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Energy, Natural Resources and Environment Division

Report on Mission to Lebanon

(During the period 10-14 April 1995)

Prepared by

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MAIN FINDINGS AND RECOMMENDATIONS

The Adviser visited several areas in Baalbeck and Hermel districts including Raas El-Assi, Wadi Fissane, Sahlat El-Ma'a, Marah El-Ain, Aarsal, Iaat and Al-Jord areas. The Adviser interviewed poor farmers, middle income farmers, government officials and UNDP/UNDCP project experts. After undertaking these visits and discussions, the Adviser reached the following conclusions:

1- There is an acute socio-economic problem resulting from the eradication of illicit crops such as cannabis and opium.

2- As mentioned before, the problem of the small farmers is mainly a financial problem rather than an environmental or energy problem.

3- As far as the renewable energy resources are concerned, there are many constraints at this moment that face the introduction of renewable energy technologies in the Hermel area which is mostly rural. Among these constraints one can mention:

a- Lack of reliable resource data, specifically for wind resource;

b- Scarcity of animal wealth, shortage of water and severe winter conditions impede the introduction of biogas technology to replace the use of kerosene and/or butane gas for cooking and baking in rural houses;

c- The excessively high cost of solar water-pumping or lighting systems within the context of the financial situation of the small farmers.

d- The access of most of the communities to the electric power grid with the exception of very few communities which are at distances not exceeding five kilometers from the electric power distribution system. The extension of the distribution system to those communities will be

probably less costly than power generation using stand-alone solar or wind energy conversion systems. The energy problem facing the communities having access to the electric power grid is the continuous interruptions of the electric power supply, which is a common problem allover Lebanon. The government of Lebanon has its own plans to solve this problem within the over all plans for reconstruction of Lebanon.

4- Even if the above mentioned constraints were disregarded, the introduction of renewable energy technologies at the moment will not help in solving the problems facing the small farmers in Baalbeck and Hermel districts.

5- Concerning the Hermel Hospital, which is the only hospital serving the whole Hermel area, it is believed that the reconstruction and rehabilitation of this hospital is of extreme importance for the socio-economic development of that area. However, the amount of waste from this 40 bed hospital is small to think about establishing an incinerator for power generation; a small hygienic incinerator is enough for toxic waste management.

The adviser recommends the following regarding the introduction of renewable energy technologies in the Baalbeck and Hermel areas:

6- A wind resource assessment programme could be initiated within the frame work of the Baalbeck - Hermel Area Integrated Rural Development Project. This resource assessment programme should be implemented with the simplest and least costly measuring instruments such as **Wind Classifiers** which will cost US$ 3000 - 5000. The classifiers are to be installed in mountainous areas where wind potential seems to be high, and their recorded readings are to be collected after one complete year. If there is a good wind pattern in one or more of these locations, then wind potential could be studied more thoroughly in these locations. Otherwise, the classifiers could be moved to other locations. This process could pave the way for the

introduction of **Wind Energy Conversion Systems (WECS)** for water pumping and electric power generation for lighting and other uses, which seems to be the most appropriate renewable energy technology for these mountainous areas at present.

7- One semi-industrial biogas digester (the proposed design features are given in the report) could be installed in one of the cow-farms near Baalbeck which is a semi-urban area. This digester will be a prototype to encourage the other owners of the cow-farms to build their own biogas digesters. However, this will serve only the middle and high income farmers.

I - INTRODUCTION

Upon the request of the Ministry of Agriculture of Lebanon, ESCWA Regional Adviser on Energy, Mahmoud Saleh undertook advisory services mission to Lebanon during the period 10 - 14 April 1995. The mission was mainly to the area covered by the United Nations Development Programme (UNDP)/ United Nations Drug Control Programme (UNDCP) project entitled "United Nations Integrated Rural Development Programme Baalbeck El-Hermel Area" No. LEB/92/016.

II - BACKGROUND

During the meeting held between His Excellency the Lebanese Minister of Agriculture, Mr. Adel Qortas, and Mr. Saleh Osman, the Regional Director of UNEP Regional Office for Western Asia/ Arab League Liaison Office (ROWA/ALLO), Mr. Qortas requested a consultant to advise on the potential of utilizing Solar and Wind energy in rural areas in Lebanon. Mr. Osman informed the Minister about ESCWA's experience and expertise in this field and informed the Minister that he will request ESCWA management to send ESCWA's Regional Adviser on Energy to discuss the matter with the concerned officials. Upon receiving this request from Mr. Osman, ESCWA management requested the UNDP Resident Representative

in Beirut to contact the concerned officials to send the terms of reference (TOR) for the mission. ESCWA received the following (TOR):

The Adviser will have to treat the following subjects and to propose practical and operational devices/solutions, in order to develop renewable energy utilization:

- **Solar Energy**
  - Heating/Working
  - Electrification
  - Fruit/Vegetable drying
  - Heating of tunnel greenhouses
  - Water Pumping

- **Wind Energy**
  - Water Pumping
  - Electrification

- **Hydraulic Energy**
  - Small Hydraulic "Turbine" Station

- **Biogas**

- **Incineration of Solid Waste**

Since the scope of the assignment was very broad and the technical areas were diversified, ESCWA proposed that the Regional Adviser undertakes a one-week mission to explore with the concerned officials and experts the exact needs in each field. The Lebanese Government approved the mission. From telephone conversations, ESCWA realized that this mission is linked to the second phase of the UNDP/UNDCP Integrated Rural Development Programme Baalbeck El-Hermel Area.

The six Immediate Objectives of the above-mentioned Programme are:

- Institutions and Local Capacity Building.
- Creation of a Credit System for Agriculture/Rural areas.
- Implementation and achievement of the proposed projects activities.
- Conduct identification/technical studies for the project activities.
- Preparation of the detailed execution feasibility studies for the project activities to be achieved during the second phase of the programme.
- Preparation at the second phase Project Document.

The adviser understood from the Programme Management that there is an intention to introduce a renewable energy component in the second phase of the programme, if possible.

III - ACTIVITIES OF THE ADVISER

In the first day of the mission, the Adviser visited the Programme Manager (PM) and discussed with him the Terms of Reference and the programme of work during the mission. It was agreed to undertake field visits to the area covered by the project in Baalbeck and El-Hermel districts to explore the possibility of introducing renewable energy technologies in any of the sites within the project areas. It was also agreed to concentrate on the following renewable energy technologies:

- Wind energy technologies for water pumping and lighting.
- Solar energy technologies for water pumping and lighting.
- Biogas technology for cooking and baking, and for environmental reason.
- Incineration of the Hermel hospital solid waste for energy generation.

The Adviser requested to be acquainted with any available climatic data. The Programme Management provided the Adviser with the climatic data available for four sites (see Annex I); namely: (a) Rayak, Latitudes 33.51 S.L and Altitude 922 meter, (b) Ksara,

Latitude 33.49 S.L and Altitude 918 meter, (c) Chlifa, Latitude 34.05 S.L and Altitude 1000 meter and (d) Tell-Amara, Latitude 33.51 S.L and Altitude 905 meter. Upon examining the given data in each site, it was clear that the annual average wind speed in each site is as follows: Rayak 199 km/day (equivalent to 2.3 m/sec), Ksara 240 km/day (equivalent to 2.78 m/sec), Chlifa 240 km/day (equivalent to 2.78 m/sec) and Tell-Amara 194 km/day (equivalent to 2.2 m/sec). The annual average wind speeds in all the four locations are below the minimum average wind speed (3 m/sec) that makes the utilization of wind energy economically viable. However, this does not constitute an indicator for elimination of wind energy technologies, since the location of the measuring station may be shielded or may not be the proper one for wind energy measurement. Therefore, it is believed that a wind resource assessment is needed for the Baalbeck and Hermel areas.

FIELD VISITS:

Over three consecutive days, three field visits were undertaken by the Adviser in order to be acquainted with the nature of the area and the needs of the people from the energy point of view.

1- The first visit was undertaken to Wadi Fissane and Hermel areas which are located at about 65 - 75 km to the North of Baalbeck city. (See attached map as Annex II). These areas are mostly mountainous rural. On the way to Hermel and Wadi Fissane, the Adviser visited several communities in Raas El-Assi, Sahlat El-Ma'a and Al-Jord.

One typical rural community visited by the Adviser in Wadi Fissane is Mrah El-Ain village. From interviewing some small farmers and visiting a rural house, the following observations could be made:

- The area is characterized by very cold climate in winter.

- Drinking water is supplied from Al-Jord through a steel pipe; however, the water supply is continuously interrupted and the people use frequently animals for water transportation from down-hill areas.

- Electric power distribution network is available, but also, long period interruptions occur frequently.

- Fuelwood is used for space heating and cutting trees is a common practice in this area; therefore, a severe deforestation problem is taking place.

- Kerosene is the main fuel used for cooking and lighting during the power cuts; also butane gas is used sometimes. Kerosene consumption is on average 40 litres per month per family at a price of 40 LL/litres (about 2.5 cents). Three butane gas bottles at a price of 10,000 LL/bottle (about US$ 6) are consumed monthly by the same family as replacement of Kerosene if not available.

- Small farmers shifted to herding after eradication of illicit crops.

- Each family owns a limited amount of sheep and goats, and on average every other family owns a cow.

- Some of the small farmers own pick-up trucks probably bought before the eradication of high return illicit crops which represented their major source of income.

- Among the very simple houses of the small farmers, one can find a very luxurious villa which is not, by any means, matched with the socio-economic conditions in these communities.

It could be concluded that the major problems in these communities are:

(a) A financial problem due to the loss of the high income from illicit crops. The production cost of such crops is minimal if compared to the production cost of other crops which need intensive labour, seeds, irrigating water, farming, pesticides,...etc.

(b) Shortage of water to irrigate their fields if they want to shift to other crops.

(c) The energy problem comes at the end, and its solution via the renewable option could be the last resort to think about at the moment. However, the only viable renewable energy resource to be utilized is the wind source - if and only if - it is proven that there exists a fairly good wind pattern in that area. It is, therefore, believed that a simple wind resource assessment programme should be initiated within the framework of UNDP/UNDCP project.

2- The Adviser visited -on the same day- the Hermel Hospital to explore the possibility of incinerating the solid waste of the hospital for heat, or electric energy generation. The hospital capacity is 40 beds and the UNDP/UNDCP project is assisting in rehabilitation of this hospital through providing it with new very up-to-date medical equipment, reconstruction and renewal of its different sections (operation theater, intensive care ...). The adviser believes that the amount of solid waste from such hospital will not be enough to operate an energy generating incinerator. It is more practical to have a small hygienic incinerator for toxic waste.

3- The Adviser visited Aarsal area at about 50 km to the north-east of Baalbeck. It is a semi-urban area with electric power distribution system covering all the area and a sewage drainage system under construction. It does not seem -at least to the Adviser if not to others- that there is a clear need to introduce renewable energy technologies in that semi-urban area.

4- The last visits were to three cow farms around Baalbeck, two of them are small farms having 16 and 30 cattles, and the third one is a middle size farm having 200 cattle heads. If there is a necessity to introduce a renewable energy component in the second phase of the UNDP/UNDCP project, then a semi-industrial demonstration biogas digester could be installed in one of the small farms. The proposed size of the digester ranges between 12 - 14 cubic meters. Either of the following two models is proposed:

(a) A modified Egyptian-Chinese fixed dome type having 12.21 cu. m. total volume and 10.9 cu. m. active volume (detailed drawing and dimensions are given in Annex III).

(b) A modified Borda type digester with floating gas holder, having a total volume of 13.6 cu. m. and an active volume of 12.1 cu. m. (detailed drawing and dimensions are given in Annex IV).

In the design and construction of any of these digesters, part of output biogas should be used in heating the inlet water to the digester, during cold weather. Otherwise, a separate solar water heater should be used.

IV - MAIN FINDINGS AND RECOMMENDATIONS

See the first two pages of this report.

V - ACKNOWLEDGEMENT

The Adviser would like to thank deeply Dr. M. N. El Ferjani, the Pragramme Manager, the experts and staff (List attached as Annex VI) of the UNDP/UNDCP project who were very helpful during this mission.

Annex (1)

Reference Evapotranspiration ETo according Modified Penman						
Project : Lebanon			Climate Station : CHLIFA			
Latitude : 34.05 S.L.			Altitude : 1000 meter			
Month	Temp. °C	Humidity %	Windspeed km/day	Sunshine hours	Radiation mm/day	ETo-Penman mm/day
January	2.7	63	207	5.0	9.3	1.58
February	3.4	63	251	5.5	11.8	2.07
March	5.3	57	276	6.3	15.5	3.00
April	8.6	50	276	7.2	19.1	4.33
May	11.9	46	251	9.1	23.2	5.53
June	15.2	42	294	11.0	26.4	7.16
July	17.4	39	311	11.7	27.1	8.07
August	17.7	39	276	11.0	25.0	7.35
September	15.1	42	225	9.4	20.5	5.48
October	11.9	44	173	7.3	14.8	3.57
November	8.3	55	156	5.9	10.8	2.12
December	4.6	63	190	5.0	8.7	1.58
YEAR	10.2	50	240	7.9	17.7	1582

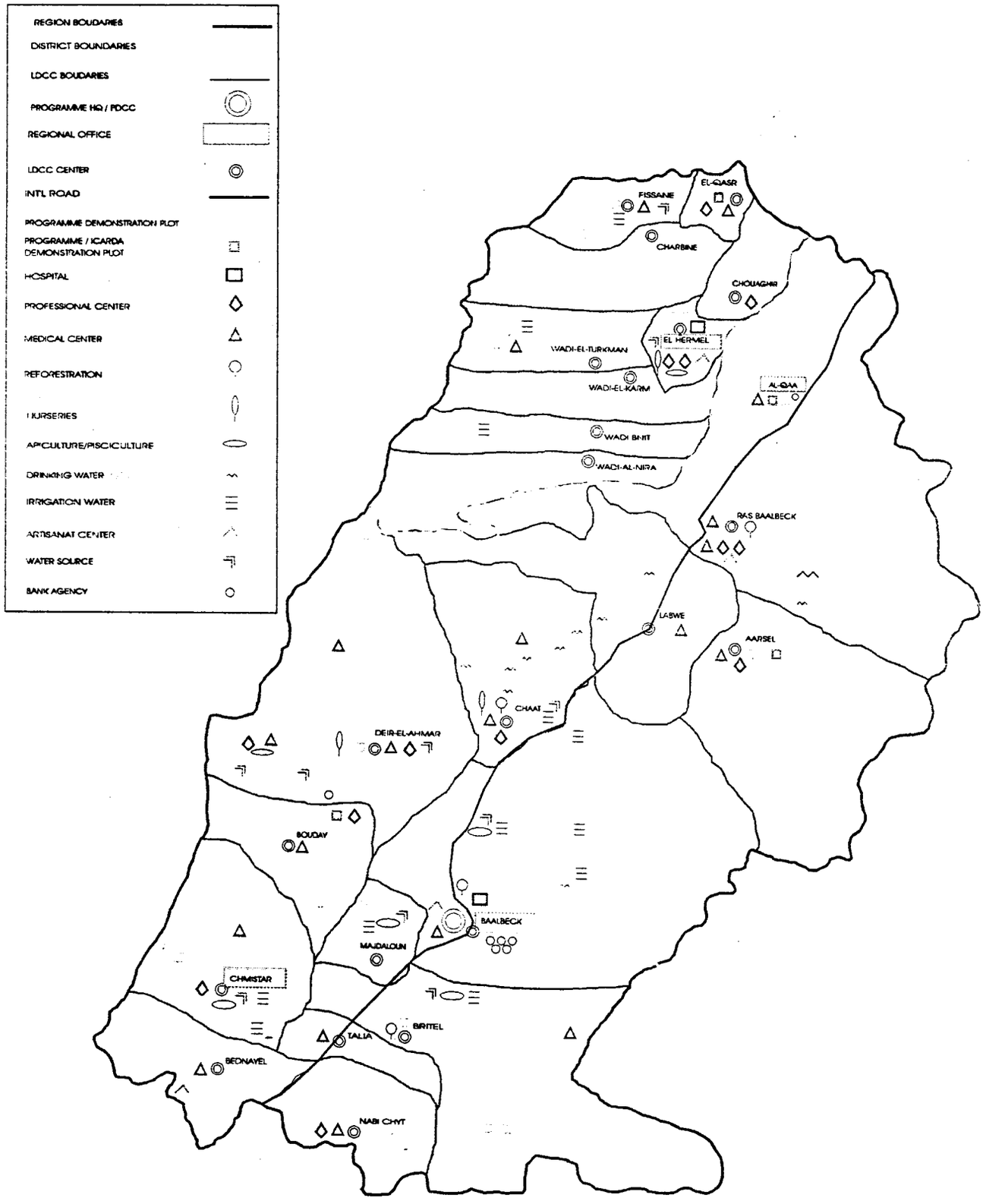
Reference Evapotranspiration ETo according Modified Penman						
Project : Lebanon			Climate Station : TELL-AMARA			
Latitude : 33.51 S.L.			Altitude : 905 meter			
Month	Temp. °C	Humidity %	Windspeed km/day	Sunshine hours	Radiation mm/day	ETo-Penman mm/day
January	0.5	61	207	5.1	9.5	1.57
February	0.6	61	216	5.6	12.0	1.94
March	2.5	56	225	6.3	15.6	2.81
April	4.5	48	207	8.1	20.4	4.04
May	7.0	44	190	9.6	24.0	5.14
June	9.6	41	199	11.9	27.8	6.38
July	11.3	38	199	12.1	27.7	6.78
August	12.0	36	190	11.3	25.4	6.42
September	10.0	40	173	10.3	21.8	5.02
October	7.4	46	164	7.9	15.8	3.44
November	4.3	53	156	6.0	11.1	2.12
December	1.7	59	207	5.1	9.0	1.65
YEAR	6.0	49	194	8.3	18.3	1443

Project : Lebanon			Climate Station : RAYAK			
Latitude : 33.51 S.L.			Altitude : 922 meter			
Month	Temp. °C	Humidity %	Windspeed km/day	Sunshine hours	Radiation mm/day	ETo-Penman mm/day
January	0.4	76	190	5.0	9.4	1.14
February	1.2	68	216	5.3	11.7	1.71
March	2.6	63	242	6.3	15.6	2.60
April	5.4	56	216	7.8	20.1	3.77
May	8.4	51	199	9.3	23.6	4.94
June	11.2	47	207	11.8	27.6	6.24
July	13.4	42	207	12.1	27.7	6.78
August	14.1	42	190	11.4	25.6	6.32
September	12.0	47	181	10.3	21.8	5.00
October	9.2	48	173	8.0	15.9	3.51
November	5.6	57	181	6.1	11.2	2.20
December	2.1	73	181	5.0	8.9	1.22
YEAR	7.1	56	199	8.2	18.3	1386

Reference Evapotranspiration ETo according Modified Penman

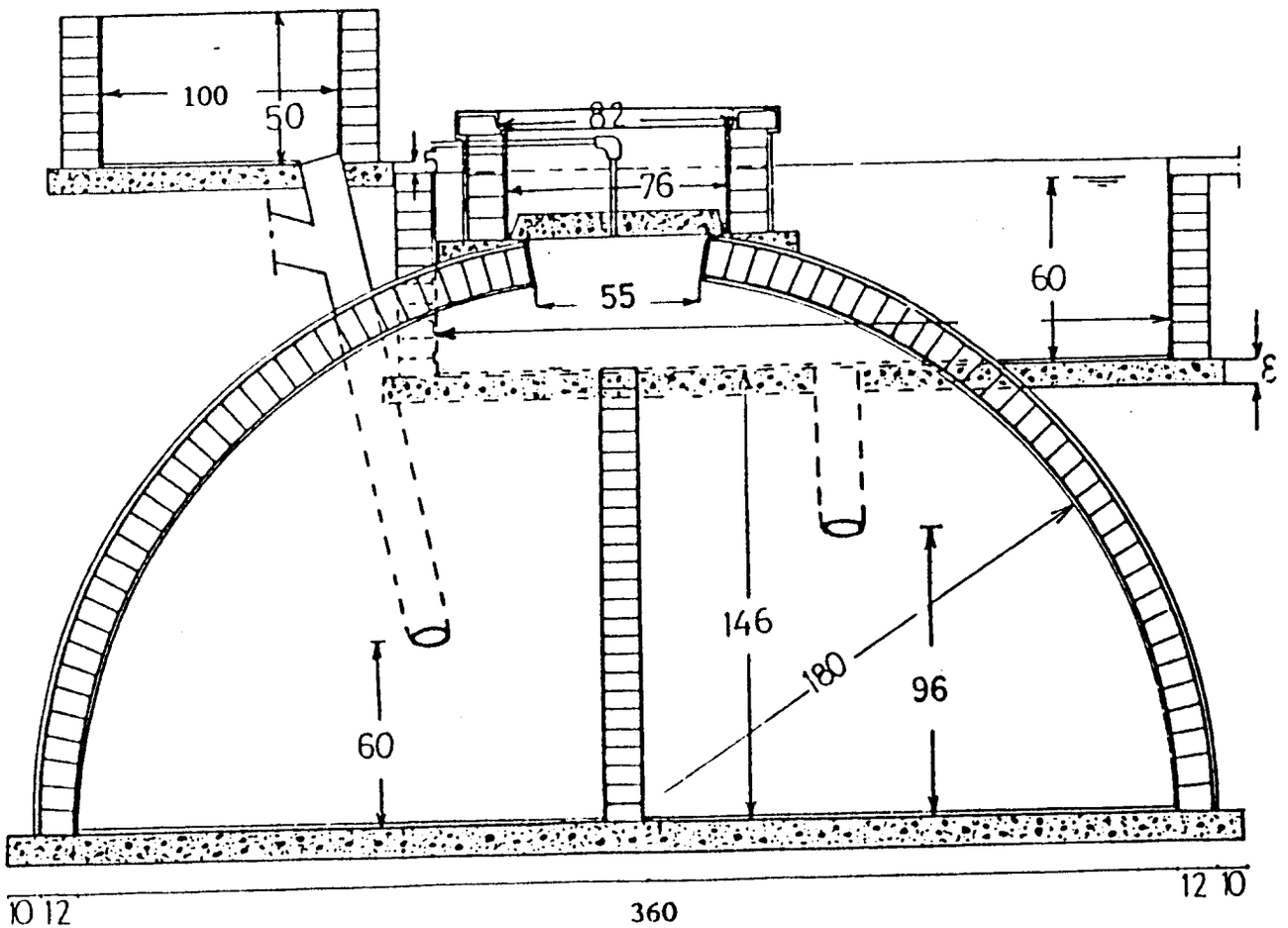
Project : Lebanon			Climate Station : KSARA			
Latitude : 33.49 S.L.			Altitude : 918 meter			
Month	Temp. °C	Humidity %	Windspeed km/day	Sunshine hours	Radiation mm/day	ETo-Penman mm/day
January	1.9	69	207	5.0	9.4	1.42
February	2.0	70	251	5.3	11.7	1.77
March	4.0	61	276	6.3	15.6	2.78
April	7.0	52	276	7.8	20.1	4.24
May	10.4	46	251	9.3	23.6	5.52
June	13.1	42	294	11.8	27.6	7.02
July	15.3	41	311	12.1	27.7	7.66
August	15.6	42	276	11.4	25.6	7.06
September	13.0	46	225	10.3	21.8	5.31
October	10.0	50	173	8.0	15.9	3.46
November	6.5	59	156	6.2	11.2	2.04
December	3.1	70	190	5.0	8.9	1.36
YEAR	8.5	54	240	8.2	18.3	1515

ANNEX II


REGION BOUDARIES
DISTRICT BOUNDARIES
LDCC BOUDARIES
PROGRAMME HQ / PDCC
REGIONAL OFFICE
LDCC CENTER
INT'L ROAD
PROGRAMME DEMONSTRATION PLOT
PROGRAMME / ICARDA DEMONSTRATION PLOT
HOSPITAL
PROFESSIONAL CENTER
MEDICAL CENTER
REFORESTRATION
NURSERIES
APICULTURE/PISCICULTURE
DRINKING WATER
IRRIGATION WATER
ARTISANAT CENTER
WATER SOURCE
BANK AGENCY
FISSANE
EL-QASR
CHARBINE
CHOUAGHIR
EL HERMEL
WADI-EL-TURKMAN
WADI-EL-KARM
AL-QAA
WADI BI-IT
WADI-AL-NIRA
RAS BAALBECK
LABWE
AARSEL
CHAAT
DEIR-EL-AHMAR
BOUDAY
BAALBECK
MAJDALOUN
CHMISTAR
BIRTEL
TALIA
BEDNAYEL
NABI CHYT

ANNEX III

Modified Egyptian - Chinese Digestor

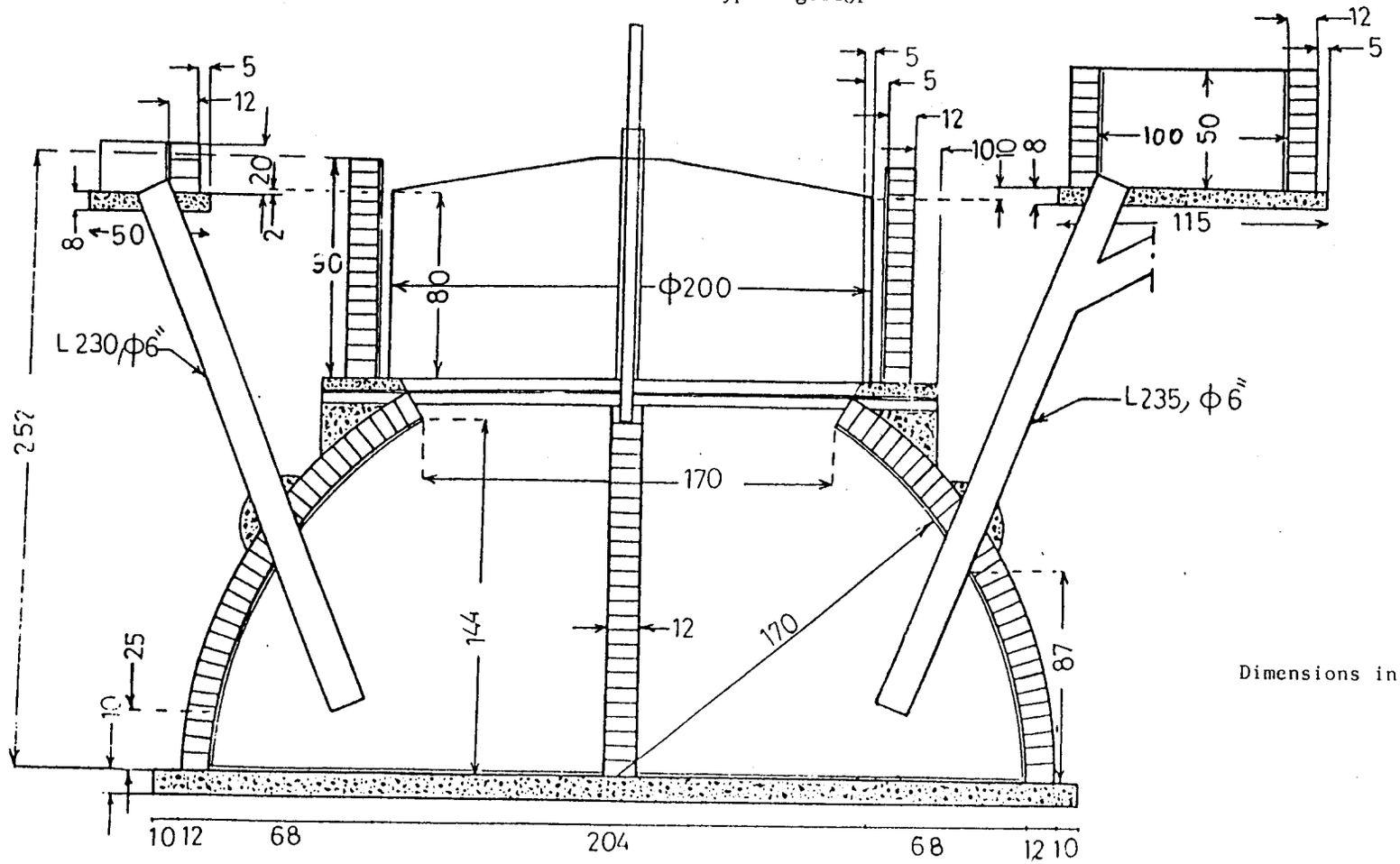


Dimensions in cm

Total volume	12.21	cu.m
Active volume	10.9	cu.m
Gas productivity	0.2 - 0.25	cu.m/cu.m/day

ANNEX IV

Modified Borda Type Digestor



Dimensions in cm

Total volume	13.5	cu.m
Active volume	12.1	cu.m
Active gas holder volume	2.2	cu.m
Gas productivity	0.25	cu.m/cu.m/day

Annex V

LIST OF PROJECT PERSONNEL CONTACTED

(1)	Dr. Mohammed Naser Al-Ferjani	Programme Manager
(2)	Dr. Shafik Bani Hani	Credit Specialist
(3)	Dr. Sultan Haider	Programme Coordinator
(4)	Mr. Abbas Tlais	Public Relations Officer
(5)	Eng. Adel Awaadah	Automation Officer