the Makhatini Flats, adjacent to the Mozambique border. The report concentrated in detail on the utilisation of the available water resources. The investigation confirmed the suitability of the area for the cultivation of various agricultural products and indicated that up to 720 hectares could be placed under intensive production. A detailed hydrological study was conducted to determine the available water. The water demand and balance was also determined, based on the cropping program.

Different methods of utilising existing water resources were investigated and evaluated. It was finally proposed that water be diverted from the Ngwavuma River to the existing Moinduzi Dam, and that water should be pumped from the Pongola River to supplement periodic shortages.

UTILISATION OF THE WATER RESOURCES AT NDUMU ESTATE FOR IRRIGATION DEVELOPMENT

Preliminary designs of the irrigation system were undertaken for 720 ha. Cotton and rice were selected as summer crops and dried beans as a winter crop. Cost estimates were conducted to determine the capital cost for the various elements, as well as applicable operational costs.

PROJECT

STERKSPRUIT AGRICULTURAL DEVELOPMENT

Locality	Sekhukhuneland, Lebowa
Services provided	Agricultural Engineering
Project cost	R4,5 million
Completion date	1987 (Investigations)
Client	Lebowa Department of Agriculture and Environmental Conservation
Development agent	Lebowa Agricultural Corporation Ltd

Project description

Sterkspruit is a farm on which about 147 black farmers are currently cultivating maize, goundnuts and coriander under flood irrigation.

A multiprofessional team under the leadership of MBB was appointed to investigate the problems the farmers experience and to propose solutions to these problems. The natural and human resources, and existing institutional and physical infrastructure were thoroughly investigated, after which a support programme was proposed. The physical infrastructure for this support programme consisted of the following:

* A mass concrete retaining wall in the Phiring River
* 33 km pipe network to supply water to each plot
* Improvement of existing roads

STERKSPRUIT AGRICULTURAL DEVELOPMENT

* Additional storage area at the co-operative buildings
* Houses for extension officers

Apart from the physical infrastructure, the agricultural inputs, mechanical requirements and institutional structures were also addressed in the investigation.

A complete financial analysis of the project was done.

REFERENCES

1. Mr André Steyn
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   SIBASA

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5. Mr JJ Wessels
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Loxton, Venn and Associates

4th Street 729 4th Street, Wynberg, Sandton, South Africa/Suid Afrika. 39265, Bramley 2018. (011) 786-6000/7. Fax (011) 887-5725

FACSIMILE TRANSMISSION

TO: Commercial Agricultural and Marketing Projects (CAPM)
ATTENTION: Mr Don Brosz
DATE: 2 December 1992
FAX NO: (09268) 86213
FROM: C A Antrobus

FAX NO: (011) 887-5725
TEL NO: (011) 786-6000
REF NO:
FAX REF NO:
PAGES INCLUDED: 6

COMMERCIAL AGRICULTURAL PRODUCTION AND MARKETING PROJECT

Thank you for contacting us regarding the above and giving us opportunity to provide you with background to our irrigation activities.

We trust we can be of assistance to you and look forward to hearing from you in this regard.

Yours faithfully

C A Antrobus

INFORMATION SHEET

COMMERCIAL AGRICULTURAL PRODUCTION AND MARKETING PROJECT

IRRIGATION CONSULTING POSITION REQUEST

NAME OF COMPANY/FIRM: LOXTON, VENN AND ASSOCIATES

ADDRESS: 729 - 4TH STREET, WYNBERG, SANDTON

P O BOX 39265, BRAMLEY, 2018

TELEPHONE NO: (011) 786- 6000 FAX NO: (011) 887-5725

DOES YOUR COMPANY/FIRM PROVIDE FOR HIRE

X YES NO Irrigation Engineering Consulting (surveying, design of irrigation systems, installation of irrigation systems, etc)

X YES NO Irrigation training (operation and management of irrigation systems, basics of irrigation - water application and management, etc)

Please provide a brief description of your consulting services, recent services and a couple of references:

PLEASE SEE ATTACHED

81

COMMERCIAL AGRICULTURAL PRODUCTION AND MARKETING PROJECT

BACKGROUND TO LOXTON VENN AND ASSOCIATES

729 - 4th Street, Wynberg, Sandton
P O Box 39265, Bramley, 2018

Tel: (011) 786-6000
Fax (011) 887-5725

Loxton, Venn and Associates (LVA) is a staff owned professional consultancy serving a wide range of clients in the agricultural and development sector of southern Africa for over 23 years. Many irrigation studies and projects have been conducted and implemented over this period. Our in-house team of over 30 professional and management staff, together with our wide range of well-known specialist associate consultants, forms a highly versatile and competitive multi-disciplinary group which can be deployed to meet the specific needs of our clients.

The attached schedule summarises projects completed after 1985 which have an irrigation component.

LVA currently manages the Ncora Irrigation scheme, a 3 000 ha smallholder irrigation scheme situated between Umtata and Queenstown in the Transkei (SE Cape). The scheme produces a range of crops under sprinkler and pivot irrigation and services some 1800 smallholders. LVA also previously managed another nearby smallholder scheme, the Qamata Irrigation Scheme, which consisted of some 2 300 ha developed to flood irrigation.

Other smallholder schemes the company has designed, implemented and managed include the Shiloh Irrigation Scheme (475 ha of grain, vegetables and pastures for dairy cows), the Keiskamma Irrigation scheme (800 ha dairy pastures) and the Tyefu Irrigation Scheme (570 ha of vegetables for the freezing market).

In Swaziland the company manages the two dairy farms of Tibiyo Taka Ngwane in the Malkerns Valley, winter pastures being sprinkler irrigated on both farms. The farms are managed by a Swaziland registered subsidiary, East African Technical Services.

To summarise, Loxton, Venn and Associates has experience in the design of irrigation systems, installation and supervision of contractors thereof, as well as the training and development of smallholder commercial farm

LOXTON, VENN AND ASSOCIATES

LIST OF MAJOR IRRIGATION PROJECTS COMPLETED SINCE 1985

August 1992

PROJECT DESCRIPTION	CLIENT	DATE COMP-LETED	TYPE OF PROJECT								
			R	L	I	F	Mk	Mg	E	D	O
NAMIBIA											
Farm Dam Construction and Rehabilitation Owambo/Kaoko	Directorate of Rural Development	1991 On-going			■					■	
REPUBLIC OF SOUTH AFRICA											
Soil Survey and drainage plan of farm	J D le Roux	1985	■		■						
Farm Development Plan	G A Hoskison	1985		■	■	■					
Effluent Irrigation. A preliminary Feasibility Study	Sastech	1985	■	■	■	■					■
Vaal River agro-economic study preliminary report	Dept. of Water Affairs	1987	■	■	■	■			■		
Cogmanskloof Irrigation Board	Dept. of Agric. & Water Supply	1987	■	■	■	■					■
Disposal of effluent by irrigation - Feasibility Study - Project Planning - Soil Surveys for site selection - Environmental Impact Assessment - Irrigation Design	Sastech	1985-91	■	■	■						■
Golden Valley Irrigation Scheme - Brief Overview Report - Rehabilitation-Feasibility Study - Financial circumstances of farmers	Directorate of Irrig. Eng.	1988-91	■		■				■		
Waaikraal Irrig. Scheme Dev.	Dept. of Local Govt. Housing and Agric.	1988	■	■	■	■	■			■	
Olifants River / Loskop Scheme: Water quality requirements of agriculture	Wates and Wagner	1990	■		■				■		
Syferfontein Colliery Rehabilitation Planning and EIA of opencast mine	Syferfontein Colliery	1990	■	■	■				■		
Irrigation water quality requirements of the farmers on the Loskop Irrigation Scheme in the Upper Olifants river	Wates and Wagner	1990			■						
A brief study into Irrigation water quality requirements of the agricultural sector in the Enyati Valley	Wates and Wagner	1990			■						
Farm Evaluation (Intensive vegetables)	Gili-fafco Farming Project	1991	■		■						■

R = Resource inventory and assessment; L = Land use planning; I = Irrigation and design planning; F = Feasibility study; Mk = Market survey; Mg = Management and annual budgeting; E = Environmental investigation; D = Rural development; O = Other.

41

LOXTON, VENN AND ASSOCIATES
LIST OF MAJOR IRRIGATION PROJECTS COMPLETED SINCE 1985

PROJECT DESCRIPTION	CLIENT	DATE COMP-LETED	TYPE OF PROJECT								
			R	L	I	F	M_k	M_g	E	D	O
Optimum Colliery Irrigation assessment	Optimum Colliery	1992	■		■				■		
Planning of Kakamas North "Low Level" extensions	Directorate Irrig. Eng.	1992		■	■						
BOPHUTHATSWANA (RSA)											
Development Plan Taung Irrigation Scheme	Agricor	1987	■	■	■	■	■				
Tsholofelo - Evaluation of Citrus Project with regard to Involvement of Commercial farmers (an integrated rural development project)		1992	■		■	■	■			■	
A development plan for Seleka Irrigation Scheme (a smallholder settlement)	Botswana Dev. Corp.	1985			■						
Oxkraal Dam and Whittlesea report for Integrated rural development projects	Dept. of Co-op. and Dev.	1985			■						
Project Plan and Evaluation. Phase 3 Lower Fish River Irrigation and Rural Development Project	Dept. of Agric., For. and RD	1989			■	■					
GAZANKULU (RSA)											
Schoemansdal Coffee Project planning - a smallholder farmer, rural development project	Kangwane Agric. Dev. Corp.	1989	■	■	■	■	■			■	
Nkomazi Irrigation Expansion Project - a regional integrated rural development project	Kangwane Agric. Dev. Corp.	1992 On-going	■	■	■	■			■	■	
KWAZULU (RSA)											
Biyela multi-facet rural development project	Institute of Natural Resources	1985-86								■	■
- Socio Economic Study											■
- Pilot Project Planning			■	■		■				■	
- Irrigation Scheme Planning			■	■	■	■				■	
- Precursor Trials Planning			■	■	■	■				■	
- Market Study							■				
- Development Proposals			■	■	■	■				■	
LEBOWA (RSA)											
Reconnaissance Soil Survey of Naphuno area	Dept. of Agric. and Env. Cons.	1985	■		■						
Glen Alpine Irrigation Project Development Plan for a rural development project	Lebowa Agric. Co.	1988-89		■	■	■	■			■	

R = Resource inventory and assessment; L = Land use planning; I = Irrigation and design planning; F = Feasibility study; Mk = Market survey; Mg = Management and annual budgeting; E = Environmental investigation; D = Rural development; O = Other.

LOXTON, VENN AND ASSOCIATES
LIST OF MAJOR IRRIGATION PROJECTS COMPLETED SINCE 1985

PROJECT DESCRIPTION	CLIENT	DATE COMP-LETED	TYPE OF PROJECT								
			R	L	I	F	M_k	M_g	E	D	O
TRANSKEI (RSA)											
Ncora Irrigation Scheme (NIS)											
- Project Planning and Development	Dept. Agric. and For.	1979									
- Annual Budgets (Cp + Cap).		On-going	■	■	■	■	■	■		■	
- Project Management								■			
- Farmer Support Programme							■	■		■	
- Cannery Planning and Development		1979-90				■	■	■			
Qamata Irrigation Scheme (QIS)											
- Interim Development Proposals	Dept. Agric. and For	1985				■				■	
- Development Plan		1988	■	■	■	■	■			■	
- Design of Pilot Project		1986		■	■						
- Annual Budgets		1984-86						■			
- Project Management		1984-86						■		■	
- Reappraisal Study		1991		■		■				■	
Lanti Irrigation Scheme	Tracor										
- Annual Budgets		1984-86					■	■			
- Irrigation Design		1991			■						
Umzimvubu Basin Study, Draft sector report on Agriculture.	Dept. of Works and Energy, Transkei	1989	■	■	■						
Mphaila Irrigation Development	Dept. Water Affairs	1986			■						
Development of Dzwerani Village Food plots	Dept. Water Affairs	1987		■	■						
Project Report a gravity section weir for Dzwerani Foodplots	Dept. of Water Affairs	1989			■						
Plans for the Irrigation Development of Matsika and Tshimbupfe	Dept. of Agric. and For.	1990			■						
SWAZILAND											
Tibiyo and Umcenge Dairy Projects	Tibiyo Taka Ngwane	1980									
- Project planning and development		On-going	■	■	■	■	■				
- Annual Budgets							■				
- Project Management (Umcenge Farm from 1989)							■		■		
Possible agricultural aid projects in Swaziland	USAID	1985	■		■	■					■
Fruit and Maize Project	Tibiyo Taka Ngwane	1988	■	■	■	■	■				
Lubisi Farm Plan for the Remainder of 1988/89 and 1989/90	Tibiyo Taka Ngwane	1988	■	■	■	■		■			

R = Resource inventory and assessment; L = Land use planning; I = Irrigation and design planning; F = Feasibility study; Mk = Market survey; Mg = Management and annual budgeting; E = Environmental investigation; D = Rural development; O = Other.

93