Topic 2

2.0 Factors Determining Farming Systems: Physical, Biological and Socio-economic

The determinants of farming system can be grouped into the natural and the socio-economic factors. The natural factors are comprised of the physical and the biological factors

2.1. Physical factors

These include all external conditions and influences affecting the life and development of an organism.

2.1.1 Climate

a) Solar radiation

Solar radiation is essential for photosynthesis, when crops utilizes visible light to produce dry matter from water and Carbon dioxide. Therefore dry matter production depends on incoming solar radiation and the type of plant that is exploiting it under normal conditions. Solar radiation is an essential determinant of the final yield of some crops in areas of adequate water supply e.g. sugar-cane and lowland rice.

b) Rainfall

Rainfall is the most important climatic variable its roles in agricultural production include the following:

1. Main source of moisture supply to the soil for the activation of plant growth,
2. Replenishment of water in rivers to allow irrigation operation,
3. Build-up of underground water reserves which are later tapped by wells in dry area through seepage and percolation, and

4. Influences soil/water/plant relationships;

The amount, incidence, variation and reliability of rainfall determine differences in cropping pattern in various ecological zones

Excessive rainfall adversely affects crop production through high run-off, soil erosion, leaching, nutrient losses, water-logging, vigorous vegetative growth or weed infestation, and general disruption of agricultural activities. On the other hand, inadequate rainfall prevents crop growth Crop growth is only sustainable for varying periods in different ecological zones because The seasonality, duration and regimes of the wet season and the number of months of inadequate rainfall per month are more important to agricultural activities than total rainfall.

Variation in the duration of the wet season determines the variety of crops grown in different zones. The onset of rains varies with ecological zones, viz. March in the interior part of southern Nigeria, April in a large part of the Middle Belt and May/June in the Sudan zone.

c) Temperature

Temperature affects evapo-transpiration, photosynthesis and soil warming. The effects of high temperature include:

1. Rapid soil organic matter (SOM) decomposition due to high microbial activities and increased rates of biochemical reactions,
2. Rendering built-in fallows ineffective,
3. Enhance the incidence of pests and pathogens,

4. Enhances high respiratory rates and exhaustion of plant assimilates in the night, resulting in low net assimilate accumulation and crop yield,

5.Affects seed germination, pollination, flowering, fruiting, ion uptake, leaf growth and cell enlargement.

d) Relative humidity

This is the ratio between the amount of water vapour actually held in the air and the maximum possible amount that can be held at a particular temperature. It is a measure of the dampness of the atmosphere. Differences in relative humidity are more critical to the unpleasant climate of Nigeria than high temperature. High relative humidity increases disease incidence on cropped farms and reduces the crop's ability to intercept solar radiation.

Contrarily, low relative humidity leads to high evapotranspiration and transpiration which eventually cause wilting of crops.

e) Winds and Ocean Currents

The predominant air masses in West Africa are the equatorial maritime air mass (moisture-laden south west monsoon winds, SWM) and the tropical continental air mass (dry and dusty north-east trade/harmattan winds, NET). The meeting point of these two air masses is called the Inter-Tropical Front (ITF), whose relative dominance brings in rain (northward movement) and harmattan (southern movement). Rain falls only in areas lying south of the ITF. The northward movement of the ITF occurs in February when the NET starts to retreat and being replaced by the advancing SWM. In July, most areas south of latitude 200N fall under the influence of rain-bearing wind from the south. In August, the ITF reaches its inland limit and remains stable for a

few weeks before moving coast-ward. In January, the ITF is near the coast once more while the NET again becomes the dominant winds. Other winds of importance to agricultural production include sea breezes, land breezes and ocean currents. The ocean currents are three, namely the Cold Benguella current, Guinea counter-current and the Cool Canary current. The currents influence climatic conditions through the winds blowing over an area; winds blowing over a warm current are usually moisture-laden while those blowing over a cold current usually have a cooling effect on the coast,

2.1.2 Soils

Crop productivity is strongly dependent on physical, chemical and biological conditions of the soil.

a) Physical Soil Factors Affecting Crop Production

These include the soil's texture, structure, porosity and bulk density.

i) Soil Texture

Soil texture is the relative proportions of sand, silt, and clay particles in the soil. This proportion of solid soil particles provides a useful guide to a soil's potential for agricultural crop production, because it exerts a major influence on soil characteristics. The soil texture influences the water-holding capacity (through the clay type and content and capillary conductivity), temperature, drainage and nutrient retention capacity of the soil. Also, soil texture influences the efficacy of soil-applied pre-emergence herbicides and other pesticides. Soils are classified into light (sandy, workable), medium (loamy, most workable) or heavy types (clay, unworkable) on the basis of

soil texture, due to its close relationship to the workability (the ease of working the soil with machinery) of the soil.

ii) Soil Structure

This is defined as the arrangement of the particles (sand, silt, clay) in the soil. It influences the soil tilth, root growth and development, gaseous exchange/aeration, drainage, water infiltration into the soil, and efficiency of water and nutrient uptake by plants (through capillary conductivity). “Structural stability” is the ability of the soil to resist deformation when wet. It is influenced by the clay content, presence of lime, iron oxides and humus. However, soil structure is not a stable soil property, and therefore changes with time and weather. Poorly stable soil aggregates slake (collapse) easily while good aggregate structure maintains the shape when wetted for a short time and gradually piece off thereafter. A good structural stability is essential to prevent soil degradation and limited crop growth. Soil structure can be improved by addition of decomposable OM (e.g. farmyard manure, FYM), crop roots and crop residues. Heavy machinery causes damage to soil structure in wet soil, especially heavy clay soils.

iii) Soil Porosity

This is defined as the percentage volume filled with air when the soil is fully drained of saturated water. The pore sizes include micropores (smallest pores containing only water which rarely dries out and is unavailable for crop uptake); mesopores (middle-sized pores containing water available to plants and which allow free aeration of the soil); and macropores (pores greater than 0.1 mm in diameter, can drain easily to allow in air after full wetting of the soil). Soil porosity influences the infiltration of water into the soil, water-holding capacity, drainage and aeration of

the soil aggregates; these properties have significant influence on the SOM status. Ecologically, soil aeration plays a significant role in organic residue decomposition; oxidation-reduction of elements, especially nutrients; plant growth; nutrient and water uptake soil compaction; soil structure; and soil cultivation. Aeration capacity is very high in sandy soils, optimal in loamy soils and very low in clay soils. However, organic matter additions (which increase the number of meso- and macro-pores) can improve the aeration capacity of clay soils.

iv) Soil Bulk Density

This is mass of soil per unit volume of the soil. It is determined by the volume of pore spaces in the soil; the more the pore spaces, the lower the bulk density, and vice versa for high bulk density or soil compaction. Soil bulk density affects the workability of the soil, especially with respect to mechanical cultivation, and especially in dry weather. Notillage or minimum tillage is also strongly affected by soil compaction.

v) Soil Water

Water is held in the soil in three forms, namely:

i) capillary water (water held by surface tension forces as a continuous film around the particles and in the capillary pore spaces of the soil)

ii) gravitational water (water held to the soil particles against gravitational forces and suction force of the roots, and which drains under the influence of gravity);

iii. hygroscopic water (water adsorbed from an atmosphere of water vapour as a result of attractive forces in the surface of the soil particles and aggregates)

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Soil water is very critical to root absorption of essential nutrients from the soil, soil temperature, microbial and microbial soil activities, organic matter decomposition, etc. The farm soil needs to be at field capacity always to ensure optimal growth and development.

b) Chemical Factors of Soil Affecting Crop Production

The soil chemical characteristics are of primary importance in crop nutrition. They include

i) Soil Organic Matter (SOM)

This is the proportion of the fresh organic material and humus (partly decomposed and synthesized organic material). These materials exert a profound influence on crop nutrients (through slow nutrient-release mechanism), soil structure and cultivation. Organic matter serves as the soil granulator, being largely responsible for particle aggregation through its efficiency on cohesion and plasticity. It is a rich source of important plant nutrients, particularly nitrogen which is entirely derived from organic matter. Organic matter influences the colour, temperature (by minimizing evaporation from soil surface), water-holding capacity,water retention, nfiltration, pH and exchangeable capacity of the soil. It is the main source of energy for heterotrophic soil microorganisms, which stimulates their reproduction and growth, thus acilitating their capacity to make the nutrients in SOM available to the plants. Organic materials in the soil are decomposed by primary decomposers (insects, earthworms, fungi) and secondary decomposers (bacteria, fungi). This, in addition to cultivation and bush burning reduce SOM content.

ii) Soil pH

This indicates the degree of acidity or alkalinity of the soil. It is significant in determining the soil chemical reactions.

iii) Available plant nutrients

Soil minerals are derived from rock weathering; the primary minerals re derived directly while the secondary minerals are derived from the primary minerals by weathering and synthesis. Plant nutrients are of three main forms, namely macro-, meso-and micro-nutrients. The macro nutrients (nitrogen, phosphorus, potassium) are primarily important in crop growth, because they are required in large quantities. The meso-nutrients are calcium, magnesium and sulphur. The micronutrients are required in minute quantities but are also important for the normal growth of some crops and certain physiological processes, namely enzyme systems, protein and carbohydrate metabolism, nitrogen fixation, chlorophyll formation, pod maturation and production, growth hormones and starch forms. They include copper, molybdenum, chlorine, boron, manganese, zinc and iron. A knowledge of the available nutrients not only guides in determining the suitability of the site (soil) for a particular crop but also in formulating soil fertilizer requirements.

c) Topography

Position of farm on the toposequence whether on the crest or valley bottom

d) Biological Factors of Soil Affecting Crop Production

These include soil fauna and flora,

i) Soil Fauna

Includes are the beneficial and damaging animal organisms. Beneficil organisms are those which break down and incorporate crop residues, and further aid in water movement and aeration e.g. earthworm. The damaging organisms consist of the larval stages of beetle, fly, grubs, worms and nematodes.

ii) Soil Flora

Pathogens such as bacteria, fungi and viruses are important as sources of soil infections in crop lands.

2.2 Biological factors

Included are crop and livestock species, pests, diseases and weeds

2.3. Socio-economic Factors

2.3.1 Endogenous factors

These are factors within the control of the rural household they are as follows:

a Family composition

b. Health and nutrition

c. Education

d. Food preferences

e. Risk aversion

f. Attitude/goals

g. Gender relations

2.3.1 Exogenous factors

These are factors that are not within the influence of the rural household. They are as follows:

a. Population

b. Tenure

c. Off-farm opportunities

d. Social infrastructure

e. Credit

f, Markets

g. Prices

h. Technology

i. Input supply

j, Extension

k. Savings opportunities