

FIELD INVESTIGATION GUIDE



4R Farm Challenge

4 R'S OF NUTRIENT MANAGEMENT

How can Farmers keep
nutrients working for crops
& out of the water?



INVESTIGATING QUESTION

- Good nutrient management means keeping nutrients where they can do their job—feeding the crop instead of being lost to the environment. The 4Rs help farmers make those decisions by matching the right source and rate with the right time and place.
- The 4Rs help farmers keep valuable nutrients working for crops and out of water.



BIG IDEA

How can
Farmers
keep
nutrients
working for
crops & out
of the
water?



QUICK FACTS:



Investigation Time | Reset Time

• 60 MINUTES

• 3-5 MINUTES



Audience

GRADES 7-12
CLASSROOM
FARM FIELD DAY
PROFESSIONAL DEVELOPMENT

Group Size

UP TO 40 WHEN IN
TEAMS OF 3-4



Learning Goals

- Identify the 4Rs of nutrient management: Right Source, Right Rate, Right Time and Right Place.
- Use field, crop, soil and weather evidence to make nutrient-management decisions.
- Explain how nutrient-management choices can affect both crop production and water quality.
- Recognize why site-specific conditions matter in Manitowoc County.

4R Farm Challenge



EQUIPMENT CHECKLIST

For 10 Farm Manager Teams:

- ☐ 10 Farm Manager folders/clipboards
- ☐ 10 sets of four 4R Decision Cards



Right Source

Right Rate

Right Time

Right Place



- ☐ 10 Farm Manager Field Notebooks / decision sheets

- ☐ 10 pencils



- ☐ 5 sets of Farm Challenge packets, duplicated as needed

- ☐ Field maps/evidence cards for each challenge



- ☐ Soil-test cards

- ☐ Crop-history cards

- ☐ Weather cards

- ☐ Nutrient-source cards

- ☐ Manitowoc County karst/shallow-bedrock reference map

- ☐ Brooke QR/video, optional

- ☐ Educator answer/discussion guide



QUICK SETUP

Before participants arrive

1. Create Farm Teams

Arrange participants in teams of 3–4.

2. Prepare five challenge stations

Place one Farm Challenge and its Evidence Packet at each station.

3. Give each team a Farm Manager Kit

Each team receives its four 4R cards, decision sheet and pencil.

4. Keep the evidence hidden initially

Teams should encounter the farm problem first and ask:

“What do we need to know before we decide?”

Then they open the evidence.



4R FARM CHALLENGE

EDUCATOR REFERENCE

Use this page to guide discussion and support student learning.

Good farmers
use information
—not guesswork.
Let's see what
the soil is telling
us!

★ THE 4RS OF NUTRIENT STEWARDSHIP ★



RIGHT SOURCE

Match the nutrient source to crop needs and field conditions. Sources can include manure, commercial fertilizer and other nutrient-containing materials.



RIGHT RATE

Apply what the crop needs while accounting for nutrients already available from soil, manure, previous legume crops and other sources.



RIGHT TIME

Apply nutrients when crops can use them and when weather and field conditions reduce the chance of loss.



RIGHT PLACE

Put nutrients where crops can access them while considering waterways, wells, sensitive groundwater areas, slope, soil and other field features.



WHY MANITOWOC COUNTY IS INTERESTING



Parts of Manitowoc County contain shallow soils over fractured Silurian bedrock and karst features. Sinkholes and other direct conduits can create pathways between the land surface and groundwater.



Manitowoc County actually maintains a Karst Inventory mapping sinkholes, closed depressions, surface bedrock and shallow-bedrock soils.



Wisconsin has additional manure application requirements in areas with shallow Silurian bedrock because of the risk of contaminants reaching groundwater.



Manitowoc County's own conservation priorities include nutrient management plans, buffers, grassed waterways, manure storage, sinkhole mitigation and depth-to-bedrock verification.



BROOKE'S SHORT VERSION ★



The 4Rs sound simple, but there isn't one right answer for every field.

Farmers have to consider the crop, soil, nutrient source, weather and landscape together.

That's what you're going to try today.

DISCUSSION TIPS

Look at all the evidence.

Don't rely on just one piece of information.

Think about trade-offs.

The best decision balances crop needs, profitability and environmental protection.

There's rarely one "right" answer.

Good farmers make the best decision with the information they have.

Good decisions today protect our crops, our water and our community for tomorrow.





OPENING CONVERSATION

HOSTING GUIDE

What does a crop need?

Ask:

“If you were growing 500 acres of corn, what would that crop need to grow?”

Let them name sunlight, water, nutrients, soil, etc.

Then:

“If nutrients help crops grow, why do we sometimes hear about nitrogen or phosphorus as water-quality problems?”

Let that contradiction sit for a moment.

Then explain:

“Nutrients aren't automatically good or bad. The question is whether they're available where they're useful—or whether they're leaving the field.”

Introduce the 4Rs.



DURING THE ACTIVITY

Five stations × approximately 8 minutes.

At each station:

1. READ — What's happening on the farm?
2. INVESTIGATE — Examine the evidence.
3. DECIDE — Develop a nutrient-management recommendation.
4. IDENTIFY — Which R—or Rs—matter most?
5. DEFEND — What evidence supports your decision?

There should deliberately not always be one perfect answer.



QUESTIONS TO ASK

While circulating, the host asks:

- What evidence matters most here?
- Is there information you wish you had?
- Which R are you using?
- Could more than one R matter?
- What could happen to nutrients that aren't used by the crop?
- Would your answer change under different weather conditions?
- How does this field's location change your decision?



Bring everyone back together.

Don't go through “correct answers” one by one.
Instead ask:

Did every decision have one obvious answer?

Then:

- Which R came up most often?
- Which scenario required more than one R?
- What information changed your mind?
- When did protecting water also protect the farm's nutrients or input dollars?

And finally return to the investigating question:

How can farmers keep nutrients working for crops and out of water?
Let participants answer it.

Closing:

“You probably noticed something today: there wasn't one rule that solved every problem. The crop changed. The soil changed. The weather changed. The landscape changed. Good nutrient management means paying attention to all of those clues—and using the 4Rs together.”



4R FARM CHALLENGE

CASE #1

STORM
COMING

★ TIMING MATTERS ★

Manitowoc County
Farm Manager

WEATHER ALERT:

Heavy rain
in tomorrow's
forecast!



THE SITUATION



It's spring in Manitowoc County.



Your corn will need nutrients,
liquid manure is available, and
your field is ready.



There's just one problem:

**HEAVY RAIN IS IN
TOMORROW'S FORECAST.**



YOUR DECISION

Would you apply nutrients
today, wait, or change
your plan?

Before you decide...



INVESTIGATE THE EVIDENCE



WEATHER FORECAST

What's coming?
How much rain?



CROP INFORMATION

What does the crop
need right now?



FIELD CONDITIONS

What is your field like
(soil, slope, moisture)?



NUTRIENT SOURCE

What product is
available?

What information matters most?

WHICH OF
THE **4Rs**
WILL HELP
YOU DECIDE?



RIGHT
SOURCE



RIGHT
RATE



RIGHT
TIME



RIGHT
PLACE





4R FARM CHALLENGE

CASE #1: STORM COMING

EVIDENCE CARD

Use these clues to make your decision.

Carefully examine each piece of evidence. What information matters most?



WEATHER FORECAST

Heavy rain expected in the next 24–36 hours.



DAY	FORECAST
Today	Partly cloudy High: 62°F
Tonight	Cloudy Low: 48°F
Tomorrow	Heavy rain 1.5 – 2.0"
Day After	Scattered showers

CLUE: Large rainfall events can move nutrients off fields or into the ground quickly.



CROP INFORMATION

Your crop is just beginning to grow.



Crop: Corn

Growth Stage:
VE (emergence)

Nutrient need:
Nitrogen will be needed in the coming weeks.

CLUE: Young plants will need nutrients soon, but timing matters.



FIELD CONDITIONS

Consider the land and soil conditions.



Moderate slope slopes toward a drainageway.



Soil is moist at the surface.



Drainageway connects to Pine Creek.

CLUE: Water moves downhill. Nutrients can move with it.



NUTRIENT SOURCE

Liquid manure is available for application.



- **Source:** Liquid dairy manure
- **Nutrients present:** Nitrogen, Phosphorus, Potassium
- **Storage tank** is near capacity.

CLUE: Manure has valuable nutrients. Apply wisely so they stay on your field.



THINK BEFORE YOU DECIDE

- What could happen to nutrients if heavy rain occurs after application?
- Will the crop be able to use the nutrients if you apply today?
- How might waiting or changing your plan affect your field and your farm?



Use the 4Rs to build your plan:



RIGHT SOURCE



RIGHT RATE



RIGHT TIME



RIGHT PLACE



4R FARM CHALLENGE

★ LOCATION MATTERS ★

CASE #2
WHAT'S THAT DEPRESSION?



THE SITUATION

- ✓ You're preparing to apply liquid manure to this field in Manitowoc County.
- ✓ While walking the field, you notice a low, bowl-shaped area.
- ✓ Maps show this area has documented karst features nearby.

Before you apply nutrients, should you take a closer look?



YOUR DECISION

Where can nutrients be safely applied—and is there anywhere you should avoid?

Investigate the evidence in your Farm File before deciding.

APPLY
(OK)

NEED MORE
INFO

AVOID
(PROTECT)

USE THE 4Rs TO GUIDE YOUR THINKING



RIGHT SOURCE

What nutrient source makes sense for this field?



RIGHT RATE

How much does the crop need—and what's already available in the soil?



RIGHT TIME

When will the crop be able to use the nutrients safely?



RIGHT PLACE

Where should nutrients go—and where shouldn't they?



Think about it: What makes this spot different from the rest of the field?



4R FARM CHALLENGE

CASE #2: WHAT'S THAT DEPRESSION?

★ LOCATION MATTERS ★

EVIDENCE CARD

Use these clues to make your decision.

🔍 Examine each piece of evidence. What information matters most?

1 KARST MAP: THIS AREA HAS RISK

This field is in an area with documented karst features.

- Sinkhole
- Closed Depression
- Surface Bedrock
- Shallow Bedrock Soils
- County Boundary

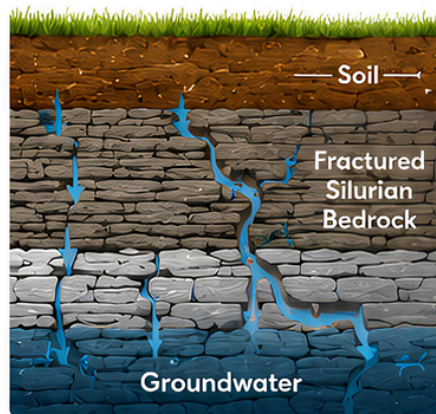


Source: Manitowoc County Karst Inventory (2023)



TIP: Karst features can create direct pathways from the surface to groundwater.

2 WHAT'S BELOW YOUR FEET?



In many parts of Manitowoc County, soils are thin over fractured Silurian bedrock.

Karst features like sinkholes and fractures can provide fast routes for water—and anything in it—down to groundwater.



Nutrients applied over karst features can reach groundwater quickly.

3 GROUNDWATER IS CLOSE



Several homes and farms nearby use private wells for drinking water.



Protecting groundwater protects our neighbors and our community.



What you apply here can affect the water someone drinks.

4 FIELD CLUES



- Low, bowl-shaped depressions can be sinkholes or other karst features.
- They may hold water after rains.
- Never assume it's just a "low spot." Investigate and follow setbacks and restrictions.



When in doubt, protect it! Know before you apply.

MARK YOUR PLAN ON THE FIELD MAP

Use the evidence to decide where nutrients can be applied.



APPLY
Good place to apply.



NEED MORE INFORMATION
Investigate further.



AVOID / PROTECT
Do not apply in this area.

THINK LIKE A FARM MANAGER



Where could nutrients move if it rains after application?



What are we trying to protect?



What information do we still need before making a decision?



GOOD FARMERS GET GOOD INFORMATION BEFORE THEY APPLY.
Use the 4Rs to make the safest, most effective decision for this field.



RIGHT SOURCE



RIGHT RATE

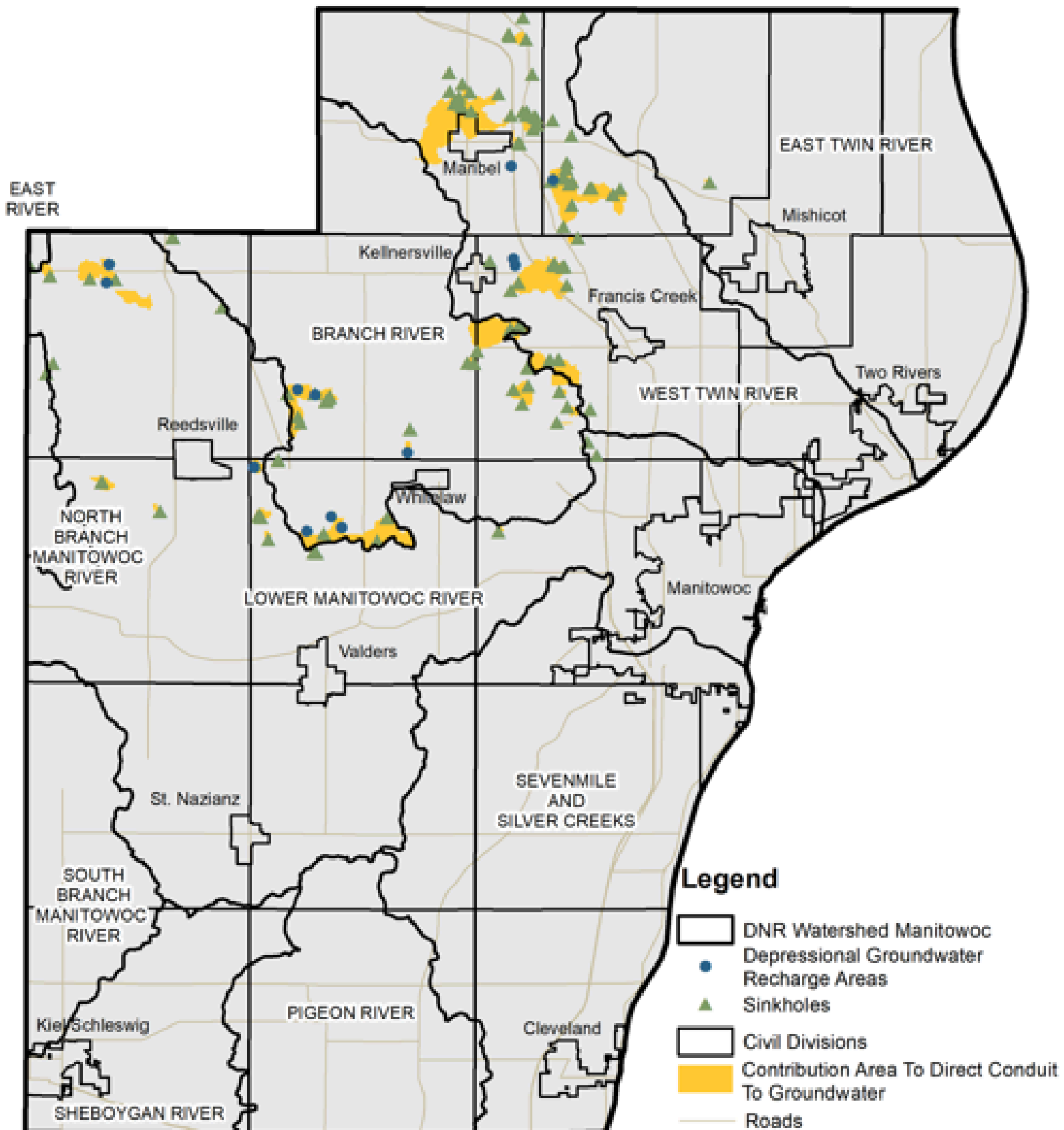


RIGHT TIME



RIGHT PLACE

Karst Features By Watershed Manitowoc County





4R FARM CHALLENGE

CASE #3: THE SOIL TEST IS IN

★ WHAT'S ALREADY THERE? ★



Good farmers use information—not guesswork. Let's see what the soil is telling us!

? THE SITUATION

You're planning fertilizer for a Manitowoc County corn field.

Your farm has used the same fertilizer blend on this field in the past.

But before you order this year's fertilizer, your new soil-test results arrive.

Do you stick with the usual plan—or change it?



SOIL TEST REPORT

Nutrient	RESULT	OPTIMUM	RATING
pH	5.6	*	H
Phosphorus (P)			H
Potassium (K)			H
Organic Matter			

Recommendations are based on university research and/or lab analysis. Results may vary. Consult your agronomist for more information.



YOUR DECISION

Choose a nutrient source and decide whether the usual fertilizer plan still makes sense for this field.



WHAT DO YOU NEED TO KNOW?

Open your Farm File and investigate the evidence before making your recommendation.



SOIL TEST RESULTS

What nutrients are already in the soil?



CROP NUTRIENT NEEDS

What nutrients does corn need?



NUTRIENT SOURCE A

Does this source match what the field needs?



NUTRIENT SOURCE B

How is this source different—and why does it matter?

FARM FILE

EVIDENCE INSIDE



WHICH OF THE 4Rs WILL HELP YOU DECIDE?



RIGHT SOURCE



RIGHT RATE



RIGHT TIME



RIGHT PLACE



Good managers use the right information to make the best decisions for the land, the crop, and our water.

Before adding something to the soil, shouldn't we find out what's already there?





4R FARM CHALLENGE

CASE #3: THE SOIL TEST IS IN

★ EVIDENCE CARD ★

Use these clues from your Farm File to make the best decision.

Good farmers use information—not guesswork. Let's see what the soil is telling us!

1 SOIL TEST RESULTS

Based on an actual 2024 Manitowoc County soil test.*
(Identifying information removed.)

CROP: Corn Silage



YIELD GOAL:
25 tons/acre

WISCONSIN NUTRIENT RECOMMENDATION

Nutrient Needs (lb/acre)			Wisconsin Recommendation (lb/acre)		
Nitrogen (N)	Phosphate (P ₂ O ₅)	Potash (K ₂ O)	Nitrogen (N)	Phosphate (P ₂ O ₅)	Potash (K ₂ O)
125	0	95	125	0	95

INTERPRETATION

Phosphorus (P)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)
EXCESSIVE	HIGH	HIGH	OPTIMUM

*Recommendations are based on university research and lab information. Follow UWEX guidelines.

READ THE CLUES



Which nutrient recommendation is zero?



Which nutrient is rated "Excessive"?



Does this field need the same amount of every nutrient?

2 NUTRIENT SOURCE A: THE USUAL BLEND

Contains:



This source supplies nitrogen, phosphorus and potassium.



THINK:

What would this source add that the soil test isn't recommending?

3 NUTRIENT SOURCE B: A MORE TARGETED PLAN

Allows the farmer to meet the recommended nutrient needs—without automatically adding phosphorus.



Meets nitrogen needs



Meets potassium needs



No added phosphorus



THINK:

How could the soil test help the farmer choose a better source and rate?

4 THINK LIKE A FARM MANAGER



The crop needs: _____



The soil already has plenty of: _____



Our nutrient plan would: _____



Evidence that supports our decision: _____



Good managers use the right information to make the best decisions for the land, the crop, and our water.

A soil test doesn't make the decision for us. It gives us evidence to make a better one.





4R FARM CHALLENGE

CASE #4: CORN AFTER ALFALFA

★ EVIDENCE CARD ★

Use these clues from your Farm File to make the best decision.



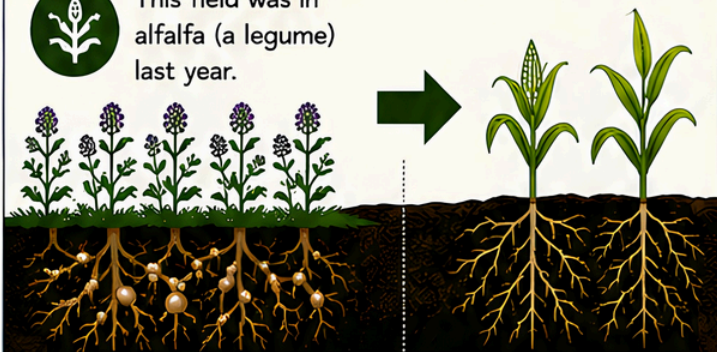
Good farmers use information—not guesswork. Let's see what the field is telling us!



1 CROP HISTORY: WHAT GREW HERE LAST YEAR?



This field was in alfalfa (a legume) last year.



Alfalfa forms nodules on its roots with helpful bacteria that capture nitrogen from the air and make it available in the soil for the next crop.

2 THE LEGUME CLUE: ALFALFA NITROGEN CREDIT

University of Wisconsin (A2809) guidance helps us estimate how much nitrogen the alfalfa crop leaves behind for the next crop.

ALFALFA NITROGEN CREDIT FOR FOLLOWING CORN (lb N per acre)

ALFALFA STAND QUALITY	MEDIUM- AND FINE-TEXTURED SOILS*		SANDY AND LOAMY-SAND SOILS*
	> 8" REGROWTH**	< 8" REGROWTH**	
Good	190	150	90
Fair	160	120	70
Poor	130	90	50

* Soil texture affects how much nitrogen is supplied.

** Regrowth = alfalfa growth after the final cutting. More regrowth means more nitrogen returned.



Use the row and column that best match the alfalfa stand quality, soil texture, and regrowth in your field to find the nitrogen credit.

3 CORN NITROGEN NEED

How much nitrogen does the new corn crop need to reach our yield goal?



YIELD GOAL:

200 bushels/acre

WISCONSIN N RECOMMENDATION*

(No credits applied)

Corn After Corn
Typical Need

160 lb N per acre

*Recommendations are based on university research and lab information. Follow UWEX guidelines.

4 THE USUAL PLAN

The farm's standard corn program for this field (follows corn after corn).

APPLY 160 lb N per acre
(as urea or equivalent)



Does this plan account for the nitrogen already in the soil from last year's alfalfa?

5 THINK LIKE A FARM MANAGER

Use the evidence to adjust the nitrogen plan.



Corn nitrogen need (no credits): _____ lb N/ac



Alfalfa nitrogen credit (from table above): _____ lb N/ac



Subtract the credit from the need: _____ lb N/ac



Adjusted nitrogen need for this year: _____ lb N/ac



Our recommendation: _____



Remember: Nutrient credits are not guarantees—weather, soil type, stand quality and management all affect how much nitrogen the next crop can use.

Crop history matters!
Using a nitrogen credit
can help us apply the
right rate—nothing more,
nothing less.



Which of the 4Rs will help you decide?



RIGHT
SOURCE



RIGHT
RATE



RIGHT
TIME



RIGHT
PLACE



Good managers use the right information to make the best decisions for the land, the crop, and our water.





4R FARM CHALLENGE

CASE #5: ONE FARM. TWO FIELDS.

★ WHICH FIELD WOULD YOU CHOOSE? ★

Good farmers use information—not guesswork. Let's see what the fields are telling us! 🔍

FIELD A

FIELD B

? THE SITUATION

Your farm needs to apply liquid manure.

You have two Manitowoc County fields available. Both are growing corn, but the fields aren't exactly alike.

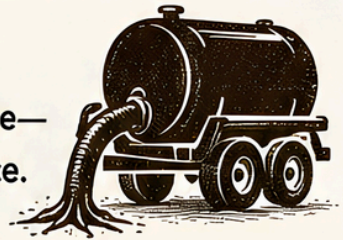
Which field would you prioritize for manure application?



YOUR DECISION

Compare Field A and Field B.

Decide where you would apply the manure—and build a 4R plan to explain your choice.



WHAT DO YOU NEED TO KNOW?

Open your Farm File and compare the evidence for both fields:



CROP NEED

Which field can use the nutrients?



SOIL TEST

What nutrients are already available?



SOIL & BEDROCK

What's below the surface?



LANDSCAPE & WATER

Are there features that increase the risk of nutrient loss?



WEATHER

Are conditions suitable for application?



NUTRIENT SOURCE

Which nutrients does the manure provide?



BUILD YOUR 4R PLAN



RIGHT SOURCE

Does this nutrient source match the crop's needs?



RIGHT RATE

How much should be applied?



RIGHT TIME

Are conditions right for application?



RIGHT PLACE

Which field is the better location?

This time, don't look for just one clue. Put the whole story together.

FIELD A or FIELD B?

What evidence supports your decision?



Good managers use the right information to make the best decisions for the land, the crop, and our water.





4R FARM CHALLENGE

CASE #5: ONE FARM. TWO FIELDS.

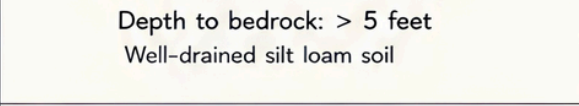
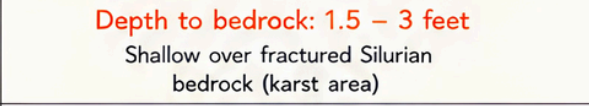
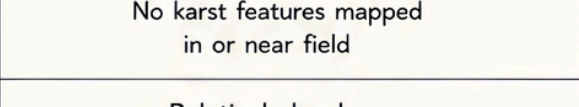
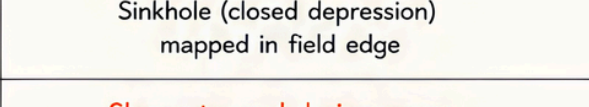
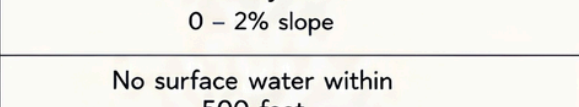
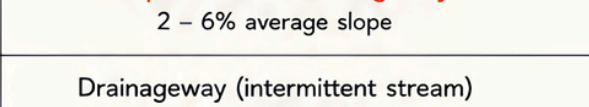
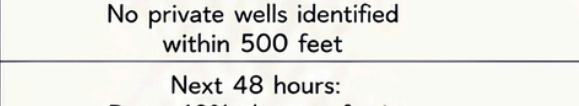
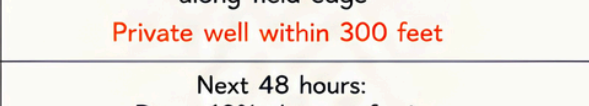
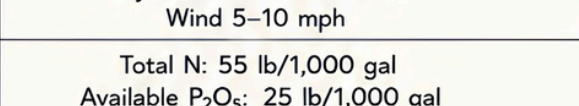
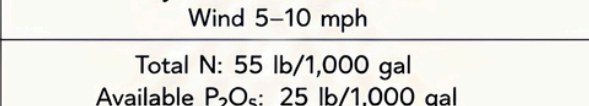
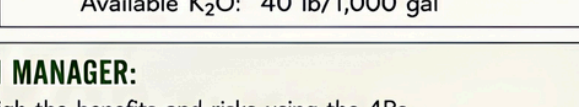
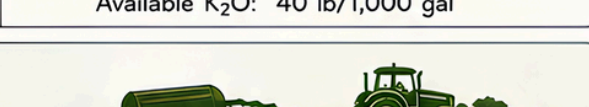
★ EVIDENCE CARD ★

Use this comparison to decide where you would apply the manure and build your 4R plan.



Good farmers
use information—
not guesswork.
Let's see what
the fields are
telling us!



EVIDENCE	FIELD A	FIELD B
 CROP What is growing?	 Corn Growth stage: V8	 Corn Growth stage: V8 (slightly ahead)
 SOIL TEST Plant-available phosphorus (P)	 Optimum 18 ppm (Bray P1)	 High 45 ppm (Bray P1)
 SOIL & BEDROCK What's below the surface?	 Depth to bedrock: > 5 feet Well-drained silt loam soil	 Depth to bedrock: 1.5 – 3 feet Shallow over fractured Silurian bedrock (karst area)
 KARST FEATURES Sinkholes, closed depressions, etc.	 No karst features mapped in or near field	 Sinkhole (closed depression) mapped in field edge
 LANDSCAPE Slope and drainage	 Relatively level 0 – 2% slope	 Slopes toward drainageway 2 – 6% average slope
 NEARBY WATER Rivers, streams, lakes, wells	 No surface water within 500 feet No private wells identified within 500 feet	 Drainageway (intermittent stream) along field edge Private well within 300 feet
 WEATHER FORECAST Upcoming conditions	 Next 48 hours: Dry, <10% chance of rain Wind 5–10 mph	 Next 48 hours: Dry, <10% chance of rain Wind 5–10 mph
 NUTRIENT SOURCE Liquid dairy manure analysis	 Total N: 55 lb/1,000 gal Available P ₂ O ₅ : 25 lb/1,000 gal Available K ₂ O: 40 lb/1,000 gal	 Total N: 55 lb/1,000 gal Available P ₂ O ₅ : 25 lb/1,000 gal Available K ₂ O: 40 lb/1,000 gal



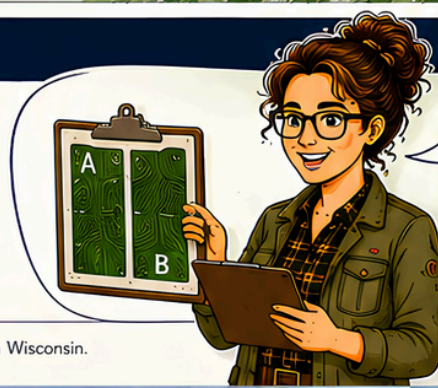
THINK LIKE A FARM MANAGER:

No field is perfect. Weigh the benefits and risks using the 4Rs.
Consider what matters most for crop needs, water quality, and the long term.



WHAT ELSE WOULD YOU WANT TO KNOW?

List any additional information that would help you make the best decision.



Sometimes the
best decision is:
I need more
information before
I decide.



4R FARM CHALLENGE

FARM MANAGER DECISION SHEET

Your job: Investigate each case. Use the evidence. Make a decision you can defend.

Good farmers use information—not guesswork. Let's see what the evidence is telling us!

CASE	OUR DECISION What will you recommend?	WHICH 4RS MATTER? Circle! Check all that apply.	STRONGEST EVIDENCE What evidence supports your decision the most?
1 STORM COMING	_____	SOURCE ☐ RATE ☐ TIME ☐ PLACE ☐	_____
2 WHAT'S THAT DEPRESSION?	_____	SOURCE ☐ RATE ☐ TIME ☐ PLACE ☐	_____
3 THE SOIL TEST IS IN	_____	SOURCE ☐ RATE ☐ TIME ☐ PLACE ☐	_____
4 CORN AFTER ALFALFA	_____	SOURCE ☐ RATE ☐ TIME ☐ PLACE ☐	_____
5 ONE FARM. TWO FIELDS.	_____	SOURCE ☐ RATE ☐ TIME ☐ PLACE ☐	_____

LOOKING BACK AT THE EVIDENCE

Which piece of evidence changed your thinking the most?

What information did you wish you had?

THE BIG QUESTION

How can farmers keep nutrients working for crops and out of water?



A good decision isn't just an answer. You should be able to explain the evidence behind it.

RESEST CHECKLIST



Between groups:

- ☐ Return each Scenario Card to its station
- ☐ Place each Evidence Card/Farm File face down or closed
- ☐ Return 4R Decision Cards to each Farm Manager Kit
- ☐ Collect Farm Manager Decision Sheets
- ☐ Replace pencils as needed
- ☐ Return the Manitowoc County karst map/reference materials
- ☐ Check that all five station packets are complete
- ☐ Wipe laminated materials if needed
- ☐ Reset tables/stations for the next team
- ☐ Note missing, damaged or confusing materials for follow-up



TROUBLE SHOOTING

Problem

Try This

- Teams are looking for one “correct” answer.
- Participants immediately choose an answer before opening the evidence.
- Teams aren't sure which R applies.
- Participants disagree.
- Participants struggle with the soil test.
- Remind them: Your job is to make the best decision you can with the evidence you have. Ask, “What evidence supports your choice?”
- Ask, “What would you want to know before making that decision on a real farm?” Then have them open the Farm File.
- That's okay—more than one R may matter. Ask them which R is most important to their decision and why.
- Don't resolve it for them. Ask each side to identify the evidence supporting its recommendation. A defensible disagreement can lead to great discussion.
- Direct them to the highlighted recommendation and nutrient ratings. They don't need to understand every number on a soil test to recognize what the evidence is telling them.

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