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Establishment of a Standard Agricultural Meteorological Observatory

1.1 Introduction

Weather is a vital factor on which depends the success or failure of agriculture. The crops are directly influenced by weather conditions from sowing to maturity. Weather manifests its influence on agricultural production through its effects on soil, plant growth and development and yield as well as on every practical phase of animal growth and development. Weather has a great influence on insects and plant diseases. In scientific research, the recording and analysis of meteorological data has assumed a paramount importance, therefore there is a need for high precision and accuracy of the data. To study the effect of various weather elements, it is essential to measure these elements regularly so that day to day fluctuations may be studied by setting up a meteorological observatory within the experimental area.

Meteorological observatory is a network of various meteorological instruments installed in a symmetric way over a site which is fully representative of the crop-soil-weather/climatic conditions of that area. Various weather parameters are measured with the help of these instruments. The main weather parameters are solar radiation, air temperature, soil temperature, relative humidity, evaporation, rainfall, sunshine hours, wind direction and speed, evaporation and cloud formation etc.

India Meteorological Department was established in the year 1875 with its head quarters at Pune, Maharastra. At the time of starting there were only 66 surface observatories. The present meteorological network in India includes Surface observatories (561), Pilot balloon observatories (63), Radio-sonde observatories (35), Agricultural meteorological observatories (197), Evapo-transpiration stations (38). Of the 197 designated agricultural meteorological observatories 127 are functioning. This network is meant for collection of data on various weather parameters as detailed above. To facilitate the collection of data at one point, six regional centers were established. They are North zone (Delhi), East zone (Calcutta), South zone (Chennai), West zone (Mumbai), and Central zone (Nagpur) for NE zone Dibrugarh is the Head Quarters. At present Pune is the central forecasting and training station. The observatories are classified into 6 categories i.e. Class I to Class VI. The classification is based on (a) physical facilities available (b) mode of transmission of data and (c) type of persons employed.

Table: 1.1 Classification of Meteorological observatories

S.No.	Character	Category / Class					
		I	II	III	IV	V	VI
1.	Other name	Special station	Synoptic station	Synoptic station	Climatic station	Rainfall station	Non-instrument station
2.	Type of persons	Highly qualified & full time	Part time skilled workers	Part time skilled	Trained workers	Trained part-time workers	Semi Skilled workers
3.	Mode of transmission	At once (on dot)	Two times a day	Once a day	Once a week	Once a month	On request
4.	Instruments	Automatic sophisticated	Ordinary	Ordinary	Partially equipped	Rain gauge	Nil

In 1932 it was realized to collect the information on the influence of weather parameters on different crops. So, most of the class I observatories throughout the country were converted into agricultural meteorological observatories. These are supervised by agencies like agricultural universities and research stations.

Meteorological observations are taken regularly and simultaneously at standard hours of observations all over the world. However, the agricultural meteorological observatories are established to record observations of different weather elements characterizing the agricultural environment influencing the growth and development of crops. The quality and quantity of crop production depends on climate of the season. Accurate and regular observations of both weather and crop growth help in establishing the crop weather relationships.

1.2 Basic aspects of Agricultural Meteorological Observations

Observations of the physical and biological variables in the environment are essential in agricultural meteorology. Meteorological considerations enter into assessing the performance of plants and animals because their growth is a result of the combined effect of genetic characteristics and their response to the environment. Without quantitative data, agrometeorological planning, forecasting, research and services by agrometeorologists cannot properly assist agricultural producers to survive and to meet the ever increasing demands for food and agricultural byproducts.

1.2.1 Physical climatic variables

Agricultural meteorology is concerned with every aspect of local and regional climates and the causes of their variations, which makes standard observation of climatic variables a fundamental necessity. It is also concerned with any climatic modifications, which may be introduced by human management of agriculture, animal husbandry or forestry operations. Physical variables of climate are observed to assist the management of agricultural activities. Such management includes determining the time, extent and manner of cultivation and other agricultural operations (sowing, harvesting, planting, application of biocides and herbicides, ploughing, harrowing, rolling, irrigation suppression of evaporation design, construction and repair of buildings for storage, animal husbandry, and so on) and different methods of conservation, industrial use and transport of agricultural products.

1.2.2 Biological variables

Besides scientific observation of the physical environment, the simultaneous evaluation of its effect on the objects of agriculture, namely, plants, animals and trees, both individually and as communities, is also a prerequisite of agricultural meteorology. The routine observations provided by climatological and agrometeorological stations should be accompanied by routine biological observations. In order to obtain the best results, these observations should be comparable with those of the physical environment in extent, standard and accuracy. Biological observations generally are phenological or phenometric in nature or both. Phenological observations are made to evaluate possible relations between the physical environment and the development of plants and animals, while the phenometric types are made to relate the physical environment with biomass changes.

1.2.3 Scale of observations

In agricultural meteorology, observations are required on the macro, meso and micro scales. On the larger scales it should make use of all available local observations of environmental physical parameters made by the international synoptic network of stations. In practice, observations can be used in real time in agriculture. For parameters with very little spatial variation (such as sunshine duration), low density observation networks normally suffice for agricultural purposes. Most of the planning activities in the agricultural realm, however, require higher-density data. These can sometimes be obtained from synoptic station observations through the use of appropriate interpolations. For biometeorological research, micro scale observations are often required. The meso scale is defined as 3 km to 100 km, the topo scale or local scale as 100 m to 3 km and the micro scale as less than 100 m

1.2.4 Extent of observations

Agricultural meteorology can and should make use of all available local observations of environmental physical parameters from fixed points in the synoptic, climatological or hydrological networks, including a broad range of area and point data derived from numerical weather analysis and predictions. This includes certain upper air data (at least in the lower layers up to 3000 m), for instance, upper winds (aerobiology) and temperature and humidity profiles (for energy budgets). In fact, it is desirable that at selected stations additional observations of more specific interest to agriculture be made.

1.3 Agricultural Meteorological Stations

1.3.1 Classification

According to WMO, each agricultural meteorological station belongs to one of the following categories:

(a) Principal agricultural meteorological stations: These provide detailed simultaneous meteorological and biological information and it is where research in agricultural meteorology is carried out. The instrumental facilities, range and frequency of observations, in both meteorological and biological fields, and the professional personnel are such that fundamental investigations into agricultural meteorological questions of interest to the countries or regions concerned can be carried out.

(b) Ordinary agricultural meteorological stations: These provide on a routine basis, simultaneous meteorological and biological information. These are also equipped to assist in research into specific problems. The programme of biological or phenological observations for research will be related to the local climatic regime of the station and to local agriculture.

(c) Auxiliary agricultural meteorological stations: These also provide meteorological and biological information. However, to a lesser extent than the above two. The meteorological information include such items as soil temperature, soil moisture, potential evapotranspiration, duration of vegetative wetting, and detailed measurements in the very lowest layer of the atmosphere. The biological information may cover phenology, onset and spread of plant diseases, and so forth.

(d) Agricultural meteorological station for specific purposes: These are the stations set up temporarily or permanently for the observation of one or several variables and/or specified phenomena.

Stations corresponding to (a) category are not common because of their requirements for trained professionals, technical personnel and equipment. In most countries the majority of agricultural meteorological stations belong to categories (b), (c) and (d).

1.3.2 Selection and layout of a station site

The accuracy of observations at a given time is a determinable fixed quality, but their representativity varies with their application. When selecting a site for a station, the purpose of its observations must be decided first – should it be regionally representative, then even in a woody region an open location is preferable, because the station's observation must relate to the lower atmosphere of the region. If the purpose of establishing a station is monitoring or operational support of some local agricultural situation, then it can be representative when its location is typical for that application, maybe in a very humid area (for disease protection purposes), or at the bottom of a valley (for studying frost protection). Even so, locations should be avoided that are on or near steeply sloping ground, or near lakes, swamps or areas with frequent sprinkling or flooding.

The site of a weather station should be fairly level and under no circumstances should it lie on concrete, asphalt, or crushed rock. Wherever the local climate and soil do not permit a grass cover, the ground should have natural cover common to the area, to the extent possible. Obstructions such as trees, shrubs and buildings should not be too close to the instruments. Sunshine and radiation measurements can be taken only in the absence of shadow during the greater part of the day. However, brief periods of shadows near sunrise and/or sunset may be unavoidable. Wind should not be measured at a proximity to obstructions that is less than ten times their height. Tree drip into rain gauges should not be allowed to occur.

Accessibility to the weather station and the possibility of recruiting good observers locally should also be criteria for selection of a site. Finally, for major stations, the likelihood that the conditions of the location will remain the same over an extended length of time with little change in the surroundings should be investigated.

A sample layout is shown in Figure 1.2. This layout is designed to eliminate as far as possible mutual interference of instruments or shadowing of instruments by fence posts. The door of the thermometer screen must open away from the sun, to ensure that direct sunlight does not enter the screen during observations. At equatorial and tropical stations, the screen will have doors opening to both the north and the south. A larger enclosure is recommended when small plants are used for phonological observations. A rather sheltered enclosure is not a good place for measuring wind; a nearby location with better exposure may be preferable for the wind mast.

1.3.3 Layout plan of an Agricultural Meteorological Observatory

The agricultural meteorological observatory is established with standard meteorological instruments. The instruments should be (a) reliable; (b) accurate (c) high precision (d) simple (e) robust and (f) easy for operation and maintenance. In addition to this it is required that:

- The exposure of one instrument should not effect the other instruments by causing shadows. For example, stevenson screen should not affect the soil thermometers with its shadow.
- The distance between the instruments should be kept according to the number of instruments installed
- The opening face of the Stevenson screen should be North in Northern hemisphere and South in Southern hemisphere. This is because the direct solar radiation should not fall on the instruments.
- The soil thermometers should always face South in Northern hemisphere and vice versa in Sourthern hemisphere

NOTE: All the instruments should be installed in accordance with the norms of Nation concerned and World Meteorological organization (WMO). This facilitates uniformity for comparison of weather data from place to place over the globe.

1.3.4 Hours of observation

Since Meteorological elements vary with time, it is necessary that they should be recorded at a particular time on every occasion.

- In India, the main observations are recorded as per the guide lines of I.M.D at 0830 and 1730 IST
- At Agromet observatories the observations are recorded at 07:00 and 14:00 hours LMT except evaporation and rainfall which are recorded at 08:30 hours IST

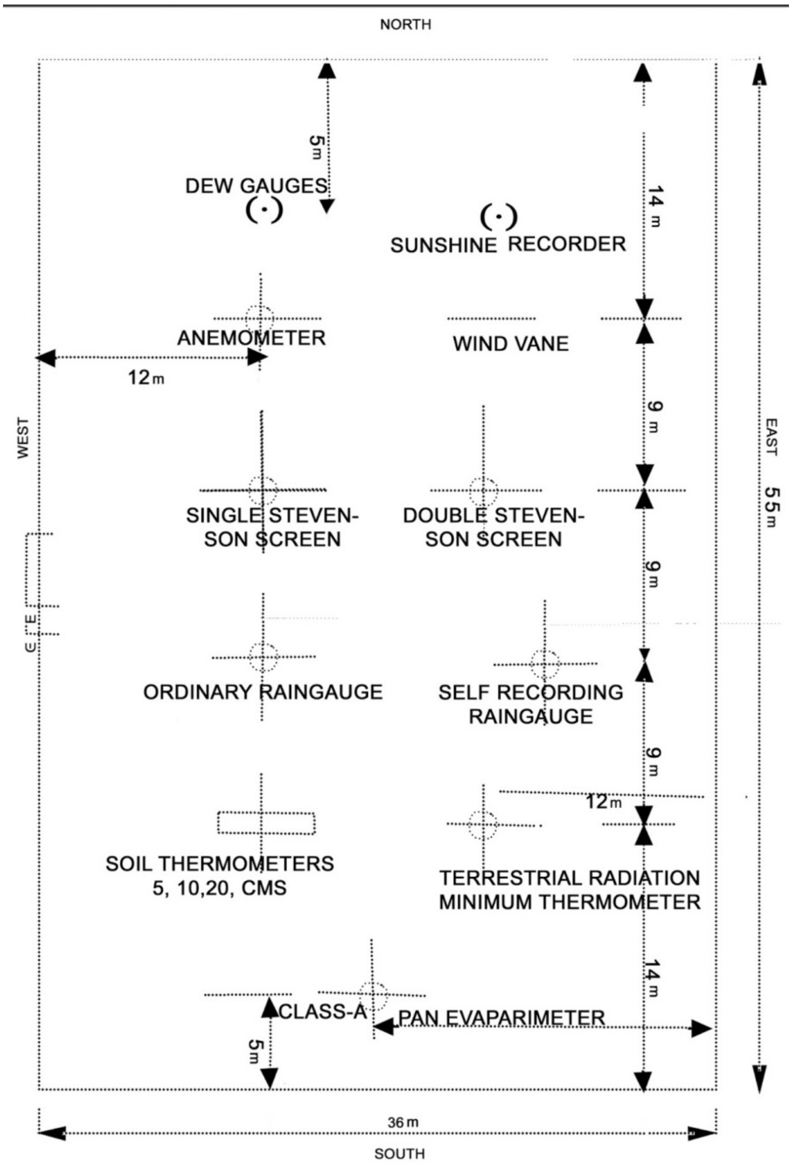

Figure 1.1 Layout of instruments in a Meteorological observatory

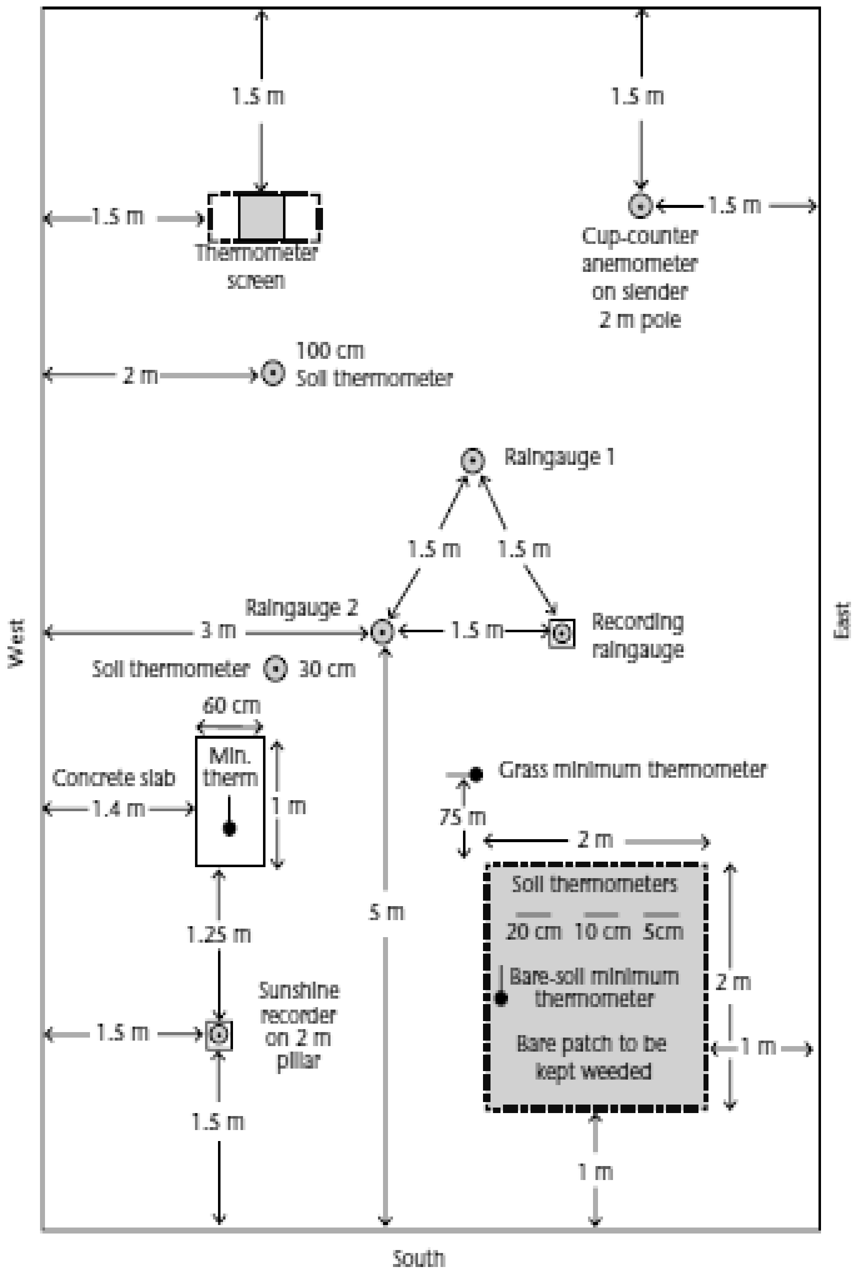

Figure 1.2 Layout of an observing station in the northern hemisphere showing minimum distances between installations (from WMO, 2000*b*)

- Radiation observations including sunshine are recorded as per LAT (Local Apparent Time). At meteorological observatories the hours are numbered consecutively from mid- night 00 hours to midnight 24 hours, the hours after noon being 13 hours, 14 hours and so on. Time as 2:30 PM and 2:30 AM are expressed as 1430 and 0230 hours I.S.T. respectively.

1.3.5 Precautions

- The instruments should be robust and easy to handle and maintain. These should be according to the Nation concerned and WMO specifications.
- The installation of the instruments should be made according to the national standards.
- The exposure of one instrument should not affect the observation of the other.
- The observer should be a trained personnel to record the observations according to the guidelines laid down by the IMD. He should be able to handle the record of the data efficiently.

1.4 Instruments for an ideal Agrometeorological Observatory

The instruments used in an ideal agro-meteorological observatory are grouped into four categories:

- Conventional eye-reading instruments
- Self- recording instruments
- Semi-automatic (distance indicating /recording instruments)
- Fully automatic data collection and data processing systems

The following instruments or appliances are kept at specific positions in the observatory.

Raingauge: Records total amount of rainfall received during 24 hours in mm.

Evaporimeter: Helps in determining the rate of evaporation measured in mm/day.

Dew gauge: Records total amount of dew deposited in a day in mm/day.

Stevenson screen: A single S.S.S. is a wooden box with certain specifications and it is available in standard sizes. It houses the following thermometers.

i. **Minimum thermometer** - Records minimum temperature attained during 24 hours.
ii. **Maximum thermometer** - Records maximum temperature attained during 24 hours.

iii. **Wet and dry bulb thermometer** - For determining the relative humidity.

The double Stevenson screen houses some autographic instruments like thermograph, barograph, hygrograph, etc., for maintaining a continuous record of temperature, pressure and relative humidity.

Sunshine recorder: Records total number of sunshine hours in a day.

Grass minimum thermometer: This thermometer is kept to record the minimum temperature attained during 24 hours when the ground is covered by vegetation.

Soil thermometers: 3 or 4 thermometers are kept with their bulbs inside the ground at different depths. These thermometers indicate the temperature of the soil at different depths.

Psychrometer: For relative humidity in micro-meteorological observations.

Wind vane: Indicates direction of wind.

Anemometer: Measures the velocity of wind in m s^{-1} or appropriate units.

Table 1.2 Installation of Meteorological instruments

Sr. No	Instrument Position	Row/(AGL)	Height	Remarks
1.	U.S.W.B Open Pan Evaporimeter	1st row/ Eastern side		➢ Its base should be placed on a wooden platform ➢ Wooden platform should be perfectly horizontal. ➢ Under the wooden platform the ground should be free from weeds for the movement of the air.
2.	Thermo-hygrograph	1st row/(No.2)	1.2 m	➢ It should be placed in a double layered wooden screen known as Stevenson's screen. ➢ It should face towards north in the northern hemisphere.
3.	Microclimate observation post	1st row/(No.3)	3.6 m	➢ It should be at 9 to 10m distance from the sunshine recorder.
4.	Sunshine recorder	1st row/(No.4)	10 ft	➢ It should be installed on a concrete pillar with steps. ➢ Base should be perfectly horizontal ➢ The groove of the recorder should be oriented in E-W direction.
5.	Soil thermometers	Middle row north side(No.1)		➢ Support the thermometers with iron stand and protect them with rod fence

Table 1.2 ***contd…***

				➢ The bulb of the thermometers should be placed at a desired depth, keeping the stem at 60^0 angle from the horizontal.
6.	Dew gauge Post	Middle row south side (No.1)		➢ It should be 9-10m away from soil thermometers towards south ➢ The post should be vertical with horizontal arms at different heights.
7.	Self Recording Raingauge	Western row (No.1)	0.75 m	➢ It should be fixed on a concrete platform ➢ The rim of the funnel should be horizontal ➢ It should be 2-3 m away from an ordinary rain gauge.
8.	Ordinary Rain gauge	Western row(No.2)	0.30 m	➢ It should be fixed on a concrete platform ➢ The rim of the funnel should be horizontal ➢ It should be between Stevenson screen and the self recording rain gauge.
9.	Maximum minimum dry and wet bulb thermometers	Western row (No.3)	1.2 m	➢ Thermometers should be kept within Stevenson screen ➢ Maximum and minimum thermometers should be placed horizontally with their bulbs tilted slightly downwards ➢ Dry and wet bulb thermometers should be placed vertically ➢ Bulb of the wet bulb thermometer should be covered with a muslin cloth and it should be kept wet by a thread, one end of which is fixed to the muslin and other end is kept in the distilled water in a bottle.
10.	Wind vane	Western row (No.4)	3.6 m	➢ It is installed on a platform fixed at the top of a pillar which is at a distance of 9-10m from screen.
11.	Cup Anemometer	Western row (No.5)	3.6 m	➢ It is installed on a platform fixed at the top of a pillar to the south of the Stevenson's screen.

1.5 Networks of Agrometeorological Stations

1.5.1 Networks

When agricultural meteorological stations are being established or reorganized, the number of stations within each region should depend on its extent, climatic types and sub-types, and the spatial variations and of such factors as the natural vegetation, main crops and agricultural methods. As far as possible, each large homogeneous phyto-geographical region should be represented by at least one principal agricultural meteorological station.

Similarly, each characteristic area devoted to a particular aspect of agriculture, animal husbandry, hydrobiology or forestry should, wherever possible, be represented by an ordinary agricultural meteorological station. Sufficient auxiliary agricultural meteorological stations should be installed to ensure adequate spatial density of the observations of the meteorological and biological variables of major agrometeorological concern to the country.

From another point of view, marginal areas of agriculture, forest, animal husbandry and silviculture will often deserve special attention. One main objective of observations made in such areas would be to determine the boundary of the region where an individual crop could be grown successfully or a specific agricultural or silvicultural procedure might be profitable; another would be to ascertain the frequency and the typical geographical distributions of the main weather hazards, with a view to reducing their adverse effects as far as possible by means of protective measures.

Areas where agricultural production is markedly exposed to losses through plant and animal diseases are of special interest, as meteorological factors can be important in the development of these diseases. National parks and nature reserves, although usually not representative of the areas that are of major economic importance in agriculture, may provide good locations for reference stations where observations can be made over long periods under practically identical conditions.

The selection of these stations, whether principal, ordinary, auxiliary or for specific purposes, will vary from one country to another, but some general guidance may be given. The first consideration is that all agrometeorological stations should be located in regions of agricultural, silvicultural, pastoral or other forms of production. For information on representativity, the following locations will often be suitable for principal (and ordinary) stations:

- Experimental stations or research institutes of agriculture, horticulture, animal husbandry, forestry, hydrobiology and soil sciences
- Agricultural and allied colleges
- Areas of importance for agriculture and animal husbandry
- Forest areas
- National parks and reserves.

In the case of auxiliary stations and stations established for specific purposes, selected farms should also be considered. If the observations are made by alternating groups of students who may be insufficiently trained for this purpose, as in the case of observatories located at higher education institutions, very careful supervision will be needed to ensure observations of acceptable quality. In general, the observational accuracy should be a major consideration, quality must not be sacrificed for quantity.

1.5.2 Inspection and supervision of stations

Agricultural meteorological stations maintained by the National Meteorological Service should be inspected at least once a year to determine the perfect exposure; to ensure that observations conform to the appropriate standards; that the instruments are functioning correctly; and are calibrated at the required times. The time interval between successive inspections of an individual station depends upon the programme of the station and the qualifications of the local personnel responsible for the programme.

If other authorities make agricultural meteorological observations, they should enter into cooperative arrangements or special agreements with the National Meteorological Service to ensure adequate supervision and maintenance of the network, including calibration of equipment.

1.5.3 Fixed Agrometeorological Stations

These stations are foreseen as operating for an extended period at a fixed place, and may be:

i. Minimum equipment stations, consisting of a small portable screen, minimum and maximum thermometers, dry and wet bulb thermometers, totalizing anemometer at a convenient height, and raingauge (For screens that are not standard, the radiation error should be determined)
ii. Standard equipment stations, consisting of standard screen instruments and raingauge as in (a) above, thermo hygrograph, wind

vane, and wind-run and sunshine recorders. These allow one to determine evaporation using empirical methods

iii. Semi-automatic stations with an uninterruptible power supply, which are required to provide the measurements when trained personnel are not available. There is no automatic data communication

iv. Automatic stations, which require less supervision, but installation, calibration and inspection, must be of a high standard. An uninterruptible power supply is required and data from these stations can be used for direct computer processing. Initial and maintenance costs, as well as proper calibrations, may be limiting factors. Data should preferably also be communicated automatically.

1.5.4 Mobile stations

Mobile stations are used for surveys and research. Some mobile stations move continuously and others need equilibrium of sensors or certain periods for measurements, such as for local wind observations. When an extended but superficial survey of air temperature and humidity is required, vehicles usually carry the instruments. Under these circumstances, thermocouples and thermistors that have a rapid response and high sensitivity are used.

When using motor vehicles, all mechanical instruments should have anti-shock mounts and should be mounted so that the recording movement is perpendicular to the direction of the most frequent vibrations, in order to reduce the effect of these vibrations on the instruments.

1.5.5 Agricultural mesoclimatological surveys

The objective of agricultural mesoclimatological surveys is to determine meteorological variables or local special factors affecting agricultural production on a local mesoscale that are not representative of the general climate of the region. The surface relief (topoclimatology) and character (landscape), regional wind circulations, water bodies, forests, urban areas etc., come under these categories. These surveys are particularly useful where high measurement densities are needed and in developing countries or sparsely populated regions, where network sites are widely separated. Additional data from temporary stations that function from one to five years are useful for comparison with data from the basic network and for evaluation of interpolation of data between temporary and basic network stations. Observations with special instruments, from fixed or mobile stations, may serve to complete the general pattern.

Mesoclimatology and topoclimatology study the influence of the earth's actual surface on climate and of the climate on that surface. Many important factors that influence the local exchanges of energy and moisture such as,

- Configuration and roughness of the earth's surface; colour, density, thermal capacity, moisture content and permeability of the soil
- Properties of the vegetation covering it
- Albedo (the reflection coefficient of a surface) and so on exchanges of gases other than water vapour, liquids, particles
- Special attention should be paid to peak values of rain, wind, and flows of water, sediment and other materials carried, because they were locally of great importance to agriculture.

1.5.6 Complementary observations to describe special mesoclimatic processes

The spatial characterization, including the vertical dimension, of mesoclimatic patterns of temperature, humidity, pressure and wind in the lower troposphere for research purposes is determined as follows:

(a) Aircraft meteorograph soundings are performed on days presenting typical air masses for each season. It may be advantageous to carry out soundings at hours of minimum and maximum surface temperatures. The soundings that are made should be selected for the problem under study, vertically spaced every 100–150 m up to 800–1000 m, and then every 300–500 m up to 3000 m

(b) Soundings up to 300–500 m are carried out with a fixed meteorograph suspended from an anchored balloon. To avoid wind motion, in the past balloons were usually fixed with three bracing lines; however, modern instruments compensate for the movement if required

(c) For the study of wind structure upto 300 m, anchored directional balloons pointing into the direction of the wind may be used. For greater heights, pilot balloons with a low rate of ascent are used; their flights are followed from the ground with two theodolites. At night the balloons must be battery-illuminated. Smoke bombs may be useful to show wind direction as well as turbulence up to a limited height.

1.5.7 Detailed physical observations of a non-routine or non permanent character (agricultural micro meteorological research)

Detailed accurate observations that are neither routine nor permanent are needed for fundamental research, and are usually carried out independently of conventional agroclimatological observations. Such observations are made to a high degree of accuracy by skilled, scientifically trained staff and mostly include micrometeorological measurements made with specially designed instruments. For observations as highly specific as these, no general method can be formulated.

1.6 Observations to be carried out at agricultural meteorological stations

1.6.1 Observations of the physical environment

The observing programme at agricultural meteorological stations should include observations of some or all of the following variables characterizing the physical environment: solar radiation, sunshine and cloudiness, air and soil temperature, air pressure, wind speed and direction, air humidity and soil moisture, evaporation and precipitation (including observations of hail, dew and fog). The water balance, evapotranspiration and other fluxes may be deduced from these and other measurements. These measurements refer to the programme that should be followed for permanent or routine nationwide observations. Nevertheless, the needs of agricultural meteorology frequently require additional and special information, mainly at principal and ordinary stations, such as the following

- Results of agricultural meso-meteorological surveys
- Data derived from remote-sensing
- Accurate physical observations on a non routine basis (for agricultural micrometeorological research).

Table 1.3 Meteorological variables and their daily values

Variable	Accuracy required in daily values
Temperature, including max/min, wet and dry bulb, soil	< ± 0.5 °C
Rainfall	± 1 mm
Solar radiation including sunshine	10% (± 1h)
Evaporation	± 1 mm
Relative Humidity	± 5%
Photoperiod	10% (± 1h)
Wind speed	± 0.5 ms^{-1}
Air pressure	± 0.1 hPa

Normally, only principal agricultural meteorological stations would attempt to conduct all the observations on

- Radiation and sunshine
- Air temperature

- Temperature of soil
- Atmospheric pressure
- Wind
- Air humidity and soil moisture (including leaf wetness)
- Soil moisture
- Leaf wetness and dew
- Precipitation (clouds and hydrometeors)
- Evaporation and water balance measurements
- Fluxes of weather variables (derived from measured quantities)
- Remote-sensing and GIS
- Recorders and integrators
- Observations of biological nature
- Observations of natural phenomena
- Observations for agroclimatological use
- Observations of direct and indirect damage owing to weather
- General weather hazards
- Greenhouse gases
- Soil erosion
- Water runoff and soil loss
- Detailed biological observations
- Observations for operational use
- Global biological observations

1.7 Synoptic Charts and Weather Reports

The term synoptic climatology is applied to investigations of regional weather and circulations. It also used to refer to any climatological analysis which makes some reference to synoptic weather phenomena. This field is concerned with obtaining an insight into local or regional climates by examining the relationship of weather elements individually or collectively to atmospheric circulation processes.

Synoptic climatology is defined as the description and analysis of the totality of weather at a single place or over a small area, in terms of the properties and motion of the atmosphere over and around the place or area.

There are essentially two stages to a synoptic climatological study

- The determination of categories of atmospheric circulation type
- The assessment of weather elements in relation to these categories.

Besides agricultural meteorological, observatories synoptic weather stations also record weather data such as rainfall, temperature, radiation, low level wind and evaporation etc. The surface observatories collect information on various weather elements and based on these, daily forecasts, warnings and weather reports are prepared. The weather bulletins are being broadcast in regional languages through Radio and Television.

1.7.1 Synoptic report: Observed weather conditions are marked in brief coded form as a synopsis of the conditions. Such a brief report on weather conditions is known as synoptic report.

1.7.2 Synoptic chart/weather map: The regular observatories record weather elements at scheduled time and send these readings through a communication system to the main observatory. They reach within an hour of observation and they are chatted on outline map of the country. using the international code of signals and abbreviations. These are called synoptic charts or weather maps.

In synoptic charts different weather phenomena and atmospheric characters are marked with different symbols as mentioned below.

Table 1.4 Atmospheric characters and their symbols

S.No.	Symbols	Weather element / character / phenomenon
1.	Narrow block items	Isobars
2.	Numbers at ends of isobars	Pressure values in mb
3.	Shading	Precipitation
4.	Arrows	Wind direction
5.	Feathers in the arrows	Wind velocity
6.	Small circles with shading	Amount of clouds

In addition to the above, different symbols are used for recording weather phenomena, in relevant columns of the pocket register and the monthly meteorological register by the observer.

1.7.3 The duties of the observer

The routine duties of the observer include

- To make regular and careful observations and to note the general character of the weather and record in the pocket register
- To prepare and dispatch the weather material through a communication system as per the instructions to the different forecasting centers, immediately after the observations are taken

- To send, heavy rainfall information to the various offices on warning list.
- To prepare and post monthly meteorological and pocket registers, for each month to the controlling meteorological office
- To keep the instruments clean and maintain the same property.

After the observer sends the data as per the standard procedure it should be decoded and the weather observations for each station must be plotted at the appropriate location in a systematic manner following the international station model. Only weather maps in first-class forecasting centers approach the completeness of the model. Printed maps and maps used for plotting, usually have an appropriately numbered circle corresponding to each reporting land station and observations are plotted about this location in the appropriate position regardless of the number of observations shown. It must be, emphasized again that the weather pattern affecting a locality is an integral part of the much larger hemispheric weather pattern. It is necessary to plot a map over a large area. Even if observations are not to be plotted, it is necessary to know the plotting scheme in order to read and interpret weather charts already plotted.