Nutrient use efficiency

Nutrient use efficiency (NUE) may be defined as yield per unit input. In agriculture, this is usually related to the input of fertiliser, whereas in scientific literature, the NUE is often expressed as fresh weight or yield per content of nutrient. Improvement of NUE is an essential pre-requisite for expansion of crop production in marginal lands with low nutrient availability. NUE not only depends on the ability to efficiently take up the nutrient from the soil, but also on the transport, storage, mobilization, usage within the plant, and even on the environment.

Nutrient use efficiency is defined as the extent to which the nutrients and management practices interact to give a specified yield level.

$$\text{NUE (\%)} = \frac{\text{Yield with applied nutrient} - \text{Yield without applied nutrient}}{\text{Amount of nutrient applied}} \times 100$$

Factors affecting NUE

A. **Soil factors**: The most important factors are soil physical conditions, soil fertility and soil reaction. On soils with poor physical condition, plant growth will be poor due to impeded drainage, restricted aeration and unfavourable soil temperature due to which the nutrients will not be used efficiently. Coarse textured soils are usually poorer in available nutrients than fine textured soils. On such soils nitrogen and potassic fertilizers should be more frequently applied than in fine textured soils. The higher the fertility status of the soil, the lower is the response. Soil reaction is an important consideration in the selection of right type of P fertilizers. The higher the organic matter status, the more is the nutrient use efficiency.

B.**Climatic factors**: include temperature, rainfall and its distribution, evaporation, length of day and growing season. Rate of nitrification is slower in cooler climate than in warmer climate, hence more amounts of fertilizers should be added in cool climate. Higher amount of fertilizers are required in high rainfall region due to leaching to obtain an expected yield potential. In arid regions, soil moisture is a limiting factor to get higher nutrient use

efficiency. The higher the light intensity, the better is the nutrient use efficiency.

C. **Crop factors**: CEC of plant roots influences the fertilizer responsiveness of the crop. A large ramifying root system of the plant absorbs nutrients more efficiently. The time of application of fertilizer should match the pattern of nutrient uptake to increase nutrient use efficiency. For legumes N fertilizer may be reduced as they can fix atmospheric N to increase N use efficiency.

D. **Agronomic factors**: include selection of fertilizer responsive crops and varieties, timely sowing, proper spacing, proper dose, time and method of fertilizer application to increase the yield and there by increasing NUE.

How to enhance nutrient use efficiency

Use efficiency of any nutrient can be increased by achieving potential yields of crops by optimizing the factors of crop production.

Selection of suitable crops and varieties, which are input responsive recommended for the region.

1. Sowing or planting the crops at optimum time.
2. Maintaining optimum plant population.
3. Use of organic manures and biofertilizers to supplement nutrients and also to bring ideal conditions for crop growth.
4. Inclusion of legumes in the cropping system as intercrop.
5. The crops should be irrigated at least to save life at critical growth stages.
6. Fertilizer scheduling must be based on soil test values to prevent nutrient deficiencies or luxury consumption.
7. P and K fertilizer and part of N fertilizer should be applied as basal and N in splits doses; for light textured soils K also should be applied in splits.
8. Band placement of fertilizers preferable to prevent losses. (Especially P to reduce fixation).
9. Under moisture stress condition, foliar application of urea at 2% concentration is effective.
10. Micronutrient deficiencies should be corrected instantly.

11. $ZnSO_4$ should be applied as package once in two seasons @ 25-50 kg/ha.

12. Problem soils must be ameliorated by taking reclamation measures.

NUE of individual nutrients also can be increased by following the above management practices along with some specific measures as follows

Nitrogen use efficiency: can be increased through

1. Split application of nitrogenous fertilizers to prevent losses due to leaching.

2. The use of slow release nitrogenous fertilizer like urea formaldehyde, sulphur coated urea, Neem coated urea etc.

3. Use of nitrification inhibitor (Eg: N-serve) to retard the conversion of NH_4^+-N to NO_3^--N to prevent leaching and make it available to crops for quite longer period.

4. By the integration of inorganic N with organic sources the soil physical condition can be optimized besides adding nutrients to the soil.

P use efficiency can be increase by decreasing P fixation and balanced application of the nutrients. P fixation can be reduced by judicious application of organic manures, application of P fertilizer by placement, inoculation (either seed or soil) with phosphorus solubilising bacteria like *Pseudomonas*, *Bacillus megathrium* var. *phosphaticum*.

K use efficiency: can be enhanced by preventing leaching loss either by split application on light soils, applying organic manure and balanced application of nutrients.

S use efficiency: Sulphur in soil solution is present as $SO4^=$ and more prone for leaching losses. The losses can be prevented by applying organic manures to improve water holding capacity of the soil and it also acts as a source of S. S oxidation can be facilitated by providing oxidized conditions in the soil.

Fe use efficiency: Most available form of iron is Fe^{2+}. All the measures which govern the soil reaction will influence Fe availability. Fe availability is more in acidic soil pH.

- Application of organic manures including greenmanuring improve the use efficiency of iron by

1. Acidifying the rhizosphere due to the release of organic acids

2. Supplementing with iron after decomposition

3. Act as substrate for heterotrophic bacteria that can reduce ferric to ferrous form (eg., *Bacillus, Clostridium and Klebsiella* etc.).

4. The microbes also produce chelating ligands called as ‘siderophores’ that can form complex with Fe^{3+}, which can be absorbed into the plant.

5. Reclamation of alkali soils

6. If deficiency appears on standing crop foliar application of Fe.

Zn use efficiency

1. Zn fertilizer should not be applied with phosphatic fertilizers.

2. Maintaining the soil pH between 5.5 – 6.5 by applying organic manures.