

Using Climate Data to Increase Agriculture Yields



- Venue: Online
- Date: 14 September 2021
- Presenter: Antonio R.T. Joyette, PhD.

Layout of Presentation

- 1. Introduction & Background**
- 2. Objectives**
- 3. Climate Elements &**
- 4. Potential Impacts On Crops**
- 5. Simple Weather Station**
- 6. Available Climate Data For Agriculture**
- 7. Accessing Climate Data**



Objective of Presentation

- 1. Objective 1: Identify important weather and climate elements that are important in agriculture;**
- 2. Objective 2: Outline some potential impacts of weather and climate elements on agriculture;**
- 3. Objective 3: Identify DIY components of a simple weather station, or an alternative suitable for monitoring weather;**
- 4. Objective 4: Identify datasets available and suggest ways in which they may be accessed;**

Introduction & Background

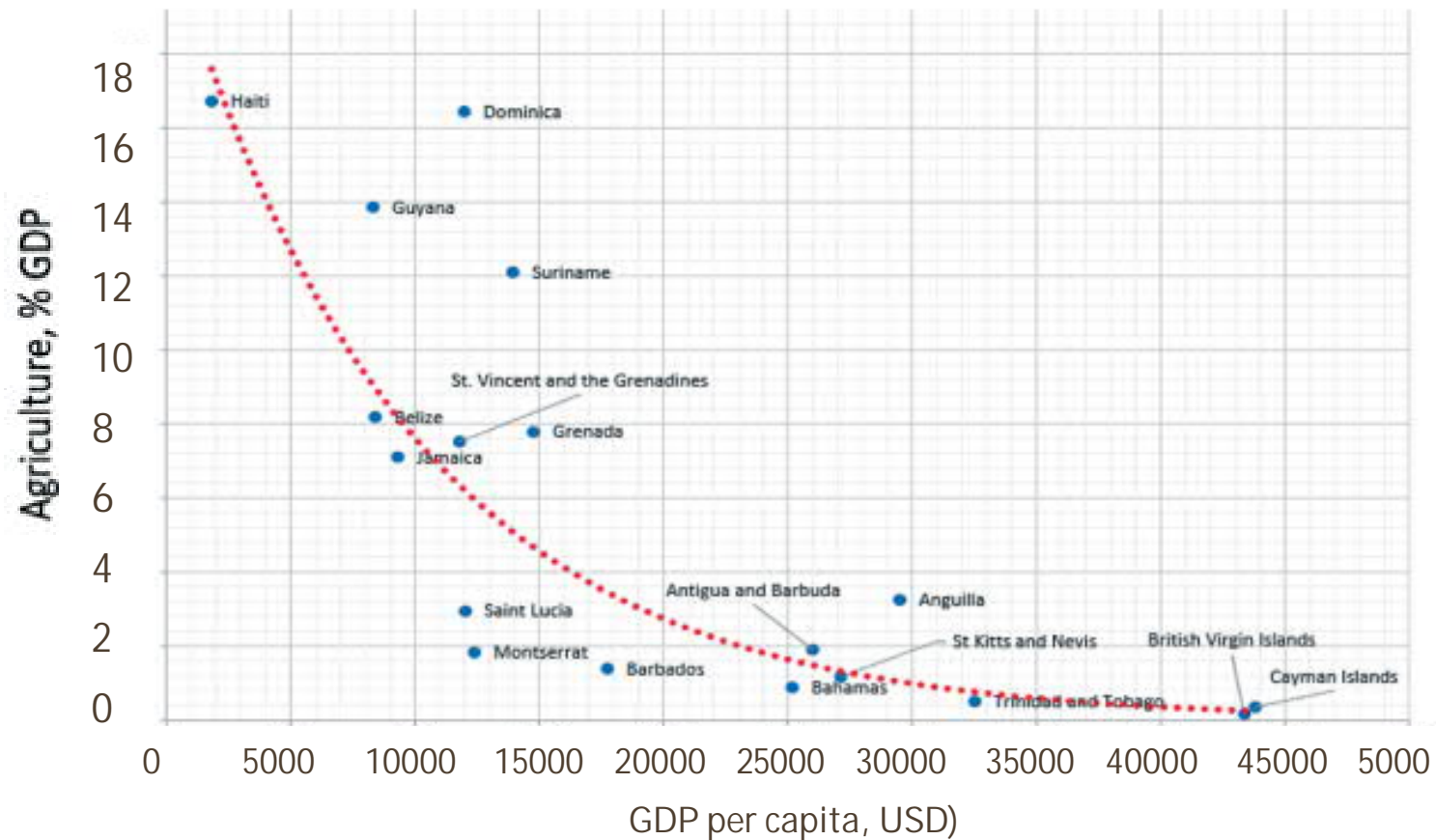
- Agriculture Remains Important in the Caribbean
 - As employment
 - As livelihood
 - As Food Security
 - As Foreign Exchange Earner
 - Basic Subsistence

In the region agriculture's contribution to GDP now ranges between 17% and less than 1%, in Haiti and Montserrat, respectively.

Typically, agriculture employs between 10-25% of labour force. However, employment in Haiti is near 50%.

Introduction & Background

GDP per capita and share of agriculture in GDP in the Caribbean



Source : FAO 2019

Introduction & Background

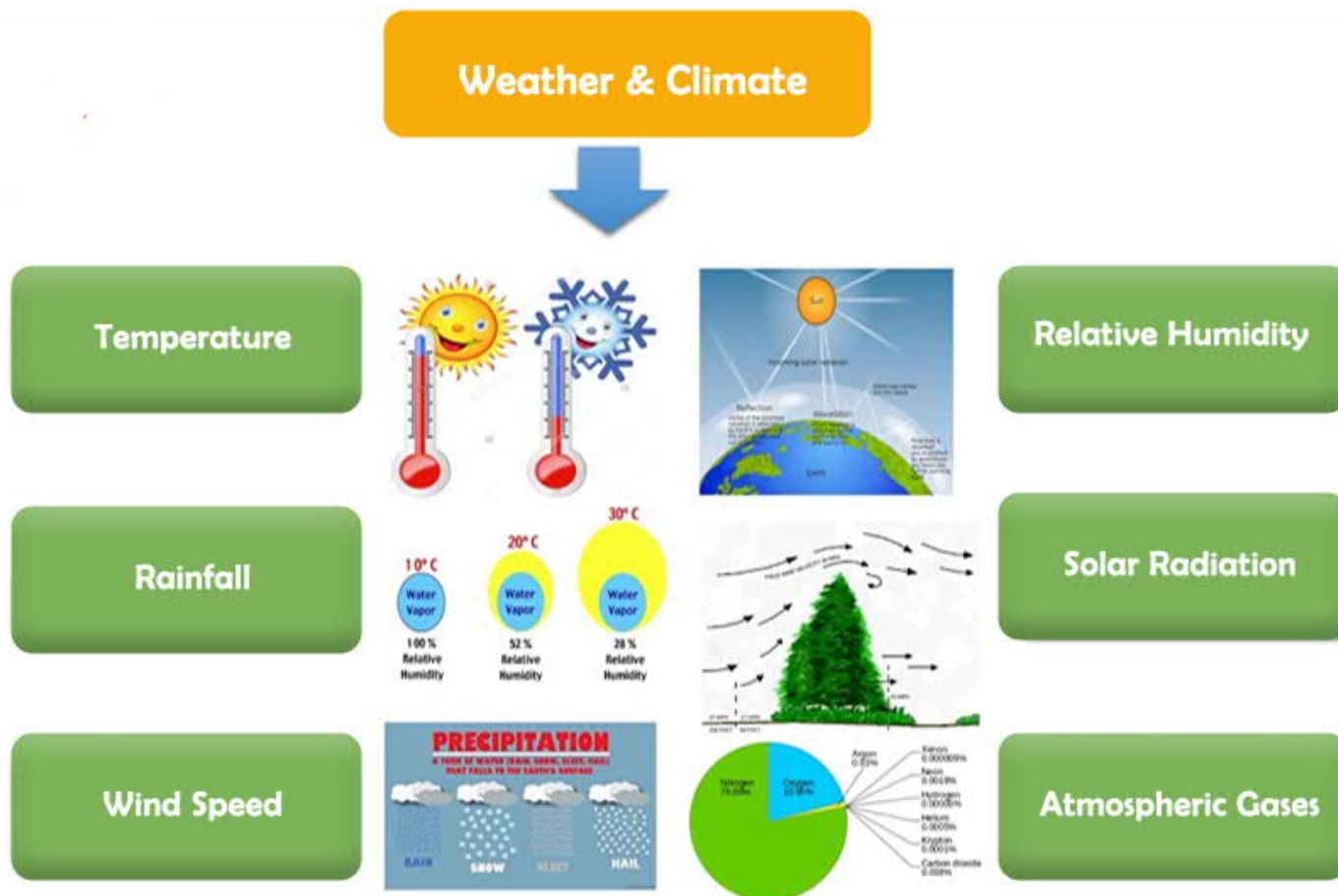
- Meteorological and Climate Data In the Caribbean
 - Early Use of Weather Information – ~1900s ; 1950s
 - Shipping, Aviation and Plantations
 - Climate Data - Real value - 1970s
 - CMO (CIMH); NMHS, UWI, 5Cs; etc.
 - Technology and Climate Data Today
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Weather & Climate For Agriculture

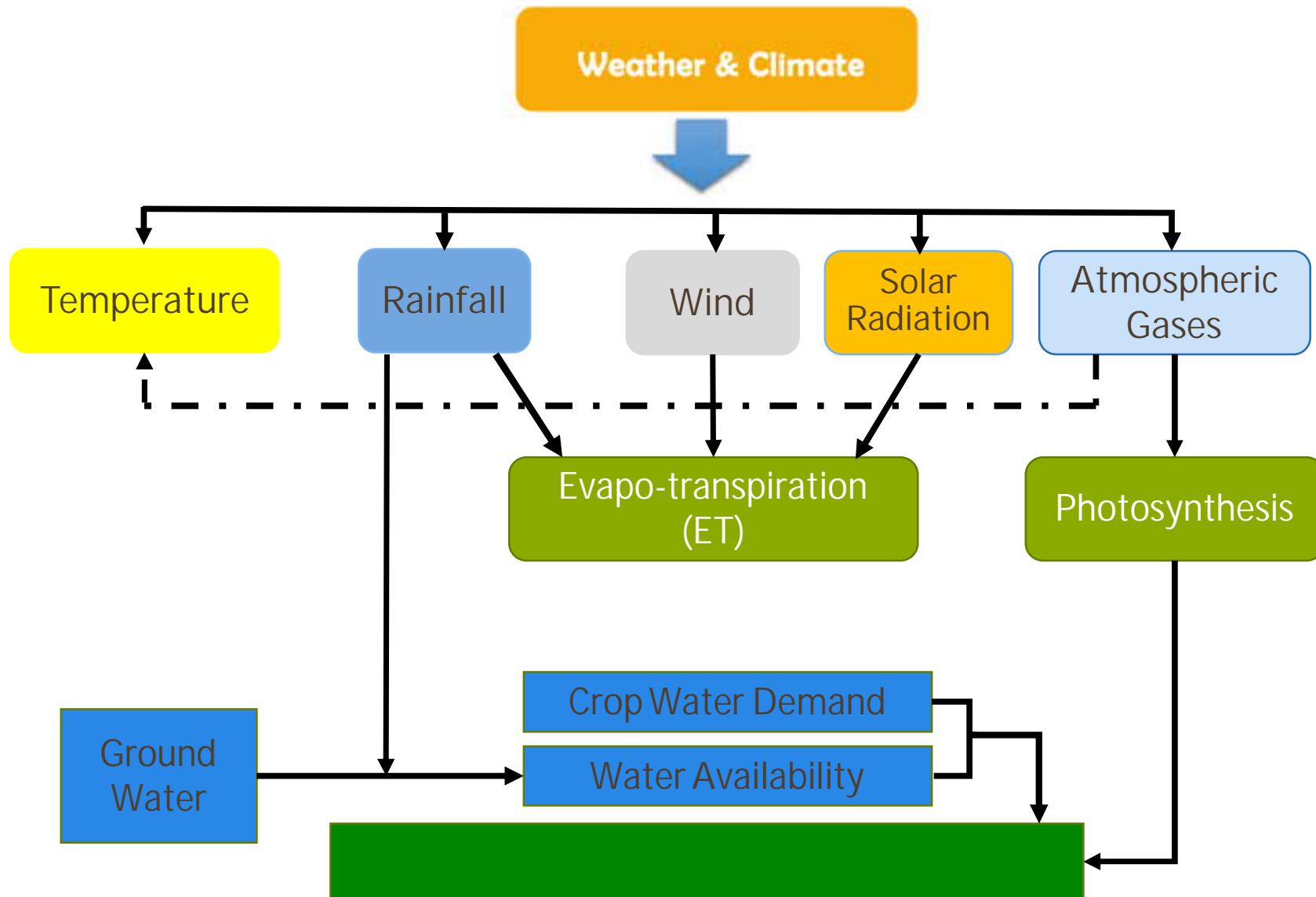
- Meteorological and or climate data are vital for agricultural production.
 - Helps to understand the climate variations that exist across countries;
 - Gives invaluable insight into the weather and micro-climate affecting farmers areas/ lands/ plantation etc.;
 - Weather information is also useful as input data in crop models for a variety of research applications to improve food security;

Weather & Climate For Agriculture

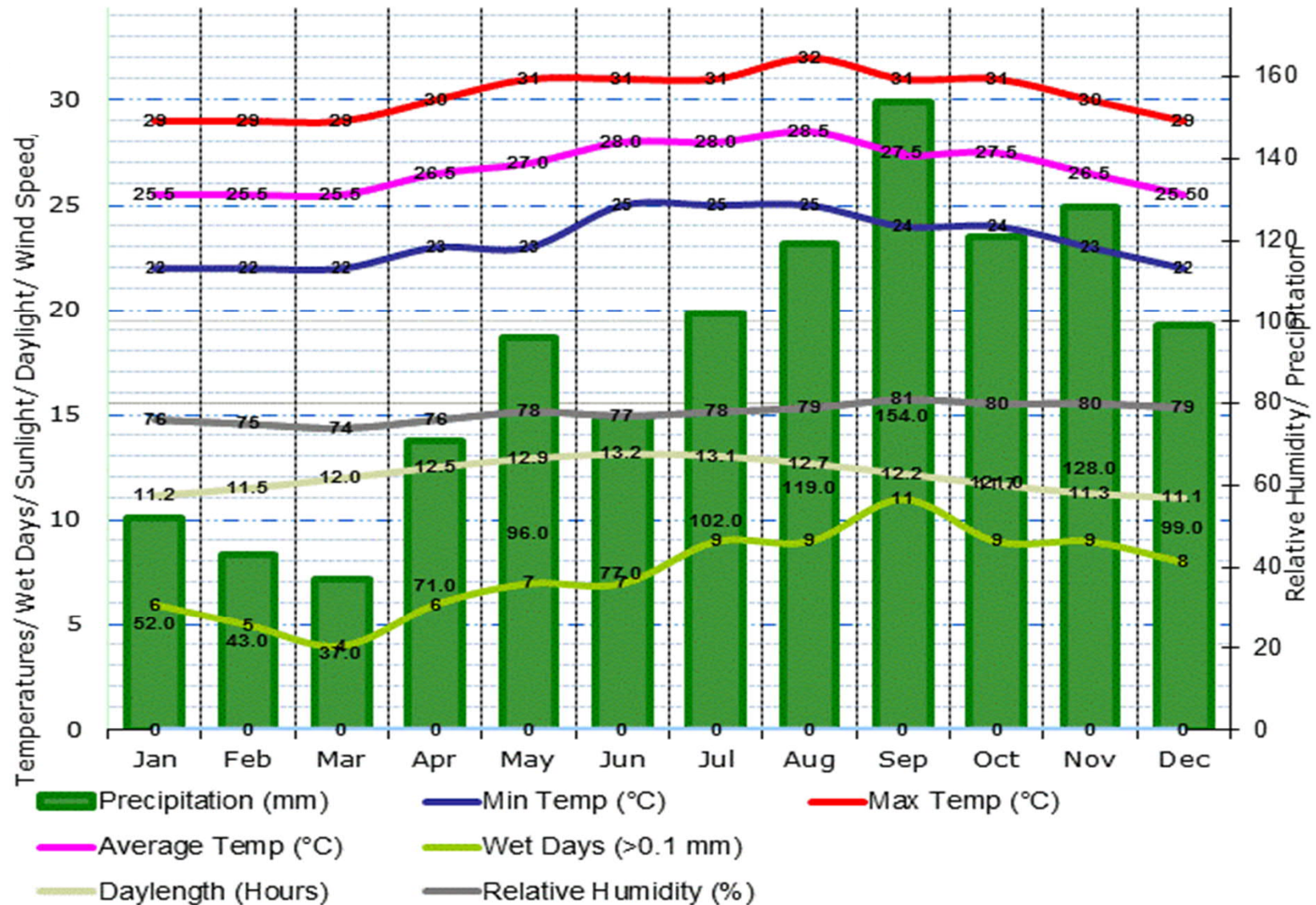
Some Climate Factors Affecting Crop Production



Weather & Climate For Agriculture



Temperature



Impact OF 2°C rise on Agriculture

Preliminary studies on the impact on the staples -corn, beans and rice for 2°C warmer and +/- 20% change in precipitation

Crop	Scenario Name	Season Length (days)	Temperature Change (°C)	% Change in precipitation	Yield (kg/ha)	% change in Yield
Dry beans C3	Baseline	87	0	0	1353.6	
	Carib A	85	+2	+20	1163.7	-14%
		85	+2	-20	1092.6	-19%
Rice C3	Baseline	124	0	0	3355.5	
	Carib A	113	+2	+20	3014.4	-10%
		113	+2	-20	2887.5	-14%
Maize C4	Baseline	104	0	0	4510.6	
	Carib A	97	+2	+20	3736.6	-22%
		97	+2	-20	3759.4	-17%

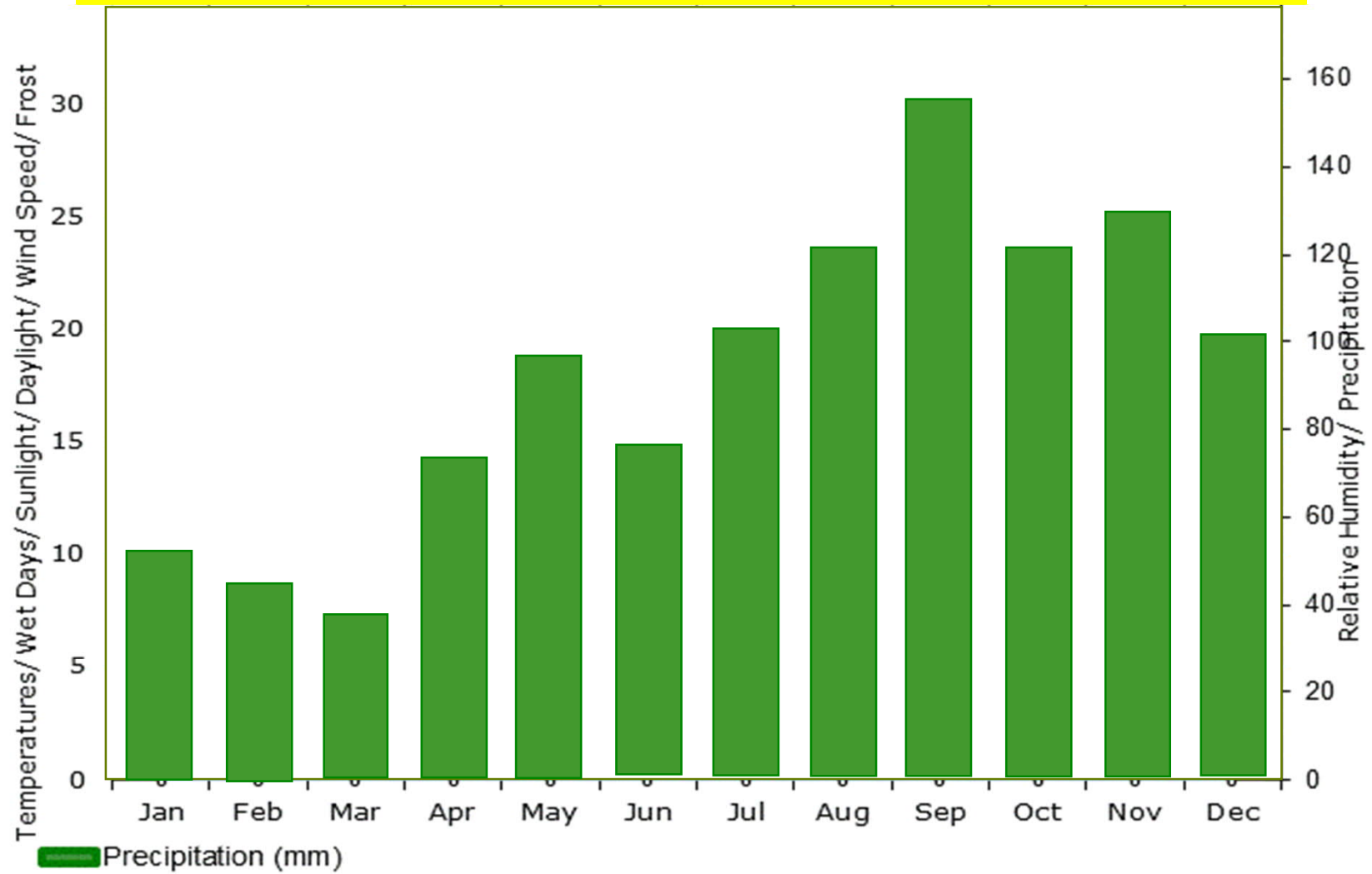
Source: Fuller/CCCCC 2012

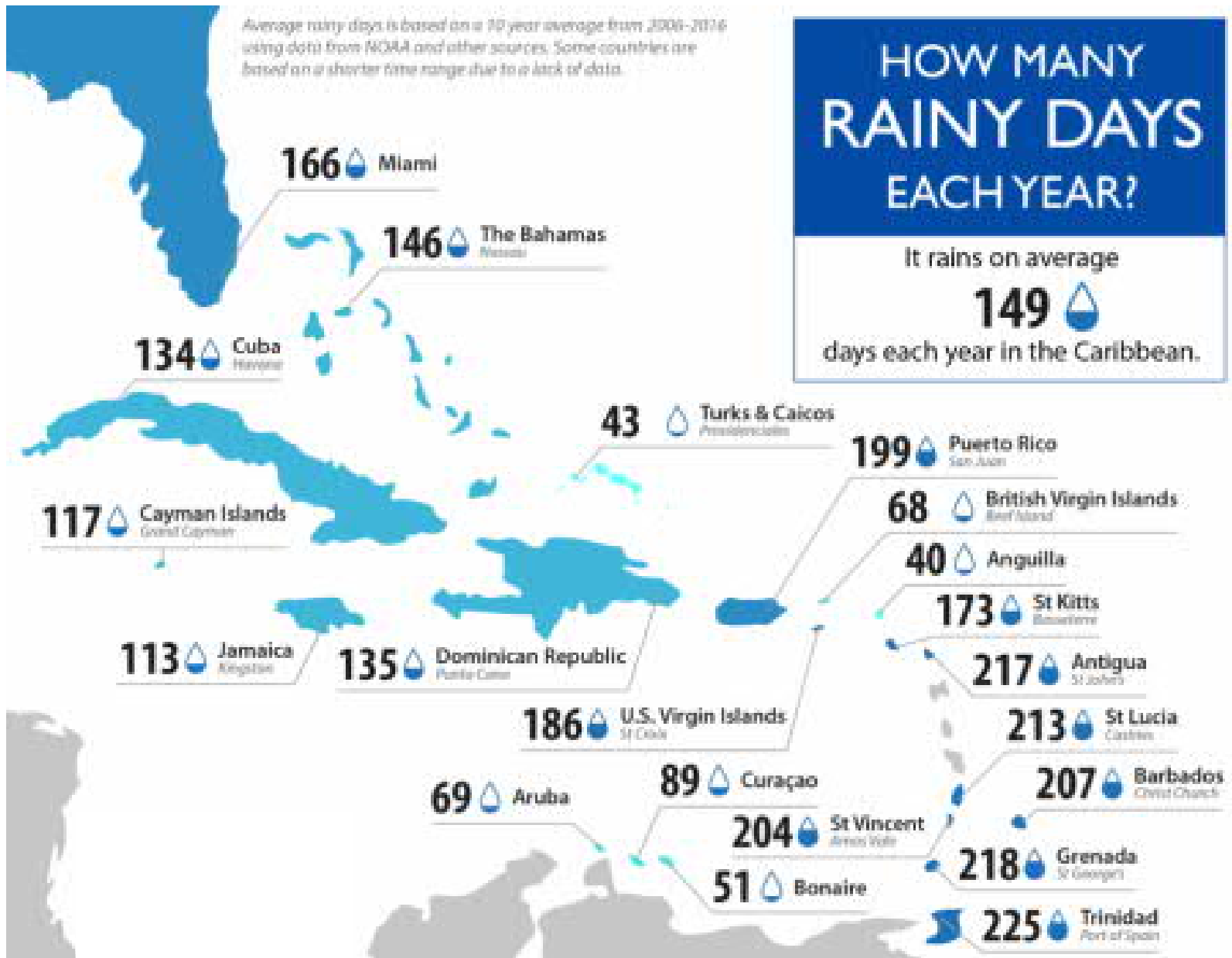
Vulnerability Studies on Agriculture in Belize

- 2008
- **PRECIS, DSSAT4 and Cropwat**
- Sugarcane and Citrus
- 2028 & 2050
- 1 & 2.5°C rise in temp
- \pm 12 & 20% change in precipitation
- Result: 12-17% decline in yields for sugarcane
- Result: 3 – 5% decline in yields for citrus

Source: Fuller/CCCCC 2012

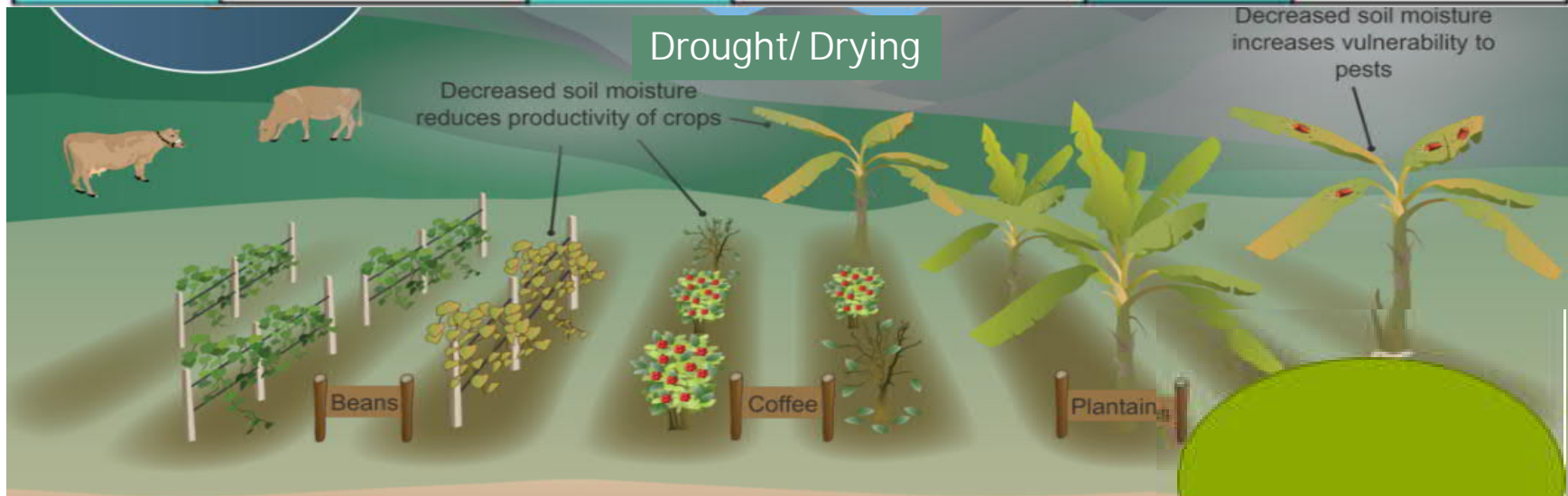
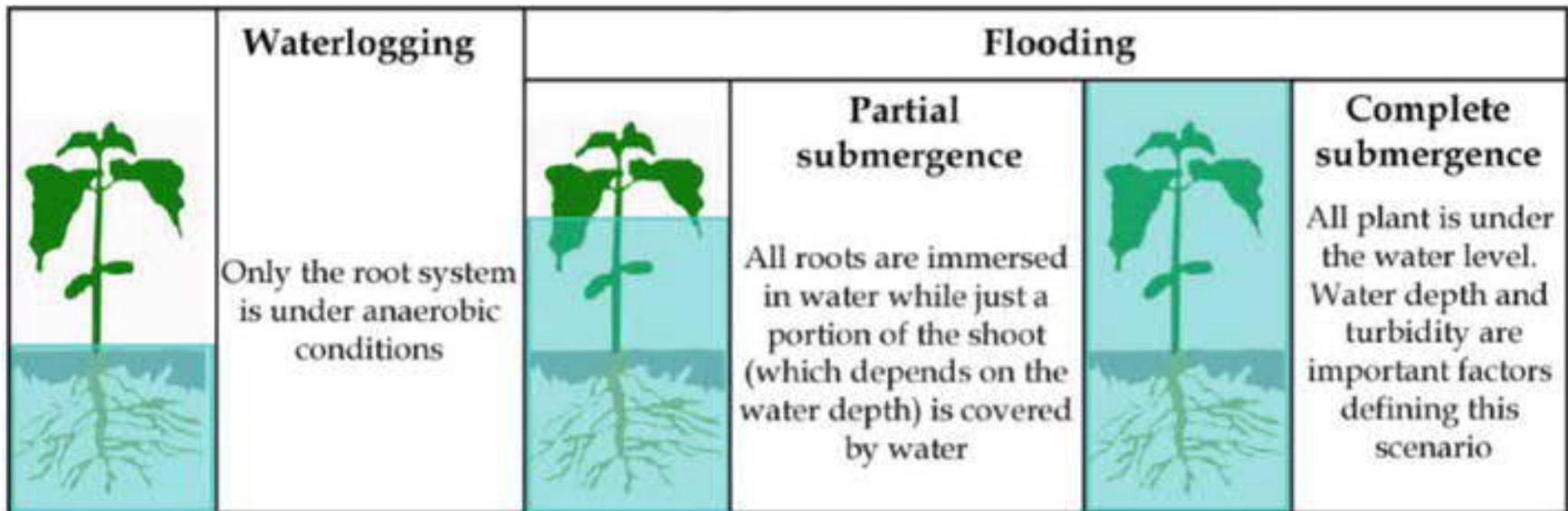
Rainfall

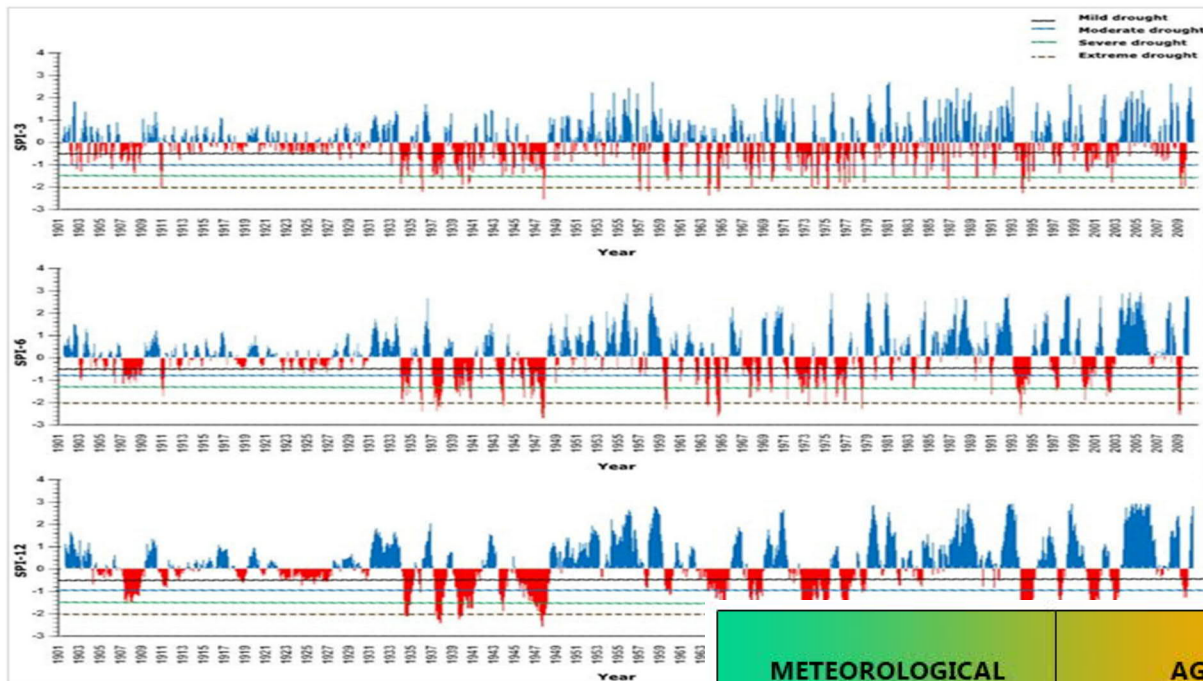




Based on NOAA dataset 2006-2016

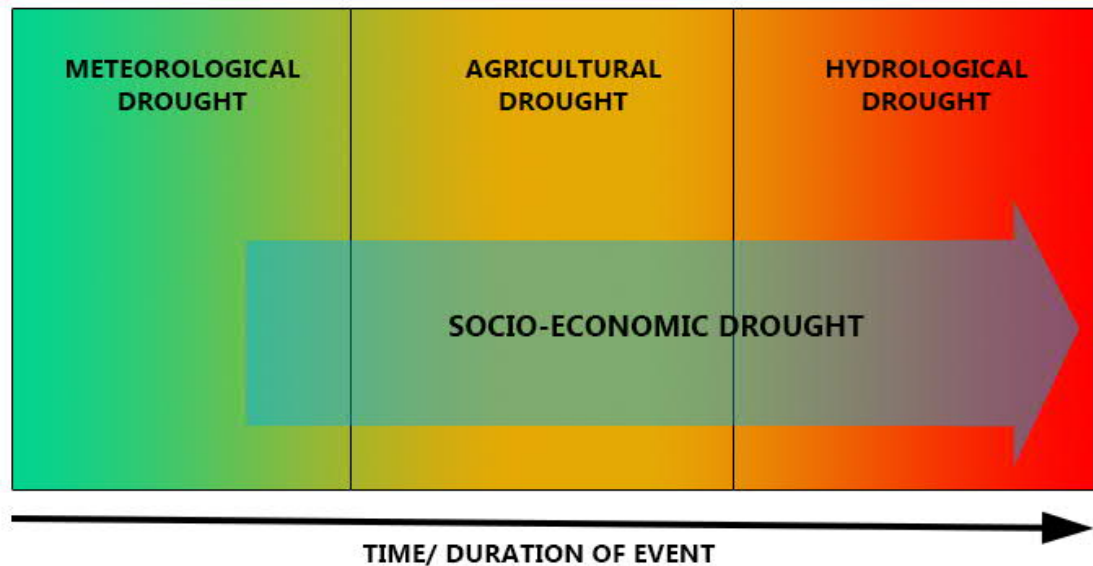
Weather and Climate Potential Impacts on Crops





Historical Drought Caribbean: 1901-2010

Source: Joyette 2015





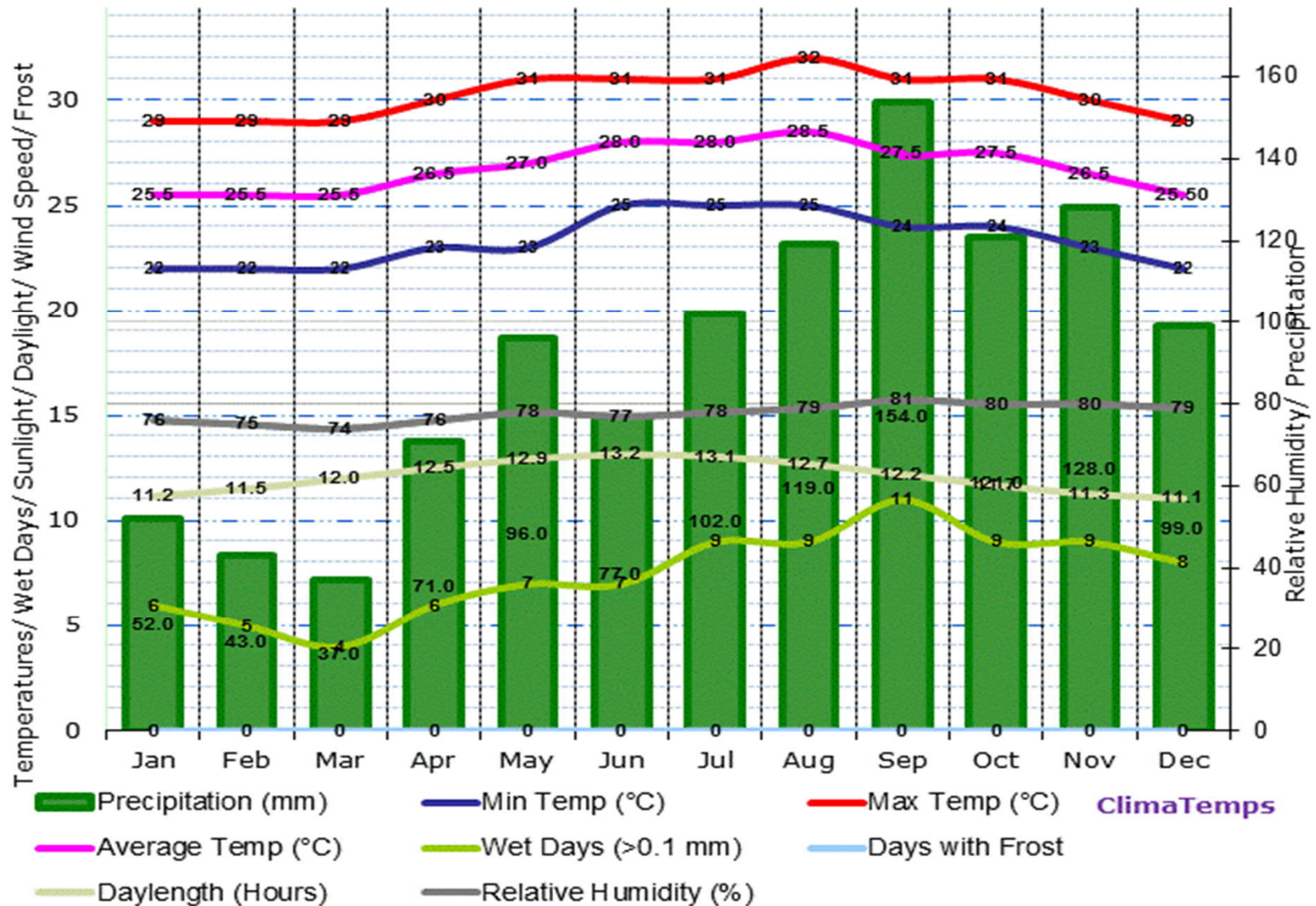
Wind Speed



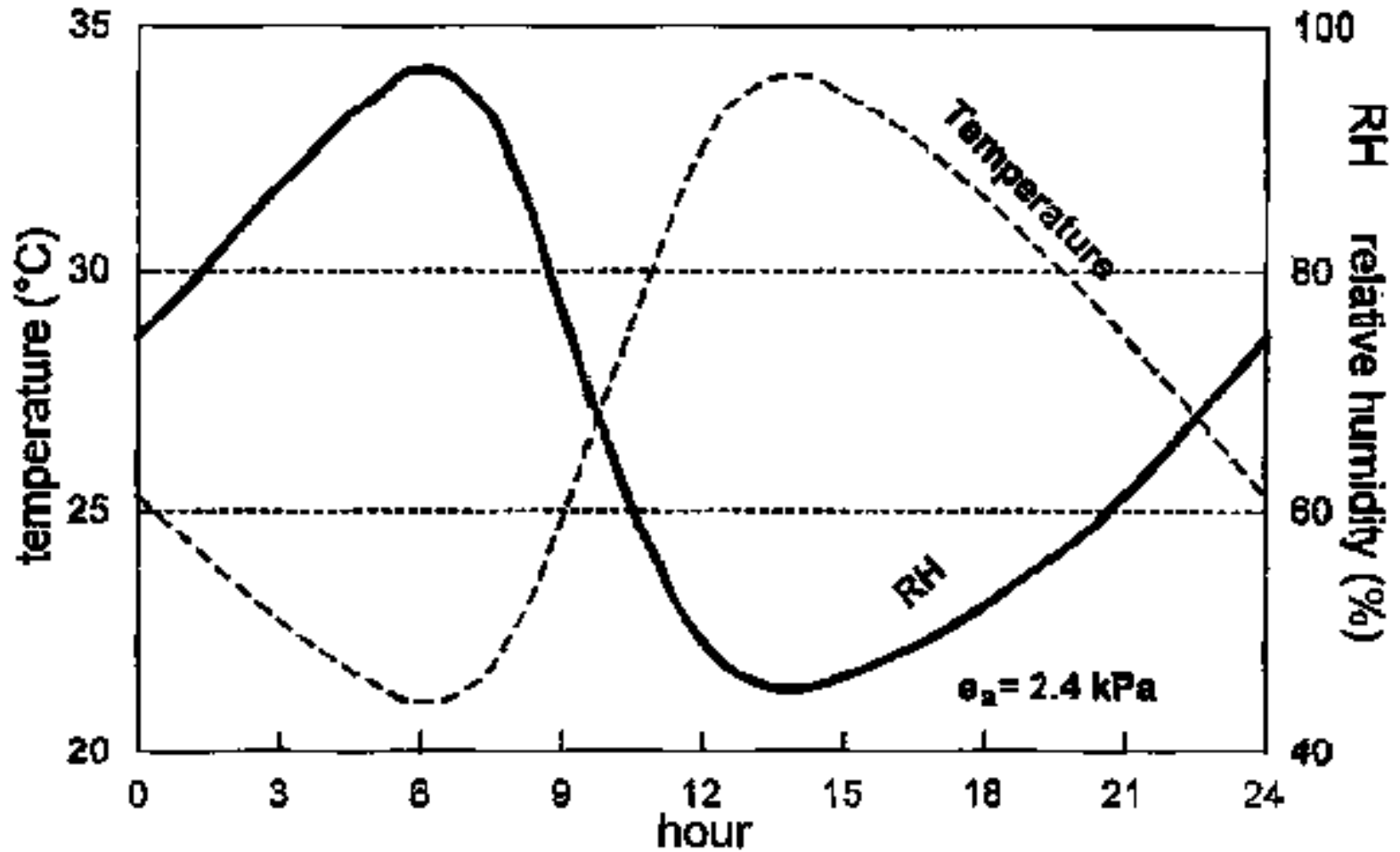
Source: Google Images



Relative Humidity

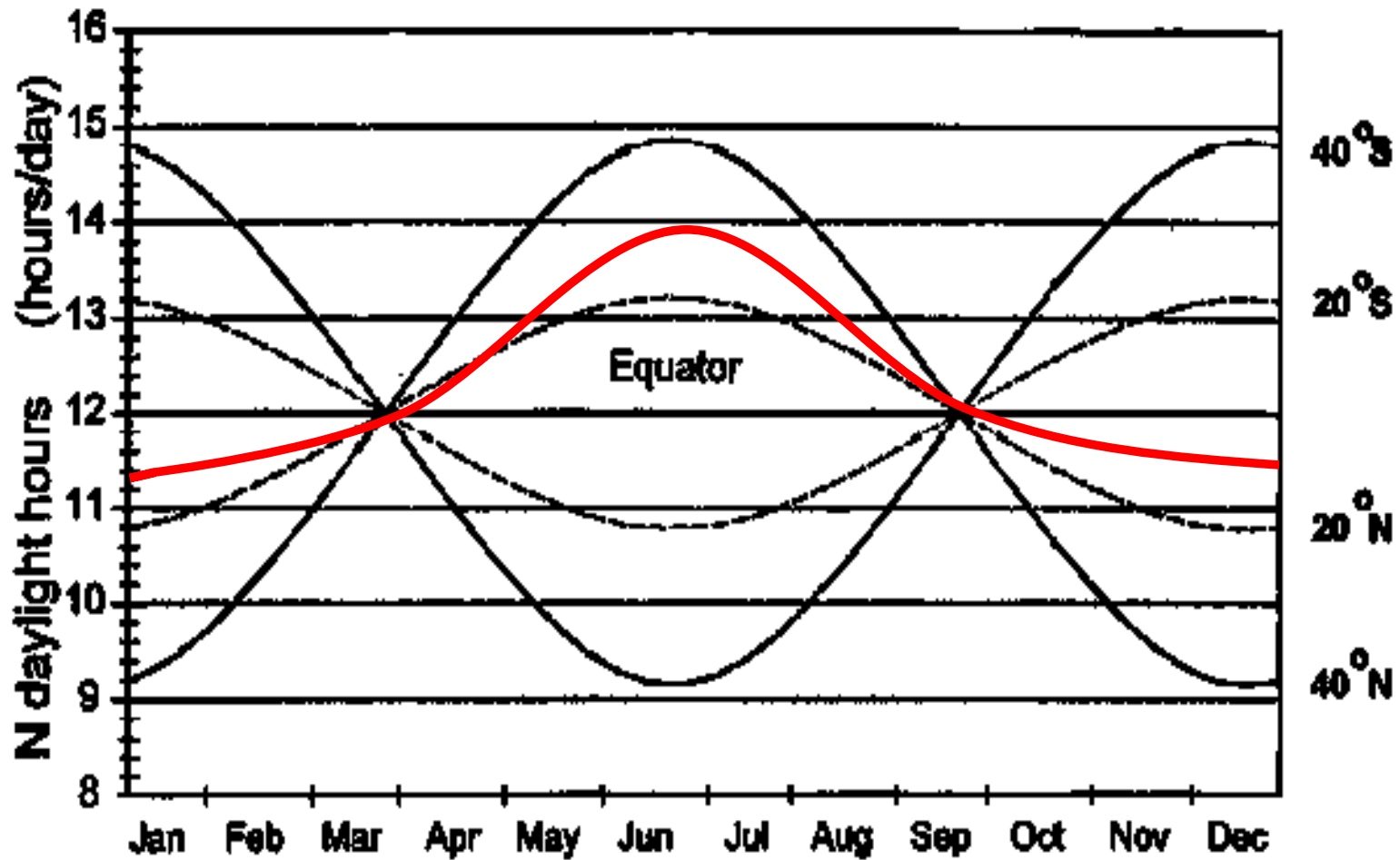


Relative Humidity



Source: Adapted from Allen et al. 1999

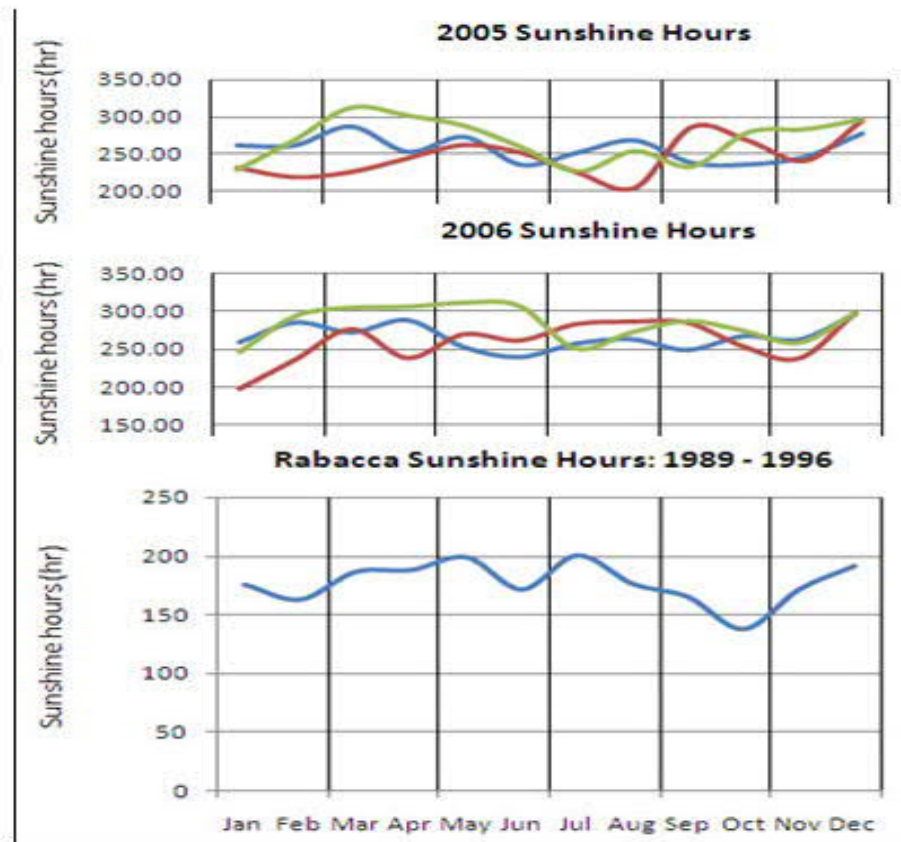
Solar Radiation (Sunshine)



Source: Adapted from Allen et al. 1999

Solar Radiation (Sunshine)

Bright Sunshine Hours



Sunshine hours (2005 and 2006) at Arnos Vale (blue), Bequia (red) and Union Island (green) Airports and Rabacca Airstrip, 1989-1996, (blue).

Source: Joyette 2007



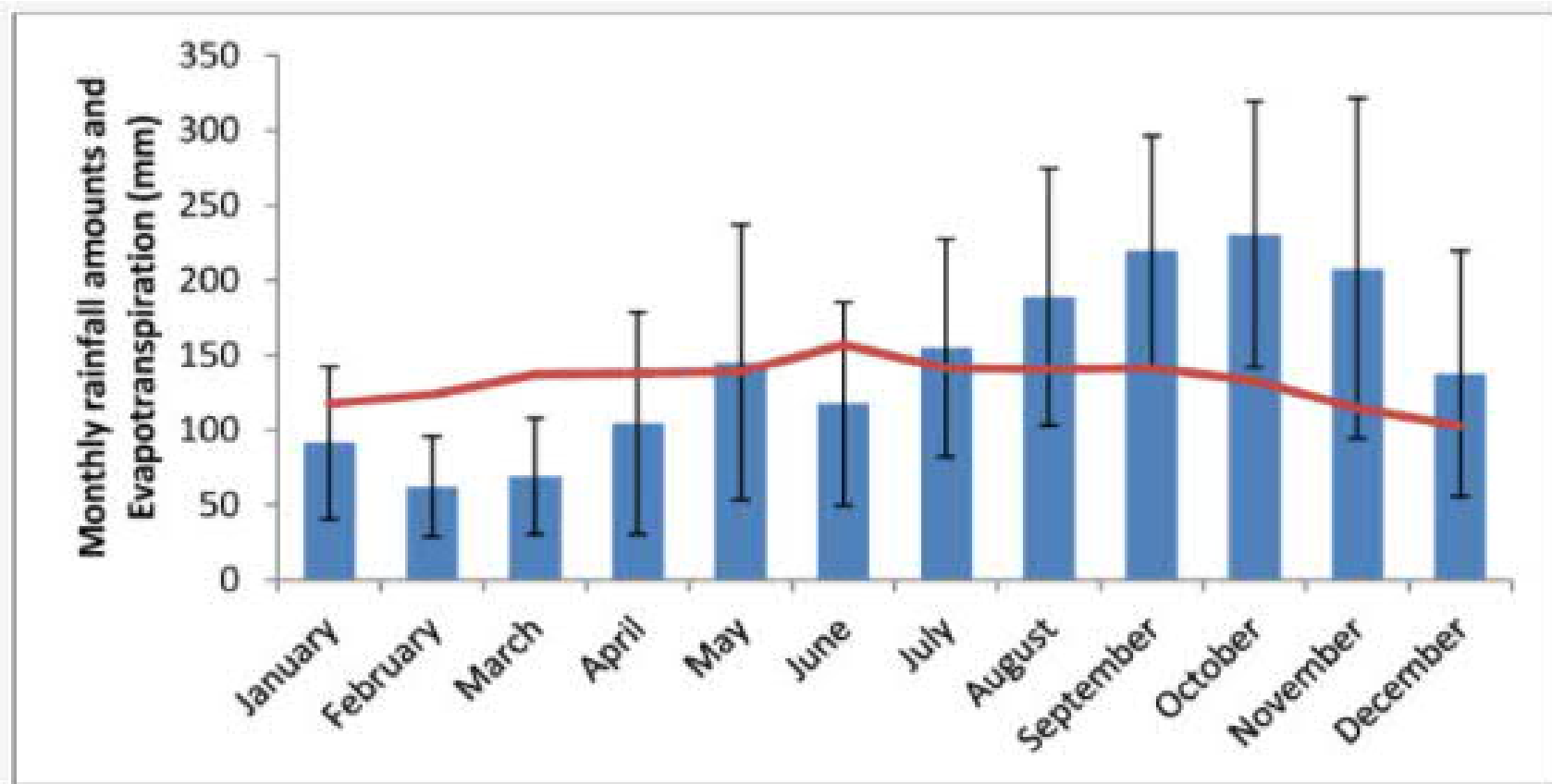
Atmospheric Gases

Atmospheric gases are important in agriculture.

- We know plants take in CO₂ nutrient and through photosynthesis produces O₂ and foliage.
- Higher concentrations of atmospheric carbon dioxide
 - boost crop yields by increasing the rate of photosynthesis, which spurs growth, and
 - reduces the amount of water crops lose through transpiration (Taub 2008; Hille 2016).
- Dissolved oxygen improves plant growth, reduces crop time.
 - E.g., incorporating dissolved oxygen into hydroponic production systems during warmer weather can help improve plant growth and reduce crop time (Kuack 2020).
- Example of negative impacts an atmospheric gas
 - Estimates of global yields of crops like soybean, maize (corn), and wheat, indicate reduction by 2-15% due to current ozone exposure (Avnery et al 2013).

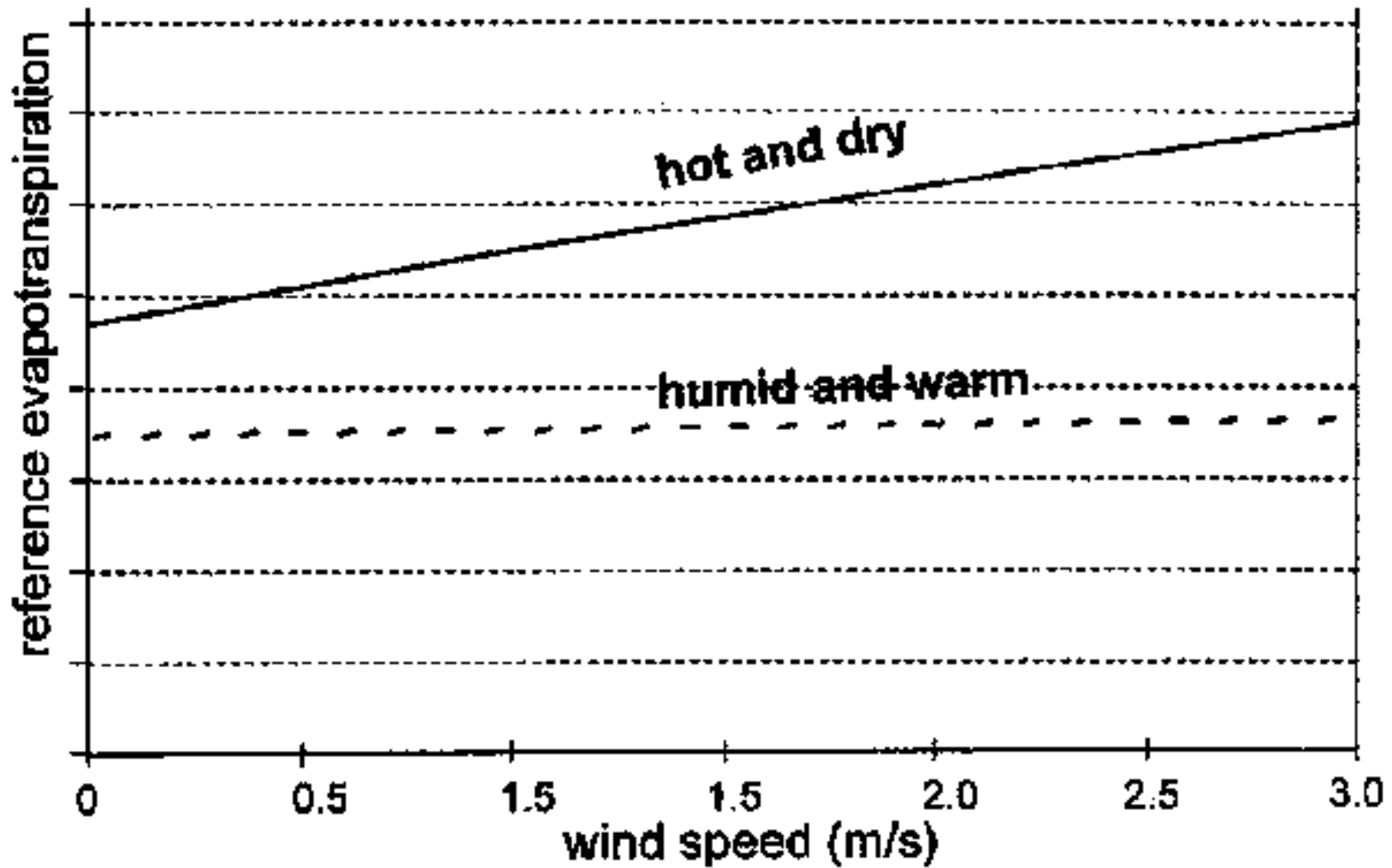
Evaporation

- Not really an element very important parameter in agriculture....as it mixes several elements – wind, rainfall, radiation (temperature) etc.



Lamb et al. 2014

Evaporation

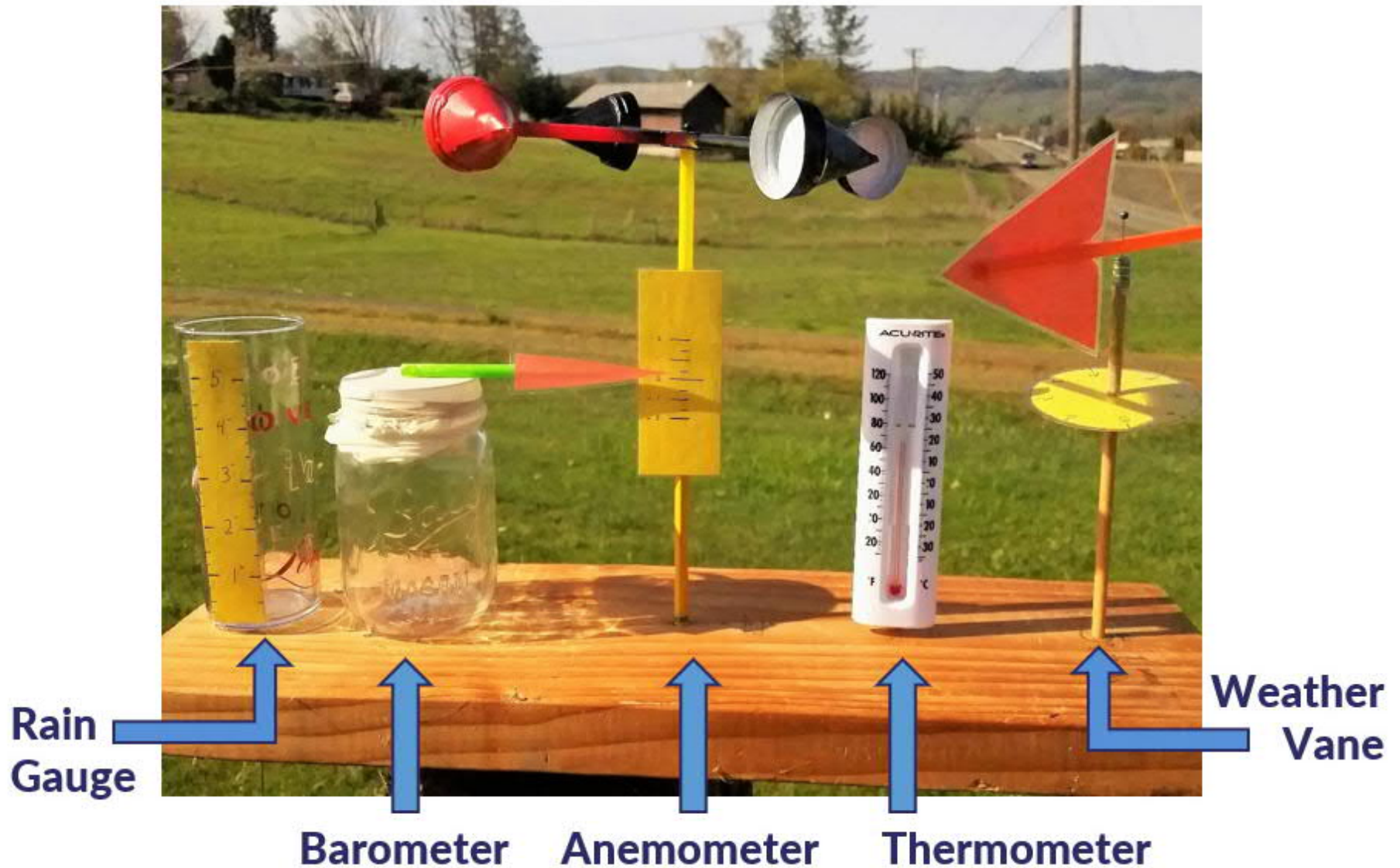


Source: Adapted from Allen et al. 1999

Meteorological Data & Information In Agricultural Decision-making

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Setting-up Simple On-farm Meteorological Station To Obtain Site-specific Weather Data



Setting-up Simple On-farm Meteorological Station To Obtain Site-specific Weather Data



8 inch plastic bottle

Graduated measurement

2 inch plastic bottle

8 inch plastic bottle

Setting-up Simple On-farm Meteorological Station To Obtain Site-specific Weather Data



★★★★★

Rain Gauge Dragonfly

SKU: 600002129

\$75.92



★★★★★

Jumbo Rain Gauge

SKU: 600002484

\$37.04



★★★★★

Weather Station Barometer

SKU: 600009194

\$109.32



★★★★★

Weather Station Comfort

SKU: 600009195

\$87.77

Setting-up Simple On-farm Meteorological Station To Obtain Site-specific Weather Data



sainlogic Wireless Weather Station with Outdoor Sensor, 8-in-1 Weather Station with Weather Forecast, Temperature, Air Pressure, Humidity...

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Save \$10.00 with coupon



Logia 7-in-1 Wi-Fi Weather Station with Solar | Indoor/Outdoor Remote Monitoring System, Temperature Humidity Wind Speed/Direction Rai...

★★★★☆ ~ 421

\$159⁹⁹

Setting-up Simple On-farm Meteorological Station To Obtain Site-specific Weather Data

Temperature :

- The sensor mounted 5 feet +/- 1 foot above the ground.
- The ground over which the shelter [radiation] is located should be typical of the surrounding area.
- A level, open clearing is desirable, so the thermometers are freely ventilated by air flow.
- Do not install the sensor on a steep slope or in a sheltered hollow unless it is typical of the area or unless data from that type of site are desired.
- When possible, the shelter should be no closer than four times the height of any obstruction (tree, fence, building, etc.).
- The sensor should be at least 100 feet from any paved or concrete surface.

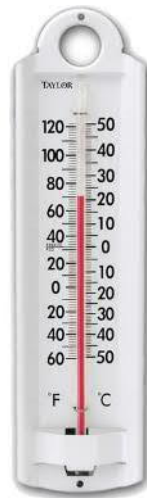
(Source: WMO 2021; NWS 2021)

Setting-up Simple On-farm Meteorological Station To Obtain Site-specific Weather Data



Suggested dimensions/specifications:

Inside--
11.25" deep x
15.00" wide x
15.00" tall in back x
17.50" tall in front



Setting-up Simple On-farm Meteorological Station To Obtain Site-specific Weather Data

Rainfall

- Gauges should not be located close to isolated obstructions such as trees and buildings, which may deflect precipitation due to erratic turbulence.
- To avoid wind and resulting turbulence problems, do not locate gauges in wide-open spaces or on elevated sites, such as the tops of buildings.
- The best site for a gauge is one in which it is protected in all directions, such as in an opening in a grove of trees.
- The height of the protection should not exceed twice its distance from the gauge.
- As a general rule, the windier the gauge location is, the greater the precipitation error will be.

(Source: WMO 2021; NWS 2021)

Setting-up Simple On-farm Meteorological Station To Obtain Site-specific Weather Data



Accessing Meteorological Information

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Accessing Meteorological Information

National agro-climatic bulletins are also routinely produced for

- **St. Vincent and the Grenadines - [Bulletin \(meteo.gov.vc\)](http://meteo.gov.vc)**
- **Antigua and Barbuda - <http://antiguamet.com/Climate/>**
- **Guyana - <http://hydromet.gov.gy/weather/the-farmers-bulletin/>**
- **Jamaica - [Agromet Bulletin – Meteorological Service of Jamaica \(met.service.gov.jm\)](http://met.service.gov.jm)**
- **Barbados - <https://www.barbadosweather.org/> (climate section)**
- **Dominica - <https://www.weather.gov.dm/newsletters/agro-meteorological-bulletin>**
- **Trinidad and Tobago routinely produces 10-daily agrometeorological bulletins**
- **Grenada (quarterly bulletin) -**
- **Belize (also produce agro-met forecasts) - [AgroMet Forecast | National Meteorological Service of Belize \(nms.gov.bz\)](http://nms.gov.bz)**
-

Caribbean Meteorological Services Websites

- [Antigua and Barbuda](http://www.antiguamet.com/) - <http://www.antiguamet.com/>
- [Barbados](http://www.barbadosweather.org/) - <http://www.barbadosweather.org/>
- [Belize](http://www.hydromet.gov.bz/) - <http://www.hydromet.gov.bz/>
- [The Bahamas](http://www.bahamasweather.org.bs/) - <http://www.bahamasweather.org.bs/>
- [Cuba](http://www.insmet.cu/) - <http://www.insmet.cu/>
- [Dominica](http://www.weather.gov.dm/) - <http://www.weather.gov.dm/>
- [The Dominican Republic](http://onamet.gob.do/) - <http://onamet.gob.do/>
- [Guyana](http://www.hydromet.gov.gy/) - <http://www.hydromet.gov.gy/>
- [Guadeloupe](https://meteofrance.gp/fr) - <https://meteofrance.gp/fr>
- [Haiti](http://www.meteo-haiti.gouv.ht/index.html) - <http://www.meteo-haiti.gouv.ht/index.html>
- [Jamaica](http://www.hydromet.gov.gy/) - <http://www.hydromet.gov.gy/>
- [Martinique](https://meteofrance.mq/fr) - <https://meteofrance.mq/fr>
- [Netherlands Antilles](http://www.meteo.an/) - <http://www.meteo.an/>
- [Suriname](http://www.meteosur.sr/) - <http://www.meteosur.sr/>
- [St. Kitts and Nevis](http://www.weather.kn/) - <http://www.weather.kn/>
- [St. Lucia](http://www.slumet.gov.lc/) - <http://www.slumet.gov.lc/>
- [St. Vincent & the Gren.](http://www.meteo.vc/) - <http://www.meteo.vc/>
- [Trinidad & Tobago](http://www.metoffice.gov.tt/) - <http://www.metoffice.gov.tt/>
- [The CIMH](http://cimh.edu.bb/) - <http://cimh.edu.bb/>

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- Images not referenced were either from the author or Google Images. If you need definite clarification, please contact me at antonio.joyette@gmail.com

