III. Based on intensity of tillage and crop residue management

Tillage is grouped as

a) **Conventional or Intensive tillage:** Intensive tillage systems leave less than 15% **crop residue** . This system involves often multiple operations with implements such as a mould board, disk, and/or chisel plough for primary tillage, harrow, cultivator for secondary tillage, leveler, ridger etc for laying seed bed.

b) **Minimum or Reduced tillage:** Reduced tillage system leave between 15 and 30% residue cover on the soil. Here, the tillage operations are reduced / minimized to the minimum required and combining two or more operations togetherly.

c) **Conservation tillage**: are methods of soil tillage which leave a minimum of 30% of crop residue on the soil surface. This slows water movement, which reduces the amount of soil erosion. However, conservation tillage systems delay warming of the soil due to the reduction of dark earth exposure to the

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c) **Conservation tillage**: are methods of soil tillage which leave a minimum of 30% of crop residue on the soil surface. This slows water movement, which reduces the amount of soil erosion. However, conservation tillage systems delay warming of the soil due to the reduction of dark earth exposure to the warmth of the spring sun, thus delaying the planting of the next year's spring crop.

d) Zero or No-tillage: is a way of growing crops from year to year without disturbing the soil through tillage. No-tillage is an emergent agricultural technique which can increase the amount of water in the soil and decrease erosion. It may also increase the amount and variety of life in and on the soil but may require increased herbicide usage.

Other concepts of tillage:

a) Stubble mulch tillage : is a new approach developed for keeping soil protected at all times either by growing a crop or by crop residues left on the surface during fallow period.

b) Off season tillage : Preparatory tillage operations that are carried out

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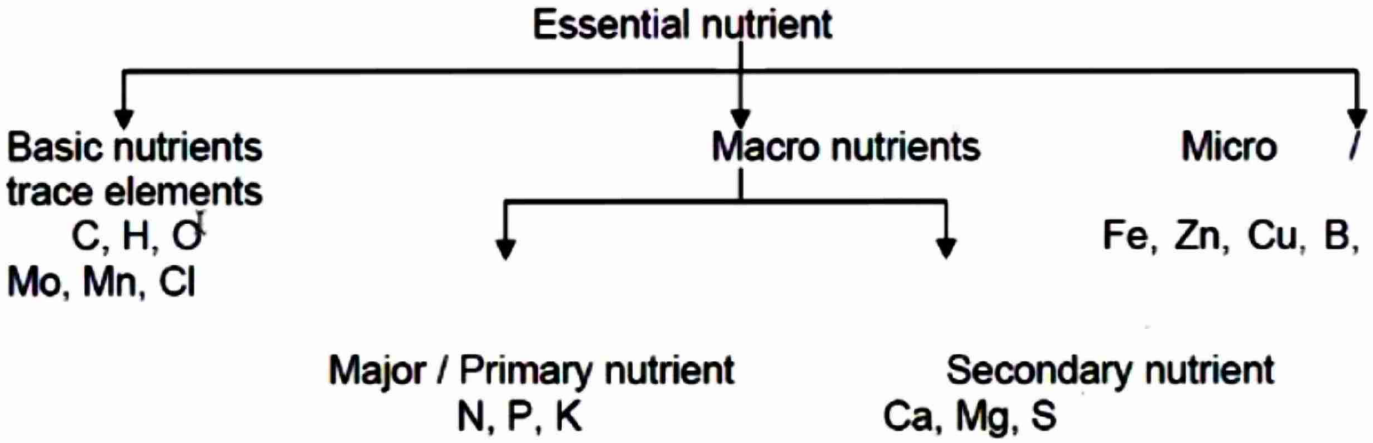
Other concepts of tillage:

a) Stubble mulch tillage : is a new approach developed for keeping soil protected at all times either by growing a crop or by crop residues left on the surface during fallow period.

b) Off season tillage : Preparatory tillage operations that are carried out during the off season before the main crop is cultivated is known as off season tillage. This includes post-harvest tillage and summer ploughing.

c) Blind tillage: Immediately after sowing of crops, passing the harrow

I. Based on quantity of nutrient present in plants, they are grouped into



Basic nutrients : contribute 96% of the total dry matter of plants and are taken in the form of water and air (CO_2)

Macro nutrients : are required in large quantity (> 1 ppm) and are further divided into

a) **Major / Primary nutrients :** are required in bulk and applied externally Eg. N, P, K.

b) **Secondary nutrients :** They are called secondary because they

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a) **Major / Primary nutrients :** are required in bulk and applied externally Eg. N, P, K.

b) **Secondary nutrients :** They are called secondary because they applied inadvertently to the soil while applying N, P, K fertilizers Eg. Ca, Mg, S.

Micro nutrients : Theya re also called trace elements and are required in minute quantity (<1 ppm). Even a slight deficiency or marginal excess concentration of these elements are harmful to the plant.

II. Based on their function in plants

i) Elements that provide basic structure to the plant : C, H, O

ii) Elements useful in energy storage, transfer, bonding : N, P, S

iii) Elements necessary for charge balance / translocation : K, Ca, Mg

iv) Elements involved in enzyme activation & electron transfer : Fe, Mn, Zn, Cu, B, Mo, Cl

III. Based on mobility

A) Mobility in the soil : Knowledge of mobility in soil helps to derive the method of application of these nutrients. Based on mobility, the nutrients are classified as

i) Mobile : These are highly soluble and are not adsorbed on clay complex

Ex : NO_3^-, SO_4^{2-}, BO_3^{2-}, Cl^-, Mn^{2+}

ii) Less mobile : They are also soluble but are adsorbed on clay complex

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Ex : NO_3^-, SO_4^{2-}, BO_3^{2-}, Cl^-, Mn^{2+}

ii) Less mobile : They are also soluble but are adsorbed on clay complex

Ex : NH_4^+, K^+, Ca^{2+}, Mg^{2+}, Cu^{2+}

iii) Immobile : They are highly reactive and get fixed in the soil. The plant roots as to go in search of these nutrients for absorption

Ex : $H_2PO_4^-$, HPO_4^{2-}, Zn^{2+}

B) Mobility in Plants : Knowledge of mobility in plant helps to find out the deficient nutrient. A mobile element in plant moves to growing point and express the deficiency in lower leaves and immobile elements shows deficiency in top leaves. Based on these nutrients are grouped as

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B) Mobility in Plants : Knowledge of mobility in plant helps to find out the deficient nutrient. A mobile element in plant moves to growing point and express the deficiency in lower leaves and immobile elements shows deficiency in top leaves. Based on these nutrients are grouped as

i) Highly mobile : N, P, K, Mg

ii) Moderately mobile : Zn

iii) Less mobile : S, Fe, Mn, Cu,Mo, Cl

iv) Immobile : Ca, B

Forms of nutrient uptake

Nutrient element	Form of uptake	Nutrient element	Form of uptake
Carbon	CO_2	Iron	Fe^{2+}, Fe^{3+}
Hydrogen	H_2O	Manganese	Mn^{2+}

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iii) Less mobile : S, Fe, Mn, Cu,Mo, Cl

iv) Immobile : Ca, B

Forms of nutrient uptake

Nutrient element	Form of uptake	Nutrient element	Form of uptake
Carbon	CO_2	Iron	Fe^{2+}, Fe^{3+}
Hydrogen	H_2O	Manganese	Mn^{2+}
Oxygen	CO_2, H_2O	Zinc	Zn^{2+}
Nitrogen	NH_4^+, NO_3^-	Copper	Cu^{2+}
Phosphorus	$H_2PO_4^-$, HPO_4^{2-}	Boron	$B_4O_7^{2-}$, $H_2BO_3^-$ & HBO_3^{2-}
Potassium	K^+		
Calcium	Ca^{2+}	Molybdenum	MoO_4^{2-}