



# 4R NUTRIENT STEWARDSHIP SYSTEM

RIGHT SOURCE, RIGHT RATE,  
RIGHT TIME, RIGHT PLACE



The Fertilizer Institute  
Nourish, Replenish, Grow

THE FERTILIZER INDUSTRY ENDORSES BEST MANAGEMENT PRACTICES BASED ON THE USE OF THE RIGHT SOURCE AT THE RIGHT RATE, RIGHT TIME AND RIGHT PLACE

to protect the environment & support the efficient production of nutritious, abundant & affordable food.

Each year, the world's population grows by 80 million and as countries are increasing their gross domestic product, individuals are enriching and diversifying their diets. Using fertilizers in an agronomically and environmentally sensitive way is critical for meeting the planet's increasing need for food, feed, fuel and fiber. Commercial fertilizers are currently responsible for 40 to 60 percent of world food production and are a key tool in assisting U.S. farmers to meet their economic and environmental goals for crop production.

Working in partnership with the farmers who manage the land is crucial to the establishment of effective nutrient management practices. TFI, its members and partnering organizations promote these best management practices (BMPs) based on the use of the right fertilizer source at the right rate, right time and in the right place. This system, which is known as the 4R nutrient stewardship system, helps every farmer execute an optimal strategy to preserve his land and create greater yields in an environmentally sensitive manner. With the help of experts such as Certified Crop Advisers (CCAs), farmers can assess soil and environmental conditions on their individual farms and develop a customized nutrient management plan that is most suitable to their site specific needs.

The natural fertilizer cycle is quite simple: as plants grow, they mine nutrients they need from the soil. When the crop is harvested, those nutrients also go to market – leaving a shortage of nutrients in the soil. Fertilizing does nothing more than complete the plant cycle to ensure that crops can get what they need to grow.

**EACH YEAR, THE TYPICAL NORTH AMERICAN CORN CROP REMOVES**

- MORE THAN 7.43 BILLION POUNDS OF NITROGEN;
- 4.32 BILLION POUNDS OF PHOSPHORUS; and
- 2.96 BILLION POUNDS OF POTASSIUM FROM OUR SOILS.



### NITROGEN (N)

*is a primary building block for all organisms. It is essential to making proteins, helps keep plants green and is a critical component of soil organic matter.*

COMES FROM THE AIR



### PHOSPHORUS (P)

*is found in every living cell. Phosphorus is a component of DNA and it also plays vital roles in capturing light during photosynthesis, helping with seed germination, and helping plants use water efficiently. Plants also use phosphorus to help fight external stress and prevent disease.*

COMES FROM ANCIENT SEA LIFE



### POTASSIUM (K)

*is essential to the workings of every living cell. It plays an important role in plants' water utilization and also helps regulate the rate of photosynthesis. Other aspects of plant health influenced by potassium include the growth of strong stalks, protection from extreme temperatures, and the ability to fight stress and pests such as weeds and insects.*

COMES FROM EVAPORATED OCEANS

*The fertilizer industry has a long standing commitment to the guiding principle of sustainability –*  
**one that is founded on the pursuit of economic,  
 social & environmental benefits.**

Getting the most benefits from this best management practices paradigm depends on the important role of many partners who participate in agricultural production, including farmers, crop advisers, scientists, policymakers, consumers and the general public.

The 4R nutrient stewardship system is directly connected to the goals of sustainable development – providing economic, social and environmental benefits. With fertilizers and modern high-yielding farming practices, more food is produced per acre of existing cropland each year so other lands may be conserved. This prevents the widespread loss of forests, rainforests and environmentally important habitat especially given that the amount of available farmland is decreasing year after year. For example, America loses two acres of farmland every minute according to the American Farmland Trust. This is particularly important considering one of the greatest threats to the Earth's biodiversity is habitat loss through the conversion of natural ecosystems to agriculture.

Unmanaged nutrient applications may increase nutrient losses, potentially degrading water and air quality. Bearing this in mind, the international fertilizer industry needs to embrace the user-friendly science-based 4R system, which relies on a site specific approach to management that takes into consideration all factors, ranging from climate and weather to soil conditions and seeds used, in order to design the most appropriate fertilization

program – one that maximizes nutrient use efficiencies and effectiveness while balancing environmental and economic goals. The right nutrient applications increase crop yields, sparing land for other uses, and increase or maintain the organic carbon sequestered in soil, playing a critical role in helping to fight climate change.

With every productive growing season, plants “mine” these essential plant nutrients from the ground. Most often, farmers are not adding nutrients into the ground – they are replacing them and restoring a soil’s nutrient balance harvest after harvest. The absence of any single nutrient in the soil can limit plant growth, even when all other nutrients are present in adequate amounts. For example, inadequate levels of phosphorus may impair nitrogen uptake by plants, potentially increasing losses into aquatic habitats.

An insufficient supply of nutrients compromises a plant’s ability to withstand harsh weather, disease and other stressors. Although dry weather played a key role in the “dust bowl” conditions of the 1930s, insufficient levels of nutrients were one of the problems that plagued Depression-era farmers. Today, the United Nations estimates that more than 30 percent of the world’s land is affected by desertification, a condition that fertilizers may help to combat and remediate.

**BEST MANAGEMENT PRACTICES (BMPs)**



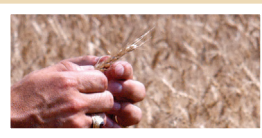
**RIGHT SOURCE**  
 MATCH FERTILIZER TYPE  
 TO CROP NEEDS

- *Select appropriate fertilizer and on-farm nutrient sources for the cropping system.*
- *Soil testing*
- *N, P, K secondary and micronutrient*
- *Enhanced efficiency fertilizers*
- *Nutrient management planning*



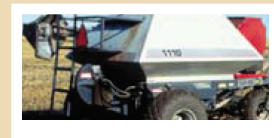
**RIGHT RATE**  
 MATCH AMOUNT OF FERTILIZER  
 TO CROP NEEDS

- *Soil testing*
- *Yield goal analysis*
- *Crop removal balance*
- *Nutrient management planning*
- *Plant tissue analysis*
- *Record keeping*
- *Variable rate technology*
- *Site-specific management*



**RIGHT TIME**  
 MATCH NUTRIENTS AVAILABLE  
 WHEN CROPS NEED THEM

- *Application timing*
- *Controlled release technologies*
- *Urease and nitrification inhibitors*
- *Fertilizer source or product choice*



**RIGHT PLACE**  
 KEEP NUTRIENTS WHERE  
 CROPS CAN USE THEM

- *Application method*
- *Incorporation of fertilizer*
- *Adjust applications to avoid any unnecessary applications to grassed waterways, buffer strips and riparian areas*
- *Couple applications with appropriate soil conservation practices*

## 4R NUTRIENT STEWARDSHIP SYSTEM REDUCES GREENHOUSE GASES

Not only can low-till and no-till farming techniques help increase the carbon content of soils and reduce erosion, there are also practice based approaches based on fertilizer BMPs that demonstrate farmers' capacity to reduce nitrous oxide\* emissions from the field.

As discussed in *Fertilizer Nitrogen BMPs to Limit Losses that Contribute to Global Warming*, authored by the International Plant Nutrition Institute, properly balanced plant nutrition through fertilizer BMPs will maximize the capture of carbon dioxide through crop photosynthesis and carbon sequestration. The site-specific, science-based 4R nutrient stewardship system

has received the support of the American Society of Agronomy's Certified Crop Advisor program and, in addition to protecting the environment, ensures that farmers achieve profitability, while providing a sustainable food supply.

Implementation of these BMPs not only will help improve crop recovery of applied fertilizers; but also reduce the risk of greenhouse gas (GHG) emissions associated with fertilizer use. However, it should be noted that more research is needed to further identify specific BMPs with the ability to mitigate climate change-related releases from farmland.

*\* Nitrous oxide is one of six key greenhouse gases that the U.S. Environmental Protection Agency is proposing to regulate. 1 ton of N<sub>2</sub>O represents 296 tons of CO<sub>2</sub> equivalents.*

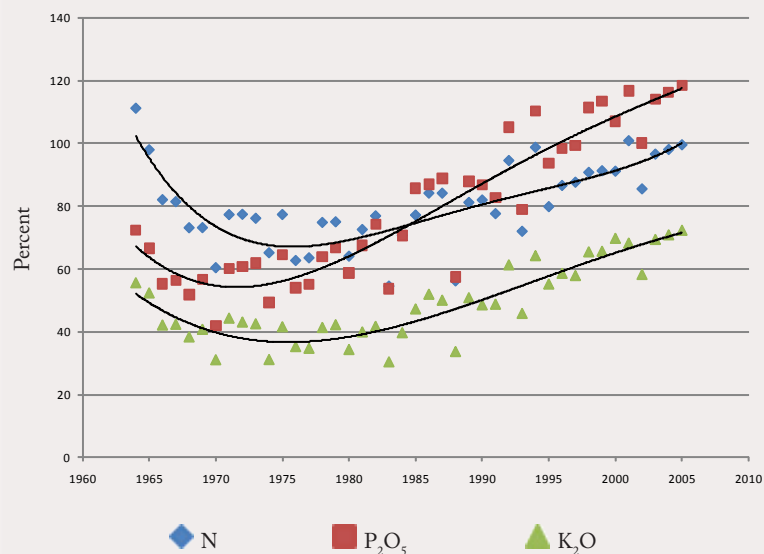
In the United States, indicators are positive that farmers are using the right nutrient source at the right time, right rate & right place.

TFI, in cooperation with the Conservation Technology Information Center (CTIC), surveyed nearly 2,000 farmers representing approximately 2.5 million acres of U.S. farmed cropland and found that more than half of respondents have fully adopted specific BMPs. These include conservation tillage, nutrient management, grass waterway and integrated pest, disease and weed management. In addition, more than 60 percent of those who fully adopted no-till practices also fully adopted nutrient management, integrated pest (insect, disease, weed) management and grass waterways practices.

Through increased use of proven and newly developed BMPs, including remote or on-the-go sensing of the crop's nitrogen status, more precise amounts of fertilizer nitrogen may be prescribed to meet crop nutrition requirements. Farmers are now using fertilizer nutrients with the greatest efficiency in history. U.S. Department of Agriculture data show that between 1980 and 2005, there was a 63 percent increase in U.S. corn yield and a 67 percent increase in total U.S. corn production.

Meanwhile, farmers' use of nitrogen applied for corn over this period decreased by 5 percent, while use of phosphate and potash fell 27 and 38 percent, respectively.

Nutrient Removal to Fertilizer Use Ratio for U.S. Grain Corn Crop



SOURCE: COMPUTED BY THE INTERNATIONAL PLANT NUTRITION INSTITUTE FROM DATA REPORTED BY USDA AGRICULTURAL RESOURCE MANAGEMENT SURVEY

NOTE: USDA ARMS SURVEY DATA NOT AVAILABLE IN 2004, 2006, 2007 OR 2008. VALUES FOR 2004 ARE AN AVERAGE OF 2003 AND 2005.

*In late 2007, the Conservation Technology Information Center (CTIC) and TFI conducted a survey, which reached slightly less than 2,000 farmers nationwide, to gain a better understanding of environmental management measures on U.S. farms and barriers to BMP adoption. The respondents represent 2.5 million acres of farmed cropland.*

## **- Summary of Results -**

### ***Respondent Background***

- 97 percent were male with an average age of 52 and 29 years of farming experience
- 56 percent were from a Midwestern state (Ohio, Indiana, Illinois, Missouri, Iowa, Minnesota, Kansas, Nebraska, North Dakota, South Dakota)
- 75 percent grow corn, soybeans and/or wheat
- 6 percent operate solely on rented land
- Approximately 2,445,335 acres (both owned and rented) are represented

### ***Level of BMP Adoption***

- Over half of respondents have fully adopted specific BMPs
- The top four BMPs are conservation tillage, nutrient management, grass waterway and integrated pest management
- More than 60 percent of respondents who fully adopted no-till also fully adopted nutrient management, integrated pest management and grass waterways
- Those operating only rented land had similar percentages of acres using conservation tillage and no-till
- Higher farm sales (\$250K and above) have significantly higher adoption rates for most conservation practices
- There is a high correlation between operation size and the number of acres farmed with conservation tillage and no-till
- Top obstacles to BMP adoption cited by row crop respondents are: cost of specialized equipment, pest problems, lower yields, and cost and returns

### ***Conservation Planning***

- 77 percent of row crop producers who responded have existing conservation plans
- Respondents are more likely to have a higher BMP adoption rate if they have a conservation plan

### ***Preferred Assistance***

- Of all respondents who indicated limited adoption or they are interested in adoption, the types of assistance preferred

are financial assistance, educational assistance and no assistance needed

### ***Soil Testing and Fertilizer Application***

- About half of the respondents report following state soil testing recommendations; slightly less than half responded that testing costs limit their willingness to test
- Nearly 70 percent use broadcast nutrient application
- Nearly 65 percent of those reporting fall fertilization report utilizing broadcast application
- About 25 percent feel limited by time constraints
- Over 70 percent of respondents apply fertilizers during spring pre-plant while over 60 percent reported fall application

### ***Nutrient Management and Crop Rotations***

- Top three barriers to adopting or increasing nutrient management practices are: costs and returns, need for better technical information and lack of time
- Top three nutrient management practices for row crop producers are: soil testing, recordkeeping and starter fertilizer-planting
- Top three barriers to diversifying crop rotation are: costs and returns, reduced profits and low demand for some crops in rotation

### ***Preferred Methods and Sources of Information***

- The top preference for receiving information is farm magazines
- Other top responses include tours/demos/field days on a working farm, e-mail, brochures/fact sheets, internet and informational CD/DVD or software
- Top information sources include Cooperative Extension, Certified Crop Advisers, Agribusiness Companies and Natural Resources Conservation Service



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