Some of the agricultural operations for managing excess, scanty and untimely rain are:

Management of excess rainfall (floods)	Keep the field drains open
	Can grow flood obstructing crops
Management of drought/scanty rain	Application of sufficient irrigation water at crop critical stages.
	Conserve water by suitable management of fallow and cropped fields viz. removal of weeds, digging pits of small size which collects runoff water etc.
Management of untimely rains	Farmers need to be advised to follow the weather forecasting by IMD for proper management of their crops through crop-weather advisories.
	Contingency crop plans need to be developed for the needy farmers.

RELATIVE HUMIDITY (RH)

The measure of humidity is generally called relative humidity. It is the ratio of actual amount of water vapour present in the atmosphere to the maximum amount required to saturate it at that temperature. Atmospheric humidity plays an important role in plant growth as it influences crop water requirement and crop- pest and disease complex.

i. Moderately high RH of 60-70% is beneficial for crop growth.
ii. Photosynthesis is indirectly affected by RH. When RH is low, transpiration increases causing water deficits in the plant.
iii. Moderately low air humidity is favourable for seed set in many crops, provided soil moisture supply is adequate.
iv. The incidence of insect pests and diseases is high under high humidity conditions.

EVAPORATION

Loss of water from surface soil or free water surface in the form of vapour into the atmosphere is referred to as evaporation. Evaporation rates depend on the change of seasons, and reach their peak in the summer months of April and May. With the onset of monsoon, there is a marked fall in the rate of evaporation. In North-East India, evaporation varies from 6 cm in December to 20 cm in May month.

Evaporation of water is helpful in using water more judiciously. Irrigation scheduling is made on the basis of values obtain from pan evaporimeter. By reducing the evaporation losses of water, farmers can effectively utilize the water from rainfall and other natural sources. Mulching is one such practice to effectively reduce evaporation in crops.

DURATION OF LIGHT

The duration of sunlight and intensity in addition, influence plant development, vegetative shapes and the production of leaves and flowers. In North Eastern parts, spatial distribution of duration of bright sunshine hours varies between 6 and 7 hr per day.

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AGRO-METEOROLOGICAL INDICES FOR AGRICULTURAL FIELD OPERATIONS

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Agriculture and agricultural productions are highly dependent on the weather conditions, by directly affecting the life cycle of crop, starting from sowing till harvesting. So, the recording and analysis of weather parameters through meteorological instruments installed in the agro-meteorological observatory or station is of the paramount importance for the crop production. Therefore, it is of utmost importance for the agro-meteorological stations that the records should be kept for- (i) instrumentation (consisting of type of instruments, their calibration, and maintenance), (ii) instrument exposures (mounting, sitting, and surroundings at toposcale), and (iii) observation procedures (sampling, averaging, frequency of measurements, recordings, and archiving).

The observations in the weather stations are recorded at 07.00 and 14.00 hrs LMT. However rainfall and evaporation observations are recorded at 08.30 hrs IST and 14.00 hrs LMT.

Instruments	Units	Measurement
Dry bulb thermometer	°C	Actual temperature of the air
Wet bulb thermometer	°C	Cool air/wet bulb temperature
Maximum thermometer	°C	Highest temperature attained during the last 24 hours
Minimum thermometer	°C	Lowest temperature reached during the last 24 hours
Ordinary rain gauge	mm	Amount of rainfall
Soil thermometers (5, 10, 15, 20 cm)	°C	Soil temperature at different depths
Wind vane	Degree (0 to 360°) directions	Wind direction
Anemometer	km/hr	Wind velocity
USWB Class-A open pan evaporimeter	mm	Daily loss of water through evaporation
Sunshine recorder	hr	Duration of bright sunshine hours

AMBIENT TEMPERATURE

Plants have different growth stages and each stage requires a different temperature range within which growth and development can take place. These are termed as cardinal temperatures *viz*. maximum, optimum and minimum.

The cardinal points of temperature for crops are:

	Minimum (°C)	Optimum (°C)	Maximum (°C)
Cool season crops	0-5°C	25-31°C	31-37°C
Warm season crops	15-18°C	31-37°C	44-50°C

These limits also differ with different crop growth stages and different regions. So the selection of crops should be based on the suitability of the regions and its climatic conditions. The ideal temperature for housing the some of the livestock are: Poultry birds: - 16-29°C; Pig or Swine: - 12-32°C; Cattle: - 5-20°C; Rabbits: - 15-18°C etc.

Crop injuries related to temperature

High temperature injuries

i) High temperature adversely affects mineral nutrition, shoot and root growth and pollen development resulting in low yield. Temperature above 50°C can even kill many annual crops. High temperature of 38ºC in rice reduced plant height and root elongation.
ii) Nutrient uptake is affected by both soil and air temperature in most of the annual crops like rice, maize, wheat etc. *E.g.* In maize crop absorption of calcium is reduced when the temperature reaches 28ºC.
iii) High temperature leads to dehydration and leaves can be scorched.

Low temperature injuries

When air temperature drops to freezing, frost often occurs. Such a low temperature can affect the several aspects of crop growth *viz*. survival, cell division, photosynthesis, water transport, growth and finally yield.

SOIL TEMPERATURE:

Plant growth is greatly influenced by soil temperature. It affects the germination of the seeds, development of roots, rate of plant growth and occurrence and severity of plant diseases. Therefore, unfavourable soil temperature during the growing season can retard the growth and development of the crop.

MEASURES TO MANIPULATE THE TEMPERATURE AND MANAGE CROP INJURIES

i) Irrigation through flooding and sprinkling can effectively manipulate the crops' environment.
ii) Rain making through cloud seeding can be done.
iii) Shelterbelts can effectively control the temperature of the crops' environment by manipulating the wind direction.
iv) Use of heaters and wind machines are effective during the frost injuries.
v) A layer of surface mulch of straw or any other organic waste helps not only to keep the soil layers cool but also to conserve soil moisture.

WIND

When the air moves in the horizontal direction on the surface of the earth, it is called wind. Its direction and its velocity influence the vegetation of any area.

Mechanical damage by wind

i. Wind increases crop water requirements by increasing evapo-transpiration with removal of accumulated humid air near the leaves.
ii. Calm to moderate wind favour dew deposition which is required under condition of soil moisture stress.
iii. Moderate wind aids in effective pollination. Heavy wind during flowering reduces pollination, causes flower shed, increases sterility and reduces fruit set in all crops.
iv. Wind speed more than 50 km/h leads to lodging of crops leading to heavy loss.
v. In general, plant growth is inhibited by wind speed of more than 10km/h.
vi. Soil and sand particles blown by wind strike the leaves and other plant parts making punctures, abrasions, lesions and tear the leaves in to pieces and strips. It will be well marked in maize, sugarcane and banana during summer.

Protection of plants from wind damage

i. Shelter belts and wind breaks: Refers to growing trees and tall crops across the direction of prevailing wind to reduce the physiological and mechanical damage to crops. Wind break reduces the wind velocity and creates favourable microclimate.
ii. Providing support or propping to the tall crops (e.g.) banana, papaya etc.

Weather requirements for general agricultural field operations:

Farming operation	Sky condition	Air temperature (°C)	Wind speed (km/h)
Land preparation	Clear or cloudy day	≤40 and ≥15	≤50
Seeding or Sowing	Clear or cloudy day	<33 and ≥15	<20
Transplanting of seeds	Clear or cloudy day	≤40 and ≥15	0-30
Weeding operations	Clear or partly cloudy day	≤40 and ≥15	≤50
Irrigation	Clear or cloudy day	Not critical and ≥15	Not critical
Spraying	Clear day or cloudy day or night	<33 and ≥15	0-18 for ground application 4-14 for aircraft application
Threshing/Sun drying/Cleaning grains/Winnowing	Clear or partly cloudy day	No upper limit and ≥15	≤25

RAINFALL

Rain is the precipitation of water in liquid form. Droplets with more than 0.5 mm diameter are, generally considered as rain. Rainfall is considered scanty with <1 mm rainfall, moderate with 1-10 mm rainfall, heavy with 10-50 mm and very heavy with> 50 mm rainfalls.

Major abnormalities affecting the crop production are – excessive rains, scanty rains and untimely rains. Performance of crops is directly related to rainfall received during the crop season and the region. E.g. the amount of 100 mm of rain may be convenient for cultivation in temperate regions but not sufficient in tropical regions due to the high rate of evaporation in the tropics.

Excessive rainfall damage: The damages are:- (i) Poor and uneven stand establishment and low vigour in crops; (ii) Increased seedling diseases; (iii) Disruptions in scouting and timely application of pest control measures; (iv) Delayed or missed cultivation and or herbicide inactivation, resulting in inadequate weed control; (v) Waterlogged soils leading to shallow rooted crops; (vi) Disrupted planting and expected harvest schedules; and (vii) Cause difficult in agricultural operations.