Climatic anomaly and Crop Production

Lecture-5

Contents

- Crop calendar Cereals Phenological observations; Oilseeds; Vegetables and Fruits
- Meteorological aspects of Crop pests and diseases, Horticulture, Animal husbandry

Climatic normal for oils and cereals seed productions

- **Climatic condition for oils production**
- **Groundnut:** it is mostly grown under rain fed condition (6.5 m ha) cultivated during monsoon season
  - ✓ And also grown on the large scale in all Tropical and sub-Tropical countries of the world.

➢ It is mostly a Tropical plant, which requires long and warm weather with abundance of sunshine.

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- Ideal rainfall for this crop is being between 500mm to 1200mm annually and average temperature of 21℃ to 27 ℃ and it requires warm and dry weather.
- Soil requirement**:** Groundnut is grown best in the well drainage sandy loam soil,
  - ✓ While clay or heavy soil is not suitable for groundnut production.
- Soil PH between 5.5 to 8.0 is good for groundnut productivity.

Cont. . .

- **Sesamum:** it is a crop of Tropical and Sub-Tropical regions.
- It grows at an elevation of 1200m to 1300m a.m.s.l
  - ✓ And mostly grown under rain fed in areas receiving an annual rainfall of 1500mm to 1600mm.
  - ✓ Temperature between 25℃ to 27 ℃ is beneficial for rapid germination.

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- Soil requirement: sesame is grown on a variety of soil type ranging from sandy loam to heavy black soil.
  - ✓PH ranging from 5.5 to 8.2.
- **Linseed:** it is cool season crop growing in summer season requires about 25 ℃ to 30 ℃ during germination and
  - ✓ About 15 ℃ to 20 ℃ during seed formation.

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- Linseed is the resistant to drought and growth well in dry land areas receiving an annual rainfall of 45 to 75cm.
- It requires comparatively higher temperature, low moisture and dry weather during maturity.
- Soil requirement: Linseed grows in all type of soil where sufficient water is available, but good in the heavier soil.

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- **Safflower:** it is grown under rain fed conditions, as it is drought resistance crops.
- It is cool season crop the optimum temperature for germination being 15.5℃, high temperature during flowering is harmful;
  - ✓The day temperature is in the range of 24℃ to 32℃ at flowering is good for high yield, but frost is harmful for the crop.

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- Soil requirement: safflower is cultivated in all type of soil including sandy soil, with neutral PH.
- **Sunflower:** it requires cool climate during germination and seedling stage which can tolerate frost moderately.
- But needs warm weather from seedling to flowering stage and warm and Sunday during flowering to maturity.
- High humidity, cloudy weather, and high rainfall at time of flowering resulted in the poor seed set.

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- Soil requirement: sunflower is being grown on wider range of soil; it thrives best on deep loam, soil with good drainage,
  - ✓The optimum range of soil PH is from 6.5 to 8.5.

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- **Climate conditions for cereal seed production**
- **Rice production:** it is grown under wider conditions of altitude and climate.

➢ Rice crop need a hot and humid climate

- ✓ But the best suited areas having high humidity, prolonged sunshine, certain water supply and
- ✓ Preferably grown in the area having annual rainfall 800mm to 1600mm.

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- Rice requires relatively high temperature ranging 25℃ to 35℃ for optimum growth and development of plant.
- Soil requirement: it is grown in all type of soil ranging from acidic to saline alkalis.
  - ✓However, the most suited for the cultivation of rice are clay and clay loam which have higher water retention capacity.

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- **Maize production:** it is a warm weather crop. It grows from sea level to 3000m altitude.
- The most suitable temperature for germination is 21℃ and for growth 32℃.
- The growth of crop stops if the night temperature falls 15.6℃,
  - ✓ Due to extreme night temperature and low humidity during the flowering, pollen are desiccated, resulting into improper pollination.

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- Soil requirement: it needs soil from loam to salty loam, with deep fertile with good water holding capacity and well drainage with PH ranging 6.5 to 7.5.

- **Sorghum production:** it requires warm climate, but its plant are very hard and with a stand high temperature,
  - ✓ It growth from sea level to a high 1500m a.m.s.l,
  - ✓ It growth under high rainfall areas of the world.

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- The minimum temperature for its germination is 7℃ to 10℃ and temperature ranges of 26℃ to 30℃ for its optimum growth.
- Soil requirement**:** it grown best on loam soil with water retention capacity.
  - ✓With acidity or salinity between PH 5.5 to 8.0.
- **Wheat production***:* it grown in all over the world in wider variety of climatic conditions.

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- It is being grown in tropical, sub-tropical and temperate zones.
  - ✓ It can be cultivated from sea level to as high 3300m a.m.s.l.
- The best wheat crops are produced in areas with cool, moist weather during growing period followed by dry weather.
- Soil requirement: it requires sandy loam soil with good structure, moderate water holding capacity and neutral reaction is best suited for wheat cultivation;
- Rain fed crop can be grown successfully in heavier soils having higher water retention capacity and good drainage.

Cardinal temperature (°c) for both oil and cereal seed production

Plant	*Minimum (c^0)*	*Optimum(c^0)*	*Maximum (c^0)*
Wheat	*3-4.5*	*25*	*30-32*
Barley	*3-4.5*	*20*	*38-40*
Maize	*8-10*	*32-35*	*40-44*
Rice	*10-12*	*30-32*	*36-38*
Tobacco	*13-14*	*28*	*35*
Suger beet	*4-5*	*25*	*28-30*
Peas	*1-2*	*30*	*35*
Oats	*3-4*	*25*	*30*
Sorghum	*8-10*	*32-35*	*40*
Lentiles	*4-5*	*30*	*36*
Carrot	*4-5*	*30*	*25*
Pumpkin	*12*	*32-34*	*40*

Oil seeds

Groundnut

Linseed

Sunflower

Cereal seeds

Impact of climate variability and climate change on crop production

- Agriculture depends on the climate more than any other human activity, and so is particularly vulnerable to climatic change.
- The IPCC estimates that because of increasing human-induced emissions of carbon dioxide, methane, nitrous oxide and other "greenhouse gases",.
  - ✓ Average temperatures may increase by about 0.3°C per decade over the next century, while sea levels could rise by at least 2-4 cm per decade.

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- ✓ This will have an impact, still to be quantified, on agriculture, forestry, fisheries, food security, and biodiversity and rural environmental conditions.

- Not all of the effects of global warming would be harmful to agriculture.
- Higher concentrations of carbon dioxide can have a fertilizing effect under optimal growing conditions:
  - ✓ 10-20% of improved crop productivity over the past century could be the result of the gradual increase in the level of the gas; and crop productivity could increase further, by up to 30 %.

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- It could also offset the damage done to plant growth by other pollutants, and increase the efficiency with which crops use water.
- Rising temperatures could increase the yield of some plants, while diminishing others.
- Rainfall could also increase, by about 10 %, but its distribution and intensity would change; some areas would benefit, others would be harmed.

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- The weather and climate would become more unpredictable, making farming and planning more difficult.
- Global warming is likely to emphasize the existing imbalance in world food production between the developed and developing countries.
- Farmers in richer countries are also most likely to be able to adapt to climate change.

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- Variation in climate is one of the main determinants of agricultural production in developing and developed countries alike.
- It is becoming increasingly clear that climatic variability is influenced not only by natural factors, but by human activities as well.
- This "human component" is believed to be responsible for "climate change" or "global warming",

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- The uncertainty makes planning for climate change difficult.
  - ✓ For example, it is likely that higher temperatures will produce more intense atmospheric circulation and a faster water cycle,
  - ✓ Leading to heavier and more erratic rains, stronger winds and more frequent floods.
- The same approach applies to the main greenhouse gases of agricultural origin,
  - ✓ Such as carbon dioxide build-up due to deforestation, methane produced by ruminant digestion and rice paddies, and nitrous oxides from fertilizer use.

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- Agriculture is responsible for an estimated one third of global warming and climate change.
  - ✓ It is generally agreed that agricultural sources, mainly deforestation and the burning of biomass produce about 25% of the main greenhouse gas, carbon dioxide.
  - ✓ Most of the methane in the atmosphere comes from domestic ruminants, forest fires, wetland rice cultivation and waste products, while conventional tillage and fertilizer use account for 70% of the nitrous oxides.

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- **Climate change Impact on Agriculture,** Climate change is a movement in the climate system
  - ✓ Because of internal changes within the climate system or in the interaction of its components, or
  - ✓ Because of changes in external forcing by either natural factors or anthropogenic activities.
- Major climate change impact on agriculture
  - ✓ Climate variability might increase, putting additional stress on fragile farming systems.

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- ✓ Climate extremes - which are almost impossible to plan for - might become more frequent.
- ✓ The sea level would rise, threatening valuable coastal agricultural land, particularly in low-lying small islands.
- ✓ Climatic and agro-ecological zones would shift, forcing farmers to adapt, as well as threatening natural vegetation and fauna.

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- ✓ The current imbalance of food production between cool and temperate regions and tropical and subtropical regions could worsen.
- ✓ Pests and vector-borne diseases would spread into areas where they were previously unknown.

➢ Global warming might also have some positive effects for farmers.

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- ✓ Increases in carbon dioxide have a fertilizing effect for many crops, increasing growth rates and water use efficiency.

- The natural variability of rainfall, temperature and other conditions is the main factor behind variability in agricultural production,
  - ✓ Which in turn is one of the main factors behind food insecurity.
- Both climate variability and climate extremes may increase because of global warming.

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- FAO works on two levels to reduce the impact of climate variability and climate change on food security.
- The Organization aims to increase farmers' ability to cope with variability:
  - Encouraging a "no-regrets" approach to agricultural development,
  - ✓ Options that increase agricultural efficiency and flexibility under current conditions, and that will also stand farmers in good stead should conditions shift over the long term.

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- Monitoring world agricultural production for planning and early warning purposes
- ✓ Establishing effective early warning systems for animal and plant diseases
- ✓ Monitoring environmental conditions and climatic changes.

➢ Agriculture is not only a victim of global warming.

- ✓ At present, it is also a contributory factor, and in the future, it could make a major contribution to reduction of global climate change.

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- 25 % of co_2 emissions come from land use change (mainly deforestation), and fertilizer use is one of the main human made sources of nitrous oxides.
- FAO encourages farmers to reduce excessive use of nitrogenous fertilizers,
  - ✓Which is costly, inefficient and harmful to the environment.

Impact of climatic born diseases and pests on crop production

- ***Aphids;*** Weather factors, especially temperature and rainfall, play a dominant role in the population dynamics of aphids in all the climatic regions of the world where crop production is possible.
- Aphids are highly sensitive to temperature changes.
- Temperatures below 20°C and above 25°C limit the buildup,
  - ✓ While an increase from 20 to 22°C enhanced the intrinsic rate of increase of aphid populations.

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- ***Armyworms;*** Economic infestations of armyworms in many parts of the world have revealed
  - ✓That precipitation is the primary factor influencing pest populations.
- ***Grasshoppers,*** Temperature sensitivity determines the geographical distribution of grasshoppers,
  - ✓Thermally specialized species restricted to warmer habitats.

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- ***Locusts;*** Distribution and sequence of rainfall is the principal determinant of locust population increase over several generations.
- Locusts move in swarms from one area to another where rain has fallen.
- Wind direction and speed at 850 hpa (about 1.5 km above the earth's surface) and convergence zones determine the paths of the locusts' movements.

Application of Statistical Models in Seasonal weather forecasting

- **A model** attempts to simulate the way in which a crop responds to its environment.
- Model outputs are usually value-added parameters that are more closely linked to crop yield than the inputs.
- The outputs are empirically related to crop yield through standard regression techniques. This procedure is known as "model calibration".

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- The result of the calibration is a mathematical expression - known as "yield function" that is used to calculate yield estimates based on model outputs.
- The main aim of the crop model and water budget described here is to estimate the amount of water consumed which, in turn, is very closely related to crop yield.
- **Modeling approach**, is based on a continuous monitoring of the cropping season,
  - ✓ Which determines a cumulative water balance for each period of 10 days ("dekad") from planting to maturity.

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- What do we mean by "cumulative"?
  - ✓ The cycle of each crop is subdivided into successive 10-day (dekad) periods taken as time unit.
  - ✓ For each dekad, rainfall, crop water requirements and crop stage are known. "Cumulative", then, means that the water.
- Balance is carried out from the beginning to the end of the crop cycle, the water available
  - ✓ i.e. soil moisture - at the beginning of each dekad being the amount available at the end of the previous one, plus rainfall, minus crop water consumption.

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- At the same time, the water stress that could affect the crop during its development is also calculated in a cumulative way.
- This model could be considered as a combination of the dynamic (water balance) and statistical (calibration of yield function) approaches.
- In fact, at harvest time, the sum of dekadal water stress suffered by the crop (the Water Satisfaction Index), crop water consumption.

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- The most important parameter of "actual evapotranspiration" and
  - ✓Some other relevant variables are combined into a forecast yield by a regression equation.
- The whole model is based on the Crop Specific Soil Water Balance (CSSWB),
  - ✓Which is a very simple, but physically sound soil water budgeting approach developed for operational use.

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- **Seasonal Climate Prediction**

- Improvement in seasonal climate prediction is one crucial factor that could reduce the vulnerability of agricultural systems to severe impacts of extreme inter-annual climate anomalies.
- The science and technology of climate prediction within monthly, seasonal, to inter-annual time scales is still young and is currently under intensive investigation worldwide.
- El Niño and Southern Oscillation are some of the known key drivers to inter-annual variability, have been associated with worldwide extreme climate anomalies, including changes in the space-time patterns of floods, droughts, cyclone /severe storm activity, and cold, and heat waves.
- For some of these, agricultural application models have been developed which transfer projected ENSO signals directly into agricultural stress indices.

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- How can climate information be used to improve decision making in agriculture? This information can be used in three main ways:

1. Strategic purposes: assessing production capability, farm layout, and Choice of project based on an interpretation of the local climate record
2. Tactical purposes: building planning and flexibility into the farming system for both levels of production and farming operations based on seasonal outlooks or forecasts.

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3. Building resilience: strengthening farming systems through diversification, risk management strategies, and off-farm income.

- Generally, Advances in climate research and satellite and computer technology have improved the potential of farmers to prepare and adjust farming operations in a variable climate.
- For this potential to be realized, the complexities of the decision-making process in agricultural systems must be acknowledged and addressed.

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- Generally, Seasonal climate forecast issued in tercile
  - ✓ i.e. *Above Normal (A), Normal (N) and Bellow Normal (B))*, with the probability of rainfall in each three categories (33.33%).

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❖ **Developing crop calendar of the place**

- Detailed information about crop stages - also known as the "crop calendar" - plays an essential role in crop monitoring and forecasting.
- This is because the effect of environmental conditions on crops depends very much on crop growth stages.
- For instance, water requirements are normally low at the initial growth stages, while they reach a maximum just after flowering.

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- Information about crop stages can be obtained from different sources, in isolation or in combination.
- An effective system involves field observers, usually agricultural extension staff, using a system of regular reporting, either by radio or by mail.

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- National crop monitoring systems also rely more and more on satellite technology.
  - ✓ Using a series of Normalized Difference Vegetation Images (NDVI), and seasonal climate outlooks, it is possible to monitor vegetation development.
- Assuming that crops follow a pattern similar to natural vegetation, planting dates - also known as the "start of the season" - can be estimated.

Global Warming Effects On Crop Yield

- Depending on present conditions, global warming and CO2 enrichment can have positive or negative impacts.
- Simulated yield increases in the mid and high latitudes are caused primarily by:
  - ✓ Positive physiological effects of' CO_2
  - ✓ At sites with cooler initial temperature regimes, increased photosynthesis more than compensated for the shortening of the growing period caused by warming.

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- Lengthened growing season and amelioration of cold temperature effects on growth.
- The primary causes of decreases in simulated yields are:
  - ✓*Shortening of the growing period.* Higher temperatures during the growing season speed annual crops through their development, causing less grain to be produced.

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- ✓ *Decrease in water availability.* This is due to a combination of:-
- ❖ Increases in evapotranspiration rates in the warmer climate,
- ❖ Enhanced losses of soil moisture and,
- ❖ In some cases, a projected decrease in precipitation in the climate change scenarios.

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- ✓ *Poor vernalization.* Vernalization is the requirement of some temperate cereal crops,
- ❖ e.g., winter wheat, for a period of low winter temperatures to initiate or accelerate the flowering process.
  - Low vernalization results in low flower bud initiation and ultimately reduced yields.

Missing for the last n days!

I, THANK YOU!!!