UF IFAS Extension UNIVERSITY of FLORIDA

HS1264
https://doi.org/10.32473/edis-hs1264-2015

What is 4R nutrient stewardship?[1]

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Introduction

This EDIS publication is the first in a series on understanding the four RIGHT (4R) nutrient stewardship applications for crop production. There is a fact sheet, SL411, introducing the details of the 4Rs (https://edis.ifas.ufl.edu/publication/ss624). This fact sheet focuses on the scientific principles, importance, and assessment of the 4Rs. It also emphasizes the relationship among the 4Rs and who decides what is correct in the 4Rs.

Fertilizers play an essential role in Florida's commercial crop production and in food security nationally and worldwide. Fertilizers provide nutrients essential for crop production but also pose pollution risks to the environment, which can constrain both the economy and society. To control water pollution caused by fertilizers, best management practices (BMPs) were first defined by the U.S. Environmental Protection Agency (EPA) in the federal wastewater permit regulation in 1977. BMPs are defined as "schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States" that "also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage" (EPA 2015b). To ensure the environmental, social, and economical sustainability of commercial crop production, an overview of a new and innovative approach to BMPs for fertilizer application known as 4R nutrient stewardship is available to environmentalists, Extension agents, crop consultants and advisors, growers, and graduate students who are interested in agriculture.

What does 4R nutrient stewardship mean?

For any commercial crop production, the quality of nutrient management practices is determined by the 4Rs. The 4R nutrient stewardship concept is defined as

- the RIGHT fertilizer source is applied at
- the RIGHT rate at
- the RIGHT time, and in
- the RIGHT place for a crop.

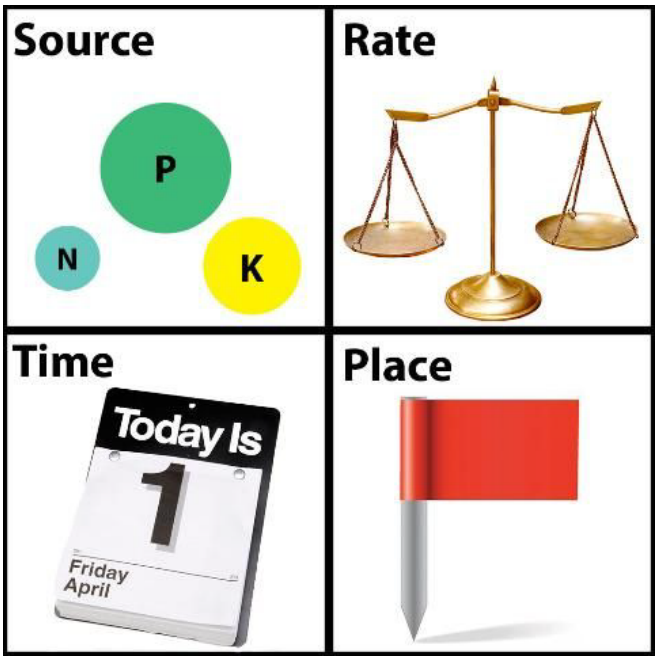

Figure 1. Schematic diagram of the 4Rs.
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This simple management concept can help growers implement appropriate management practices for fertilizer application to enhance the sustainability of agriculture. All of those involved in crop production, including growers, crop consultants and advisors, extension faculty, research scientists, policymakers, consumers, and the public, must participate in advancing the goals of the 4R program.

Why is 4R nutrient stewardship so important?

The 4R nutrient stewardship is important because there are many sustainability issues related to fertilizer and nutrient management in commercial crop production such as

- food security and safety,
- soil health, fertility, and quality,
- non-renewable resources,

Reviewed: 10/2025

- eutrophication (nitrate, phosphate, algae bloom pollution) and water quality,
- air quality (ammonia volatilization),
- greenhouse gas emission (carbon dioxide (CO_2) and nitrous oxide (N_2O)),
- stratospheric ozone depletion caused by N_2O, and
- heavy metal pollution in soil (cadmium).

Each of the items on the above list is closely associated with human wellness and quality of life.

Are the 4Rs interdependent or independent?

The four facets of nutrient management practices are fully interdependent and linked in the cropping system.

- The 4Rs of nutrient management—source, rate, time, and placement—are fully linked and interconnected to every step of management practice for every farming system.
- No one of the 4Rs can be right when any of the 4Rs is wrong.
- The 4Rs must work in sync with each other and with the environment.
- The combination of the 4Rs changes with the farming system.
- The combination of the 4Rs changes with local water quality issues.

What are the scientific principles for 4R nutrient stewardship?

The fundamental scientific principles are the basis of the 4R nutrient stewardship because the basic sciences are fundamental to the growth and development of plants grown on soils.

- The sciences applied to the 4Rs include biology, chemistry, physics, etc.
- Applying scientific principles to managing plant nutrients tests the scientific principles of plant nutrition.
- Scientific principles help guide the development of practices that determine the 4Rs.
- The principles are the same worldwide, but actual practices are crop and site-specific.

How should we assess implementing 4R nutrient stewardship?

The goals of 4R nutrient stewardship are to enhance the economic, environmental, and social sustainability of the cropping system. All the indicators related to the economy, environment, and society should be assessed (Table 1).

Who decides what is right in the 4Rs?

All participants decide the 4Rs. Participants include

- Growers.
- Scientists.
- Extension faculty.
- Crop consultants and advisors.
- Environmentalists.
- Agribusiness professionals.
- Stakeholders.

Everything from crop selection to market choice and consumption are factors that will determine what set of nutrient management practices are correct.

Summary

The 4R nutrient stewardship includes the right fertilizer source applied at the right rate, the right time, and the right place for a crop producing sustainable economic, social, and environmental outcomes.

- The 4Rs are all interdependent and interconnected.
- The 4Rs play irreplaceable roles in sustainability of the economy, society, and environment.
- The 4R nutrient stewardship is guided by biology, chemistry, and physics.
- The 4R nutrient stewardship is an essential tool for commercial crop production BMPs.
- All stakeholders of commercial crop production decide what counts as "right" in the 4Rs.
- In Florida, the right irrigation including the right irrigation time and right dose of irrigation water is extremely important for the above 4R nutrient stewardship because 80% of the commercial crops grown on sandy soils.

References and Further Reading

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Tables

Table 1.

Crop yield	Profitability
Yield stability	Soil productivity
Product quality	Soil quality
Nutrient use efficiency of all applied fertilizers	Water quality
Water use efficiency	Air quality
Energy use efficiency	Biodiversity
Labor use efficiency	Farm income
	Nutrient budget

[1] This document is HS1264, one of a series of the Horticultural Sciences Department, UF/IFAS Extension. Original publication date July 2015. Revised January 2019 and June 2022. Visit the EDIS website at https://edis.ifas.ufl.edu for the currently supported version of this publication.

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