The first lecture

INTRODUCTION

1-1 Definition of Agrometeorology

Agrometeorology, abbreviated from agricultural meteorology, science of meteorology to the service of agriculture, in its various forms and facets, to help with the sensible use of land, to accelerate the production food, and to avoid the irreversible abuse of land resources (Smith, Agrometeorology is also defined as the science investigating the logical, climatological, and hydrological conditions that are sign if agriculture owing to their interaction with the objects and processes culture production (Molga, 1962). The definition of biometeorology adopted by the International Society Biometeorology (ISB) states, "Biometeorology is an interdisciplinary science dealing with the application of fields of meteorology and climatology biological systems" (Hoppe, 2000, p. 383). The general scope includes kinds of interactions between atmospheric processes and living isms—plants, animals, and humans. By this definition, it becomes that there are roughly three sub branches of biometeorology: plant, and human biometeorology (Hoppe, 2000). The domain of agrometeorology is the plant and animal sub branches. The third sub branch, biometeorology, is outside the scope of agrometeorology.

1-2 Importance and applications of Agrometeorology

There is hardly a branch of human activities as dependent on the weather as agriculture. Agricultural production is for a large part still dependent on weather and climate despite the impressive advances in agricultural technology over the last half a century. More than ever, agrometeorological services have become essential because of the challenges provided to many forms of agricultural production by increasing climate variability and associated extreme events as well as climate change, all of which affecting the socio-economic conditions, especially of developing countries.

1-2-1 Applications

The practical application of this knowledge is linked to the availability and accuracy of weather and climate forecasts or expected weather and climate patterns, depending on the time scale. The requirements range from accurate details of short-range weather forecasts (less than two days), medium range forecasts (less than ten days) at certain critical times to seasonal predictions of climate patterns. To ensure that development plans are not rendered meaningless by a significant change in weather and climate behavior, indications of possible climatic variability, and of increasingly frequent and serious extreme events in the context of global climate change, are necessary as agrometeorological services in addition to the application of other agrometeorological information. Although reliable long-term weather forecasts relevant to the agricultural community are not yet available on a routine basis all over the world, significant services may be provided by means of agrometeorological forecasts such as on the dates of phonological events, the quantity and quality of crop yields, and the occurrence of animal and crop epidemics. regionally and at world scale. Long-term planning of global food production must therefore take into account the effects of year-to-year fluctuations in weather patterns, The global climate is influenced by a lot of factors. Two of the most important components are CO_2 and water vapor in the atmosphere. Beside the oceans, forests absorb CO_2 and release water vapor. Burning forests produce considerable masses of CO_2. So it is necessary to promote reforestation and protect forests against fire and human beings as well as against other destruction, such as by insects, diseases and pollutants.

Forest meteorology as a component of agrometeorology provides useful information and services for application to the forest authorities, the foresters and in case of forest fires to the fire-brigades. Agrometeorological services in developing countries have to shoulder greater responsibilities due to greater population pressure and changing modes of agricultural practices. More and more demands pertaining to agrometeorological information and services are expected from the farming communities in the future on technologies, farming systems patterns, water management, weather based pest and disease control etc., preferably with local innovations as starting points. Thus the future challenges include the necessity to emphasize a bottom up approach so that forecasts, specific advisories and contingency planning reach even the small farmers for applications in their planning and day-to-day agricultural operations.

Other important advisory fields that require attention are:

- Management and modification of microclimate.
- Meteorological information for guiding irrigation and drainage.
- Environmental risks and disaster mitigation.
- Highland and mountain agriculture.
- Prediction of El-Nino and rainfall variability for agricultural planning.
- Information on weather based pesticides/insecticides applications.
- Arial transport of pollutants and knowledge regarding low level winds for operational activities.
- Workday probabilities (e.g. in marine and lake fishing).
- Agro advisory services for farmers on a regional level to strengthen and provide accurate forecasts and advisories for the farming community.
- Communication of information in a format/language understandable to users.

In more advanced agricultural production, with potential for technology transfer where the absorption capacity exists, we may add:

- Crop weather modelling with special emphasis on crop growth simulation models.
- Development of complex data collection systems and speedy processing and interpretation of large spatial data collections.
- Geographical information systems and their use for crop planning at smaller than present scales.
- The use of remote sensing technologies to generate information/ advisories for large areas.
- Quantifying Carbon sequestration.
- Use of audio-visual media and internet for quick dissemination of information to the users.

2-1 The relation between physical climatology and Agrometeorology and their Effects

A branch of meteorology that examines the effects and impacts of weather and climate on crops, rangeland, livestock, and various agricultural operations. The branch of agricultural meteorology dealing with atmospheric-biosphere processes occurring at small spatial scales and over relatively short time periods is known as micrometeorology, sometimes called crop micrometeorology for managed vegetative ecosystems and animal biometeorology for livestock operations. The branch that studies the processes and impacts of climatic factors over larger time and spatial scales is often referred to as agricultural climatology.
Agricultural meteorology, or agrometeorology, addresses topics that often require an understanding of biological, physical, and social sciences. It studies processes that occur from the soil depths where the deepest plant roots grow to the atmospheric levels where seeds, spores, pollen, and insects may be found.
Agricultural meteorologists characteristically interact with scientists from many disciplines. Agricultural meteorologists collect and interpret weather and climate data needed to understand the interactions between vegetation and animals and their atmospheric environments. The climatic information developed by agricultural meteorologists is valuable in making proper decisions for managing resources consumed by agriculture, for optimizing agricultural production, and for adopting farming practices to minimize any adverse effects of agriculture on the environment. Such information is vital to ensure the economic and environmental sustainability of agriculture now and in the future.
Agricultural meteorologists also quantify, evaluate, and provide information on the impact and consequences of climate variability and change on agriculture. Increasingly, agricultural meteorologists assist policy makers in developing strategies to deal with climatic events such as floods, hail, or droughts and climatic changes such as global warming and climate variability. Agricultural meteorologists are involved in many aspects of agriculture, ranging from the production of agronomic and horticultural crops, trees, and livestock to the final delivery of agricultural products to market. They study the energy and mass exchange processes of heat, carbon dioxide, water vapor, and trace gases such as methane, nitrous oxide, and ammonia, within the biosphere on spatial scales ranging from a leaf to a watershed and even to a continent. They study, for example, the photosynthesis, productivity, and water use of individual leaves, whole plants, and fields. They also examine climatic processes at time scales ranging from less than a second to more than a decade.

- **Agricultural Climatology**

In general, the study of climate as to its effect on crops; it includes, for example, the relation of growth rate and crop yields to the various climatic factors and hence the optimum and limiting climates for any given crop. Also known as agroclimatology.

- **Biometeorology**

A branch of meteorology and ecology that deals with the effects of weather and climate on plants, animals, and humans. The principal problem for living organisms is maintaining an acceptable thermal equilibrium with their environment. Organisms have natural techniques for adapting to adverse conditions. These techniques include acclimatization, dormancy, and hibernation, or in some cases an organism can move to a more favorable environment or microenvironment. Humans often establish a favorable environment through the use of technology.

• Climatology

The scientific study of climate. Climate is the expected mean and variability of the weather conditions for a particular location, season, and time of day. The climate is often described in terms of the mean values of meteorological variables such as temperature, precipitation, wind, humidity, and cloud cover. A complete description also includes the variability of these quantities, and their extreme values. The climate of a region often has regular seasonal and diurnal variations, with the climate for January being very different from that for July at most locations. Climate also exhibits significant year-to-year variability and longer-term changes on both a regional and global basis. The goals of climatology are to provide a comprehensive description of the Earth's climate over the range of geographic scales, to understand its features in terms of fundamental physical principles, and to develop models of the Earth's climate for sensitivity studies and for the prediction of future changes that may result from natural and human causes.

• Crop Micrometeorology

The branch of meteorology that deals with the interaction of crops and their immediate physical environment.

• Micrometeorology

The study of small-scale meteorological processes associated with the interaction of the atmosphere and the Earth's surface. The lower boundary condition for the atmosphere and the upper boundary condition for the underlying soil or water are determined by interactions occurring in the lowest atmospheric layers. Momentum, heat, water vapor, various gases, and particulate matter are transported vertically by turbulence in the atmospheric boundary layer and thus establish the environment of plants and animals at the surface. These exchanges are important in supplying energy and water vapor to the atmosphere, which ultimately determine large-scale weather and climate patterns. Micrometeorology also includes the study of how air pollutants are diffused and transported within the boundary layer and the deposition of pollutants at the surface. In many situations, atmospheric motions having time scales between 15 min and 1 h are quite weak. This represents a spectral gap that provides justification for distinguishing micrometeorology from other areas of meteorology. Micrometeorology studies phenomena with time scales shorter than the spectral gap (time scales less than 15 min to 1 h and horizontal length scales less than 2–10 km). Some phenomena studied by micrometeorology are dust devils, mirages, dew and frost formation, evaporation, and cloud streets.

• Ecosystem

An ecosystem is a complete community of living organisms and the nonliving materials of their surroundings. Thus, its components include plants, animals, and microorganisms; soil, rocks, and minerals; as well as surrounding water sources and the local atmosphere. The size of ecosystems varies tremendously. An ecosystem could be an entire rain forest, covering a geographical area larger than many nations, or it could be a puddle or a backyard garden. Even the body of an animal could be considered an ecosystem, since it is home to numerous microorganisms. On a much larger scale, the history of various human societies provides an instructive illustration as to the ways that ecosystems have influenced civilizations.