



Lesson Plan: The 4Rs of Nutrient Management

Target Grade Level: 8th - 9th Grade **Topic:** Protecting water quality through the 4Rs: Right Nutrient, Right Time, Right Amount, and Right Place.

I. Lesson Objectives

- Students will identify the **4Rs of nutrient management** and explain their role in preventing nonpoint source pollution.
- Students will analyze how specific geological features in Wisconsin, such as **karst and sinkholes**, increase groundwater susceptibility to contamination.
- Students will simulate farm management decisions to understand the trade-offs & considerations between agricultural productivity and water quality protection.

II. Wisconsin Academic Standards (Environmental Literacy & Sustainability)

- **ELS.EX2.B.m:** Analyze the relationships between living (biotic) and non-living (abiotic) parts in an ecosystem and examine the impact of each on the system.
- **ELS.EX4.A.m:** Develop and analyze models that describe cycles and flows of Earth's systems, including the cycling of nitrogen and oxygen among the hydrosphere and geosphere.
- **ELS.EN6.B.m:** Analyze how individual and civic dispositions... influence decision-making and impact natural and cultural systems.

III. Background for Educators

Nutrient management is a strategy for obtaining the maximum return from fertilizer resources while protecting environmentally sensitive areas. In Manitowoc County, agriculture is a \$1.5 billion industry, with over **110,000 dairy cows** generating massive amounts of manure that must be managed responsibly.

The primary pollutants of concern are **phosphorus** (which causes algae blooms in surface water) and **nitrates** (which contaminate groundwater/drinking wells). Because much of the region has **shallow soil over fractured bedrock (karst)**, nutrients can move rapidly from the surface into the drinking water supply without being filtered.

IV. The Supporting Document: The 4Rs Cheat Sheet

- **Right Nutrient:** Use soil tests to determine exactly what the crop needs (e.g., Nitrogen vs. Phosphorus).
- **Right Amount:** Apply only what the plants can use. Account for "manure credits" from previous applications.
- **Right Time:** Avoid spreading on **frozen or snow-covered ground**, especially in February and March when **53% of annual runoff** occurs.
- **Right Place:** Maintain **5-foot tillage setbacks** and **300-foot manure setbacks** from streams; avoid spreading within **100 feet of a sinkhole or well**.



V. The Game: "Manitowoc Farm Manager"

Setup: Divide the class into "Farm Teams." Each team starts with 500 acres of cropland and a "Water Quality Score" of 100.

Gameplay: Teams must make decisions for "Season Rounds." Each round, the teacher presents a scenario. Teams choose an action and see the impact on their yield (profit) and their Water Quality Score.

Each team starts with a **Water Quality Score of 100** and a **Profit Score of 100**.

Updated Game Scenarios with Numerical Values

Round 1: The Spring Melt (Right Time) 1

- *Scenario:* It is early March with frozen ground and full manure pits; heavy rain is forecasted .
- **Choice A (Spread now):** Emptying the pits saves on emergency storage costs. **(+20 Profit / -20 WQ Score).**
- **Choice B (Wait):** Waiting for thawed ground causes a 10% operational delay. **(-10 Profit / +10 WQ Score).**

Round 2: The Sinkhole Field (Right Place) 2

- *Scenario:* A 40-acre field contains a sinkhole—a direct conduit to groundwater 2, 3.
- **Choice A (Spread whole field):** Maximum yield across all acres. **(+15 Profit / -30 WQ Score).**
- **Choice B (100-foot buffer):** Using targeted fertilizer elsewhere maintains standard yield. **(0 Profit Change / +5 WQ Score).**

Round 3: The Soil Test Results (Right Nutrient/Amount) 4

- *Scenario:* Soil tests show high Phosphorus but low Nitrogen .
- **Choice A (Standard N-P-K mix):** Cheaper upfront cost for bulk fertilizer. **(+10 Profit / -15 WQ Score).**
- **Choice B (Nitrogen-only fertilizer):** Specifically tailored to crop needs; more expensive than bulk. **(0 Profit Change / +10 WQ Score) .**

Round 4: The Riparian Zone (Right Place) 4

- *Scenario:* Your field borders the Branch River, an "Exceptional Resource Water" .
- **Choice A (Tillage to the bank):** Maximizes plantable space by ignoring the 5-foot setback . **(+10 Profit / -25 WQ Score).**
- **Choice B (Grass buffer strip):** Removes land from production to filter runoff . **(-5 Profit / +20 WQ Score).**

Round 5: The Alfalfa Credit (Right Amount)

- *Scenario:* Planting corn after alfalfa, which naturally provides nitrogen.



- **Choice A (Full fertilizer application):** Wasted expense on unnecessary nutrients. **(-10 Profit / -15 WQ Score).**
- **Choice B (Apply "Manure Credits"):** Using the nitrogen already in the soil saves money. **(+10 Profit / +10 WQ Score).**

Round 6: The Phosphorus Limit (Right Nutrient)

- *Scenario:* A field has reached its Phosphorus limit.
- **Choice A (Apply manure anyway):** Saves on hauling costs to other locations. **(+10 Profit / -20 WQ Score).**
- **Choice B (Haul to distant field):** Increased labor and fuel costs to protect the local watershed. **(-15 Profit / +15 WQ Score).**

Round 7: Heavy Rain Forecast (Right Time)

- *Scenario:* A major storm is forecasted for tomorrow.
- **Choice A (Apply today):** Sticking to the schedule regardless of weather. **(0 Profit Change / -25 WQ Score).**
- **Choice B (Postpone application):** Waiting for better conditions to ensure nutrients stay in the soil. **(-5 Profit / +10 WQ Score).**

Round 8: Late Winter Crunch (Right Time)

- *Scenario:* Mid-February with snow-covered ground and full pits.
- **Choice A (Spread on snow):** Immediate solution to storage issues. **(+20 Profit / -30 WQ Score).**
- **Choice B (Rent extra storage):** Paying for storage until the 53% annual runoff window passes. **(-15 Profit / +20 WQ Score).**

Round 9: The Neighbor's Well (Right Place)

- *Scenario:* A neighbor's drinking well is near your property line.
- **Choice A (Spread to property line):** No change in production area. **(0 Profit Change / -30 WQ Score).**
- **Choice B (100-foot setback):** Voluntary buffer to protect local drinking water. **(0 Profit Change / +15 WQ Score).**

Round 10: Grassed Waterway (Right Place)

- *Scenario:* Erosion is forming a gully on a sloped field.
- **Choice A (Tillage through gully):** Temporary fix to keep planting. **(+5 Profit / -20 WQ Score).**
- **Choice B (Install waterway):** Costs for installation and loss of crop rows. **(-10 Profit / +25 WQ Score).**

Reflection: Which was harder to keep high: Profit or Water Quality? How did your decisions reflect the **trade-offs** farmers face between productivity and the environment?



Manitowoc Farm Manager

Team Name: _____

Starting Acres: 500

Starting Water Quality Score: 100

Round	Scenario Title	Choice A/B	Profit Impact (\$)	Water Quality (+/-)	Running WQ Total
					100
1 Right Time	The Spring Melt				
2 Right Place	The Sinkhole				
3 Right Nurtient/Amount	The Soil Test Result				
4 Right Place	The Riparian Zone				
5 Right Amount	The Alfalfa Credit				
6 The Phosphorus Limit	The Phosphorus Nutrient				
7 Right Time	Heavy Rain Forecast				
8 Right Time	Late Winter Crunch				
9 Right Place	The Neighbor's Well				
10 Right Place	Grassed Waterway				
TOTAL		Final Profit:		Final WQ Score	

Did any of your decisions for "Profit" in early rounds make it harder to maintain a high "Water Quality Score" later in the game?

