**UNIT ONE**

**BASIC CONCEPTS OF SOIL FERTILITY AND SOIL HEALTH**

**SOIL FERTILITY VRS SOIL PRODUCTIVITY**

**Soil fertility**refers to the capacity of a soil to support the production of crops and livestock. A fertile soil can support optimal plant growth from seed germination to plant maturity. In other words, It is the capacity of soil to supply sufficient quantities and proportions of essential chemical elements (nutrients) and water required for optimal growth of specified plants as governed by the soil’s chemical, physical and biological attributes.

On the other hand, **soil productivity** is the capacity of the soil to produce crops with specific systems of management and is expressed in terms of yields.

**NB:** All productive soils are fertile, but not all fertile soils are productive.

***The Reasons*** could be either one or two or interplay of many constraints. These are water logging, saline or alkaline condition, adverse climate etc. Under these conditions, crop growth is restricted though the soil has sufficient amounts of nutrients.

**Soil health** refers tothe physical, chemical and biological fertility of soil. It is therefore, an intersection of the three approaches or holistic approach to enhancing the overall fertility of the soil.

**INDICATORS AND MEASUREMENT OF SOIL FERTILITY**

Soil fertility indicators refer to a set of measurable and verifiable parameters that distinguishes fertile soil from infertile ones.

Fertile soil indicators include:

* Colour- largely dark coloured soils indicate a good amount of organic matter and humus. However, it is not a full proof indicator since some dark coloured soils belonging to the Akuse series are dark but not necessarily fertile. Other indicators include the following:
* Texture: sandy soils tend to be less fertile due to their in ability to hold nutrients and water.
* Less availability of rocks and stones
* Low frequency of watering/irrigation
* Visible cracks on the soils during the dry season
* Good crop performance, like maize, millet etc without the use of fertilizers, manures and crop residues,
* Presence/growth of plants that survive during the dry season
* Presence of green vegetation during the dry season
* Presence of wild sisal and many ever green trees/vegetation

**Indicators of infertile soil:**

* Poor crop performance even with the application of fertilizers or manures
* Occurrence of red or light coloured sandy soils
* Poor natural vegetation even where water is not limiting
* *Cyperus rotundus seen all over,*  for instance*,*
* Compacted soils
* Prominence of coarse sand depositions on the landscape
* Stunted plants even during the raining season when water is adequate
* Fast drying up of soils after rains or irrigation
* Presence of white spots/patches on the soil surfaces
* Presence of salts or salt patches on the soil surface.
* Presence of very coarse sands, gravel and stones on the landscape.

**MEASUREMENT OF SOIL FERTILITY**

Soil fertility measurement begins with sampling of the soil to determine some key physical, chemical and biological parameters. There are standard methods or procedures for taking soil samples for these determinations.

The general steps include the following:

* Collect soil cores to the required depth
* Collect enough cores to make the representative samples.
* A sample should not represent too large an area.
* Collect soil samples to represent different soil or topography types.
* Provide samples information on the form being submitted to a laboratory.

In picking soil samples for fertility measurement, the following should be observed:

* Avoid waterlogged areas
* Avoid recently fertilized, either by organic or inorganic fertilizer.
* Avoid disturbed areas
* Avoid recently burned locations

**SOIL FERTILITY CHALLENGES IN THE TROPICS**

The fertility of the soils in the tropics and sub-tropics, which includes major soils of Ghana’s agroecological zones, have both ***inherent*** and ***externally induced*** fertility challenges.

The **inherent factors** of the low fertility of these soils are as follows:

* Type of parent materials
* High amounts of rainfall (precipitation)
* Low soil organic matter (SOM) or carbon
* High decomposition rate of SOM
* Low external inputs of fertilizer
* Continuous cropping

These factors are briefly expanded as follows:

1. **Type of parent material:**

The kind of parent material leads to dominant mineral that forms the chemical interphase for most soils and nutrient retention and availability. The tropics is one of the oldest landscape and coupled with hot-humid climate, weathering is intense leading to abundance of low activity clay minerals such as **Kaolinite, goethite, gibbsite,** etc. which have low cation exchange capacities, hence, the low CEC observed in tropical soils. **Cation exchange capacity** here refers to the amount of cations that the negatively charged surfaces of soil colloids can hold onto and exchanged between the soil solution and the colloidal surfaces. The lower the amount of negative charges surfaces on the soil surfaces, the less the amount of positively charged nutrients the surfaces can hold, hence, the term low cation exchange capacity (low CEC).

1. **High amount of rainfall:**

The tropics and sub-tropics are characterized by heavy and erratic rainfall pattern which lead to **leaching** of basic cations such as calcium (Ca), Magnesium (Mg), Potassium (K) and sodium (Na), which results in the accumulation of Al, Fe, Mn and Zn, hence, soil acidity.

1. **Low soil organic matter contents:**

This is as a result of rapid decomposition aided by the high ambient temperature. In addition, the high rainfall amounts also aid this decomposition process.

The **external factors** are as follows:

1. **Continuous cropping:**

Sub-sahara Africa has agricultural practices that tend to deplete nutrient resources of the soil. Some of these practices are nutrient mining through harvest practices that leave very little behind for incorporation into soil, bush burning and the low use of external inputs such as manures and fertilizers.

1. **Leaching:**

During rainfall water that percolates/ sinks down through the soil pore spaces carry with it important soil nutrients that are moved beyond the reach of plant roots resulting in low availability of nutrients around plants roots for growth and good crop yield. However, the process of leaching of nutrients beyond plants roots zones is not accelerated by rainfall alone. Excessive amounts of irrigation water also lead to the acceleration of leaching.

1. **Erosion:**

The excessive amounts of rainfall at ago, meeting low soil percolation or infiltration results in surface run off. This surface run off carries with it large and small soil particles which hold on its surfaces soil nutrients. In addition, the smaller soil particles, which tend to play key roles such as porosity, aeration and increase in water holding and hydraulic conductivity leading to improved soil fertility are largely affected in this process thereby reducing the fertility of the soil in the process.

1. **Bushfires:**

These destroy the soil as well as the organic matter much needed to build the soils’ resilience against soil degradation factors such as direct raindrops that initiates soil dispersions and facilitates erosion. In its wake, bush fires accelerate not just organic matter loss, but also nitrogen and sulphur through a process of volatilization. The direct heat of burning may reduce the population of microorganisms in the soil and affect the soil texture and structure.