AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523
BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY

1. SUBJECT CLASSIFICATION	A. PRIMARY Agriculture	AP12-0000-G358
	B. SECONDARY Drainage and irrigation--Honduras	

2. TITLE AND SUBTITLE
Needs and requirements for irrigation,Comayagua and vicinity,Honduras

3. AUTHOR(S)
Hargreaves,G.H.

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1972	20p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS
Utah State

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

9. ABSTRACT

10. CONTROL NUMBER PN-RAA-404	11. PRICE OF DOCUMENT
12. DESCRIPTORS Honduras Water supply	13. PROJECT NUMBER
	14. CONTRACT NUMBER CSD-2167 Res.
	15. TYPE OF DOCUMENT

AID 590-1 (4-74)

NEEDS AND REQUIREMENTS FOR IRRIGATION

COMAYAGUA AND VICINITY

HONDURAS

By

George H. Hargreaves

A study prepared for the United Nations World Meteorologic Organization, the WMO-UNDP Proyecto Hidrometeorologico Centroamericano, PHCH; and the Direcion General de Irrigacion, Minesterio de Recursos Naturales, Republica de Honduras

June 1976

TABLE OF CONTENTS

NEEDS AND REQUIREMENTS FOR IRRIGATION
COMAYAGUA AND VICINITY, HONDURAS

Introduction

The valley areas in the vicinity of Comayagua and Siguatepeque offer considerable potential for agricultural development. Irrigation facilities have been constructed capable of delivering irrigation water to areas for more extensive than those currently irrigated.

This study does not attempt to evaluate the economics of irrigation in the area nor the extent of soils suitable for development to irrigated agriculture. An analysis is made of the adequacy and dependability of precipitation as well as the deficiencies of rainfall in meeting the needs and requirements for good crop or plant growth. Dependability of precipitation is evaluated at five locations using the available rainfall records.

Potential evapotranspiration is used as a measure of irrigation needs and requirements. Methodology is presented for analyzing the irrigation requirements of specific crops.

Climate

The climate of the area is characterized by about six dry months with some variation depending upon the location. Rainfall is usually fairly adequate for crop and vegetative production during May through October. Precipitation may, however, be moderately deficient during some months of the rainy season, particularly during July and August.

Rainfall data from five locations for periods varying from 2 to 22 years are used to analyze the adequacy of precipitation. Temperature data are available for four of these locations indicating mean annual values of about 24 to 25 degrees Centigrade. There is little variation throughout the year, the winter months being 2 to 4 degrees lower than the higher mean monthly values. Humidity data are available from two locations indicating rather low humidities (56 to 68 percent) during December through June with higher humidities in the other months. Based upon the available data for Playitas and Siguatepeque, the monthly values of relative humidity were estimated for the other locations.

Wind velocity data are not available in a form suitable for use for this study. The data from Playitas, however, indicate that wind velocities are significantly below average for Central America. Based upon terrain, wind direction and local observation, wind velocities were estimated for the five locations.

The data herein described are printed out in a subsequent section which provides a computer analysis of moisture adequacies and deficiencies.

Definition of Terms

Potential Evapotranspiration, ETP, is the amount of water transpired or transferred, including evaporation, from an actively growing short grass with a continuously adequate moisture supply.

Dependable Precipitation, PD, is precipitation at the 75 percent probability (that precipitation equaled or exceeded during three years out of four). It is best determined from a long period of record by means of a gamma distribution analysis. In this study an approximation is made using the relationship of mean precipitation, PM, to dependable precipitation.

Moisture Deficit, ETDF, is the difference between potential evapotranspiration and dependable precipitation.

Moisture-Availability Index, MAI, is a measure of the adequacy of precipitation over a period of time in supplying moisture requirements. It is computed by dividing the dependable precipitation by the potential evapotranspiration.

Equations Used

An equation for estimating Class A pan evaporation from a pan located in standardized, low advective conditions, usually in a fairly extensive irrigated area can be written

$$EVPC = .43 \times RMM \times CT \times CHV \times CWV \times CEV \quad (1)$$

in which

EVPC = estimated monthly Class A pan evaporation

RMM = monthly extraterrestrial radiation expressed as equivalent evaporation by dividing the radiation ($cal/cm^2/day$) by the heat of vaporization at the mean monthly temperature, TM, and converting to appropriate units, mm per month (Table 1)

CT = .40 + .024 x TM (1a)

(TM = mean monthly temperature in ^{o}C)

CHV = $.05 + 1.42 \times (1.00 - HM)^{1/2}$ (1b)

(HM = mean monthly relative humidity - the mean of three readings, 0600, 1200, 1800 hours)

CW = .72 + .039 x W6 (1c)

(W6 = wind in km/hr at an instrument height of 6 meters)

CEV = 1.00 + .00007 x EL (1d)

(EL = elevation in meters).

The equation used for estimating potential evapotranspiration, ETP, can be written

ETP = .35 x RMM x CT x CH x CW x CE (2)

in which

CH = $.05 + 1.42 \times (1.00 - HM)^{1/2}$ (2a

(with a maximum value of CH = 1.00)

CW = .80 + .028 x W6 (2b

Table 1. Mean monthly values of extraterrestrial radiation

Latitude Degrees	Expressed as Equivalent Evaporation in Millimeters Per Day											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
North												
60	1.41	3.36	6.88	11.31	15.14	17.06	16.25	13.03	8.67	4.58	1.92	0.96
55	2.55	4.62	8.08	12.18	15.55	17.18	16.50	13.71	9.77	5.85	3.11	2.02
50	3.77	5.89	9.23	12.98	15.93	17.30	16.73	14.34	10.79	7.09	4.35	3.21
45	5.04	7.14	10.30	13.69	16.23	17.38	16.91	14.87	11.74	8.30	5.63	4.46
40	6.32	8.36	11.30	14.31	16.45	17.38	17.01	15.32	12.59	9.45	6.90	5.75
35	7.59	9.53	12.21	14.82	16.58	17.30	17.01	15.66	13.35	10.54	8.15	7.04
30	8.84	10.64	13.03	15.23	16.60	17.13	16.92	15.90	14.01	11.55	9.36	8.32
25	10.05	11.68	13.75	15.52	16.51	16.85	16.72	16.02	14.56	12.48	10.53	9.56
20	11.20	12.64	14.37	15.70	16.32	16.48	16.42	16.04	15.00	13.33	11.63	10.76
15	12.29	13.51	14.88	15.77	16.02	16.00	16.02	15.93	15.33	14.07	12.66	11.91
10	13.30	14.28	15.27	15.72	15.61	15.42	15.51	15.72	15.54	14.71	13.61	12.98
5	14.23	14.96	15.55	15.55	15.09	14.74	14.90	15.39	15.63	15.24	14.47	13.98
0	15.07	15.53	15.71	15.27	14.47	13.97	14.19	14.95	15.61	15.66	15.23	14.90

Table 1. (Continued)

Latitude Degrees	Expressed as Equivalent Evaporation in Millimeters Per Day											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
South												
- 5	15.81	15.98	15.75	14.88	13.76	13.12	13.39	14.41	15.46	15.96	15.89	15.72
-10	16.45	16.33	15.67	14.37	12.95	12.18	12.51	13.76	15.20	16.15	16.45	16.44
-15	16.98	16.55	15.48	13.76	12.06	11.17	11.54	13.01	14.82	16.21	16.89	17.06
-20	17.40	16.66	15.16	13.05	11.09	10.10	10.51	12.17	14.33	16.16	17.22	17.57
-25	17.71	16.65	14.73	12.24	10.05	8.97	9.42	11.25	13.73	15.99	17.43	17.97
-30	17.91	16.52	14.19	11.34	8.95	7.80	8.28	10.25	13.03	15.70	17.54	18.27
-35	17.99	16.27	13.54	10.36	7.80	6.61	7.10	9.18	12.23	15.29	17.52	18.46
-40	17.98	15.92	12.79	9.31	6.61	5.40	5.89	8.06	11.33	14.78	17.40	18.54
-45	17.86	15.46	11.94	8.19	5.41	4.19	4.69	6.89	10.35	14.16	17.18	18.54
-50	17.66	14.90	11.00	7.02	4.20	3.02	3.49	5.68	9.29	13.45	16.87	18.46
-55	17.40	14.25	9.98	5.81	3.01	1.90	2.34	4.46	8.16	12.64	16.49	18.33
-60	17.12	13.54	8.88	4.57	1.88	0.91	1.28	3.24	6.97	11.76	16.07	18.20

$$CE = 1.00 + .00004 \times EL \qquad (2c)$$

RMM and CT are the same as given in equation 1.

For estimating the evapotranspiration deficit, ETDF, the equation used was

$$ETDF = ETP - PD \qquad (3)$$

in which

$$PD = -10 + .70\ PM \qquad (3a)$$

PM = long term mean monthly precipitation in mm (3b)

Equation 3a was developed by plotting the 75 percent probability of precipitation from a gamma distribution analysis (that equaled or exceeded three years out of four) as a function of mean precipitation. Equation 3a is a best fit relationship for the precipitation data from Nicaragua, Colombia, Ecuador and 23 eastern states of the United States.

For the five stations, a moisture availability index, MAI, was calculated from the equation

$$MAI = PD/ETP \qquad (4)$$

Moisture Availability Analysis

For the five locations, a computer analysis was made of the moisture available from rainfall and its adequacy in meeting moisture requirements. The moisture availability index, MAI, is used as an index of moisture adequacy with the following classification:

MAI = 0 - .33	Very deficient
MAI = .34 - .67	Moderately deficient
MAI = .68 - 1.00	Somewhat deficient
MAI = 1.01 - 1.33	Adequate
MAI = 1.34 and above	Excessive

In the computer printout the following column headings are used:

Column Number	Symbol	Description
1	MO	The month of the year.
2	TM	Mean monthly temperature in ^{o}C.
3	HM	Mean monthly relative humidity expressed decimally (the average of readings at 600, 1200 and 1800 hours).
4	W6	Mean wind speed in km/hr at an instrument height of 6 meters from totalized data (estimated).
5	PREC	Mean monthly precipitation for the period of record.
6	RMM	Extraterrestrial radiation for the station latitude and for the monthly temperature expressed in equivalent mm of evaporation.
7	EVPC	Evaporation in mm calculated with an average correction for wind speed (CWV = 1.00).
8	EVPC 2	Evaporation in mm for equation 1 using a correction for estimated wind speed.

Column Number	Symbol	Description
9	ETP	Estimated potential evapotranspiration using an average correction for wind (CW = 1.00).
10	ETP2	Calculated potential evapotranspiration from equation 2 using estimated wind speed.
11	PD	Dependable precipitation from equation 3a.
12	ETDF	Evapotranspiration deficit from equation 3.
~~12~~ 13	MAI	Moisture availability index from equation 4.

The moisture availability analysis is given for Playitas, El Taladro, Comayagua, Flores and Siguatepeque as Table 2. In the Comayagua area, rainfall is very deficient during six months, is moderately deficient during two to four months, and is adequate or only somewhat deficient during two to four months.

Irrigation Requirements

Irrigation requirements depend upon the crops to be grown. Without information on the soils of the area and of the current areas in various crops, an estimation of possible future cropping is very approximate. Assumptions are made in order to prepare an example to be used in making more precise calculations as more information becomes available.

For purposes of this study the following crop pattern in percentage of irrigated area is assumed.

Table 2. Moisture Availability Analysis

PLAYITAS HON LAT 14 27 LONG 87 43 ELEV 630

MO	TM	HM	W6	PREC	RMM	EVPC	EVPC2	ETP	ETP2	PD	ETDF	MAI
1	22.3	.65	4.0	9.	391.	146.	128.	117.	107.	0.	107.	.00
2	22.7	.62	4.0	5.	386.	151.	133.	121.	110.	0.	110.	.00
3	24.7	.56	4.0	5.	467.	207.	181.	165.	151.	0.	151.	.00
4	25.3	.60	6.0	10.	475.	204.	194.	163.	158.	0.	158.	.00
5	25.9	.60	6.0	105.	456.	216.	206.	172.	167.	64.	103.	.38
6	26.4	.68	4.0	92.	478.	189.	166.	151.	138.	54.	84.	.39
7	25.8	.69	4.0	182.	495.	190.	167.	152.	139.	117.	21.	.85
8	25.8	.74	4.0	155.	495.	175.	154.	140.	128.	98.	29.	.77
9	25.8	.77	5.0	167.	465.	155.	142.	124.	117.	107.	10.	.92
10	26.1	.78	4.0	146.	445.	147.	129.	117.	107.	92.	15.	.86
11	22.6	.76	3.0	34.	389.	123.	103.	98.	87.	14.	73.	.16
12	22.6	.68	5.0	18.	380.	137.	126.	110.	103.	3.	100.	.03
AVE	24.7	.68	4.4	77.	447.	170.	152.	136.	126.	45.	80.	.36

EL TALADRO HON LAT 14 27 LONG 87 43 ELEV 531

MO	TM	HM	W6	PREC	RMM	EVPC	EVPC2	ETP	FTP2	PD	ETDF	MAI
1	23.0	.65	4.0	5.	391.	149.	130.	119.	109.	0.	109.	.00
2	23.4	.62	4.0	23.	386.	154.	135.	123.	112.	6.	106.	.05
3	24.7	.60	4.0	11.	467.	197.	173.	158.	144.	0.	144.	.00
4	26.5	.60	6.0	41.	476.	210.	200.	168.	162.	19.	144.	.12
5	27.1	.60	6.0	139.	497.	222.	212.	177.	172.	87.	89.	.51
6	25.7	.68	4.0	164.	478.	186.	163.	149.	136.	105.	31.	.77
7	26.1	.70	4.0	103.	495.	189.	165.	151.	138.	62.	76.	.45
8	25.8	.75	4.0	91.	495.	172.	151.	138.	126.	54.	72.	.43
9	25.7	.77	5.0	192.	465.	155.	142.	124.	116.	124.	-8.	1.07
10	24.9	.78	4.0	95.	444.	147.	125.	114.	104.	56.	47.	.54
11	23.0	.76	3.0	30.	389.	124.	104.	99.	88.	11.	77.	.13
12	22.9	.68	5.0	16.	380.	138.	127.	111.	104.	1.	103.	.01
AVE	24.9	.68	4.4	76.	447.	170.	152.	136.	126.	44.	82.	.34

Table 2. (Continued)

COMAYAGUA HON LAT 14 25 LONG 87 34 ELEV 579

MO	TM	HM	W6	PREC	RMM	EVPC	EVPC2	ETP	ETP2	PD	ETDF	MAI
1	21.6	.65	5.0	12.	391.	143.	131.	114.	108.	0.	108.	.00
2	23.0	.62	5.0	12.	386.	152.	139.	122.	114.	0.	114.	.00
3	24.5	.60	5.0	15.	467.	196.	179.	157.	147.	1.	145.	.01
4	25.5	.60	7.0	35.	476.	204.	203.	163.	163.	14.	148.	.09
5	26.5	.60	7.0	109.	496.	218.	217.	175.	174.	66.	108.	.38
6	25.5	.63	5.0	166.	478.	185.	169.	148.	139.	106.	33.	.76
7	25.6	.69	5.0	119.	495.	189.	173.	151.	142.	73.	69.	.52
8	25.9	.75	5.0	156.	495.	172.	157.	138.	129.	99.	30.	.77
9	25.2	.77	6.0	200.	464.	153.	146.	122.	118.	130.	-12.	1.10
10	24.8	.78	5.0	135.	444.	142.	130.	113.	107.	84.	22.	.79
11	23.7	.75	4.0	35.	390.	128.	112.	103.	94.	14.	79.	.15
12	23.7	.68	5.0	16.	380.	141.	125.	113.	106.	1.	105.	.01
AVE	24.5	.68	5.3	84.	447.	168.	157.	135.	128.	49.	79.	.38

FLORES HON LAT 14 15 LONG 87 34 ELEV 620

MO	TM	HM	W6	PREC	RMM	EVPC	EVPC2	ETP	ETP2	PD	ETDF	MAI
1	22.3	.65	5.5	3.	390.	146.	136.	116.	111.	0.	111.	.00
2	23.2	.62	5.5	8.	385.	153.	143.	122.	117.	0.	117.	.00
3	24.6	.60	5.5	12.	467.	197.	184.	157.	150.	0.	150.	.00
4	26.0	.60	7.5	21.	476.	207.	210.	166.	167.	5.	163.	.03
5	26.8	.60	7.5	172.	497.	220.	223.	176.	178.	110.	68.	.62
6	25.6	.63	5.5	156.	478.	186.	174.	149.	140.	99.	42.	.70
7	25.8	.70	5.5	102.	496.	188.	175.	150.	143.	61.	82.	.43
8	25.8	.75	5.5	109.	495.	172.	161.	138.	131.	66.	65.	.50
9	25.4	.77	6.5	177.	464.	154.	150.	123.	121.	114.	7.	.94
10	24.8	.78	5.5	115.	443.	142.	132.	113.	108.	70.	38.	.65
11	23.4	.75	4.5	18.	388.	125.	112.	100.	93.	3.	90.	.03
12	23.3	.68	5.5	4.	379.	139.	130.	111.	106.	0.	106.	.00
AVE	24.7	.68	5.8	75.	447.	169.	161.	135.	131.	44.	86.	.33

SIGUATEPEQUE HON LAT 14 35 LONG 87 36 ELEV 1378

MO	TM	HM	WG	PREC	PMM	EVPC	EVPC2	ETP	ETP2	PD	ETDF	MAI
1	17.9	.65	6.0	13.	390.	133.	127.	105.	102.	0.	102.	.00
2	18.1	.62	6.0	9.	385.	137.	131.	108.	105.	0.	105.	.00
3	21.0	.56	6.0	6.	466.	193.	184.	153.	148.	0.	148.	.00
4	21.8	.58	8.0	23.	474.	196.	203.	155.	159.	6.	153.	.04
5	22.2	.59	8.0	161.	494.	207.	213.	163.	167.	103.	64.	.61
6	22.6	.64	6.0	191.	[illegible]	187.	178.	148.	143.	124.	19.	.87
7	22.2	.66	6.0	188.	[illegible]	187.	178.	147.	143.	122.	21.	.85
8	22.2	.70	6.0	156.	493.	176.	168.	139.	135.	99.	35.	.74
9	22.0	.76	7.0	235.	463.	148.	147.	117.	117.	154.	-38.	1.33
10	21.0	.78	6.0	235.	443.	133.	127.	105.	101.	154.	-53.	1.52
11	19.4	.78	5.0	70.	389.	111.	102.	88.	83.	39.	44.	.47
12	18.1	.70	5.0	41.	379.	121.	111.	96.	93.	19.	71.	.21
AVE	20.7	.67	6.3	111.	445.	161.	156.	127.	124.	68.	56.	.55

Table 2. (Continued)

Crop	Percent of Area
Pasture	60
Corn and Beans	10
Vegetables (tomatoes, etc.)	5
Bananas and Plantain	5
Fallow	20
TOTAL	100

For purposes of estimating irrigation requirements, the printout for Comayagua is used. This is because the rainfall record is the longest and therefore probably the most representative. In the calculation of irrigation requirements the estimated potential evapotranspiration, ETP is multiplied by a crop coefficient. Crop coefficients for a wide variety of crops are given in Table 3.

Crop coefficients from Table 3 are used to setimate the irrigation requirements for the crops shown above. These are presented in Table 4, Irrigation Requirements, indicating a gross annual requirement of 1.76 meters depth of irrigation for surface irrigation at 55 percent application efficiency and an annual requirement of 1.29 meters for sprinkler irrigation at a 75 percent efficiency. This assumes that 20 percent of the area will be either fallow or used for crops produced by natural rainfall.

TABLE 3. CROP COEFFICIENTS, K

CROP	Root Depth in Meters	Full Crop Cover: Range in K	Full Crop Cover: Average K	Seasonal K: Range	Seasonal K: Mean
Field and Oil Crops	1.00-1.30	1.10-1.32	1.22	.73-.99	.89
Fruits					
Grapefruit	1.20		.79		.79
Naval Oranges	1.07		.65		.65
Grain and Forage Crops	1.12-1.35	1.08-1.70	1.37	.95-1.15	1.04
Grass Crops					
Bermuda Lawn	1.19		1.05		1.05
Blue Panicium Grass	1.20		1.11		1.11
Green Manure Crops	.86-1.31	.97-1.22	1.11	.85-1.18	.96
Winter Vegetables	.64-.95	1.22-1.86	1.45	.85-1.18	1.01
Summer Vegetables	.86-.95	1.22-1.40	1.28	.82-.84	.83

Notes: Root depth is zone from which 90 percent of soil moisture depletion occurred. Coefficients are to be used with estimated potential evapotranspiration, ETP.

Source: [1]Erie, L.J., Orrin F. French and Karl Harris, "Consumptive Use of Water by Crops in Arizona". (Tech. Bulletin 169: University of Arizona Agricultural Experiment Station, 1965), 44 pp.

[2]Middleton, J.E., O. W. Pruitt, P. C. Crandall and M. C. Jensen, "Central and Western Washington Consumptive Use and Evaporation Data, 1954-62", (Bulletin 681: Washington State University Agricultural Experiment Station, 1967), 7 pp.

Table 4. Irrigation Requirements (in mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
ETP in mm	114	122	157	163	175	148	151	138	122	113	103	113	1619
K for pasture, bananas, etc.	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	
K for corn and beans	1.25	1.20	.50								.65	.85	
K for vegetables	1.25	1.25	1.20	.50							.65	.85	
Pasture: K x ETP	142	152	196	204	218	185	189	172	152	141	129	141	2021
Corn: K x ETP	142	146	78								67	96	529
Veg: K x ETP	142	152	188	82							67	96	727
Pasture, etc., x 65%	92	99	125	133	142	120	123	112	99	92	84	92	
Corn, etc., x 10%	14	15	8								7	10	
Veg x 5%	7	8	9	4							3	5	
Fallow x 20%	0	0	0	0	13	11	23	20	21	18	3	1	
Weighted Total	113	122	144	137	155	131	146	132	120	110	97	108	1515
PD	0	0	0	0	64	54	117	98	107	92	14	3	549
Net Irrigation Requirement	113	122	144	137	91	77	29	34	13	18	83	105	966
Surface Irrigation (E = 55%)	205	222	262	249	165	140	53	62	24	33	155	191	1761
Sprinkler Irrigation (E = 75%)	151	163	192	183	121	103	39	45	17	24	111	140	1289

Summary and Conclusions

Soils, crop and economic information were not made available for this study. When these data become available, preferably in published form, further analysis should be made relative to the feasibility of the irrigation of particular crops. The economics of surface irrigation need to be compared with these for projected sprinkler irrigation.

The climate of the area seems well suited for the production of irrigated vegetables during the November through April dry season. Providing adequate areas of good soils are available and that favorable market conditions can be assured, vegetable production could in the future comprise significantly more than the five percent of the area assumed in the estimation of irrigation requirements.

By making various estimations and assumptions, an approximation of irrigation requirements is made. In order to confirm or adjust the assumptions with respect to the climate of the area, additional data are required. Mean monthly relative humidity as an average of three readings (600, 1200 and 1800 hours, or 0700, 1300 and 1900 hours) should be recorded for a period of several years at each location. Wind speed should be recorded and published in km/hr for each month from totalized data at an instrument height of six meters.

During the November through April period, moisture from rainfall is very deficient for crop and/or vegetative production. Rainfall during the May through October period is not seriously limiting on the production of annual crops suitable to the soils and climate of the region. Assuming adequate levels of fertility and inputs required to control weeds and insect pests, then non-irrigated agriculture during the rainy months may compete favorably with irrigated agriculture. Although this study does not permit definite conclusions to be drawn, it would seem desirable that a careful evaluation be made of the comparative economic benefits to be derived from expenditures for additional irrigation development as compared with the benefits possible from the use of fertilizer and other agricultural inputs.

Irrigation should seldom be developed as a single practice but as one of the requirements for development of a higher level of technology in agriculture. The sustained use of irrigation is frequently not economical without the use of fertilizer and of improved agricultural practices.

Acknowledgments

The methodology for "dependable precipitation" and "moisture availability index" was developed jointly with Jerald E. Christiansen, Professor Emeritus, Agricultural and Irrigation Engineering, Utah State University. The research leading to the equations used was financed by the Agency for International Development Contract AID/csd-2167 and carried out at Utah State University.

The data required and background information were made available by the Depto. de Estudios Hidrologicas y Climatologicas, Direccion

General de Irrigacion, Ministerio de Recursos Naturales Republica de Honduras and the WMO-UNDP Proyecto Hidrometroologico Centroamericano.