

# AN INTRODUCTION TO CROP NUTRIENT USE EFFICIENCY

# NUE

Mineral fertilizers contain **concentrated, consistent and readily available plant nutrients** which enable farmers to **grow more crops on less land** and without which we would only **produce 50% of our current agricultural output**. Because biological systems are leaky, however, all fertilizers are naturally subject to losses to the environment.



To achieve the triple wins of **food security, environmental protection and climate change adaptation & mitigation** the application of fertilizers must be carefully managed. One of the most important ways to do this is by using best management practices that help achieve high Nutrient Use Efficiency (NUE) **Nutrient Use Efficiency (NUE)**:



## WHAT IS CROP NUE



NUE is the proportion of nutrients applied from all sources that are taken up by the crop. It is a useful indicator to determine how efficiently nutrients are being applied and gauge their potential environmental losses.



Crop NUE is the ratio between the nitrogen (N) output (the amount of N removed from the field when crops are harvested) and the N input (the total N applied to cropland from mineral fertilizers, livestock manure and biological N fixation).



Low N output/input ratios below 50% often reflect nutrient loss risks to the environment, while high ratios above 100% reflect soil nutrient mining practices that reduce soil fertility if practiced over several years. Both cases are unsustainable.



The N output/input ratio is generally considered close to optimum at around 60-90%, depending on the farming system and the crops cultivated, where crop productivity is high.



Crops such as fruits and vegetables typically have a lower NUE because they require high amounts of N to grow. Leguminous crops such as soybean have a high NUE because they are able to convert N from the air into forms they can use, a process called biological N fixation (BNF).



Because they are less able to retain nitrates, meanwhile, sandy soils have a lower NUE potential than loam soils.

## CROP NUE TRENDS

Crop NUE declined in most developed countries until the 1980s, before improving since then due to the broader implementation of best management practices and better access to technology and knowledge, while most developing countries have experienced further gradual decline.



At the global level, crop NUE has been steadily rising for three consecutive decades, driven by continuous improvement in developed countries and, more recently, in China. Global crop NUE was estimated at 59% in 2017 (excluding N inputs from atmospheric deposition).

Sub-Saharan African countries, many of which currently have excessively high crop NUE due to the wide-spread underuse of fertilizers, are adopting more virtuous crop NUE trends, reflecting rising N fertilizer use and crop yields.



## IMPROVING CROP NUE

A variety of different tools, techniques and practices can be used to sustainably improve NUE:



RIGHT SOURCE



RIGHT RATE



RIGHT TIME



RIGHT PLACE

Best management practices such as 4R Nutrient Stewardship (applying the Right nutrients source, at the Right rate, at the Right time, in the Right place) help increase crop nutrient uptake.



Precision Farming tools such as soil sensors, variable rate prescriptions, yield maps, decision support software, soil mapping, multispectral imaging and auto-guidance systems can help farmers to precisely monitor and meet crops' nutrient needs.



Integrated Soil Fertility Management (ISFM) is a holistic approach that enhances plant nutrient uptake by selecting crop variety, considering the biological and physical dimensions of soil health and adapting practices to local conditions.



Water-soluble fertilizers can be applied together with irrigation water, known as fertigation. By providing plants with nutrients and water in a highly efficient way directly to their root zone, fertigation can produce up to 90% NUE.



Slow-release, controlled-release and stabilized fertilizers can be used to extend the release of nutrients and help farmers to better match crops' requirements over time, resulting in their improved nutrient uptake.