

Miscellaneous Paper No. 11



**AGRO-CLIMATIC ZONES MAP OF JAMAICA (1:250,000)
(First Edition)**

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**MINISTRY OF AGRICULTURE
RURAL PHYSICAL PLANNING DIVISION
JAMAICA SOIL SURVEY PROJECT**

SUMMARY

Studies of monthly rainfall, potential evapo-transpiration and air temperature data at 142 point locations in Jamaica show there is a fairly wide range of agro-climatic conditions in the island. Median rainfall ranges from 700 mm/year along the southern Clarendon border to over 6500 mm/year in the Blue Mountain range. Average potential evapo-transpiration, calculated according to Priestley and Taylor's formula, varies from 1600 mm/year to less than 1100 mm/year. The main 75%-dependable growing period is shorter than 2 months in the dry southern coastal plains, but 12 months long in the very humid eastern parishes. Mean daily air temperature gradually decreases from 26 to 13 degrees Celsius as the elevation increases from 0 to 2254 metre above mean sea level.

Jamaica is mapped into agro-climatic zones using 75%-dependable rainfall, potential evapo-transpiration and air temperature as the main differentiating criteria. Summary tables showing the median annual rainfall total and duration of the 75%-dependable growing period(s) for each point location are included in the report. About 10.7% of Jamaica belongs to the Dry Moisture Availability Zone (MAZ), 27.3% to the Intermediate MAZ, 49.3% to the Wet MAZ and 12.7% to the Very Wet MAZ. The distribution of mean daily air temperature is as follows: 24-26 degrees Celsius (54% of total extent), 22-24 degrees (30%), 20-22 degrees (12%), 17-20 degrees (3%) and 13-17 degrees (1%).

The digitized version of the 1:250,000 agro-climatic zones map can serve as the basis for national crop zoning studies using the Jamaica Geographical Information System (JAMGIS).

Broad delineations of the soil moisture and temperature regimes of USDA Soil Taxonomy in Jamaica are proposed. The udic and ustic moisture regimes are most extensive in the island, followed by the perudic, aridic and aquic regimes. Both the iso-thermic and iso-hyperthermic soil moisture regime occur in the island (5 resp. 95 per cent of total extent).

Key words: agro-climatic zones, soil moisture regime, soil temperature regime, Jamaica, JAMGIS.

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1. INTRODUCTION

A good understanding of the inter-relation between crop response and environmental conditions (e.g. climate, landform and soils) is needed in agro-economic planning, notably in Jamaica which shows a fairly wide range in climatic conditions (JMS 1973, SSU 1989c). To the author's knowledge a limited number of "agro-climatic" studies is available for Jamaica; the following review is not meant to be exhaustive. Quite a number of so-called "agro-climatic" maps only demarcate zones of similar mean annual rainfall (e.g. Rockie, undated). Other maps delineate areas of similar rainfall conditions on the basis of the average number of "dry" months, which are defined as receiving less than a pre-selected amounts of rainfall (e.g. Agric. Chem. Division 1969, Royes and Baccus 1988). In order to be more meaningful for agricultural planning, agro-climatic studies should also account for the fact that water availability to crops varies with the prevailing rainfall and evapo-transpiration conditions. IICA (1983) considered this inter-relation in its agro-climatic study of Jamaica. The 1.1 million scale of this map, however, is somewhat small for national planning purposes. Hence, there is a clear need for a more detailed agro-climatic zones map of Jamaica.

The main objectives of this study are to:

- 1) delineate zones of similar rainfall, potential evapo-transpiration and air temperature conditions at a scale of 1:250,000.
- 2) create a climatic data base (computerized map with key attribute tables) which can be used by planners for crop zoning studies at the regional and national level.
- 3) propose criteria which will allow for the global delineation of USDA soil moisture and temperature regimes in Jamaica.

The agro-climatic zones map can be used in conjunction with the General Soil Map of Jamaica (SSU 1985), which has been published at the same scale.

This report includes four chapters, two appendices and one enclosure. In Chapter 2 reference is made to the data sources and statistical procedures according to which the respective climatic data sets have been analyzed. The criteria for delineating the agro-climatic zones are discussed in Chapter 3, which also includes the findings of the study. Procedures for delineating soil moisture and temperature regimes in Jamaica are outlined in Chapter 4. This last chapter also outlines the general methodology for carrying out crop zoning studies using the Jamaica Geographical Information System (JAMGIS). Tables showing the duration of the 75%-dependable growing period(s), for the 142 rainfall recording stations under review, are included in

Appendix I. The names of these stations are listed on a parish basis in Appendix II. The 1:250,000 Agro-climatic Zones Map of Jamaica is enclosed in the report.

2. MATERIALS AND METHODS

2.1 Sources of climatic data

The National Meteorological Office boasts a good data base (see JMS 1973). Climatic data for 142 rainfall recording stations islandwide have been processed at the Rural Physical Planning Division using the Jamaica Physical Land Evaluation System (Batjes and Bouwman 1989, SSU 1989a). The resulting tables of monthly rainfall probabilities, potential evapo-transpiration and air temperature (SSU 1989c) form the data base for the present study.

2.2 Mapping procedure

Agro-climatic zones are mapped using the rating system developed by Soil Survey Staff (e.g. SSU 1989b).

The moisture availability zones and sub-zones were mapped on the basis of the joint interpretation of the "rainfall" statistics (SSU 1989c) and topographical features. All boundaries were manually drawn by interpolation on a 1:250,000 base map (Survey Department 1972). The average density of observations is 1.3 per 100 square kilometre, i.e. about 1 observation point per 12 square centimetre area on the 1:250,000 map. It should be noted that most stations are located in economically important and accessible areas. Consequently, there are only few observation points in the Cockpit Country and the Blue Mountain Range.

Air temperature in Jamaica is linearly related to elevation (see SSU 1989c). Air temperature zones are plotted on the basis of the 1000 feet contours of the topographical map of Jamaica (Survey Department 1972).

The boundaries mapped for the respective climatic zones are somewhat arbitrary because all climatic changes inherently are of a transitional nature. In some areas the boundaries of the temperature zones have been slightly shifted so that they coincide with the boundaries of nearby moisture availability zones. A limited number of complexes have been defined for air temperature in areas of intricate topography (e.g. Blue Mountains and Central Inlier). The above was necessary to keep the overall map pattern clear and legible.

The final map was processed with the Jamaica Geographical Information System (JAMGIS).

3. AGRO-CLIMATIC ZONES MAP

3.1 Moisture Availability Zones

An adequate rainfall supply is needed to ensure crop growth under rainfed conditions. The first entry on the legend divides the island into zones of similar moisture availability conditions. These zones are demarcated on the basis of the annual R75/PET ratio. R75 stands for 75%-dependable rainfall, i.e. the minimum rainfall total surpassed in 3 out of 4 years. It relates well to the risk that can be borne by small farmers in rainfed agriculture, i.e. a probability of having at the most one crop failure in every 4 years.

Soil Survey Staff have defined the Moisture Availability Zones (MAZ) on the basis of the R75/PET ratios (see SSU 1989b). The class defining values for these ratios are somewhat arbitrary in view of the limited amount of agricultural research on crop-water relationships under local environmental conditions. The selection of boundary defining criteria as shown in Table 1 therefore is mainly based on:

- "crop-moisture" relationships as discussed in FAO (1979) and ILACO (1981),
- field knowledge about the requirements of important economic crops such as banana, cacao, citrus, coconut, coffee and sugar cane.

Table 1. Class defining criteria for moisture availability zones (MAZ).

MAZ	R75/PET ratio	description
D	0.30 - 0.49	Dry
I	0.50 - 0.99	Intermediate
W	1.00 - 1.49	Wet
V	1.50 - 4.00(*)	Very wet

* Tentative upper boundary.

The "dry" zone is defined as an area having a marked water deficit during the major part of the year; few commercial crops can be grown satisfactorily unless irrigated. In the "intermediate" zone there also is a marked water period of deficit at some time of the year. However, the seasonal rainfall distribution is such that a wide range of climatically adapted crops can be grown under rainfed conditions, provided soil and management conditions are favourable. Dependable rainfall exceeds

PET in the "wet" and "very wet" zones. The "wet" zone has one or two dry periods which are clearly defined, yet short. Rainfall in the "very wet" zone is high throughout the year. As such, the "very wet" and "wet" moisture availability zones differ significantly in terms of overall "crop suitability". The "very wet" zone is mainly suited for crops which do not require a dry period to ensure good growth and harvesting. Climatically adapted crops for the respective moisture availability zones can be identified on the basis of agricultural handbooks (e.g. Booker 1984, ILACO 1981).

Table 2. Range in median annual rainfall observed in the respective moisture availability subzones.

sub MAZ	R75/PET ratio	N	median annual rainfall (mm)				
			R50	+ SD	CV	Min. Max.	
D1	0.30-0.39	8	828	45	5%	757	886
D2	0.40-0.49	10	953	68	7%	847	1025
I1	0.50-0.74	15	1273	156	12%	1021	1478
I2	0.75-0.99	40	1585	129	8%	1297	1850
W1	1.00-1.24	42	1941	125	6%	1765	2254
W2	1.25-1.49	10	2437	281	12%	2046	2980
V1	1.50-1.99	9	3139	418	13%	2350	3818
V2	2.00-2.49	6	4177	393	9%	3608	4658
V3	2.50-4.00	2	5738	1073	18%	4979	6497

Note: R50 is the median rainfall (mm/year), SD the standard deviation, CV the coefficient of variation, and N the number of observation points.

3.2 Dependable growing period zones

In this study, three moisture availability subzones are defined within the "very wet" zone. Previously, only two of such subzones were considered (SSU 1989b) but the updated data base (SSU 1989c) showed that further refinements were possible.

From Table 2 it is clear that fairly homogeneous moisture availability subzones can be delineated on the basis of the selected R75/PET ratios. The coefficients of variation for median annual rainfall in the nine subzones are rather small, i.e. between 5 and 18 per cent. The value of 18 per cent was obtained for the smallest sample. The total range in median rainfall in the sample population, however, is considerable (757-6497 mm/year).

Table 3 shows that the duration of the main 75%-dependable growing period is similar within each moisture availability subzone. However, the seasonal rainfall pattern within a particular subzone can vary widely from one parish to the other (see Appendix I). This is particularly evident in the case of the length of the short dependable growing period (see Table 3).

The starting date of the main 75%-dependable growing period has not been considered in the legend because this would have made the map too intricate (see Enclosure).

Table 3. Duration of the main and short 75%-dependable growing periods and number of consecutive "dry" months and cumulative "humid" months for the respective moisture availability subzones.

Moist. Avail. Subzone	N	MAIN 75%-DGP			SHORT 75%-DGP			Consec. "dry"			Cumul. "humid"		
		L	+- SD	CV	L	+- SD	CV	L	+- SD	CV	L	+- SD	CV
D1	8	1.3	0.5	37%	-	-	-	10	0.8	8%	0	-	-
D2	10	2.2	0.6	28%	-	-	-	5.1	0.9	19%	0	-	-
I1	15	4.0	0.9	23%	0.5	0.8	156%	4.3	0.8	19%	0.6	0.5	85%
I2	40	6.1	1.3	21%	1.4	1.4	103%	2.8	1.0	35%	1.5	0.8	55%
W1	42	8.0	1.6	20%	0.9	1.4	168%	1.7	1.0	62%	3.5	1.1	31%
W2	10	8.5	1.8	21%	1.4	1.9	136%	1.1	1.0	90%	4.8	1.1	24%
V1	9	9.1	1.5	16%	1.0	1.5	150%	0.7	0.7	106%	6.3	1.2	19%
V2	6	12.0	0.0	0%	-	-	-	-	-	-	8.1	1.7	21%
V3	2	12.0	0.0	0%	-	-	-	-	-	-	11.5	0.7	6%

* L is the average length of the feature considered and SD its standard deviation both expressed in months (rounded off to the nearest decimal place); CV is the coefficient of variation in per cent; "dry" means: $R75/PET < 0.30$; "humid" means: $R75/PET > 1.00$; '-' means not observed.

The general "R75/PET" pattern in each subzone is described on the legend to the agro-climatic zones map. Table 4 shows the extent of each moisture availability subzone. The "wet" zone is most extensive in the island, followed respectively by the "intermediate", "very wet" and "dry" zones (49.3%, 27.3%, 12.7% and 10.7% respectively). Basically, this implies that in almost 77% of the island numerous varieties of climatically adapted crops (e.g. temperature and photo-periodicity) can be produced under rainfed conditions. Extensive irrigation will be required in the "dry" zone, which mainly occurs along the southern coast line. Excessive rainfall is the main climatic limitation for agriculture in the "very wet" zone, which occurs along the Blue Mountain range and in the central, western part of the island.

Table 4. Extent of moisture availability zones in Jamaica.

MAZ subzone	extent	
	Km2	%
D1	504	4.7
D2	695	6.0
I1	998	9.1
I2	1,980	18.2
W1	4,184	38.3
W2	1,199	11.0
V1	675	6.3
V2	328	3.0
V3	377	3.4

* Km2 stands for square kilometres.

3.3 Air temperature zones

Altitude in Jamaica ranges from 0 to about 2254 metre above mean sea level causing mean daily air temperature to gradually decrease from 26 to 13 degrees Celsius. This linear relationship allows for the mapping of thermal classes according to Table 5. The extent of the respective classes is shown in Table 6.

A broad grouping of thermal classes gives the following information: mean daily air temperature fluctuates between 22-26, 17-22 and 13-17 degrees Celsius in about 83, 15 and 2 per cent of the island respectively. This reflects that a wide range of tropical, subtropical and temperate crops can be grown in selected locations in Jamaica. These areas can easily be identified using the GIS (see Section 4.2).

Table 5. Key to thermal classes (degrees Celsius).

Code	a	b	c	d	e
Tmin.	19-22	17-19	16-17	13-16	9-13
Tmean	24-26	22-24	20-22	17-20	13-17
Tmax.	29-32	27-29	25-27	22-25	18-22
Alt. (x100m)	0-3	3-6	6-9	9-15	>15

* Alt. is the approximate range in elevation.

Table 6. Extent of thermal zones in Jamaica.

Thermal class	extent	
	Km2	%
a	5,890	53.8
b	3,270	29.9
bc	184	1.7
c	1,093	10.0
cd	369	3.4
d	17	0.1
de	93	0.9
e	24	0.2

Note: Range of mean daily air temperature for class 'cd' is 17-22 degrees Celsius (see Table 5).

4. POSSIBLE APPLICATIONS

4.1 USDA soil classification

In order to permit sound classification according to USDA Soil Taxonomy (SMSS 1987a) the soil moisture and temperature regimes have to be determined. To this avail, the soil moisture and temperature regimes calculated for 15 locations in Jamaica (SMSS 1987b) were compared with the data shown in Tables 3 and 5. The results of these comparisons are presented in Tables 7 and 8 respectively.

Table 7. General relationship between soil moisture regimes and moisture availability zones in Jamaica.

Soil Moisture Regime	R75/PET ratio	Moisture Avail. Zone
Aridic	0.30-0.39	D1
Ustic	0.40-0.99	D2, I1 and most of I2*
Udic	1.00-2.49	W1, W2 and V1
Perudic	>2.50	V2 and V3

* The remaining part of I2 is Udic.

It should be noted that in semi-arid environments with sparse vegetation and poor physical soil properties, the soil moisture conditions can be drier than the annual R75/PET ratio would suggest.

The Aquic moisture is not represented in Table 7 because it cannot be delineated on the basis of the R75/PET ratio.

Two soil temperature regimes occur in Jamaica, namely the iso-hyperthermic and iso-thermic regime (see Table 8). The latter occurs only in limited extents in the Blue Mountain range and Central Inlier (Craig Head area).

Table 8. General relationship between soil temperature regime and thermal classes in Jamaica.

Soil Temperature Regime	average annual soil temperature	Thermal Zone
iso-thermic	15-22 deg. Celsius	d and e (>900 m)
iso-hyperthermic	>22 deg. Celsius	a, b, most of c (<900 m)

4.2 Regional crop zoning

The agro-climatic zones map and accompanying data base report (SSU 1989c) were mainly developed to serve as the "data base" for physical land evaluation studies using JAMPLES and crop zoning studies using JAMGIS. The general procedure for the latter type of studies has been developed and tested at RPPD within the framework of two GIS-studies (RPPD 1988 and 1989).

First, the agro-climatic requirements of the crops under study are identified, for instance through a search of literature (e.g. Booker 1984, FAO 1979 and ILACO 1981) which is complemented with local experience. Secondly, these requirements are expressed in the class-values of the map units (see Tables 2 and 4). This allows for GIS based matching of crop requirements with the agro-climatic mapping units, because both factors are expressed in the same units. The final result of this exercise is a series of maps which depict areas of similar agro-climatic suitability for the crop(s) under consideration. This type of GIS studies should be made at a scale of 1:250,000 in view of the resolution level of the existing data layers.

The terrain (slope data layer) and soil conditions (soils data layer) can be considered in more complex, agro-ecological crop zoning studies. It should be observed that such detailed studies will only be feasible in areas which have detailed environmental data bases (e.g. RPPD 1988).

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APPENDIX I

Duration and occurrence of the 75%-dependable growing period(s)
at 142 rainfall recording stations in Jamaica
grouped according to Moisture Availability Zones (MAZ).

General explanation:

Agro-climatic tables of monthly rainfall probabilities, potential evapo-transpiration and air temperature for all stations under review can be found in SSU (1989c).

Key to abbreviations used in following tables:

- : $R75 < 0.3 \times \text{PET}$, i.e. "dry" month in more than 25% of the years.
- p: $0.3 \leq R75/\text{PET} < 0.5$, field preparation is possible if at least the next two months qualify as a "M" or "H".
- M: $0.5 \leq R75/\text{PET} < 1.0$, sowing/planting or harvesting recommended in most cases.
- H: $1.0 \leq R75/\text{PET}$; period of net water surplus.
- u: utilization of "last" rains plus stored soil moisture.
The duration of 'u' is estimated at 1 month provided:
 - $0.3 \leq R75/\text{PET} < 0.50$ in specified month, and
 - preceding month qualified either as a "M" or "H".

Abbreviations used for parishes:

CL = Clarendon
HA = Hanover
KN = Kingston
MA = Manchester
SD = St. Andrew
SA = St. Ann
SC = St. Catherine
SE = St. Elizabeth
SJ = St. James
SM = St. Mary
ST = St. Thomas
PO = Portland
TR = Trelawny
WE = Westmoreland

Table 1: Time of occurrence of the 75% dependable growing period at selected stations of the "dry" moisture availability zone ($0.30 \leq R75/PET < 0.50$).

Parish Station	J	F	M	A	M	J	J	A	S	O	N	D	R75/PET	R50	Years
MAZ-D1															
SC Bernard Lodge	-	-	-	-	-	-	-	-	-	M	u	-	0.34	757	50-85
MA Gut River	-	-	-	-	-	-	-	-	p	M	-	-	0.35	782	31-51
KN Norman Manley	-	-	-	-	-	-	-	-	p	M	-	-	0.35	799	29-80
CL Tarrentum	-	-	-	-	-	-	-	-	-	M	-	-	0.36	870	54-80
CL New Monymusk	-	-	-	-	-	-	-	-	-	M	-	-	0.39	831	51-79
KN St. George's	-	-	-	-	-	-	-	p	p	M	-	-	0.39	839	31-80
SC Dawkins	-	-	-	-	-	-	-	-	p	M	u	-	0.39	859	50-79
CL Salt Savannah	-	-	-	-	-	-	-	-	p	M	-	-	0.39	886	51-80
MAZ-D2															
CL Amity Hall	-	-	-	-	p	-	-	-	M	M	-	-	0.41	863	51-68
CL Morelands	-	-	-	-	p	-	-	-	p	M	-	-	0.42	901	51-79
SC Spanish Town	-	-	-	-	p	-	-	-	p	M	u	-	0.42	847	51-79
CL Parnassus	-	-	-	-	p	-	-	-	p	M	u	-	0.45	1002	51-79
CL Milk Spring	-	-	-	-	p	-	-	-	M	M	-	-	0.46	898	51-68
CL New Yarmouth	-	-	-	-	p	-	-	-	p	M	u	-	0.46	1000	51-81
MA Alligator Po.	-	-	-	-	p	-	-	p	M	M	u	-	0.47	972	15-72
SC Old Harbour	-	-	-	-	p	-	-	-	p	M	u	-	0.49	1025	51-80
SA Runaway Bay	u	-	-	-	p	-	-	-	p	M	M	M	0.49	1007	31-75
TR Falmouth	-	-	-	-	p	-	-	-	p	M	M	u	0.49	1014	31-77

* Full station names are:
 St. George's College
 Alligator Pond

Table 2: Time of occurrence of the 75% dependable growing period(s) at selected stations of the "intermediate" moisture availability zone ($0.50 \leq R75/PET < 1.00$).

Parish Station	J	F	M	A	M	J	J	A	S	O	N	D	R75/PET	R50	Years
MAZ-I1															
TR Duncan's	u	-	-	-	p	-	-	-	p	M	M	M	0.51	1026	31-77
SJ Rose Hall	-	-	-	-	p	-	-	-	p	M	M	u	0.53	1021	31-68
CL May Pen	-	-	-	-	p	-	-	p	M	H	u	-	0.59	1148	51-80
SA Discovery Bay	M	u	-	-	p	-	-	-	p	M	H	M	0.60	1283	49-77
SJ Sangster Airp.	-	-	-	-	p	p	-	p	M	M	M	u	0.60	1112	63-80
SD Hope Gardens	-	-	-	-	p	-	-	p	M	H	M	-	0.61	1178	31-72
HA King's Vale	-	-	-	p	M	M	M	M	M	M	-	-	0.61	1327	31-61
SE Hounslow	-	-	-	M	u	-	-	M	M	H	M	u	0.62	1225	35-76
ST Yallahs	-	-	-	-	p	p	p	p	M	H	u	-	0.65	1417	31-68
SE Black River	-	-	-	p	M	-	p	M	M	M	M	-	0.66	1262	19-78
CL Sevens	-	-	-	-	p	-	-	M	M	H	M	-	0.67	1352	58-80
SJ Mo' Bay PWD	-	-	-	-	M	M	-	M	M	M	M	u	0.70	1378	31-77
CL Belle Plain	-	-	-	-	M	u	p	M	M	H	M	-	0.71	1476	51-79
ST Easington	-	-	-	-	p	p	p	M	M	H	u	-	0.72	1478	29-86
SE Southfield	-	-	-	p	M	-	-	p	M	H	M	-	0.72	1412	31-77

[continued overleaf]

* Full station names are:
 Sangster Airport
 Montego Bay Public Works Department (PWD)

Table 2 (cont.): Time of occurrence of the 75% dependable growing period(s) at selected stations of the "intermediate" moisture availability zone ($0.50 \leq R75/PET < 1.00$).

Parish Station	J	F	M	A	M	J	J	A	S	O	N	D	R75/PET	R50	Years
MAZ-I2															
WE Negril Pt. LH	-	-	-	p	M	M	M	M	M	M	u	p	0.75	1362	31-80
SA Ocho Rios	M	u	-	-	p	p	-	p	M	M	H	M	0.76	1526	31-77
SA St Ann's Bay	M	u	-	-	p	-	-	-	p	M	H	H	0.76	1500	30-77
TR Clark's Town	u	-	-	-	M	M	u	M	M	M	H	M	0.78	1465	31-77
SJ Hampden	u	-	-	-	M	M	u	M	M	M	M	M	0.79	1493	49-77
SA Alexandria	-	-	-	p	M	u	p	p	M	M	M	u	0.78	1297	32-75
SA Oracabessa	M	M	-	-	p	-	p	p	M	M	H	H	0.80	1691	31-77
SJ Anchovy	-	-	-	p	M	M	M	M	H	M	M	u	0.80	1443	31-50
WE Sav. La Mar	-	-	-	p	M	M	M	M	H	H	u	-	0.80	1478	31-80
SC Ewarton	-	-	-	p	M	M	M	M	M	H	M	-	0.81	1376	50-80
CL Chapelton	-	-	-	p	M	u	-	M	M	H	M	-	0.82	1544	51-80
SM Port Maria	M	u	-	p	p	-	p	p	p	M	H	H	0.83	1607	51-80
SC Swansea	-	-	-	-	M	M	u	M	M	H	M	u	0.83	1452	48-89
HA Lucea	p	-	-	-	M	M	M	M	H	H	M	u	0.83	1609	31-77
SJ Adelphi	u	-	-	-	M	M	u	M	M	H	M	M	0.83	1481	32-68
TR Stewart Town	M	-	-	p	M	M	u	M	M	M	H	M	0.85	1479	41-78
CL Beckford Kraal	p	-	-	M	M	u	p	M	M	H	M	u	0.85	1535	66-80
SC Worthy Park	-	-	-	-	M	M	M	M	M	H	M	u	0.86	1526	01-89
SM Agualta Vale	M	M	u	p	p	-	-	p	M	M	H	M	0.86	1711	51-80
ST Morant Pt. LH	M	-	-	-	M	u	-	p	M	H	H	M	0.87	1696	31-80
SD Gordon Town	-	-	-	p	M	u	-	M	H	H	M	u	0.88	1694	31-68
SC Bog Walk	-	-	-	-	M	M	M	M	M	H	M	-	0.89	1518	50-76
SC Enfield	-	-	-	p	M	M	M	M	M	M	M	u	0.89	1602	50-80
SC Linstead	-	-	-	-	M	M	M	M	H	H	M	u	0.89	1640	51-77
SC Wakefield	-	-	-	p	M	M	M	M	M	H	M	-	0.89	1613	50-80
SM Iter Boreale	H	M	u	M	u	-	-	p	p	M	H	H	0.90	1674	51-80
SM Annotto Bay	M	M	u	p	p	-	-	p	p	M	H	H	0.91	1774	51-80
SC Charming Hole	p	p	-	p	M	M	M	M	H	H	M	u	0.91	1551	51-89
SD Constant Spr.	-	-	-	p	M	u	p	M	H	H	M	u	0.93	1636	35-78
MA Porus	-	-	-	p	M	M	u	M	H	H	M	u	0.93	1813	48-80
SC Corn Ground	-	-	-	p	M	M	M	M	H	H	M	u	0.94	1662	51-89
ST Morant Bay	p	-	-	-	p	M	M	M	H	H	M	u	0.94	1850	31-68
SC New Hall	-	-	-	p	M	M	M	M	M	H	M	u	0.95	1671	50-80
MA Hartham	p	-	-	p	M	u	p	M	M	H	M	u	0.95	1534	55-80
MA Spur Tree	u	-	-	M	M	M	-	M	H	H	M	M	0.95	1532	60-80
SA Brownstown	M	M	-	p	M	u	-	p	M	H	H	H	0.98	1713	01-77
SA Cave Valley	-	-	-	M	H	M	u	M	H	H	u	-	0.99	1637	31-77
SE Lacovia	-	-	p	M	H	M	u	H	M	H	M	u	0.99	1798	31-77
CL Croftshill	-	-	-	p	M	M	u	p	H	H	M	u	0.99	1655	51-80
MA New Port	p	-	p	p	M	M	u	M	H	H	M	u	0.99	1579	51-80

* Full station names are:
 Negril Point Lighthouse
 Morant Point Lighthouse
 Constant Spring

Table 3: Time of occurrence of the 75% dependable growing period(s) at selected stations of the "wet" moisture availability zone (1.00<= R75/PET<1.50).

Parish Station	J	F	M	A	M	J	J	A	S	O	N	D	R75/PET	R50	Years
MAZ-W1															
SM Richmond PF	H	M	-	-	P	P	P	P	M	H	H	H	1.00	1812	51-80
SC Glengoffe	U	-	-	-	P	M	M	-	M	H	H	M	1.03	1906	50-79
SM Orange River	H	M	U	-	P	M	U	-	M	M	M	H	1.03	1838	51-80
SM Fort Stewart	H	M	U	M	M	-	-	P	M	M	H	H	1.03	1946	51-80
SM Hampstead	H	M	M	M	M	M	-	P	P	M	H	H	1.04	1952	51-80
SA Claremont	M	U	P	P	P	M	M	M	M	H	H	H	1.04	1844	29-78
SA Moneague	M	U	P	P	P	M	M	M	M	H	H	M	1.04	1862	01-77
SC Riversdale	U	-	-	-	P	M	M	M	M	H	H	M	1.04	1810	50-80
ST Duckenfield	M	U	-	-	P	M	M	M	M	H	H	M	1.04	1955	51-80
CL Frankfield	-	-	-	-	P	M	M	M	M	H	H	M	1.05	1900	51-80
SM Grays Inn	H	M	U	-	P	P	M	-	M	H	H	H	1.05	1977	51-80
SM Dover	H	M	U	U	P	P	P	P	M	H	H	H	1.05	2022	51-80
MA Williamsfield	-	-	-	P	M	M	M	M	M	H	H	U	1.06	1858	51-80
MA Grove Place	-	-	-	P	M	M	M	M	M	H	H	U	1.07	1765	31-77
HA Green Island	-	-	-	P	M	M	M	M	M	H	H	U	1.08	2023	31-77
SE Santa Cruz	-	-	-	P	M	M	M	M	M	H	H	U	1.09	1991	01-77
SM Lucky Hill	H	M	U	P	M	M	U	P	M	H	H	H	1.10	1960	51-80
SE Holland	-	-	-	P	M	M	M	M	M	H	H	U	1.10	1946	36-80
MA Kendal	-	-	-	P	M	M	M	M	M	H	H	U	1.10	1894	31-72
WE Little London	-	-	-	P	M	M	M	M	M	H	H	M	1.10	2010	31-68
MA Green Vale	-	-	-	P	M	M	M	M	M	H	H	M	1.10	1708	51-80
SM Brainerd	M	U	-	-	M	M	M	M	M	H	H	H	1.10	1937	51-80
SD Stony Hill	-	-	-	-	M	M	M	M	M	H	H	U	1.11	1940	31-77
SC Mason River	P	P	-	-	M	M	M	M	M	H	H	U	1.11	1770	66-80
ST Serge Island	P	P	-	-	M	M	M	M	M	H	H	U	1.12	2121	48-68
SC Point Hill	P	P	-	-	M	M	M	M	M	H	H	U	1.13	1819	51-79
MA Mile Gully	P	P	P	P	M	M	M	M	M	H	H	U	1.14	1776	51-80
MA Mandeville	P	-	P	P	M	M	M	M	M	H	H	U	1.14	1867	51-80
SC Spaldings	P	P	P	P	M	M	M	M	M	H	H	U	1.14	1780	58-80
CL Kelits	P	P	P	P	M	M	M	M	M	H	H	U	1.15	2016	51-80
MA Manchester P.	U	-	-	-	M	M	M	M	M	H	H	M	1.16	2035	63-83
SM Carron Hall	H	M	U	U	M	M	M	M	M	H	H	H	1.18	1960	51-80
WE Bluefields	P	-	P	P	M	M	M	M	M	H	H	U	1.18	2136	31-80
SM Wey Hill	M	U	P	P	M	M	M	M	M	H	H	U	1.20	2254	51-80
MA Christiana	-	-	-	-	M	M	M	M	M	H	H	U	1.20	1895	51-80
SC Sligoville	-	-	-	-	M	M	M	M	M	H	H	U	1.20	1921	50-80
WE Frome II	-	-	-	-	M	M	M	M	M	H	H	U	1.22	2166	45-68
TR Albert Town	-	-	-	-	M	M	M	M	M	H	H	U	1.22	1953	31-68
SE BalacIaya	-	-	-	-	M	M	M	M	M	H	H	U	1.22	2253	31-80
SJ Montpelier	P	P	-	-	M	M	M	M	M	H	H	U	1.23	2089	51-87
MA Marshall Pen	-	-	-	-	M	M	M	M	M	H	H	U	1.24	1922	51-80
MA Tregeron	-	-	-	-	M	M	M	M	M	H	H	U	1.24	1942	51-72

* Full station names are:
 Richmond Prison Farm
 Manchester Pastures

Table 3 (cont.): Time of occurrence of the 75% dependable growing period(s) at selected stations of the "wet" moisture availability zone ($1.00 \leq R75/PET < 1.50$).

Parish Station	J	F	M	A	M	J	J	A	S	O	N	D	R75/PET	R50	Years
MAZ-W2															
PO Buff Bay	H	M	u	p	M	u	M	M	M	H	H	H	1.29	2487	31-77
WE Lambs River	-	p	-	M	H	H	H	H	H	H	M	u	1.33	2214	51-87
SM Castelton Gar.	M	u	-	M	H	M	u	H	H	H	H	H	1.33	2456	51-80
SM Enfield	H	M	M	M	u	p	-	p	M	H	H	H	1.33	2670	52-80
SJ Catadupa	-	p	p	M	H	H	H	H	H	H	M	-	1.33	2462	51-87
SC Guy's Hill	H	M	u	M	M	M	u	M	M	H	H	H	1.35	2342	51-80
CL Thompson Town	-	-	-	M	H	M	M	M	H	H	M	M	1.38	2098	51-79
MA Craig Head	p	-	p	H	H	M	u	H	H	H	M	u	1.46	2046	51-80
WE Mint	-	-	p	M	H	H	H	H	H	H	M	u	1.48	2618	45-77
PO Caenwood	H	M	u	M	M	M	M	M	M	H	H	H	1.49	2980	45-80

* Full station name is:
Castleton Gardens

Table 4: Time of occurrence of the 75% dependable growing period(s) at selected stations of the "very wet" moisture availability zone ($1.50 \leq R75/PET < 4.00$).

Parish Station	J	F	M	A	M	J	J	A	S	O	N	D	R75/PET	R50	Years
MAZ-V1															
PO Cedar Valley	M	M	u	M	H	u	p	M	H	H	H	H	1.53	2677	31-78
WE New Market	p	p	p	H	H	H	H	H	H	H	M	u	1.58	3331	31-80
SD Cinchona	M	M	u	M	H	u	-	M	H	H	H	H	1.60	2350	51-80
PO Manchioneal	M	M	-	p	H	H	M	H	H	H	H	H	1.60	3171	31-68
PO Bath	M	u	-	M	H	M	M	H	H	H	H	H	1.72	3116	31-77
PO Port Antonio	H	u	-	p	H	H	H	H	H	H	H	H	1.76	3319	31-77
WE Bethel Town	-	p	p	M	H	H	H	H	H	H	M	-	1.78	3320	51-87
HA Cascade	M	u	p	M	H	H	H	H	H	H	M	M	1.87	3153	34-80
PO Balcarres	H	M	u	M	H	u	p	p	H	H	H	H	1.88	3818	31-68
MAZ-V2															
PO Darley	H	H	M	M	H	H	H	M	H	H	H	H	2.03	3608	35-77
PO Swift River	H	H	M	H	M	M	M	M	M	H	H	H	2.09	3923	31-67
PO Fruitful Vale	H	H	M	M	M	M	M	M	H	H	H	H	2.31	4435	35-77
ST Barret's Gap	H	M	u	M	H	H	H	H	H	H	H	H	2.31	4019	31-77
PO Fellowship	H	M	u	M	H	H	H	H	H	H	H	H	2.35	4424	51-77
PO Ecclesdown	H	H	M	M	H	H	H	H	H	H	H	H	2.42	4658	41-77
MAZ-V3															
PO Moore Town	H	H	M	H	H	H	H	H	H	H	H	H	2.83	4979	51-80
PO Millbank	H	H	H	H	H	H	H	H	H	H	H	H	3.49	6497	51-80

APPENDIX II

Names of rainfall recording stations

CLARENDON

- Amity Hall
- Beckford Kraal
- Belle Plain
- Chapelton
- Croftshill
- Frankfield
- Kellits
- New Monymusk
- New Yarmouth
- May Pen
- Mason River
- Milk Spring
- Morelands
- Parnassus
- Salt Savanna
- Sevens
- Spaldings
- Tarrentum
- Thompson Town.

HANOVER

- Cascade
- Green Island
- King's Vale
- Lucea

KINGSTON AND ST. ANDREW

- Cinchona
- Constant Spring
- Gordon Town
- Hope Gardens
- Norman Manley International Airport
- St. Georges College
- Stony Hill

MANCHESTER

- Alligator Pond
- Christiana
- Craig Head
- Hartham
- Kendal

- Green Vale
- Grove Place
- Gut River
- Manchester Pastures
- Mandeville
- Marshall's Pen
- Mile Gully
- New Port
- Porus
- Spur Tree H.E.
- Tregaron
- Williamsfield

ST. ANN

- Alexandria
- Brownstown
- Cave Valley
- Claremont
- Discovery Bay
- Moneague
- Ocho Rios
- Runaway Bay
- St. Ann's Bay

ST. CATHERINE

- Bernard Lodge
- Bog Walk
- Charming Hole
- Corn Ground
- Dawkins
- Enfield
- Ewarton
- Glengoffe
- Grass Piece
- Linstead
- New Hall
- Point Hill
- Riversdale
- Sligoville
- Spanish Town
- Swansea
- Wakefield
- Worthy Park

ST. ELIZABETH

- Balaclava
- Black River
- Holland
- Hounslow

- Lacovia
- Santa Cruz
- Southfield

ST. JAMES

- Adelphi
- Anchovy
- Catadupa
- Hampden
- Montego Bay PWD
- Montpelier
- Rose Hall
- Sangster International Airport (Montego Bay)

ST. MARY

- Aqualta Vale
- Annotto Bay
- Brainerd
- Carron Hall
- Castleton
- Dover
- Enfield
- Fort Stewart
- Gray's Inn
- Guy's Hill
- Hampstead
- Iter Boreale
- Lucky Hill
- Oracabessa
- Orange River
- Port Maria
- Richmond Prison Farm
- Wey Hill

ST. THOMAS

- Barret's Gap
- Bath
- Duckenfield
- Easington
- Morant Bay
- Morant Point Light House
- Serge Island
- Yallahs

PORTLAND

- Balcarres
- Buff Bay
- Caenwood

- Cedar Valley
- Darley
- Ecclesdown
- Fellowship
- Fruitful Vale
- Manchioneal
- Millbank
- Moore Town
- Port Antonio
- Swift River

TRELAWNY

- Albert Town
- Clark's Town
- Duncan's
- Falmouth
- Stewart Town

WESTMORELAND

- Bethel Town
- Bluefields
- Frome II
- Lambs River
- Little London
- Mint
- Negril Point Light House
- New Market
- Savanna La Mar