

## Technological Options for Enhancing Nutrient Use Efficiency in Field Crops

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### SUMMARY

Nutrient use efficiency (NUE) is a very important concept in the evaluation of crop production systems. Nutrient use efficiency of applied fertilizers is very low due to many reasons like surface run off, leaching, volatilization, denitrification, fixations in the soil, and poor management practices. Hence there is a need to increase the nutrient use efficiency and yield by using modern tools and technique, new fertilizers formulations, best management practices that apply nutrients at the right rate, time, and place and accompanied by the right agronomic practices.

### INTRODUCTION

Meeting demand for food is a global challenge as recent estimates indicate that global crop demand will increase by 100 to 110% from 2005 to 2050 (Tilman *et al.*, 2011). Others have estimated that the world will need 60% more cereal production between 2000 and 2050 (FAO, 2009). The challenge is how to increase food production in the country by around 60 per cent over next two decades without jeopardizing the soil and water resources which are already under great stress. Improving nutrient use efficiency have been listed among today's most critical and daunting research issues. NUE is a critically important concept for evaluating crop production systems and can be greatly impacted by fertilizer management as well as soil-plant-water relationships. There is a need to understand the best soil and water management practices which helps in increasing nutrient use efficiency and yield by using less fertilizers so that the goal of sustainable agriculture can be achieved. Nutrient use efficiency can be optimized by fertilizer best management practices that apply nutrients at the right rate, time, and place and accompanied by the right agronomic practices.

### Nutrient Use Efficiency of Different Nutrients

Nutrient	Efficiency	Cause of low efficiency
Nitrogen	30-50 %	Immobilization, volatilization, denitrification, leaching
Phosphorus	15-20%	Fixation in soils Al – P, Fe – P, Ca – P
Potassium	70-80%	Fixation in clay – lattices
Sulphur	8-10%	Immobilization, Leaching with water
OMicro nutrients (Zn, Fe, Cu, Mn, B)	1-2%	Fixation in soils

### Approaches on Improving Nutrient Use Efficiency

#### Use of Next Generation Fertilisers to increase fertiliser use efficiency

Controlled and gradually released fertilizer like prilled urea, polymer coated urea and sulphur coated urea helps in reducing the losses of fertilizer and also increases the fertilizer use efficiency. The main work of that fertilizers is slowly release of fertilizer specially nitrogen to the crops. The volatilization process will slow down and plant will get maximum fertilizer or nutrient from soil which is applied by the farmers in the form of coated fertilizer. It is also helpful to reduce the effect of leaching effects of fertilizers.

#### Fortified fertilizers

Fortified fertilisers are normal grade fertilisers which are already being used by the farmers, with the addition of other nutrients like S, B, Zn in the main grade. This kind of fertilisers is aimed for those farmers who do not use secondary or micro nutrients. Zincated DAP, Zincated SSP, Boronated SSP and Sulphur enhanced fertilizers (20:20:0:13S and 24:24:0:8S) are available in the Indian markets.

#### Customized fertilizers

Customized Fertilizers are a multi nutrient carrier designed to contain macro and /or micro nutrient forms, both from inorganic and / or organic sources, manufactured through a systematic process, satisfying the

crop's nutritional needs, specific to its site, soil and stage and validated by a scientific crop model. For example: Paddy- 10:26:17: 1:0.3 (NPK Zn B) and Wheat- 10:18:25:4:0.5:0.2 (NPK S Zn B).

### Slow-release fertilizers

**N-substances of low water solubility:** Urea Formaldehyde (UF), Crotonylidenediurea (CDU), Isobutylidenediurea (IBDU), Sulphur coated urea, Neem coated urea.

**Nitrification inhibitors:** These compounds inhibit nitrification process by reducing the activities of nitrifying bacteria. e.g., Nitrapyrin, Dicyandiamide (DCD), Thiourea.

**Urease inhibitors:** Inhibits the urease enzyme activity e.g. NBPT (N-serve), ATS (ammonium thiosulphate), Hydroquinone.

### Water soluble fertilisers (WSF)

Water soluble fertilisers comes with various combinations of NP, PK, NPK, KS and even with the added micronutrients. Moreover, WSF grades are free from harmful materials like chloride, fluoride etc. and therefore safe to crops. These fertilisers are 100% water soluble. Both water and fertiliser can be saved if WSFs are included in drip system.



Prilled Urea (1-2 mm)



USG (1-3 grams/particle)

### Fertigation

The mixing of fertilizer especially water-soluble fertilizers is giving more benefit to the plants and crops. The application of fertilizer directly in liquid form very near to the root zone. Plants roots hairs are absorbing more liquid amount as comparison the roots. The efficiency of nutrients will increase by fertigation as comparison to other methods.

### Chlorophyll meter

Chlorophyll meter can be used to estimate the N content of crop in general most of the 'N' found in the chloroplast of plant, it helps in measuring the leaf chlorophyll content. It has ability to self-calibrate for different soils, climate and crop varieties. It is also recommended to assess the effectiveness of late applied nitrogen in standing crops to increase grain yield and protein content.



### Leaf color chart

LCC is a diagnostic tool which can help farmers for making appropriate decisions regarding the need for nitrogen fertilizer applications in standing crops. Conceptually it is based on the measurement of relative's greenness of plant leaves which directly co-related with its chlorophyll content. Nitrogen is a principal component of leaf chlorophyll so; measurement over various phonological stages serves as the indirect basis for nitrogen management rice. LCC saves nearly 26% fertilizer N. It helps to synchronize N supply, crop demand and enhance N use efficiency.



**Green seeker:** It uses active light source to measure and determine N rate by comparing it with a N rich strip within the field. Benefits-

- Fast and precise optical sensing.
- Reduce crop fertilizer costs.
- Only apply nitrogen to plants that need it.
- Real time variable rate fertilizer application.



### Precision farming

Precision farming is an information and technology-based farm input management systems which aims at the use of technologies and principles to identify, analyses and manage spatial and temporal variability associate with all aspects of agricultural productions with in fields for maximum profitability, sustainability, enhancing crop performance, protecting land resources and maintain or improve the environment quality.



### The 4R Nutrient Stewardship

The 4R's of nutrient stewardship, or nutrient management, are commonly referred to when talking about proper nutrient application. The 4R's stand for right source, right rate, right time, and right place and serve to guide farmers to the management practices that help keep nutrients on and in the field.

## 4R NUTRIENT STEWARDSHIP



RIGHT SOURCE



RIGHT TIME



RIGHT RATE



RIGHT PLACE

**Right source:** Ensure a balanced supply of essential nutrients, considering both naturally available sources and the characteristics of specific products in plant-available forms. Ammonium nitrate is considered to be a better source of nitrogenous fertilizer for upland crops whereas ammonical and amide form of N are superior to the nitrate containing sources for lowland rice crop.

**Right rate:** Adequate and balanced application of fertilizer is one of the most common practice for improving the efficiency of fertilizer. Fertilizer rates greater than the optimum level leads to lower utilization efficiency.

**Right time:** Greater synchronization between crop demand and nutrients supply is necessary to improve nutrients use efficiency. Split application of N is superior to basal application. P is usually applied as basal and in some light textured soils split application of K is advisable.

**Right place:** Placement decisions depend on the crop and soil conditions which influence nutrient uptake and availability. For example, in rice, basal application of urea with no standing water is superior to broadcast application of urea into standing floodwater at 10 days after transplanting in reducing the volatilization losses of ammonia.

## IIT Kharagpur develops new DGPS-enabled Soil Mapping Technology to improve Efficiency of Fertilizer Application



Prof. V K Tewari, Director of IIT Kharagpur along with his former research scholar Dr. Sneha Jha from the Dept. of Agricultural and Food Engineering explored an alternate method of creating a soil nutrition map that can be accessed in real-time through differential global positioning system for variable rate application of NPK. “This technology can manage the automated application from 5 to 400 Kg per hectare. Application of such desired amount of NPK precisely at a specific location will enhance crop production and avoid environmental degradation,” said Prof. Tewari. “This technology would be able to reduce 30% of fertilizers used in manual methods thus ensuring substantial savings in resource applications,” he further added remarking on how this technology can bring the cost of fertilizer application by improving the efficiency of the job and reducing manual labour.

### CONCLUSION

Improving nutrient use efficiency is a worthy goal and fundamental challenge in modern crop production systems for improving the long-term sustainability. Judicious application of fertilizer – right rate, right time, right place, and right agronomic practice targeting both high yields and nutrient efficiency will benefit farmers, society, and the environment. N management using through SSNM, chlorophyll meter and LCC gives higher grain yield and NUE as compared to blanket N recommendation. Integrated nutrient management and balance fertilization improve not only plant performance, but also NUE of production system. Optimal time, rate, methods of application and use of specially formulated forms of fertilizer, including urease and nitrification inhibitors are also potential means for improving NUE. However, we must be cautious that improvements in efficiency do not come at the expense of the farmers’ economic viability or the environment.

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