Nutrient application algorithm

1/9/2026

Tom Butler, EPA

Outline/goal

Define process of applying nutrients in CAST

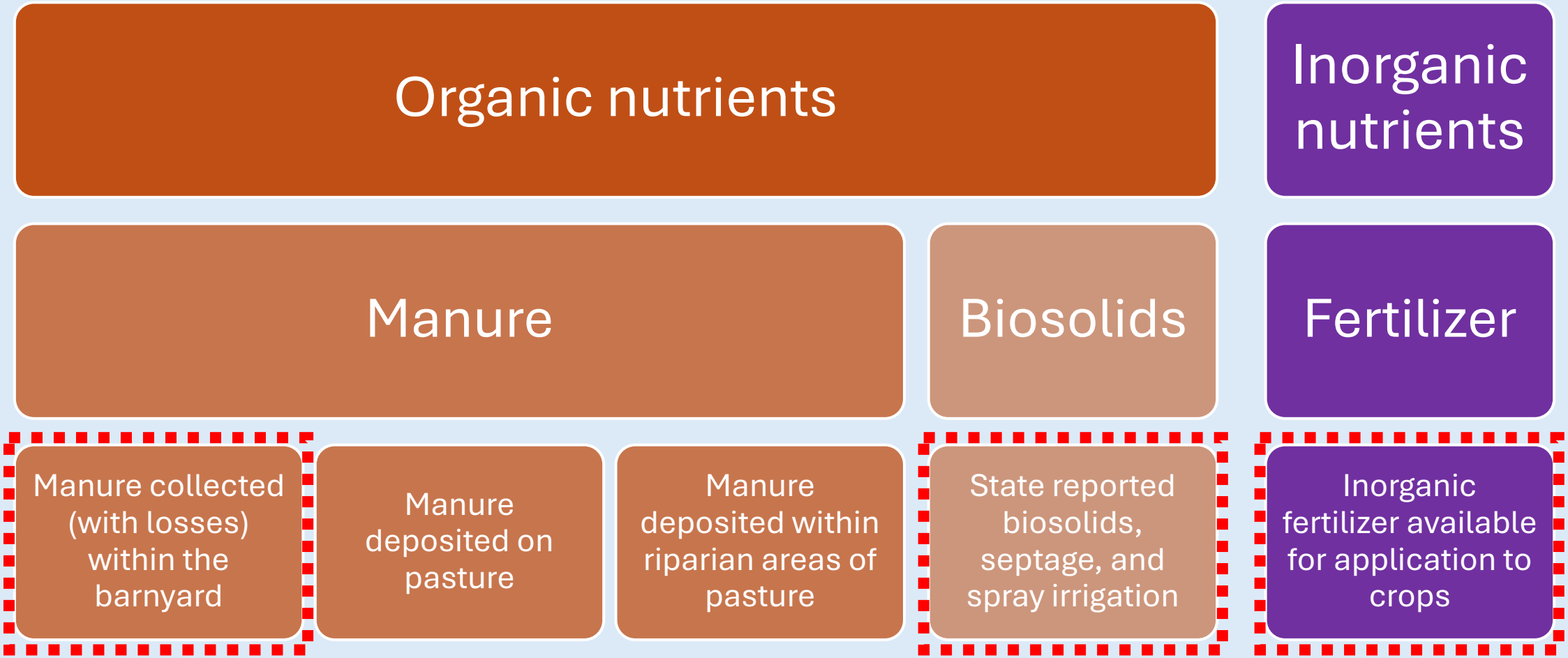
Collect feedback

GOAL:

- Understand and improve the model processes for applying nutrients when accounting for treatment/transport of organic sources for Phase 7.

CAST Agriculture nutrient categories

BOX Denotes item is used for application



NOTE* Not all organic nutrients that are applied are Plant Available

A quick note on fertilizer application: N

Phase 6

Group 1	Group 2	Group 3
• Grain with manure • Silage with manure • Small grains and grains • Other agronomic crops • Specialty high and low • Small grains and soybeans	• Pasture • Other Hay	• Full season soybeans • Legume hay

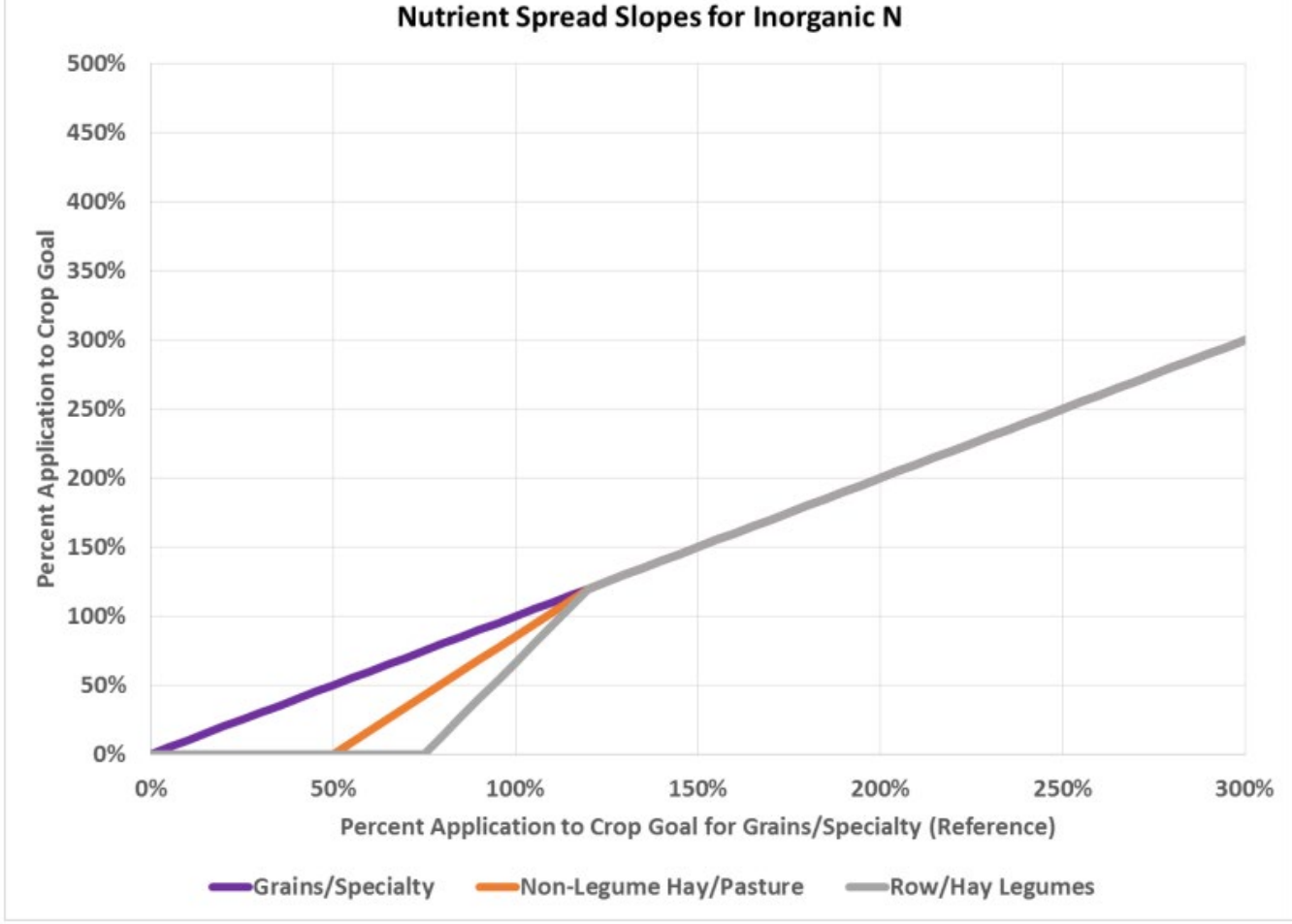


Figure 3-10: Inorganic Nitrogen Application Curves by Crop Group

A quick note on fertilizer application: N

Phase 6

Group 1	Group 2	Group 3
• Grain with manure • Silage with manure • Small grains and grains • Other agronomic crops • Specialty high and low • Small grains and soybeans	• Pasture • Other Hay	• Full season soybeans • Legume hay

Phase 7

Group 1	Group 2	Group 3
• Grain with manure • Silage with manure • Small grains and grains • Other agronomic crops • Specialty high and low • Small grains and soybeans • **Pasture High** • **Hay High**	• **Pasture Low** • **Hay Low**	• Full season soybeans • Legume hay

A quick note on fertilizer application: P

Phase 6

Group 1	Group 2
• Grain with manure • Silage with manure • Small grains and grains • Small grains and soybeans • Full Season Soybeans • Other agronomic crops • Specialty high and low	• Pasture • Other Hay • Legume hay

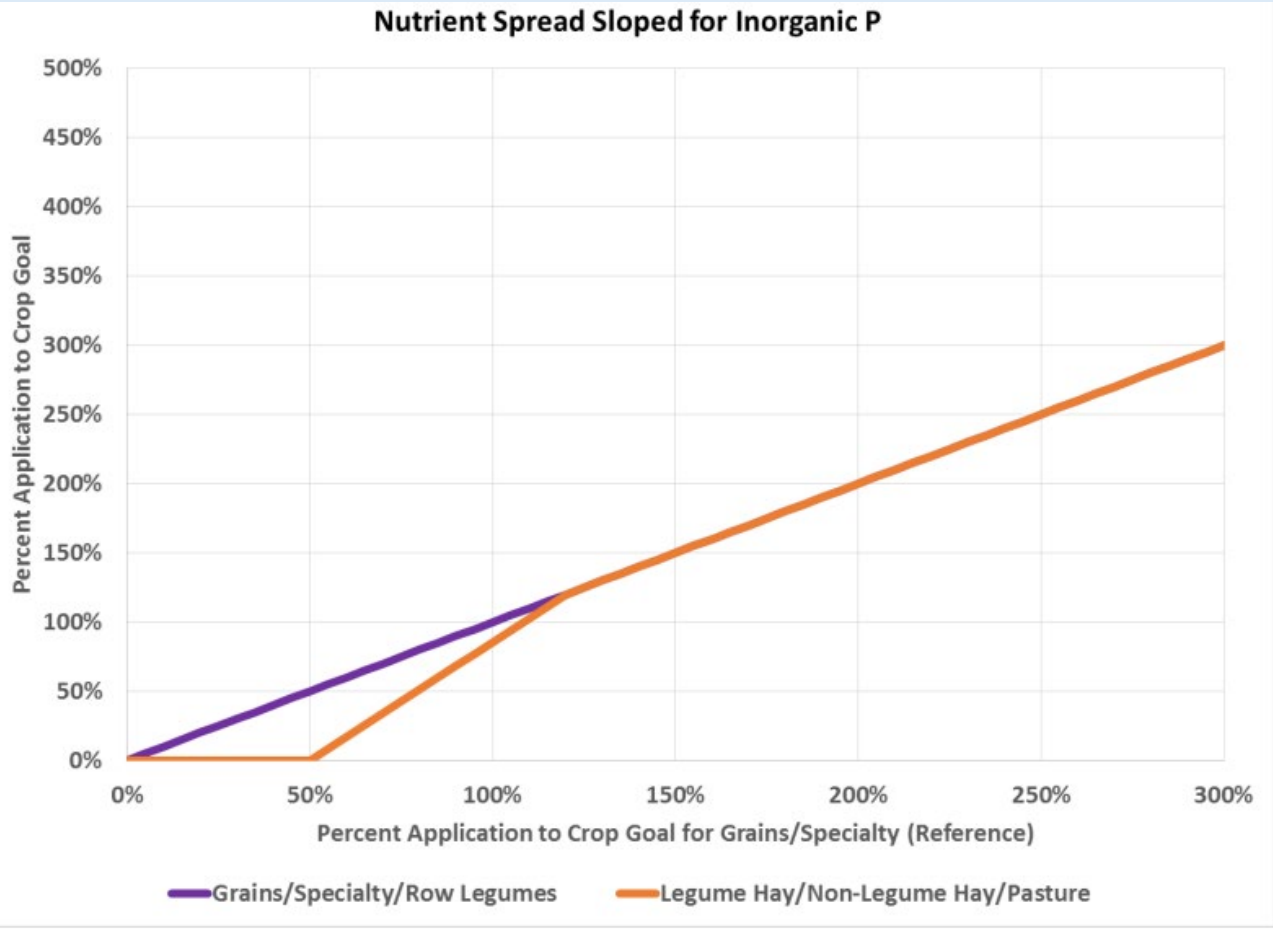


Figure 3-11: Inorganic phosphorus application curves by crop group

A quick note on fertilizer application: P

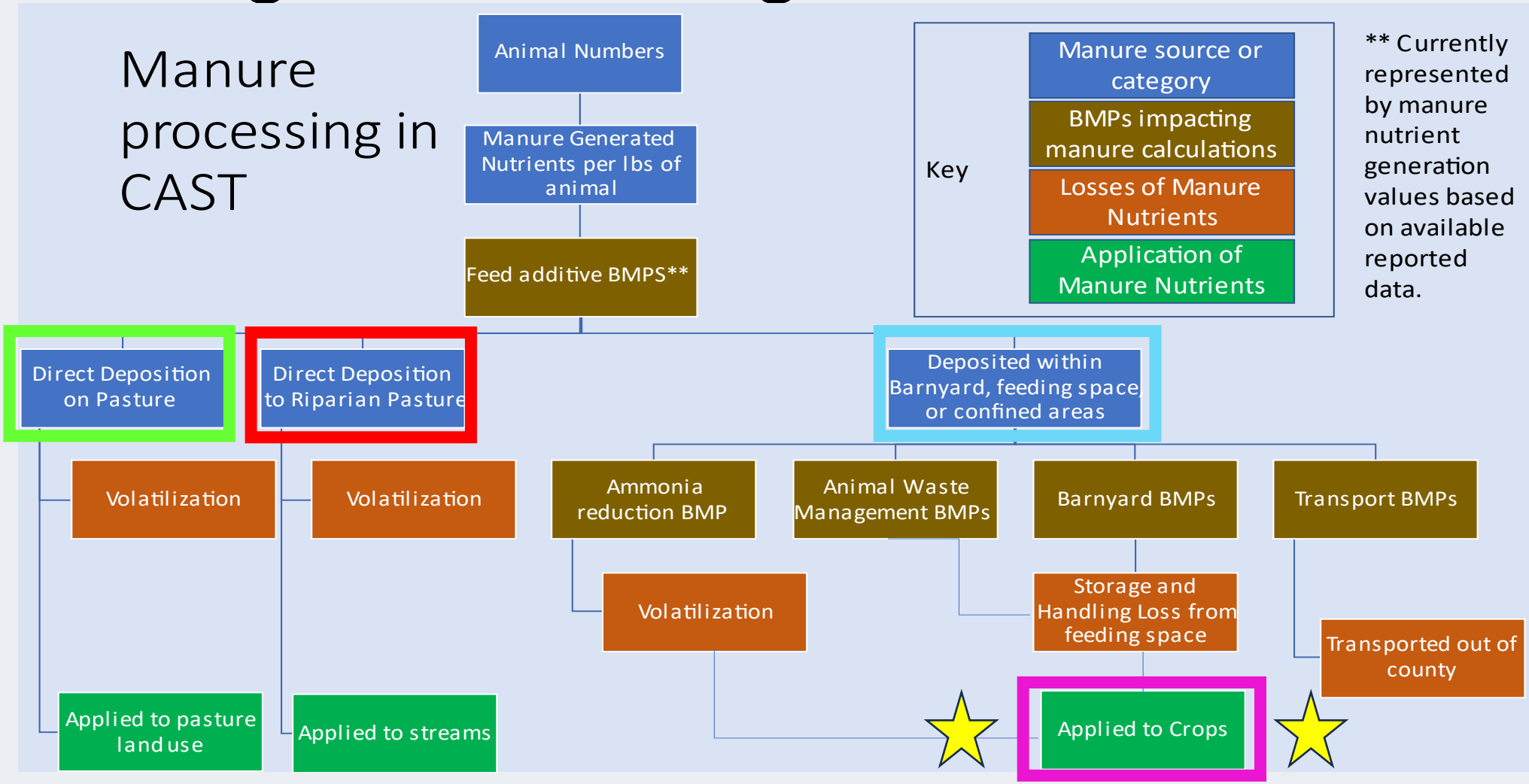
Phase 6

Group 1	Group 2
• Grain with manure • Silage with manure • Small grains and grains • Small grains and soybeans • Full Season Soybeans • Other agronomic crops • Specialty high and low	• Pasture • Other Hay • Legume hay

Phase 7

Group 1	Group 2
• Grain with manure • Silage with manure • Small grains and grains • Small grains and soybeans • Full Season Soybeans • Other agronomic crops • Specialty high and low • **Pasture High** • **Hay High**	• **Pasture Low** • **Hay Low** • Legume hay

Manure generation diagram:



- Manure nutrients stay in their county of origin UNLESS they are transported
- Barnyard BMPs refers to runoff control management
- NOTE* after application to fields volatilization and additional BMPs can be used to increase the plant available nutrients

Manure Applications 3.4

Find an observed yield (NASS) and calculate the nutrients used to grow that yield (crop need)

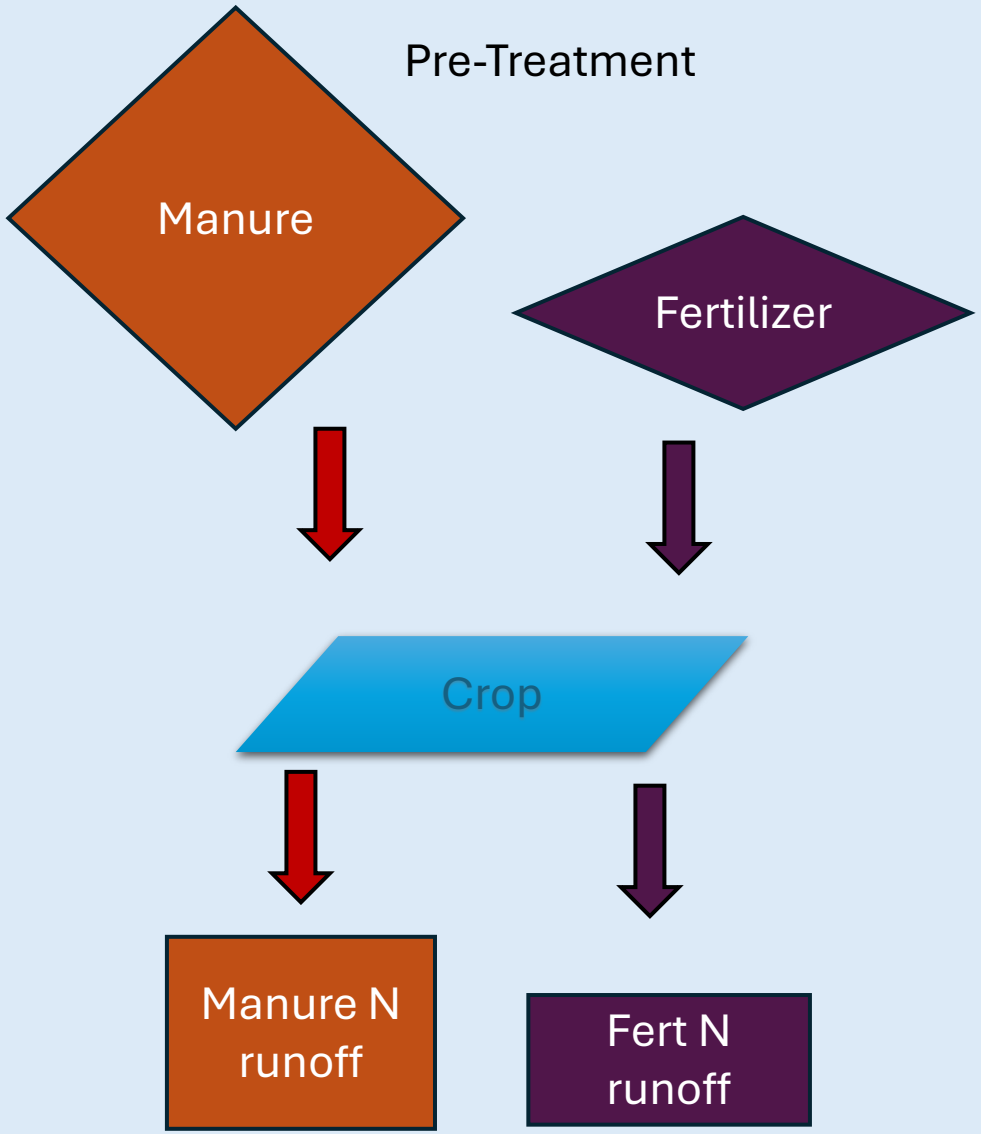
Sequential application:

- biosolids
- manure
- inorganic fertilizer

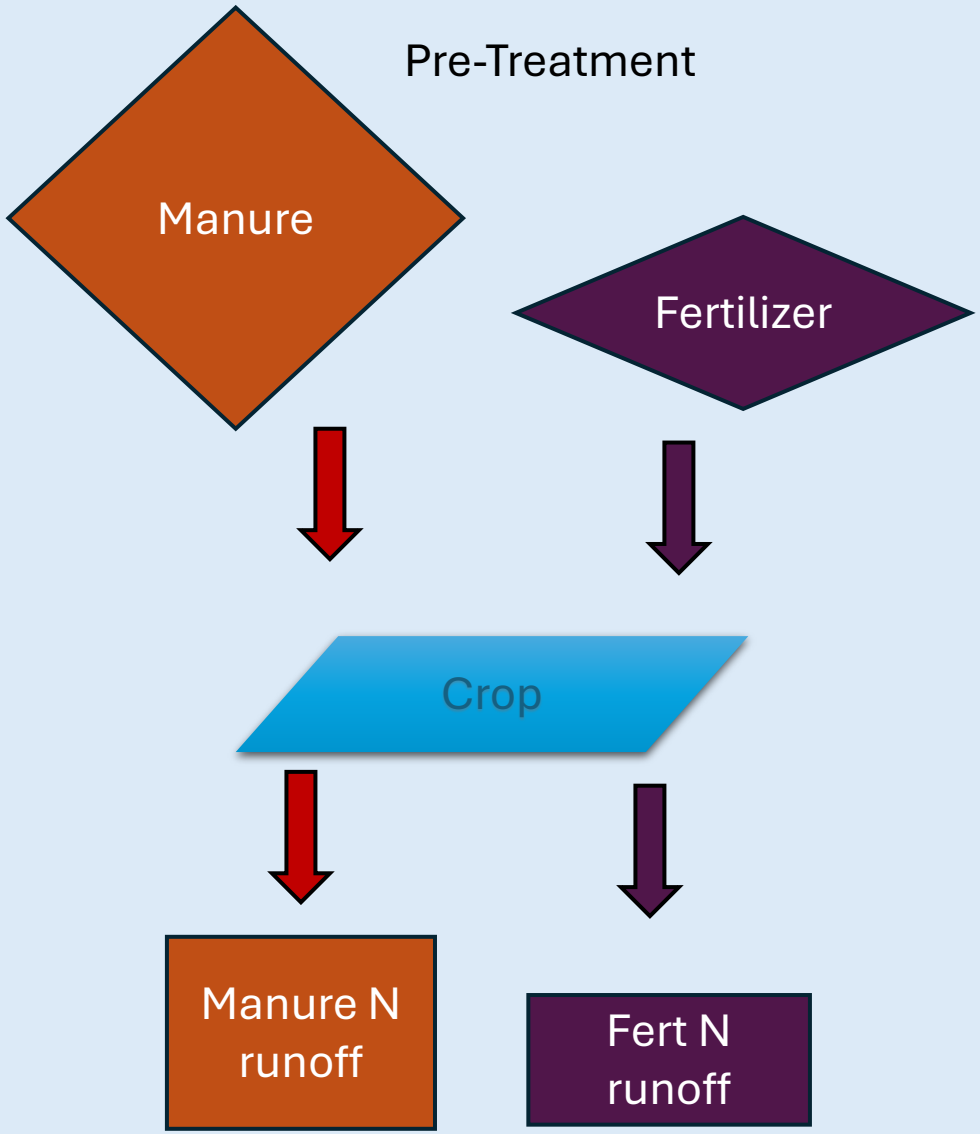
Meet crop need (application goal)

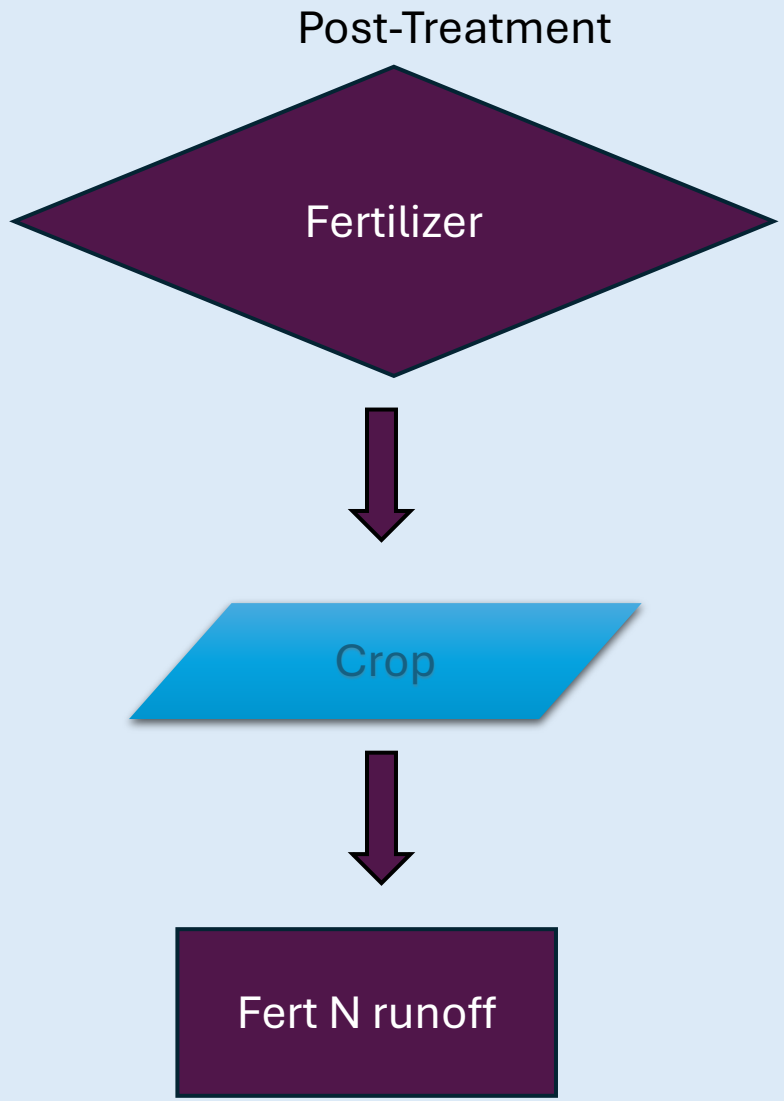
Not all manure is plant available

Visualizing the process



Visualizing the process





Assume that fertilizer is brought in to replace lost nutrients from manure

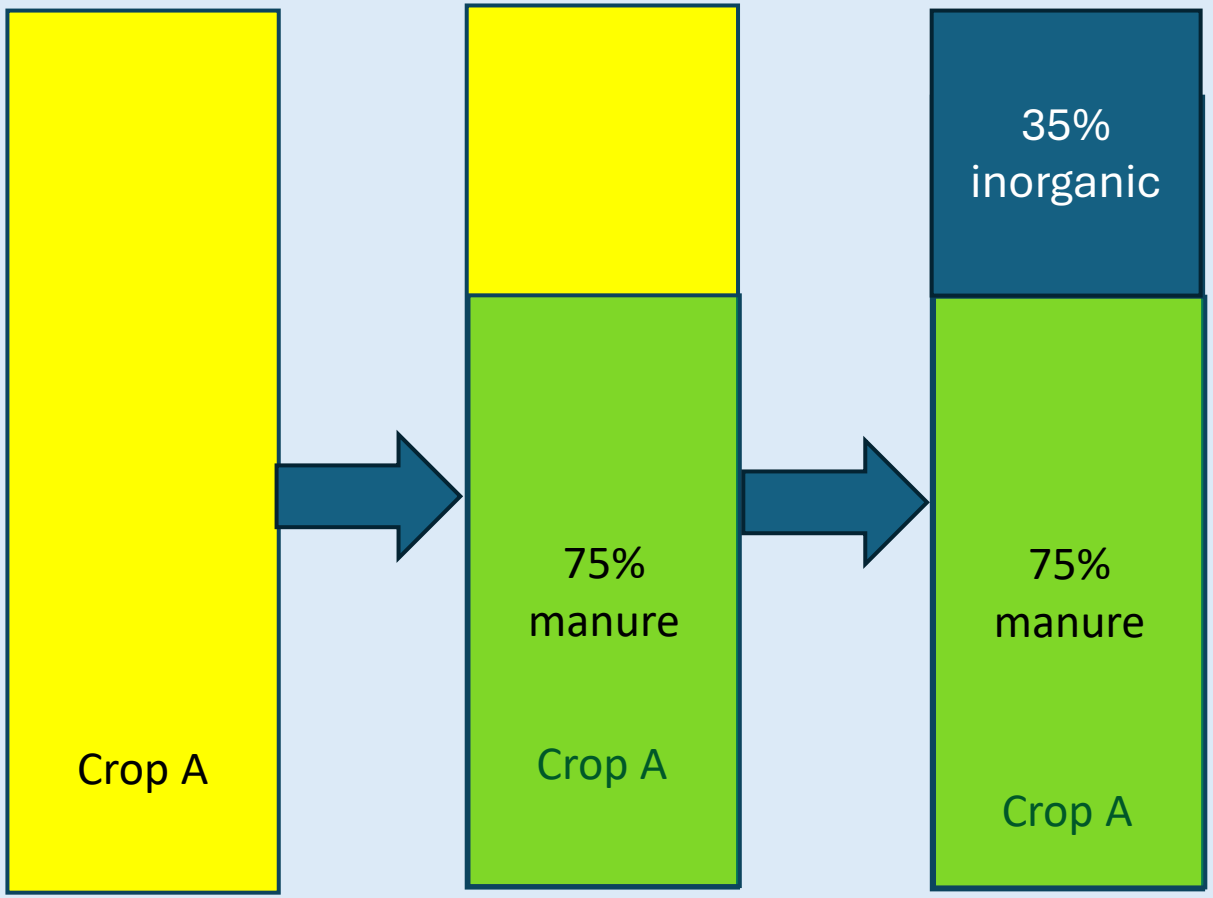
Credit

Another way to look at it

Crop A has calculated nutrient need

All available manure nutrients are applied

Inorganic nutrients are calculated and applied – may be more or less than need



- In this example we are satisfying 110% of crop need
  - (75+35=110%)
- This is possible within CAST

Replacement – With a BMP

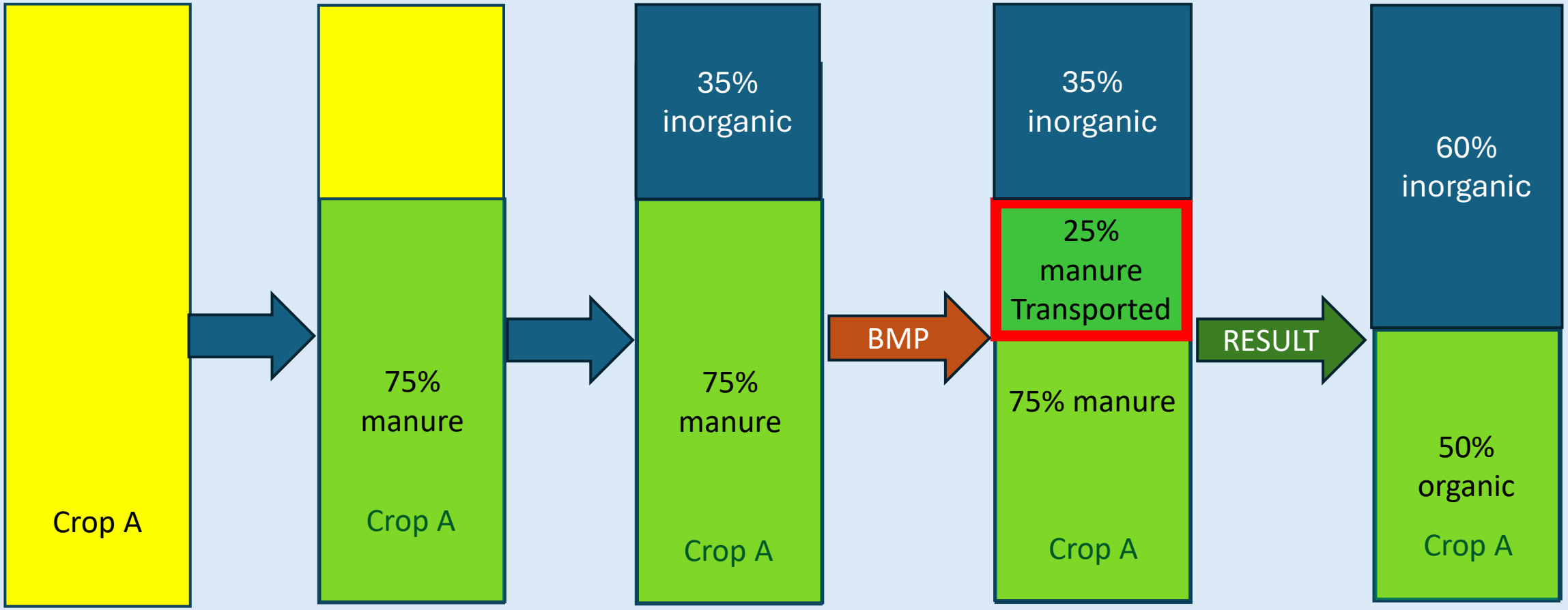
Crop A has calculated nutrient need

All available manure nutrients are applied

Inorganic nutrients are calculated and applied – may be more or less than need

Manure transport removes manure nutrients

Inorganic nutrients are used to replace transported manure



Still meeting crop need

Something to consider: Nutrient Management

The current replacement of organic nutrients with inorganic sources can cause unrealistic shifts in Nitrogen load

Implementing Nutrient Management in CONJUNCTION with manure treatment leads to a reduction in Nitrogen.

Replacement with NM

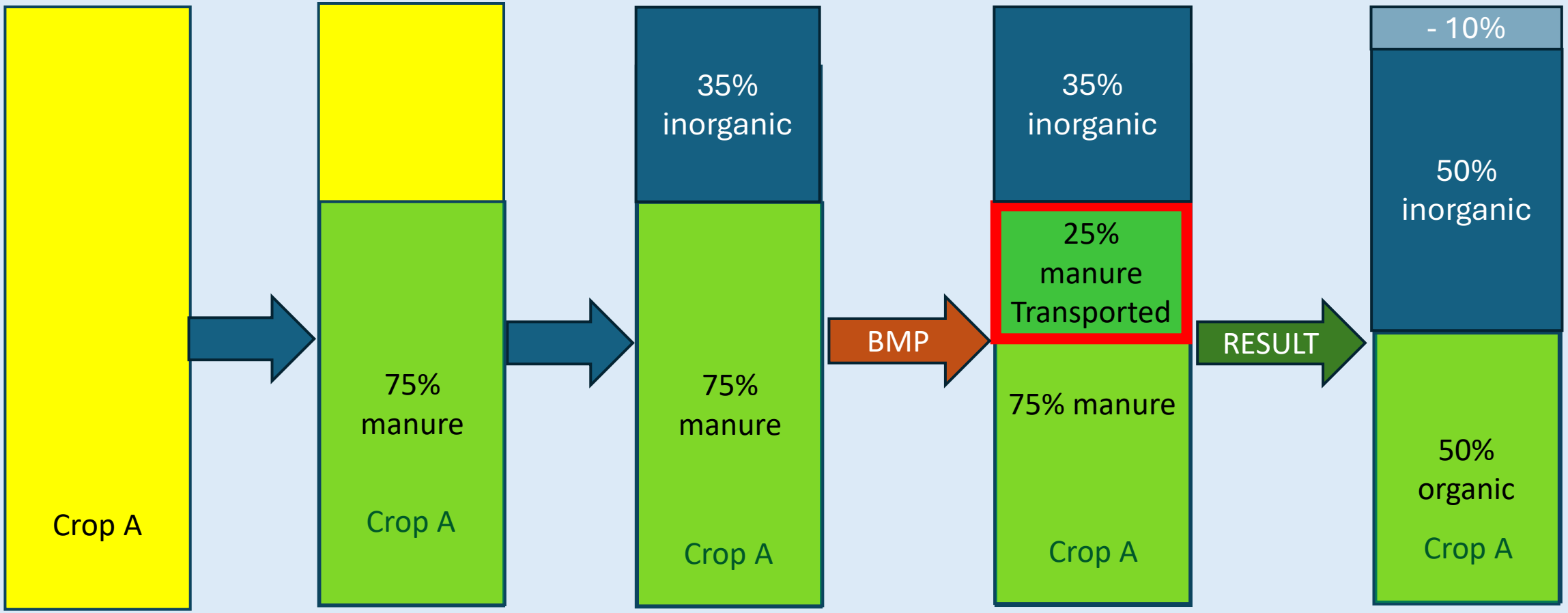
Crop A has calculated nutrient need

All available manure nutrients are applied

Inorganic nutrients are calculated and applied – may be more or less than need

Manure transport removes manure nutrients

Reported Core Nutrient Management would reduce inorganic nutrients



The rationale:

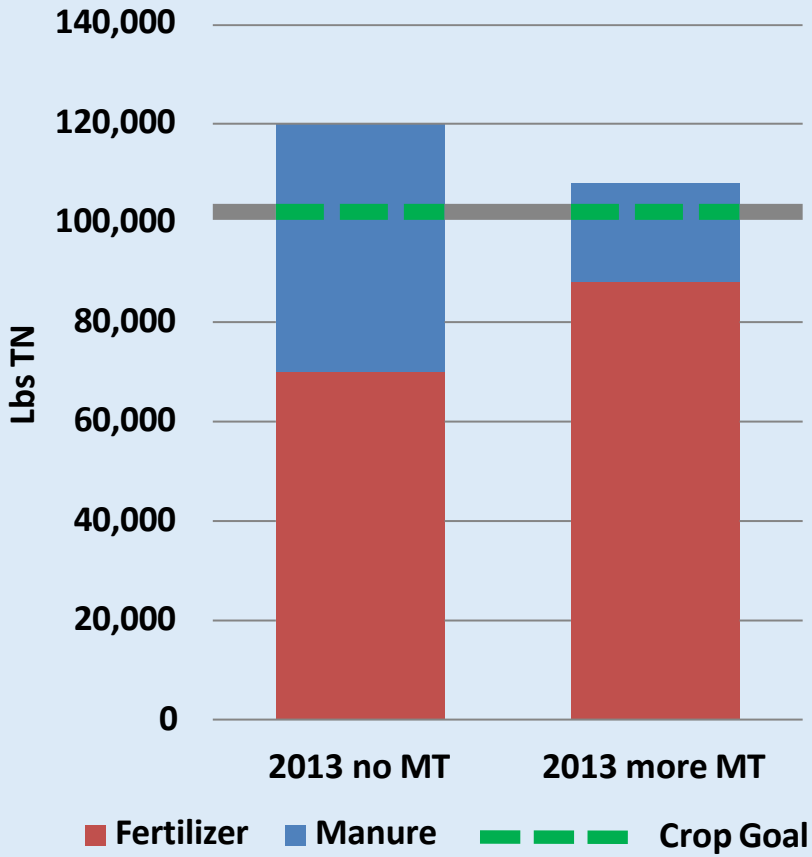
- How should credit be given for additional manure transport in counties where nutrients **exceed** crop goal?
- How should credit be given for additional manure transport in counties where nutrients **do not exceed** crop goal?

- AMS recommends the following for every county:
  - Every additional **pound of manure PAN** transported out of a county should be replaced with **one pound of inorganic PAN**.
- Phosphorus transport is tied to previous transport and manure/fertilizer availability e.g. :

Example Scenario	P Pounds transported	P Pounds removed
Base year (known fertilizer data)	500	
Year A	1000	-500
Year B	200	300

Crediting Manure Transport

Total Nitrogen

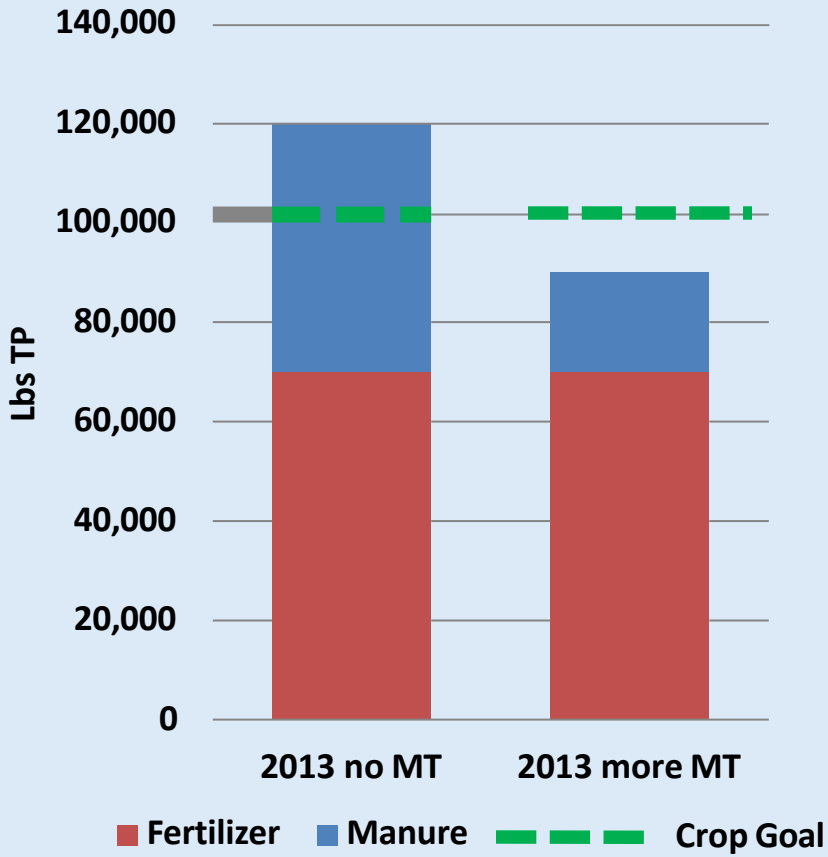


Manure decreases.

Fertilizer increases at a 0.6:1 ratio.

Total applications-to-crop goal decrease.

Total Phosphorus



Manure decreases.

Fertilizer remains constant.

Total applications-to-crop goal decrease.

Advantages of Manure Transport Methods

- Reflects more efficient use of N.
  - In 2012, every 1 lb of manure TN transported would be replaced with 0.6 lbs of inorganic TN (40% reduction in inputs, on average across watershed).
  - Value can vary by county and manure type being transported.
- Reflects likely current and future limits on use of P.
- Incentivizes manure transport for both nutrients and provides clear assumptions for trading credits if partners choose to use model's methodology.

Replacement; a concern:

- This method has NOT worked as intended.
  - Replacement of TN can potentially lead to high fertilizer application
- Leads to unexpected results
  - Fertilizer sensitivity to runoff is higher
    - Impacts loads negatively

Questions?

How can we improve? Let’s Discuss!

- What we have heard:
  - NM will not allow applications over 100% of crop need (application goal)
- Change replacement
  - Install limit (100%?)
- Keep in mind modeling scale
  - County NOT farm
  - Rare that an entire county has more nutrients from manure than its crops need
  - Need to think along these lines