INITIAL INVESTIGATION INTO THE PROBLEMS AND PROSPECTS OF THE IRRIGATION OF FRUIT AND VEGETABLES ON THE BELIZE COMMERCIALIZATION OF ALTERNATIVE CROPS PROJECT

SUBMITTED TO:

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BELIZE COMMERCIALIZATION OF ALTERNATIVE CROPS PROJECT

INITIAL INVESTIGATION INTO THE PROBLEMS AND PROSPECTS OF THE IRRIGATION OF FRUITS AND VEGETABLES

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

SECTION I

INTRODUCTION

The findings of this initial investigation into the problems and prospects of irrigation have been divided into eleven separate sections in order to maintain clarity. The main proposal for the irrigation of the fruit and vegetables is contained in Section VI and the estimated cost of the equipment recommended in Section X. The bill of quantities for the various irrigation systems proposed can be found in Appendix 2.

Wherever possible this report has followed the guidelines laid down in the "Scope of Work" received at the start of the assignment.

SECTION II

INITIAL INVESTIGATION

A. Natural Rainfall

Study of the local rainfall figures for both Orange Walk and Corozal Districts show a distinct "dry" season from February through to mid-May; with the fourteen-year average for those months being under two inches. Discussions with local farmers also confirm that rainfall from September to January can also be unreliable and erratic. This period coincides with the planting season for the proposed winter vegetables. Therefore, reliable irrigation would appear to be essential for the success of the project.

B. Local Irrigation experience

Flood irrigation has been carried out for many years at Big Fall rice ranch in the Belize District. Sprinkler irrigation has also been practiced intermittently by Tobacco growers in Cayo District, Certified Seed growers in Belize District and also by the Belize Sugar Industries research station, on their seed beds at Santa Cruz.

In 1984, Hummingbird Hershey Ltd installed twelve acres of drip emitters on their cocoa as an experiment to try to increase yields. They have a "dirty" open water source, so installed a sand media filter and drip emitters which can be stripped and washed out. Their experiments are inconclusive as yet. There is one other drip-type system in the country, which is currently owned by Mr. Rod Allen of Cayo District. This equipment has apparently changed hands several times between vegetables growers due to a possible lack of understanding of drip irrigation technology.

Having visited a cross-section of farmers in the Orange Walk and Corozal Districts it is apparent that the most widely used method to date is the "bucket method". This involves pumping water usually from a hand dug well with a small gasoline driven pump unit, through black polyethylene hose up into an overhead storage tank or directly to fifty gallon drums set out in the field. The water is then taken from the drum and carried to the plants by bucket. Having interviewed several farmers using this method it seems that the acreage irrigated is directly related to family size.

C. Local Expertise

MNR's irrigation engineer, Mr. Gordon Holder, is based at Central Farm and has a wealth of experience in the sprinkler irrigation and drainage fields in Belize and the eastern Caribbean. He is very keen to assist in the irrigation and drainage aspects of this project. Future short-term specialists should definitely call on his assistance.

D. Water Sources

All water sources looked at in the initial survey were hand dug wells averaging from fifteen to thirty feet in depth. This water source will be ideal for drip emitter irrigation systems, as the top of the wells can easily be screened off to keep out organic matter, greatly reducing the cost of filtration. A pressure screen filter should prove suitable. All wells looked at are considered to have an adequate supply of water for the one acre trials planned for this year, but may have to be deepened if any increase in acreage is planned. All wells should be test pumped as soon as possible.

The Rio Hondo could prove to be a valuable water source in the future, but at present access roads are poor or non-existant, and so land adjacent to the river is virtually undeveloped. This is also the case with most other rivers and fresh water lagoons in the northern part of Belize; the developed land is adjacent to the main roads rather than the rivers.

E. Contamination

Initial electrical conductivity tests indicate that the worst area for salinity is adjacent to the Consejo road north of Corozal Town. Some samples from that area tested as high as 4.7 mmho/cm. The remainder of the area appears to be generally below 3.0 mmho/cm.

The New River, which is believed to be contaminated by factory waste below Tower Hill was not viewed as a potential water source at this stage. However, samples were taken above (south of) the factory and those appear to be good.

F. Prospects for Irrigation

From the initial survey the prospects for irrigation look good for this coming season as long as enough sites can be found that offer good security. Theft is a major problem in Belize and so any equipment which is loaned to farmers will have to be locked up at night, unless someone is actually living on site.

SECTION III

SELECTION OF POTENTIAL TRIAL SITES

A. Initial farmer selection

Following the orientation and general investigations by the short-term team. a meeting was arranged between the BABCO Administrator, Chemonics' COP, A/H, the short-term team, and the District Agricultural Officers from Orange Walk and Corozal. At this meeting the District Agricultural Officers presented lists of suitable farmers from each of the five zones in each district, thus allowing for further selection during the interview process with individual farmers. During this meeting it was generally agreed upon that prospective farmers should have a water source either on, or adjacent to their land. A discussion on potential crops also took place at the same meeting and will be covered in Section V.

B. Farmer interviews

The short-term team led by the A/H, then proceeded to visit the selected farmers in each zone throughout the two districts. The team was also accompanied by the extension agent responsible for each zone, who had assisted with the initial farmer selection process. At each prospective site, water and soil samples were taken, and the water source inspected. Farmers were told about the project, and during the course of the visit were recorded for their level of interest, capability, and whether or not they had any prior mechanical/machinery experience, which might help them manage an irrigation system.

Many of the farmers visited were already attempting to diversify into vegetable and fruit production with varying degrees of success, and this was noted with interest. Consideration was also given to the distance from main highways, and the condition of access roads, bearing in mind that the quality of fresh produce is not helped by rough, pot-holed roads. In some cases it was suggested they could consider crops such as Coco yam, which should not be affected by the standard of roads encountered. Some of the farmers visited were obviously not suitable for this project and in most of these cases alternates were found, ending with the selection of

25 farmers, who were interested in vegetable production.

We also visited four co-operatives in the Corozal District who are going to plant papaya with a view to selecting two farmers from each group to work with the project. Several farmers were also visited in the Sarteneja/Chunox area of Corozal District with pineapple production in mind, but none were actually selected.

SECTION IV

WATER QUALITY

A. pH.

All the samples taken were tested for water pH, and fell within a range from 6.5 to 7.4, which is well within the acceptable levels for irrigation water.

B. Salinity

All samples were also tested for salinity, and the majority had electrical conductivity values of less than .8 mmho/cm, which is an acceptable level for irrigation water especially in an area where moderate rainfall occurs. Those that were above this level are as follows:-

		mmho/cm
1.	Consejo Rd. site # 1 (closest to ocean)	4.71
2.	Consejo Rd. site #2	4.28
3.	Consejo Rd. Marcelo	3.20
4.	Consejo Rd. Carlos Chan	2.80
5.	Corozal vegetable co-op. Sawyer	3.32

If the above sites are used for papaya or vegetable production a close watch should be kept on salt levels in the soil; however a problem is not envisaged due to the leaching action of annual rainfall, and the proposed irrigation, which can also be used for flushing out salts if necessary.

C. Iron

All samples were also tested for iron levels in view of the proposed micro-irrigation equipment. Most samples analyzed were found to contain insignificant levels of iron, however the following

sites should be watched:-

		mg/l
1.	Victor Ayuso	.1
2.	Gregorio Espiritu (Drip)	.1
3.	Justo Cobb	.2
4.	Xaibe co-op. (Drip)	.2
5.	Roberto Cal (Drip)	.1

Although these levels are not high they should definitely be monitored during the first season, especially at those sites where drip systems are to be used. There are certain bacteria in the water, which can produce precipitation of insoluble ferric oxide by oxydizing soluble ferrous oxide. The precipitate forms a red sludge which can, in time, block emitters and drip tape. The usual treatment for this is to chlorinate the water source, in this case the well, thus killing the bacteria. This can be done simply with liquid chlorine, which is readily available in Belize, by pouring 200-500 ppm into the well before pumping. The volume of water to be treated can be easily calculated by measuring the diameter and depth of water in the well. The farmer should be given assistance with this treatment initially.

SECTION V

SELECTION OF POTENTIAL EXPORT CROPS

A. Selection Criterion

At the same meeting which was held to discuss farmer selection, crop selection was also discussed and the following selection parameters were noted.

1. Likelihood of strong winter market.
2. Subcontractor preference
3. In-country experience and acceptance.
4. Alternative uses.
5. Pest and disease problems.

B. Short List

In all, some thirty fruits and vegetables were mentioned during the discussions, but in the end the list was reduced to about ten vegetables and two fruits using the above parameters, as follows.

1. Okra (1.3. above)
2. Sweet Corn (1.3.4.) (Fresh or frozen)
3. Snap beans (1.3.4.) (Green or dry)
4. Melons (2)
5. Cucumbers (4) (Fresh and pickling)
6. Hot peppers (1.3.4.) (Fresh, pickling and drying)
7. Squash (3)
8. Cherry Tomatoes (3)
9. Cho-cho (3) (Market research necessary)
10. Coco yam (3) (Market research necessary)
11. Papaya (3)
12. Pineapple (3.4.)

If finally only six crops will be selected for this years' trial, then the above list gives plenty of scope for discussions with the subcontractors in September. More thought should probably be given to other crops such as halaconia, red ginger, foliage and annatto, which is already grown locally.

SECTION VI

RECOMMENDED IRRIGATION PRACTICES

A. General

Having visited some twenty-five to thirty farmers in the two districts, we found a range of soils from sandy loam to heavy clay, with many of them having an underlying layer of limestone. These soils will obviously be described in detail by the soils specialist in his report, but suffice it to say that most of them were well suited to furrow irrigation. I feel that for a majority of these farmers a furrow system would be a natural evolutionary step from the "bucket method" already mentioned in Section II. We saw furrow irrigation being used successfully by Mennonite farmers in the Little Belize area on tomatoes and peppers, and I feel that the farmers which I have recommended for this method in Appendix I will be well suited to it.

On some of the lighter soils I have recommended above-ground drip emitter systems. This type of equipment could of course be used on all the trials, however I feel that a number of the farmers would not be able to cope with the advance technology of drip irrigation at this stage. For this reason I have selected three of the most progressive farmers in each district to use drip emitter systems.

Overhead sprinkler irrigation in my opinion is not well suited to this project. This is because of the type of crops being grown, many of which are susceptible to disease problems, which are

encouraged by the high humidity found even in the dryer part of the year. Overhead sprinklers would tend to make these conditions even worse. However, I have recommended two half-acre trials with sprinklers on sweet corn and okra, which should not have any disease problem. This will enable a comparison to be made between the different types of equipment recommended.

On the papaya trials in Corozal District I have recommended burried drip tape, which is well suited to this type of orchard crop, and will also serve as a good comparison to the three other methods being used in the trials.

B. Furrow irrigation

Each of the fourteen furrow systems recommended will consist of a small gasoline driven pump unit drawing water from the farmers well. In some cases the wells are more than 25 feet deep, and so a five horse power pump unit with a jet attachment in the well will be necessary. The water will be delivered to the furrows by means of a single length of two inch diameter black polyethylene hose. The system design should be finalized with the help of a transit and laid out at the time the equipment is delivered to the farmer by the specialized field teams. Furrows should be no more than fifty feet long, and idealy the "double ridge" method should be used so the irrigation furrow runs down the middle between two rows of plants, with spraying walk ways between every other row of plants. Center furrow to center furrow should be approximately six feet for most of the crops. Sufficient hose will be allowed for in Section X

so that water can be delivered to the head of furrows anywhere on the one acre trial plot. This will give the team complete flexibility when making the final design and layout. In several cases the farmers will already have their own pump units and hose, but will still need assistance with the layout of their equipment.

C. Sprinkler irrigation

The two half-acre sprinkler systems will consist of a small gasoline driven pump unit drawing water from the farmers well and delivering it into a main line and then two lateral sprinkler lines, of one and a half inch diameter black polyethylene hose. Each lateral line will have five single nozzle sprinklers with 7/64 inch nozzles and will deliver 2.2 gallons per minute at forty pounds per square inch pressure. The sprinklers should be spaced at forty feet along the laterals and the laterals should be forty feet apart, giving a forty-foot by forty-foot spacing. The equipment will have to work for two hours per day to apply .2 inches (gross) of water. This should be the maximum amount required at the peak growing period with no rainfall. Farmers will,of course,have to be instructed in irrigation scheduling as in Section VII. It is envisaged that this equipment will be installed at the beginning of the season and left in place i.e. solid set. For a list of materials please refer to section X.

D. Drip Emitter irrigation

The six farmers selected for drip systems all have a high level of interest in the project, and already have some experience in vegetable production, as well as a proven ability to take advantage of new technology. Their soils in general are lighter and are not

so suitable for a furrow system; and, in most cases, the trial site is located close to a main highway to facilitate maximum supervision during the first season.

For the first trials, we suggest that six sets of equipment come in a standard package form. In other words, each system will include a pump unit which, for design purposes, should be situated halfway along one side of a square acre. From there a one and a half inch PVC mainline will deliver water to the entire length of one side of the square. Connected to this mainline will be thirty one drip lines situated every six-and-one half feet. Each drip line will have sixty-four one gallon per hour emitters, one approximately every three feet. Each system will also include a fertilizer tank, two screen filters and a pressure gauge. The system is designed around a maximum evapotransportation rate of .2 inches per day and allows for a plant water use efficiency factor of .9, and a crop coverage factor of .8. Using these parameters the system will apply the peak daily water requirement of .142 inches in two hours. The standard spacing of the emitters at six and a half feet by three feet, three inches (two meters by one meter) should suit most of the vegetable crops selected so far, especially if the "double ridge" method is used as in the furrow irrigation trials. The distance between emitters should prove to be satisfactory in most cases, however on coarse textured soils, where plants are closer together it may be necessary to pull the lateral/emitter line one-and- one half feet up the row for a further two hour irrigation set.

The design has been done this way for the first trial to keep initial equipment costs to a minimum. Again, the specialized field team will have to supervise the installation of each system, and later to closely supervise water management and the application of fertilizers, and nematocides if necessary.

E. Drip Tape irrigation

As mentioned earlier, it has been proposed that the project work with three vegetable growers' co operatives in the Corozal area, who are currently planting papaya. The co-operatives are working in groups of ten, ten and eight farmers respectively, each planting one to one-and-one-half acres of papaya each. It has been suggested by the COP that trials may be established with two farmers from each group.

For these trials I would like to recommend the use of burried drip tape, injected down the center of each bed. The papayas will be planted on a seven by nine feet spacing, i.e. seven feet between the plants and nine feet between the rows. The equipment would also consist of a small diesel driven pump unit pumping from a well into a two inch PVC mainline, which will run down the center of the field. Submains of one inch PVC pipe will then branch off the mainline to feed the drip tape laterals, which are connected to the submain every nine feet. The mainline, sub-main and drip tape laterals will all be burried underground so damage from machinery or machetes should be minimal.

The peak water requirement for papayas in this area is .12 inches per day (gross); this could be applied in two hours to one trial plot. The equipment will also include a pressure screen filter, fertilizer injection kit and flow meter at the pump, as well as two Y-filters and a pressure gauge at the submain head works.

F. Installation of equipment

Installation of the furrow and sprinkler irrigation systems should be supervised by a short-term irrigation specialist working together with the specialized field teams. The drip emitter and drip tape systems should be installed by the same teams, but in conjunction with a technical representative from the manufacturer of the equipment. Hardie Irrigation of San Diego, California who are leading manufacturers of both these products, have already offered to do this work free of charge.

If the drip tape is to be installed after the papaya trees are already established, then I would suggest it be laid in position on the surface and covered with some kind of mulch, such as baggasse, which is readily available.

G. Security

In view of bad theft problem and the fact that several farmers already have their own pumps I would like to suggest that farmers who wish to participate in trials should be asked to make a deposit, when the irrigation equipment is delivered. This would have the following results:- 1. A farmer who already has a pump will not ask for another one, if he has to pay a deposit.

2. If a farmer allows his pump or engine to seize up due to neglect he should forfeit part or all of his deposit

3. If a pump unit or equipment belonging to the project is stolen the farmer should loose all or part of his deposit.

If no deposit is asked for, the farmers will have little respect for the equipment and just consider it another "hand-out". This is not an image the project should encourage.

SECTION VII

IRRIGATION MANAGEMENT

A. Scheduling

For optimum growing conditions soil should be at field capacity. Many experienced irrigation farmers know when to irrigate simply by feeling the soil in a particular field. Some of the selected farmers may reach this level after a season or two, but to start off, they will need help. The simplest method of irrigation scheduling is the "check book" method which farmers should find easy enough to understand. In order to use this method it will be necessary to set up a Class "A" evaporation pan. To establish the total moisture being lost each day, the evapotranspiration rate, one has to multiply the pan evaporation rate by the percentage of crop coverage and then by the 'crop factor'. This figure is then balanced against any incoming moisture such as rainfall or irrigation. Once a field is at field capacity, this system is easy enough to manage. Tensiometers in the field can also be used as a double check and can also be used to establish an accurate 'crop factor'. I would suggest that this work be carried out by the A/H, who will be visiting the farmers on a frequent basis anyway. The A/H should also try contacting Mr. D.T. Smith of the Belize National Meteorological Service as he may well be able to be of some assistance regarding scheduling when the time comes.

B. Chemical application

All the farmers who are going to use either the drip emitter or drip tape systems will be supplied with chemical application equipment as part of the package, and they should definitely be encouraged to use it. By utilizing this equipment they will be able to deliver plant nutrients and other chemicals directly to the root zone of the plant very efficiently and also save themselves a lot of time and labor, which would be required to apply these chemicals by hand. Each farmer will be trained in the use of this equipment when he takes delivery of his system.

C. Filtration

The filtration system is the heart of any micro irrigation system and so it is of utmost importance that farmers understand the operation and maintenance of their respective filtration equipment. To start with all hand dug wells must be sealed or screened off at the top to prevent any organic matter from falling in the well. All plant growth in the well should be cleaned out before the equipment is installed. Both types of drip system will come equipped with screen filters, which are designed for filtering inorganic matter, such as sand, silt and scale, and should prove adequate provided they are flushed on a regular basis. Here again training is most important. Before irrigating the farmer should also flush out the submain, which will be fitted with a special flushing outlet at each end.

In the case of the drip tape systems the water will be filtered a second time by two 200 mesh wye filters before it enters the drip tape laterals, whose orifices are only .014 to .025 inches in diameter. The ends of the drip tape laterals can also be opened for flushing and this is sound practice before starting up the system. In the case of the drip emitter systems the emitters can actually be taken apart in the field if they are seen not to be working, and then washed out and put back together. This is something the farmer can learn to do easily.

D. Salinity

Some water sources in the project area do contain a fairly high level of salt but due to the relatively high rainfall, which falls during the year there will be frequent leaching of any salts deposited by the irrigation water. Although it is considered that salt is not a potential problem, salt levels in the water and soil should be monitored. Salinity is also mentioned in Section IV.

SECTION VIII

IRRIGATION PERSONNEL AND TRAINING

A. Irrigation Specialists

In view of the fact that irrigation is essential for the success of this project particular attention should be paid to the selection of personnel and to the continuity of short-term assignments regarding the aspects of equipment selection, design, procurement, installation, training and maintenance.

Subcontractor personnel to work with the specialized field teams should,where possible,have prior experience in irrigation.

B. Training

Farmers selected to work with the project would undoubtedly benefit from any training, which can be made available. One idea which has been suggested is for the project to finance a bus trip to southern California, where it would be possible for farmers to visit farmers markets and supermarkets to look at quality and packaging aspects; an irrigation equipment manufacturer,and also to see large scale irrigated vegetable production at first hand.

The manufacturers of the drip emitter, and drip tape products which are installed, should also provide a training program on the management and maintenance of this equipment for the individual farmer in the first phase of the growing trials. They should also be asked to provide a one day seminar on the technical aspects of micro-irrigat for the benefit of all the extension agents and agricultural officers

in the two districts. Hardie Irrigation of San Diego, has already offered to provide this training program and to host a group of farmers at their plant in California, free of charge.

SECTION IX

AGRONOMIC PRACTICES

A. Land preparation

Many of the prospective sites we visited had already been ploughed, and in most cases the generally clay-based soils had formed large clods. These rough, uneven fields may prove difficult to refine to a suitable tilth for vegetable planting with machinery, which is normally used for preparing sugar cane lands. For the one acre trials this coming season, the most suitable machine for this job would be a small two-wheeled rota-tiller, which can be used by the farmer himself, instead of the bigger equipment which usually has to be hired. I would recommend that the project consider buying some of these machines and loaning them to the farmers on a similar basis the irrigation equipment. During our travels, we did see a large twelve foot, tractor drawn rotavator at the Yo Creek Experimental Station. It may be possible to get the use of this machine next year when larger acreages are planned for.

B. Beds

It is recommended that in all cases vegetables be planted on raised beds, due to the torrential rainfall and flash flooding, which can occur at any time in the project area; but mainly during the early part of the growing season (September to November). These raised beds, will not be a problem during the dryer part of the year due to the fact that we will have irrigation on everything except Coco yams.

In the case of the Furrow Irrigation and Drip Emitter trials it is recommended that wherever possible the crops be planted using the double-ridge method. This will allow the irrigation water to be distributed in the furrow between the double rows of plants, out of the farmers way; whether it be by the furrow or drip line method. The space between alternate rows can then be left free and dry for spraying, harvesting and other jobs. I have recommended only one drip emitter line per two plant rows in order to reduce the cost of the equipment. The drip emitter lines should remain on the surface of the soil between the plants, unlike the drip tape, which should be injected nine inches below the surface using a special shank supplied by the manufacturer which is attached to the tractor tool bar.

C. Mulch

I would also recommend the use of mulch, firstly on the raised papaya beds and secondly, on the double ridges with drip emitters. The drip emitter hose can be laid on top of the mulch so that the emitters can be checked to see if they are working. The advantages of using mulch are, firstly, to stop weed growth and secondly to reduce or even eliminate evaporation of water from the top of the bed or ridge. The efficiency of burried drip tapes can be as high as ninety-five per cent with normal plant cover, but with mulch this can be increased even further. The ideal mulch material in the project area is baggasse from the sugar mill at Tower Hill, which is readily available, and will also enhance the soil structure later when incorporated. The mulch should also help reduce the damage to drip hoses by machetes and hoes as cleaning will not be necessary.

D. Fertilization

Farmers using the furrow system should not apply nitrogen or compound fertilizers in the irrigation water; as due to the lack of uniformity of water placement much of the fertilizer will be leached out of the root zone. They should rather 'place' the fertilizer by hand on the outside of the ridge away from the irrigation furrow, making sure to cover it.

Farmers using the drip emitter and drip tape systems must apply their fertilizers through the system whenever possible. This application method is very efficient due to the systems excellent uniformity of water application along the plant row. This means that each plant along the row will receive almost the same amount of fertilizer where it needs it; in the root zone. This uniformity of water and fertilizer application will also help in producing a uniform crop.

SECTION X

ESTIMATED COSTS AND PROCUREMENT

A. General

Due to the fact that the planting of some crops has already begun, and to the likelihood of erratic rainfall in the early part of the growing season, it is important that procurement of the equipment is started as soon as possible. With this in mind I would suggest that much of the recommended equipment can, in fact, be purchased locally, saving a lot of time and extra work. This would have several benefits:

1. Merchants selling pump units locally do offer after sales service and spare parts. One of the companies is represented in both Orange Walk and Corozal.

2. If requested in advance local companies are able to offer pump units at duty free prices.

3. In my opinion the project should make local purchases whenever possible. This would not only help improve infrastructure and services available to the farmer, but would also help the image of the project with the local people.

4. As already mentioned, it could also save a lot of time, making irrigation available to farmers in early October if necessary.

Certain equipment, such as the drip tape and filters are not available locally and so would need to be purchased in the United States. In this case I would suggest that Chemonics Procurement Department contact the manufacturers of these products directly to be assured of the best prices and assistance with installation and training programs. This would probably not be forthcoming from a United States domestic dealer for such a small quantity.

B. Furrow Irrigation

The following is a summary of estimated costs of equipment available in Belize, sufficient to irrigate a one acre trial plot.

1. Standard equipment - to pump from a well with water level no deeper than twenty two feet.

one pump unit - 3 H.P.	432.50
one set of suction and delivery fittings	50.00
315 feet of 2" polyethylene hose	236.25
US $	718.75 (DUTY PAID)

2. Pump fitted with jet arrangement to pump from wells deeper than twenty two feet.

one pump unit - 5 H.P.	565.00
one jet attachment	90.00
Suction and delivery fittings	50.00
315 feet of 2" polyethylene hose	236.25
US $	941.25 (DUTY PAID)

Note: Two brands of pump unit are available locally:-

1. Briggs and Stratton gasoline engine with a German Rupp pump.

2. Honda gasoline engine with a Honda pump. The prices used here are for the Honda, which is the more expensive of the two.

C. Sprinkler Irrigation

1. Standard equipment to pump from a well no more than twenty-two feet deep.

one pump unit - 3 H.P.	432.50
one set of suction and delivery fittings	50.00
525 feet of 1½" polyethylene hose	196.87
two 1½" elbows	1.90
one 1½" T	1.47
one adaptor 2"X 1½"	2.00
hose clips	2.00
ten 1½" T's with 5 foot 3/4 risers	70.00
ten model 30 sprinklers	160.00
two 1½" end plugs	2.00
US $	918.74 (DUTY PAID)

2. Pump with jet arrangement and equipment as above.

US $ 1098.75 (DUTY PAID)

Note: Prices are for the more expensive pump unit as in B. and are strictly estimated. Before procurement these prices should be confirmed with various merchants.

D. Drip Emitter Irrigation

1. Standard pump unit

one pump unit - 3 H.P.	370.00
one set of suction and delivery fittings	50.00
PVC fittings	20.00
Drip equipment, filters, fertilizer tanks	866.50
PVC main.	US $1306.50 (DUTY PAID

2. Pump with jet arrangement and equipment as above.

US $ 1,396.50 (DUTY PAID

Note: These prices are also for a standard one-acre package of equipment as in B and C. Prices of imported goods also include a fifteen per cent margin for freight and packaging etc. from the United States. More accurate figures should be obtained from the manufacturer at time of procurement.

E. Drip Tape Irrigation

1. Corozal Vegetable Co-operative

one diesel pump unit	1,462.50
one set of suction and delivery fittings	50.00
one jet attachement	90.00
one set of fertilizer injection fittings	105.00
Filtration equipment	381.00
2" PVC mainline and fittings	129.00
two 1" PVC submains	211.82
two sets of Bi-wall (24X96 #19)	473.76
	US $ 2,903.08 (DUTY FREE)

2. Xaibe Co-operatives

one diesel pump unit	1,462.50
one set of suction and delivery fittings	50.00
one jet attachment	90.00
one set of fertilizer injection equipment	105.00
filtration equipment	381.00
2½" PVC Mainline and fittings	650.00
Two 1½" PVC submain	126.96
Two sets of Bi-wall (18x72 #19)	507.32
US $	3,372.78 (DUTYFREE)

3. Marcos Co-operative

The exact dimensions and size of the trial site had still to be finalized at the time of our visit. However for planning purposes approximate cost of a complete set of equipment similar to 1. and 2. to cover two farmers' land (1.5 acres each) would be U.S $3,651.35 (DUTY FREE)

F. Sources of Supply

1. In Belize City

a) Rebco. Manager Mr. Al Roberts, telephone number 02-44703. Distributors for Briggs and Stratten and German Rupp pumps. Also have agents in Orange Walk and Corozal.

b) Santiago Castillo. Manager Mr. Leo Castillo.Telephone number 02-44313. Distributors for Honda pump units,

c) Salvador Habet. Manager, Mr. Tony Habet. Telephone number 02-45427. Distributors of a full line of PVC pipe and fittings.

d) Augusto Quan. Manager, Kenny Quan. Telephone number 02-3308. Distributors of a full line of PVC pipe and fittings and also black polyethylene hose and fittings.

e) Belize Estate. Manager, Mr. Ranei Perera telephone number, 02-45843. Distributors for Petter diesel engines and Warsop pumps from England.

2. In the United States

a) Hardie Irrigation, 1588N. Marshall Avenue, El Caycn, California 92022. Export Manager, Barry Pedler. Telephone number 619-562-2950. They also have an office and warehouse in Florida, which may prove more convenient for shipping. Barry Pedler is prepared to help with any initial design problems and also with the installation and training program. He is already familiar with Belize.

SECTION XI

FUTURE EXPANSION OF IRRIGATED ACREAGE

A. Competition to the Project

In the course of our investigations we heard much reference to a possible agreement between Belize Sugar Industries and PetroJam, the Jamaican oil refinery, to reopen La Libertad sugar mill for the production of ethanol. If this goes ahead,many of the farmers with whom we have talked concerning vegetable production may be tempted to go back to cane production; bearing in mind that the present acreage of cane would have to be increased to keep both mills in full production. Experience would indicate that people usually return to the thing they know best. It should also be remembered that the peak period for harvesting vegetables in January and February also coincides with the sugar cane harvest.

B. Labor

Before expanding the area under vegetable production in any one zone full consideration should be given as to the availability of labor for harvesting and packing. In many of the areas, where we looked at prospective trial plots the farmers themselves usually had sufficient children to work one acre, but if this were increased to five acres next year, labor could well prove to be a problem. This is one of the many reasons why drip irrigation has been recommended at this early stage; it is virtually labor free.

C. Test Pumping

The amount of water produced by the shallow, hand dug wells on most of the proposed sites could also prove to be a constraint

to expansion. It was hoped to test pump at least one well as part of our investigations, but finding a pump of sufficient capacity in good working order proved difficult in the short time available. The Ministry of Health was approached in this regard as they have two drilling rigs which operate in the area, but it appears that although they drill wells, they have no means of pumping them to advise the farmer of their capacity before he purchases a pump. It would seem that this could be a good candidate for USAID funding.

D. Water sources

To expand the one acre trials next year it may prove easier to drill new wells mechanically beside the existing hand-dug wells. In this way it will be possible to go deeper and hopefully find more water.

One of the sites which we visited at Guinea Grass village had the New River running adjacent to it. The Santos brothers who farm it are progressive in their outlook, and the soils were very suitable for vegetable production. The site was also adjacent to the main road so this would be a good prospect for expansion. Some farmers who had land for expansion were not always suitable. Fresh water lagoons and other rivers in the area should definitely be investigated for next season.

E. Infrastructure

Most of the zones in Orange Walk and Corozal Districts straddle the main northern highway or at worst are only two or three miles off it along an unpaved road. However there are two zones which

are "out on a limb" some twenty to thirty miles from the main highway. These are zone five in Corozal District (Chunox/Sarteneja) and zone 2 in Orange Walk District (San Felipe/August Pine Ridge). These zones should not be considered for expansion until the roads are improved. Coco yams are a good possibility in these zones if a good market can be found.

F. Finance

At the present time, finance is already a constraint to some of the smaller farmers in the project area who wish to purchase irrigation equipment. This is mainly due to lack of collateral. Some of these farmers will of course be assisted by the project during the first year of trials, however for the continued growth of the vegetable growing industry in this area finance is essential not only for irrigation equipment, but for all the other inputs. Making finance available to the vegetable growers in the project area should be given immediate consideration.

Appendix 1

Prospective Farmer Survey: Gathered Irrigation Information By Zone

Corozal District

NAME	VILLAGE	CROP DISCUSSION	RECOMMENDED IRRIGATION	SOIL TYPE	SAMPLED S	SAMPLED W	REMARKS
Zone #1							
Baltazar Vasquez	Paraiso	½ acre Okra	Sprinkler	Clay loam	X	x	Well
Carlos Chan	Consejo	Tom./Squash	Furrow	Heavy clay	X	X	Well
Zone # 2							
Rudy Correa	San Joaquin	Cuc./Squash	Furrow	Clay Loam	X		No well yet. Grows Chayote
Cesar Cowo	"	Okra/Toms.	Furrow	Clay Loam	X		No well but will dig one
Felipe Fabro	Calcutta	H.peppers/toms	Furrow	Heavy Clay	X	X	Nematodes problem
Zone #3							
Gilberto Sosa	Chan Chen	H.peppers/Toms	Drip	Clay Loam	X	X	Well
Justo Cobb	San Pedro	Toms./Pepper	Furrow	Clay	X	X	Well
Zone #4							
Pedro Campos	San Narciso	Okra/Coccs	Dry	Heavy Clay	X		Grows for J. Thomas
Armando Keme	"	Beans/H.pepper	Drip	Heavy Clay	X	X	Well. Will grow anything
Gregorio Espiritu	San Roman	Cuc./Squash	Drip	Clay	X	X	Has DFC loan. Enthusiastic
Zone #5							
Everaldo Wiltshire	Chunox	H.peppers/Toms	Furrow	Clay Loam	X	X	Belizean Mennonite. Well
Gerbacio Kiso	Progresso	W/Melons/Cuc.	Furrow	Clay Loam	X	X	Well

Appendix 1

Prospective Farmer Survey: Gathered Irrigation Information By Zone

Orange Walk

NAME	VILLAGE	CROP DISCUSSED	RECOMMENDED IRRIGATION	SOIL TYPE	SAMPLED S	SAMPLED W	REMARKS
Zone #1							
Julian Chell	Chan Pine Ridge	Sq./Melons	Drip	Sandy Loam	X	X	Has Belize Outlet
Roberto Cal	Yo Creek	Cuc./Melons	Drip	Sandy Loam	X	X	Has Belize Outlet
Guadalupe Pech	Yo Creek	Sw.Corn/Beans	Dry Control	Silty Clay	X		No well at present
Zone #2							
Alberto Medina	August Pine Ridge	W/Melon/Sq.	Furrow	Sandy Loam	X	X	
Genaro Novelo	San Felipe	Coco Yam	Dry	Under Clay Sandy Clay Loam	X	X	
Zone #3							
Eluterio Camara	Guinea Grass	Cuc/Sw.Corn	Furrow	Loam Clay	X	X	
Eloy Santos	Guinea Grass	Coco Yam	Furrow		X	X	
Rigoberto Leiva	Guinea Grass	Hotpepper	Drip	Sandy Loam	X	X	To dig well
Zone #4							
Brigido ,Toledano	Douglas	Sw.corn/Beans	Furrow	Clay loam	X	X	
Agulino Castillo	San Estevan	Sw.corn/Okra	Furrow	Clay loam	X	X	
E. Guttierez	San Estevan	Beans/Sq.	Furrow	Clay Loam			
Zone #5							
Gum Hernandez	Orange Walk	Beans/Sw.corn	Dry Control	Clay Loam	X		No water
Victor Ayuso	Orange Walk	Okra/H.Pepper	Furrow	Clay Loam	X	X	

SUMMARY

Appendix 1

Prospective Farmers Survey:-

1. Recommended Irrigation

A. Orange Walk District

1)	Drip Emitters	- 1 acre systems	- 3 farmers
2)	Sprinkler	- ½ acre systems	- 1 farmer
3)	Furrow	- 1 acre system	- 6½ farmers (6½ acres)
4)	Dry 'Control'	- 1 acre lots	- 3 farmers

B. Corozal District

1)	Drip emitters	- 1 acre systems	- 3 farmers
2)	Sprinkler	- ½ acre systems	- 1 farmer
3)	Furrow	- 1 acre systems	- 7 farmer
4)	Dry 'Control'	- 1 acre lots	- 1 farmer

2. Crop Possibilities discussed - acreages/No. of farmers

		Orange Walk	Corozal	Total
1.	Sweet Corn	5 x ½a = 2½a		2½ a
2.	Hot Peppers	3 x ½a = 1½a	4 x ½a = 2a	3½ a
3.	Green Beans	4 x ½a = 2a	1 x ½a = ½a	2½ a
4.	Cucumbers	2 x ½a = 1a	3 x ½a - 1½a	2½ a
5.	Melons	3 x ½a = 1½a	1 x ½a = ½ a	2 a
6.	Squash	3 x ½a = 1½a	3 x ½a = 1½a	3 a
7.	Okra	2 x ½a = 1a	3 x ½a = 1½a	2½ a
8.	Cherry Tomatoes	1 x ½a = ½a	6 x ½a = 3 a	3½ a
9.	Coco Yams	.. .. = 1½a	1 x ½a = ½ a	2 a
		13 A	11 A	24 Acres

APPENDIX II

BILL OF QUANTITIES

A. Furrow Irrigation

Please refer to Section X B

B. Sprinkler Irrigation

Please refer to Section X c

C. Drip Emitter Irrigation

2,000 Emitters (2m X 1m spacing)

100 Goof plugs

6,664 feet of 13 mm I.D. Lateral hose

31 end clamps figure 8

31 Grommet rubber ring offtake with compression ring seal

210 feet 1½" PVC pipe

1 can of cement

2 1½" brass gate valves

2 Schreader valves for testing pressure

1 Adaptor for pressure gauge and schreader valve

1 Pressure gauge

2 Screen filters 150 mesh

1 fertilizer tank and hook up kit.

11 1½" male adaptors. PVC

5 1½" elbow 90° PVC

2 1½" elbow 45° PVC

2 1½" Tee PVC

2 1½" threaded cap. PVC

1 pump unit to do 33 g.p.m. at 45 psi

1 set of suction and delivery fittings

D. Corozal Co-operative

Note: Quantitities for two blocks, plus pump and main line.

11,520 feet Bi-wall 24 X 96 19 gauge

2 2" x 1" PVC reducer

2 1" Gate valve

2 1" Screen filter 200 mesh

12 1" 90° Elbow PVC

10 1" x 20 foot PVC pipe

18 1" X1" x 1" PVC CROSS

18 ½" x 20 foot PVC pipe

36 1" x 3/4" reducers PVC

36 3/4" x ½" reducers PVC

36 ½"F x Bi-wall adaptor

2 1" Male adaptor

2 1" Threaded cap PVC

2 Pressure guage

2 Schreader valve

2 Adaptor for schreader valve

2 Tin solvent cement

14 2" x 20 foot PVC pipe

14 2" PVC Tees

3 2" 90° PVC Elbows

1 flow meter GPF0065

1 Pressure screen filter 200 mesh AMM0300

1 Mazzie injector A1V1078

1 Hook up kit AV11001

2 2" x @' X 1" Tees PVC

2 PVC male adaptors

1 3 H.P. Diesel pump unit to do 56 g.p.m. at 60 ft. M.D.

1 set of suction and delivery fittings

1 Jet attachment

E. Xaibe Co-operative

16,200 feet Bi-wall 18x72 19 gauge EBB4500 (two blocks)
16 Grammet take off KGC16
16 16mm Bi-wall X Bi-wall T FTR 1697
32 Bi-wall X Poly coupling FCR 1697
120 feet 16 mm Polyethylene 'Dura-Pol'
8 1½" Elbow PVC
10 1½" Male adaptor PVC
2 1½" Gate valve VBG0402
4 1" Screen filters 420-1-2000
8 1" Male adaptors PVC
2 1" 90° Elbow PVC
8 1½" x1" Reducing bushing PVC
4 1½" Tee PVC
2 2½" x 2½" x 1½" reducing Tee PVC
2 Schreader valve assembly
2 Pressure gauge
8 1½" x 20 foot PVC pipe
24 2½" x 20 foot PVC pipe
1 2½" PVC End cap
2 2½" 90° Elbow PVC

5 2½"x 2½"x 1½" PVC Tee

2 2½" x 2" PVC Reducer

2 2" Male adaptors

1 flow meter GPF0065

1 Pressure screen filter 200 mesh. Amm0300

1 Mazzie injector A1V1078

1 Hook up kit AV11001

2 2½"x 2½" x 1" Tees PVC

1 2½" Male adaptor PVC

1 3 H.P. Diesel pump unit to do 60 g.p.m. at 99 ft. M.D

1 Set of suction and delivery fittings

1 Jet attachment

Note: The above quantities and their estimate costs in Section X were produced as part of the initial investigation, and so should be carefully checked and confirmed after all trial sites and their dimensions have been finalized.