

# Green manures for organic production: A Prairie-centric literature review with broad outcomes

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## What is a Green Manure?

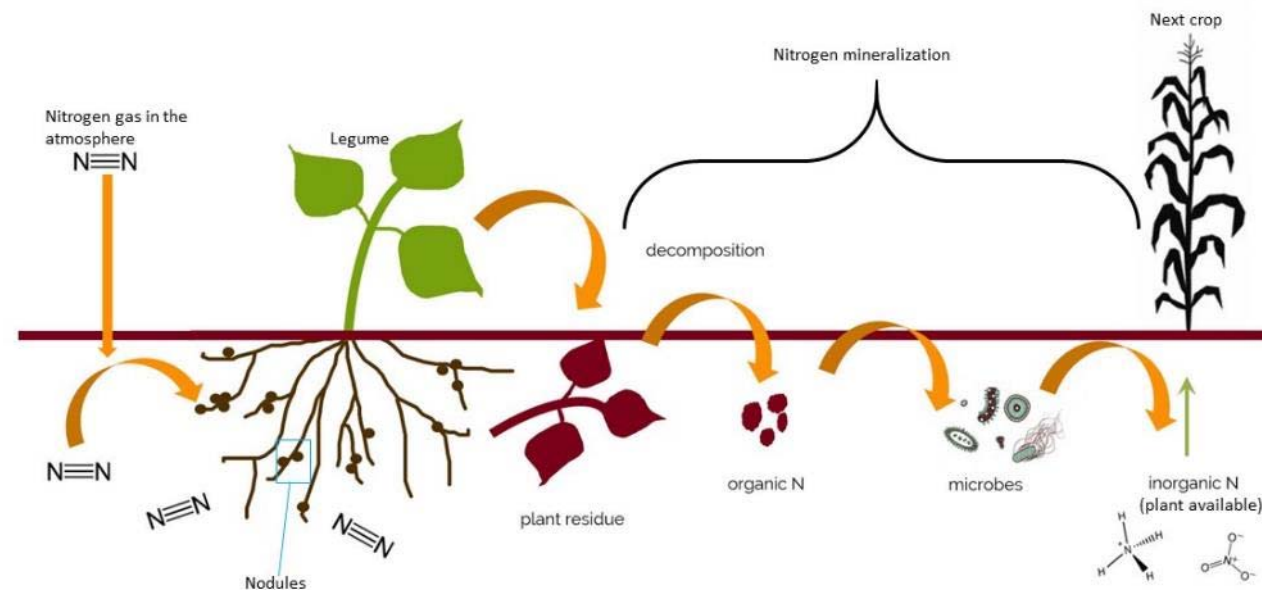
A crop that is planted to improve soil fertility, without intent to harvest a product

**Legumes**




# What is a Green Manure?

## And, Why are They Important?







“A lack of acceptance of green manuring in the organic farming community suggests that either the extension of these ideas is insufficient or that there remain difficulties in practical application... these become increasingly important when justifying the time, effort and costs of green manuring.”

- Enviro-Scan



# Barriers to Green Manure Uptake



Economic cost  
Soil moisture  
Weed pressure  
Seed cost, availability  
Inoculant availability  
Equipment needs

# Purpose of the Review



## prairie organic grain initiative

*To achieve resiliency and stability while growing the organic sector in the Prairies by focusing on both quantity and quality of organic grains and developing relationships across the value chain.*

### New Grower Stream

**Objective:**  
*Increased number of  
new organic producers*

With high organic prices for organic grains, there is a strong incentive for growers to convert to organics. But the pathway to becoming organic often seems daunting, and the transition period is seen as a significant risk that will take considerable effort. Through targeted marketing, a suite of resources and supports for transitioning producers, and a series of training events, this stream will increase the number of organic growers.

### Optimization Stream

**Objective:**  
*Improved management  
increases quantity and  
quality*

Organic grain production remains underdeveloped. While there has been some research and investment in organic infrastructure in the Prairies, there are still significant gaps. Through compiling the latest research on organics, creating resources, training producers on how to implement these practices, mobilizing the industry and helping to build organic infrastructure, this stream will improve organic field crop quantity and quality.

### Market Development Stream

**Objective:**  
*Increased markets for  
prairie organic grains*

A major barrier to profitable organic production is whole-farm business planning and marketing of organic products. The Prairie organic brand needs to be promoted in new as well as existing markets. Information sharing across the whole value-chain is also crucial for market development. Through data integration, networking and buyer missions abroad, this stream will ensure profitability for producers and processors while providing improved market access.



## Scope of the Review

- Research conducted over the last 35 years on the Canadian Prairies and adjacent US Northern Great Plains
- 56 Prairie-region studies were included in the review
- Included both organic and non-organic studies
- Coincided with surveys of informational needs



# Overarching Topics

## Regional variation

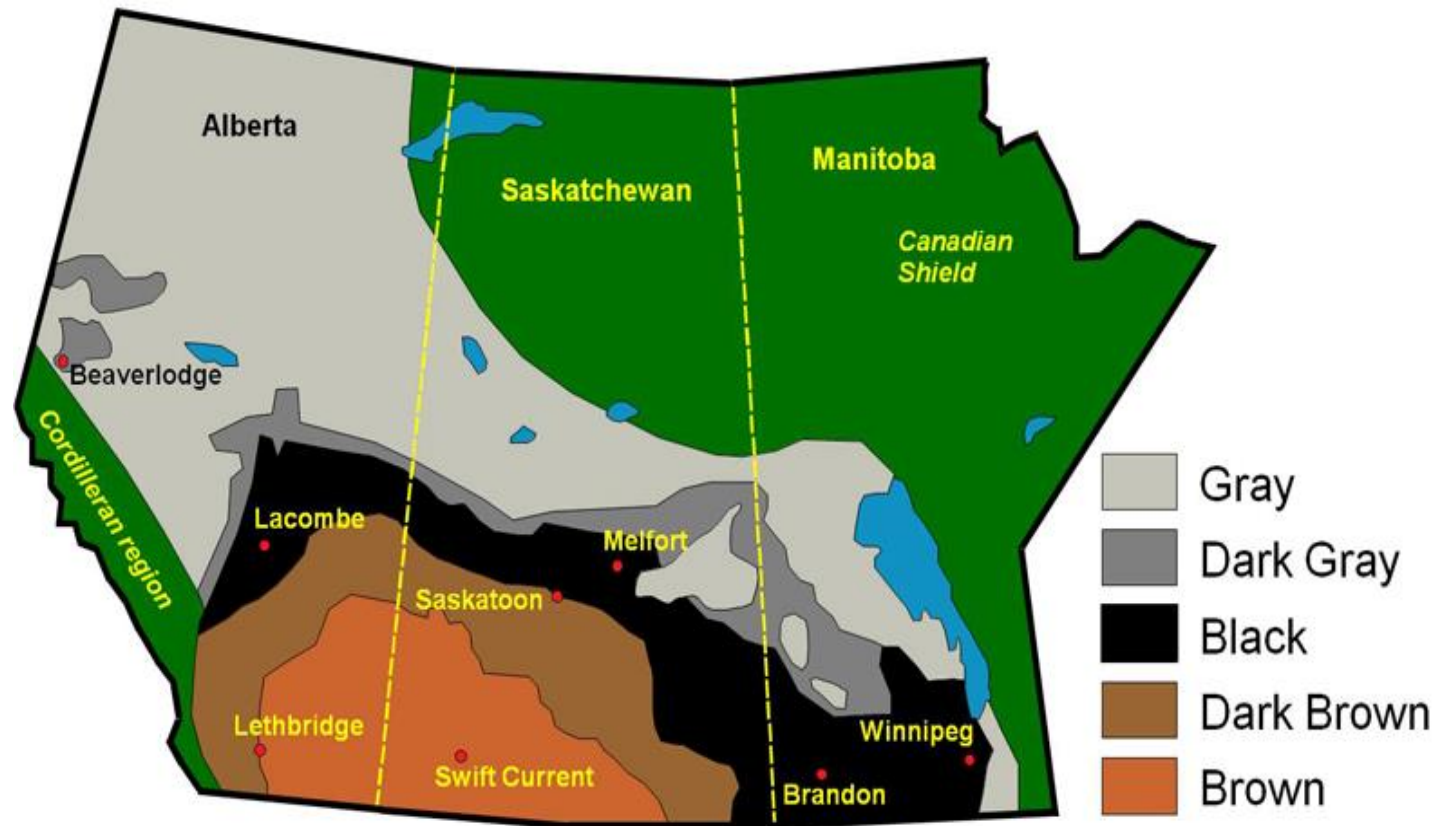
- Species/variety choice
- Tailored management

## Overcome barriers to uptake

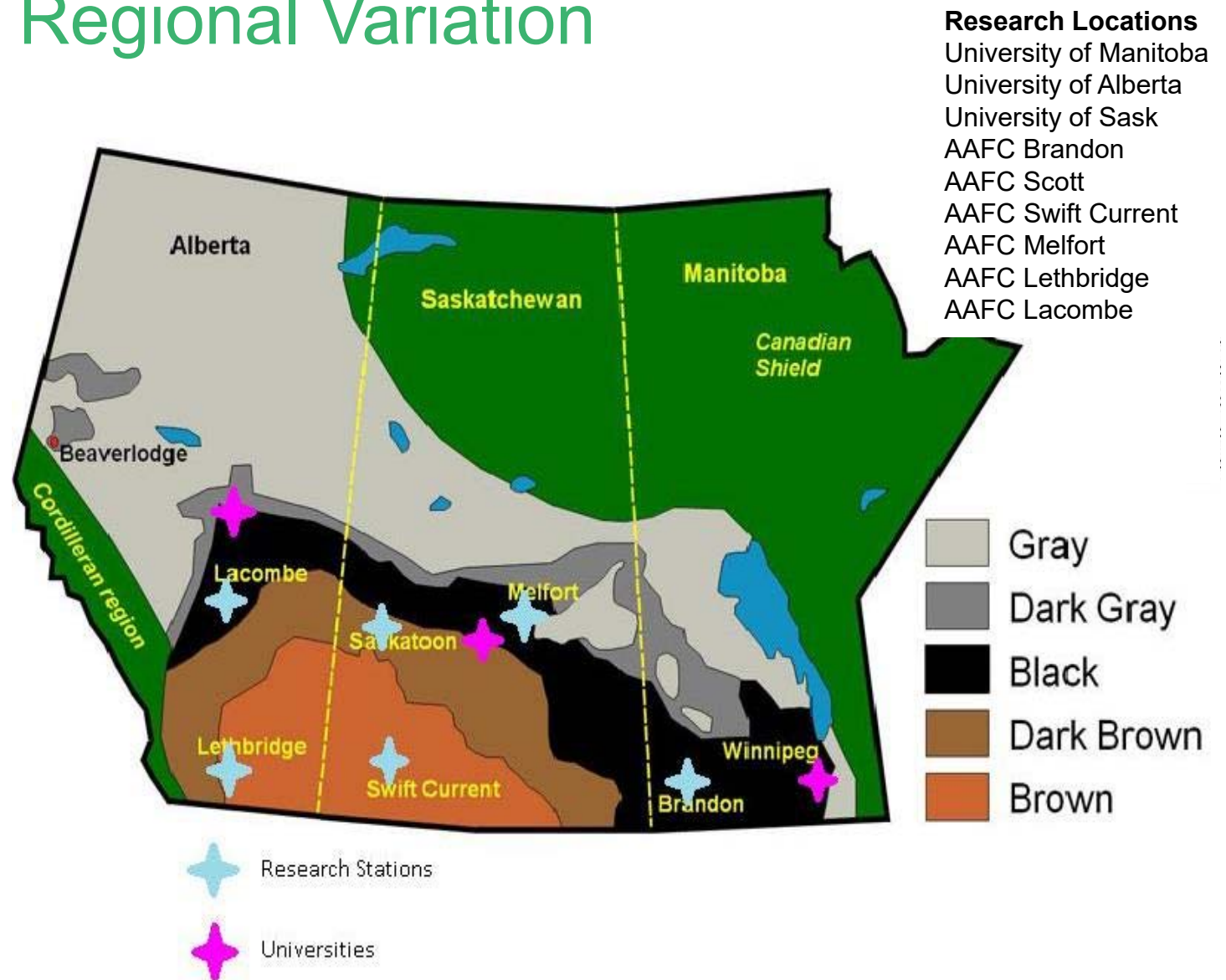
- Document benefits
- Provide management options



# Regional Variation



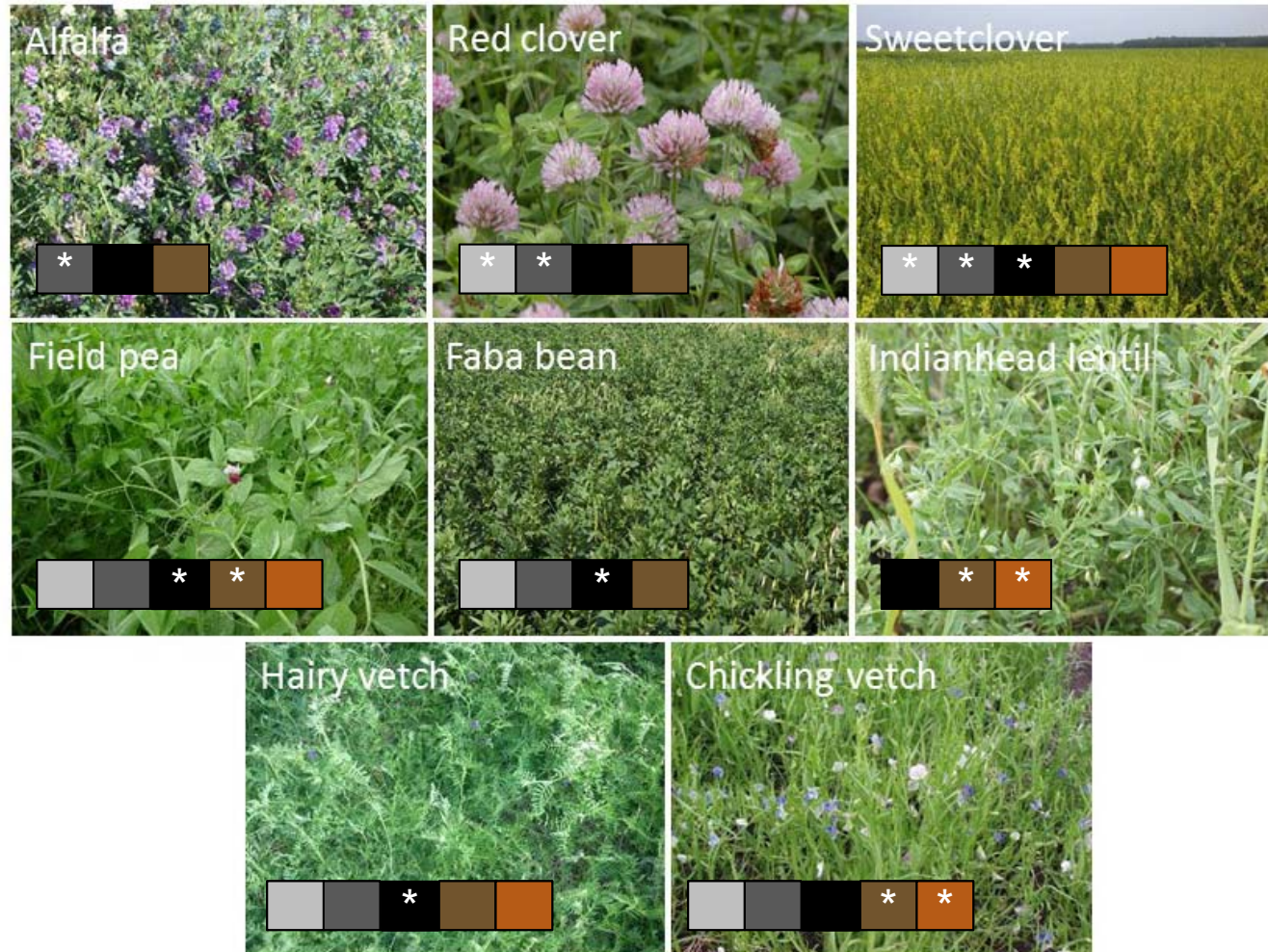
# Regional Variation





# Regional Variation: Species Choice

Badaruddin & Meyer 1989, 1990  
 Biederbeck et al. 2005, 1998,  
 1996, 1993  
 Biederbeck & Bouman 1994  
 Blackshaw et al. 2001, 2010  
 Bowren et al. 1969  
 Brandt 1996  
 Bullied et al. 2002  
 Campbell et al. 1991, 1993  
 Cicek et al. 2014, 2015  
 Foster 1990  
 Halde & Entz 2014  
 Halde et al. 2014  
 Hoyt & Leitch 1983  
 Kelner & Vessey 1995  
 Kröbel et al. 2014  
 Lawley & Shirliffe 2004  
 McCartney & Fraser 2010  
 Miller et al. 2011  
 Moyer et al. 2007  
 O'Donovan et al. 2014  
 Rice et al. 1993  
 Rick et al. 2011  
 Shirliffe & Johnson 2012  
 Thiessen Martens et al. 2005  
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 Vaisman et al. 2014  
 Zentner et al. 1996, 2004





# Overarching Topics

## Regional variation




- Species/variety choice
- Tailored management

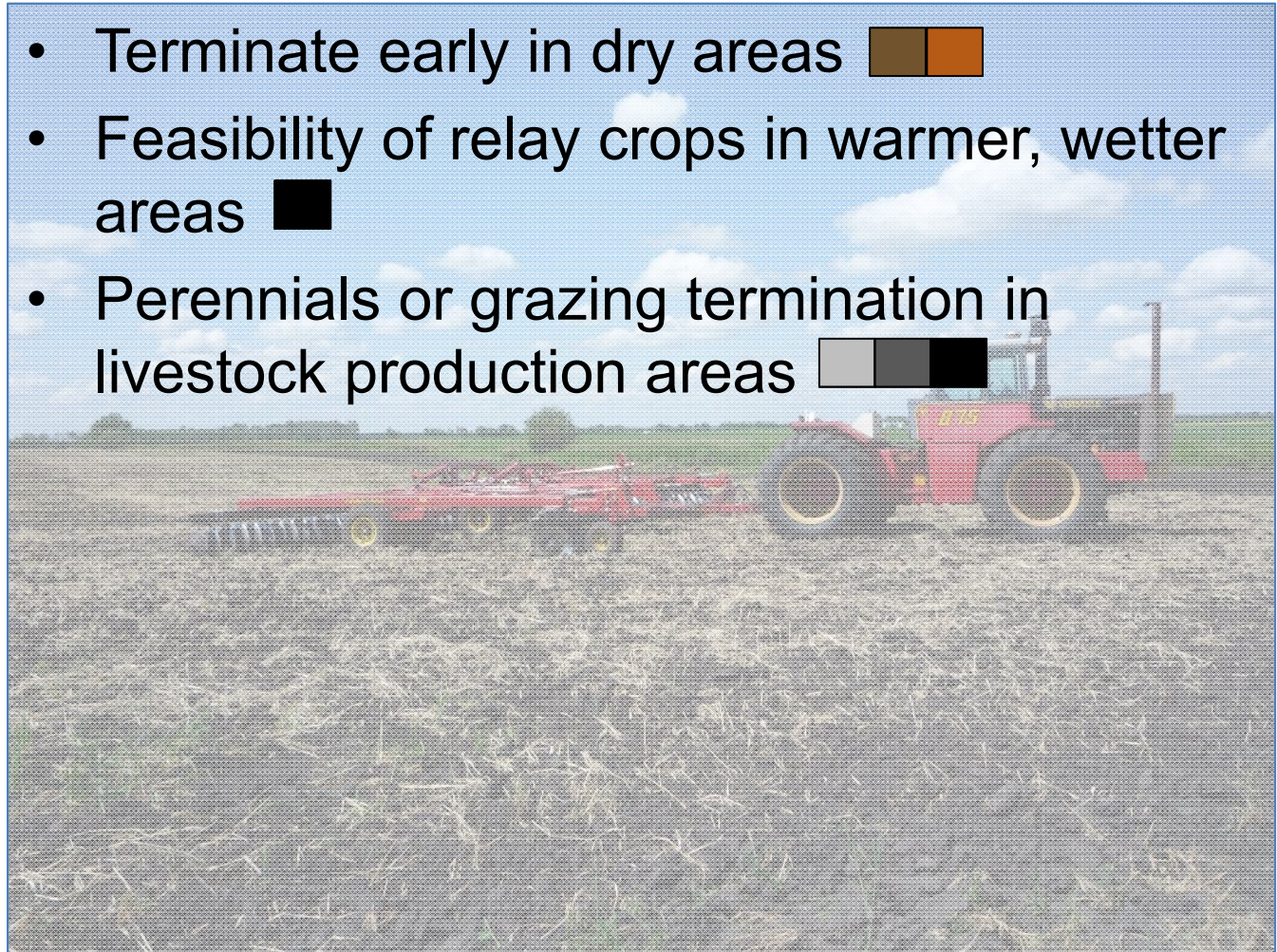
## Overcome barriers to uptake

- Document benefits
- Provide management options



# Regional Variation – Management

- Terminate early in dry areas 
- Feasibility of relay crops in warmer, wetter areas 
- Perennials or grazing termination in livestock production areas 



Foster 1990  
Miller et al. 2011  
Pikul et al. 1997  
Thiessen Martens et al. 2001  
Woodley et al. 2014  
Zentner et al. 1996, 2004



# Overarching Topics

## Regional variation

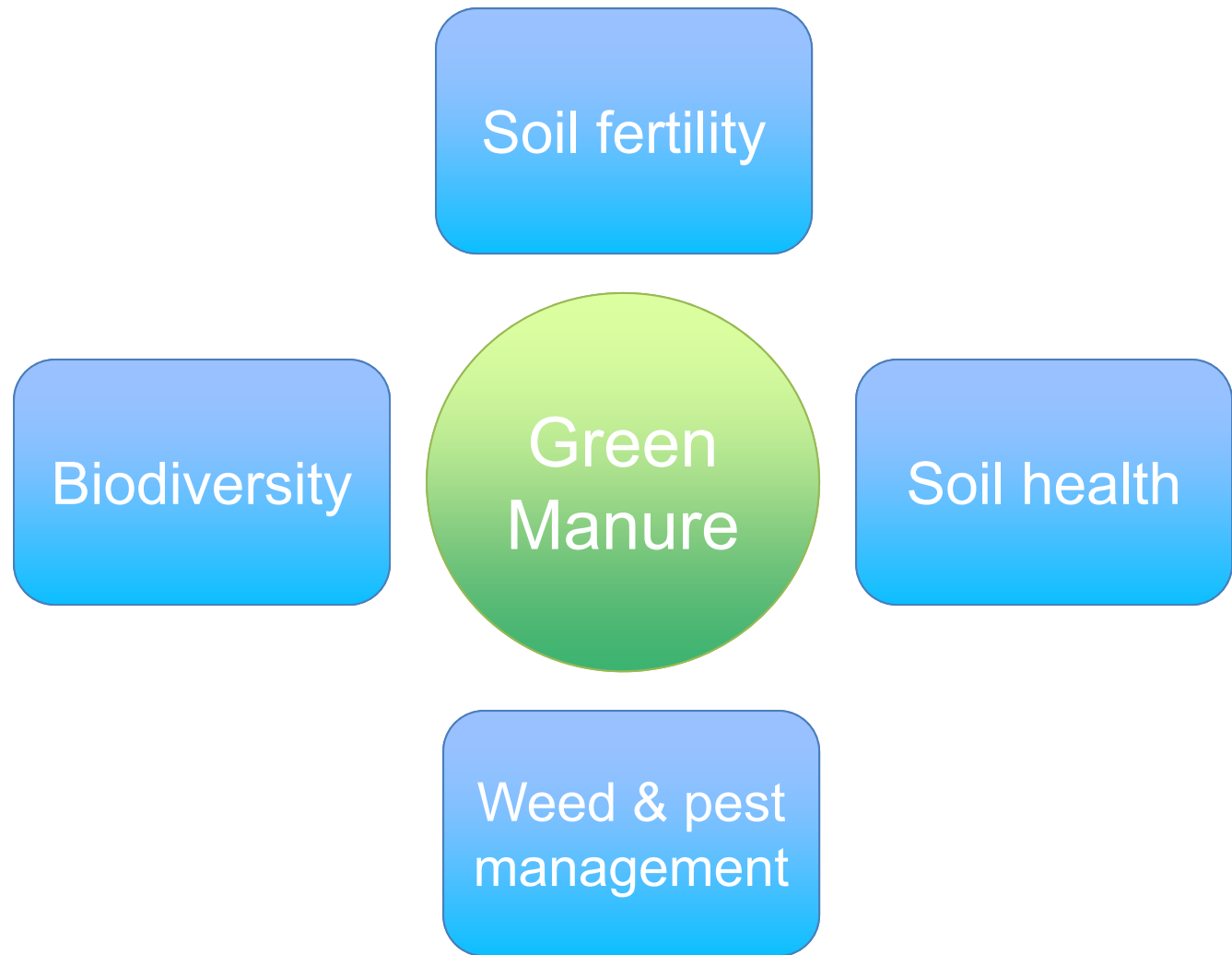
- Species/variety choice
- Tailored management

## Overcome barriers to uptake

- Document benefits
- Provide management options



# Green Manure Benefits



# Green Manure Benefits: Soil Fertility



Soil fertility

Biomass  
Species variation  
Management

Biodiversity

Green  
Manure

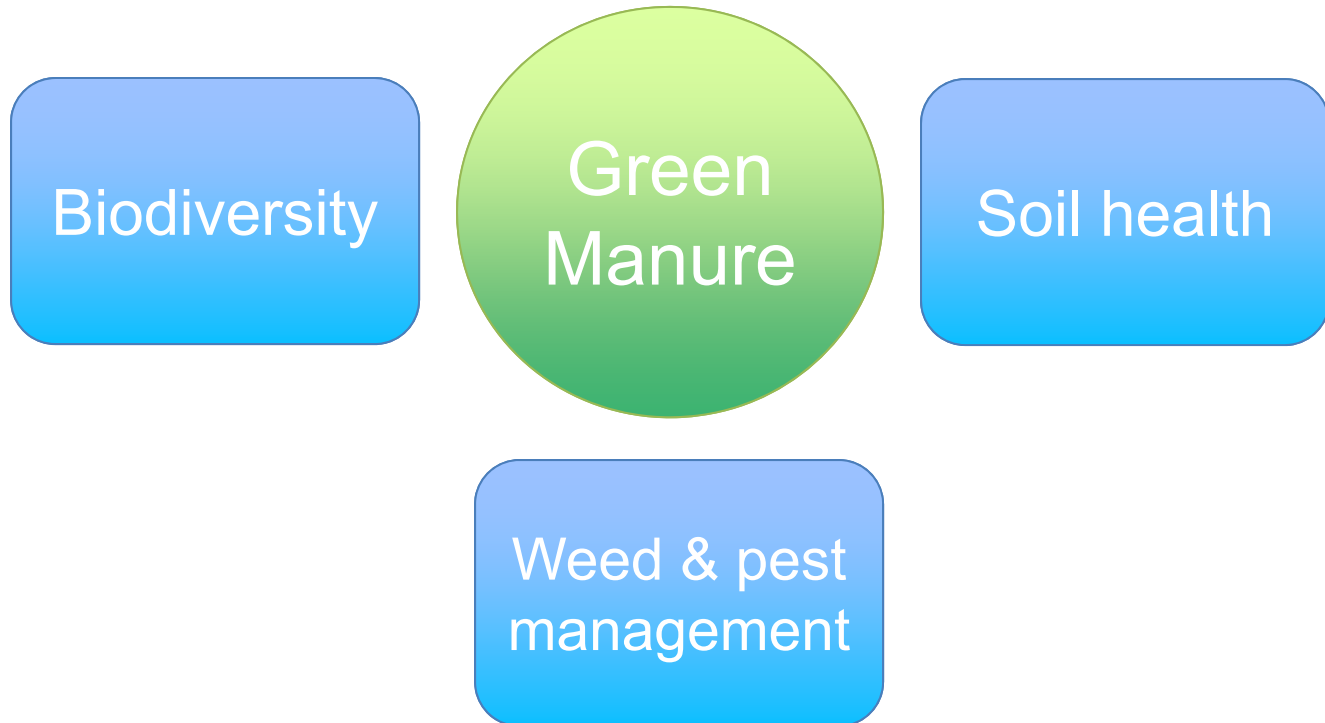
Soil health

Weed & pest  
management

Baddarudin & Meyer 1989, 1990  
Biederbeck et al. 1993, 1996  
Biederbeck et al. 1996  
Blackshaw et al. 2001, 2010  
Bowren et al. 1969  
Brandt 1996  
Bullied et al. 2002  
Campbell et al. 1991, 1993, 2006  
Cicek et al. 2014, 2015  
Foster 1990  
Halde et al. 2014  
Hoyt & Leitch 1983  
Kelner & Vessey 1995  
Kröbel et al., 2014  
McCartney & Fraser 2010  
Miller et al. 2008, 2011  
Moyer et al. 2007  
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Rice et al. 1993  
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Zentner et al. 1996, 2004, 2006



# Green Manure Benefits: Soil Fertility



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Rice et al. 1993  
Rick et al. 2011  
Shirliffe & Johnson 2012  
Thiessen Martens et al. 2001  
Woodley et al. 2010  
Zentner et al. 1996, 2004, 2006

# Green Manure Benefits: Soil Health



Biodiversity

Green  
Manure



Weed & pest  
management

Soil biology  
Active organic matter  
Soil resilience

Biederbeck et al. 1998, 2005  
Biederbeck et al., 1998  
Lupwayi et al., 1998  
Lynch, 2014  
Mahli et al. 2009  
Miller et al, 2008



# Green Manure Benefits: Weeds/Pests

Biederbeck et al. 1993  
Biederbeck & Bouman 1994  
Blackshaw et al. 2010  
Cicek et al. 2014, 2015  
Halde et al. 2014  
Lawley & Shirliffe 2004  
Miller et al. 2011  
Moyer et al. 2007  
Shirliffe & Johnson 2012  
Vaisman et al. 2014

Biodiversity

Green  
Manure

Disrupt cycles  
Allelopathy  
Competitiveness

Weed & pest  
management

Soil fertility

Soil health

# Green Manure Benefits: Biodiversity



Support of beneficials  
Diversification of rotations





# Overarching Topics

## Regional variation

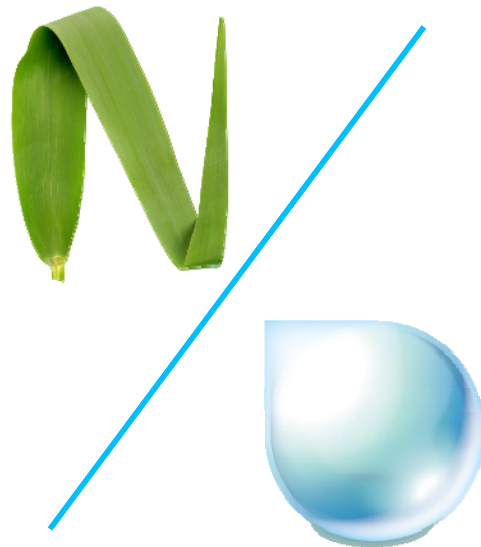
- Species/variety choice
- Tailored management

## Overcome barriers to uptake

- Document benefits
- Provide management options

# Green Manure Management

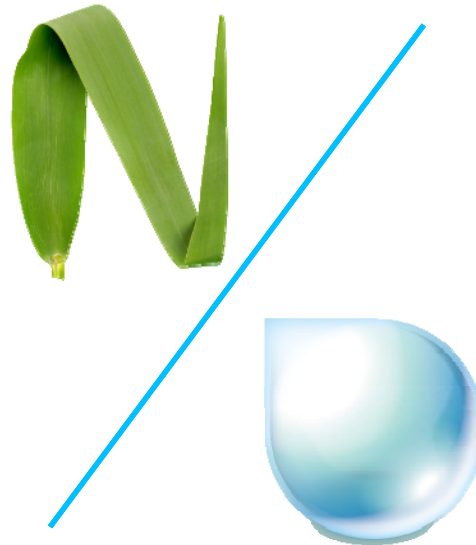
- Often a balance between nitrogen supply and moisture conservation





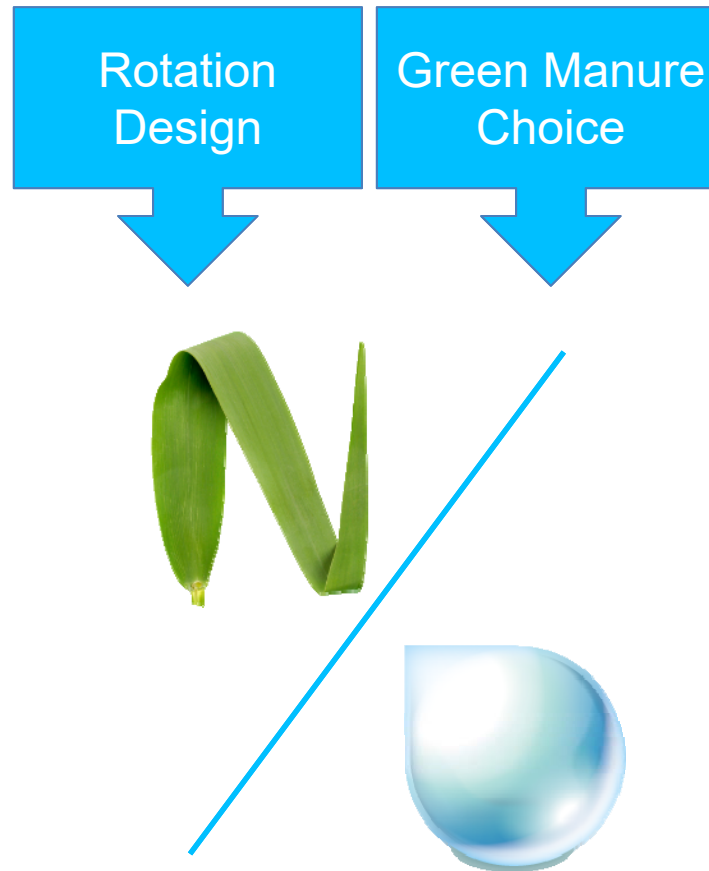
# Green Manure Management

Rotation  
Design



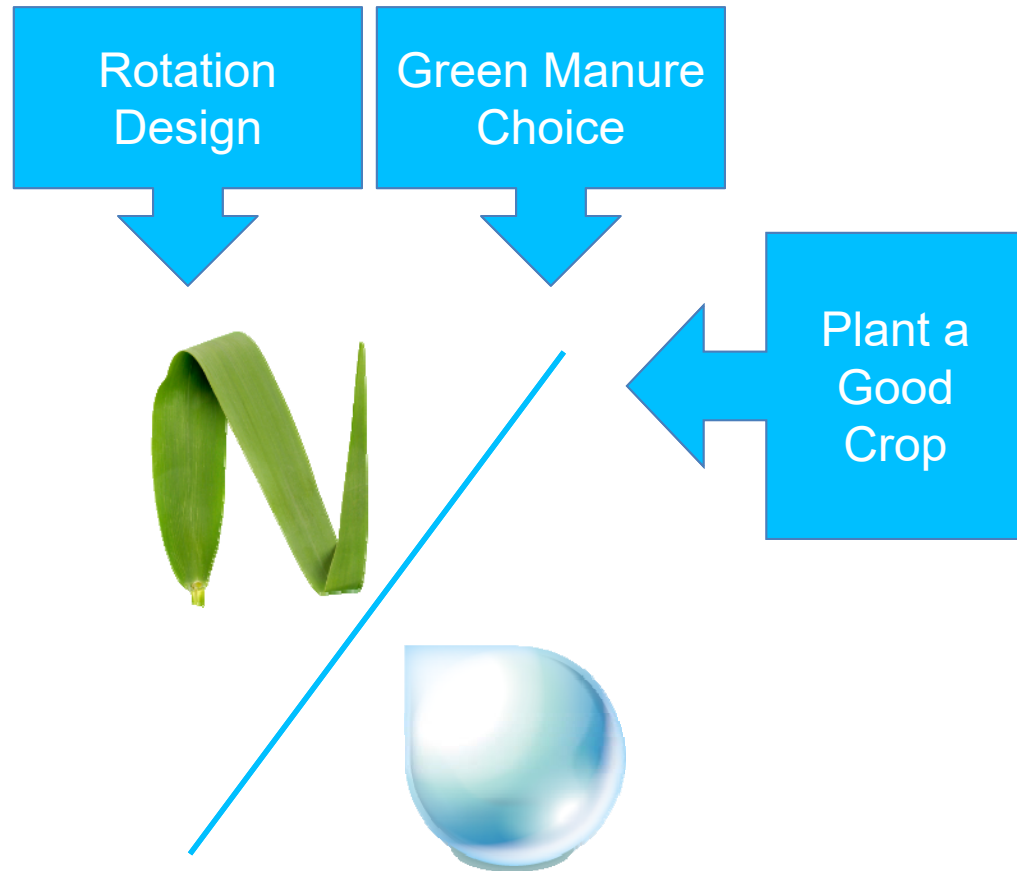
Blackshaw et al. 2010  
Campbell et al. 1991  
Carr et al. 2013  
Cicek et al. 2014, 2015  
Entz et al. 2002  
Halde & Entz 2014  
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2011  
Thiessen Martens et al. 2001,  
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Vaisman et al. 2011, 2014

# Green Manure Management



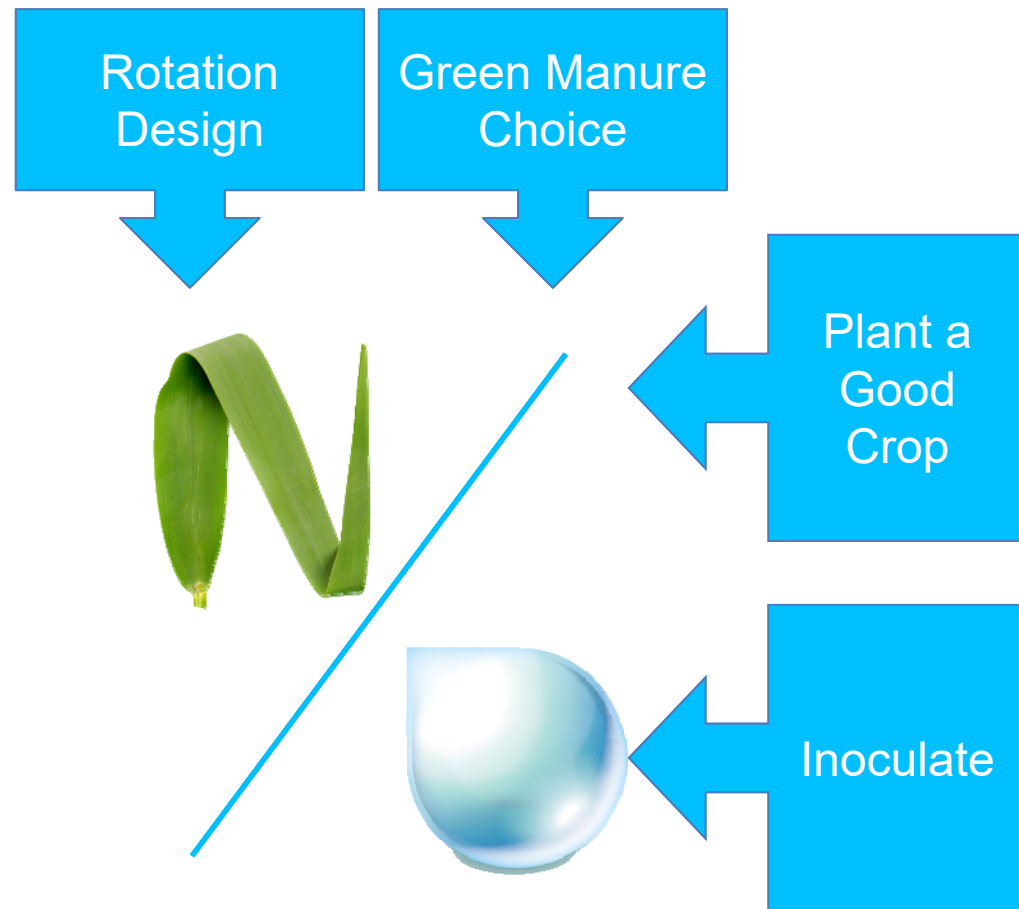


# Green Manure Management



Lawley and Shirliffe 2004

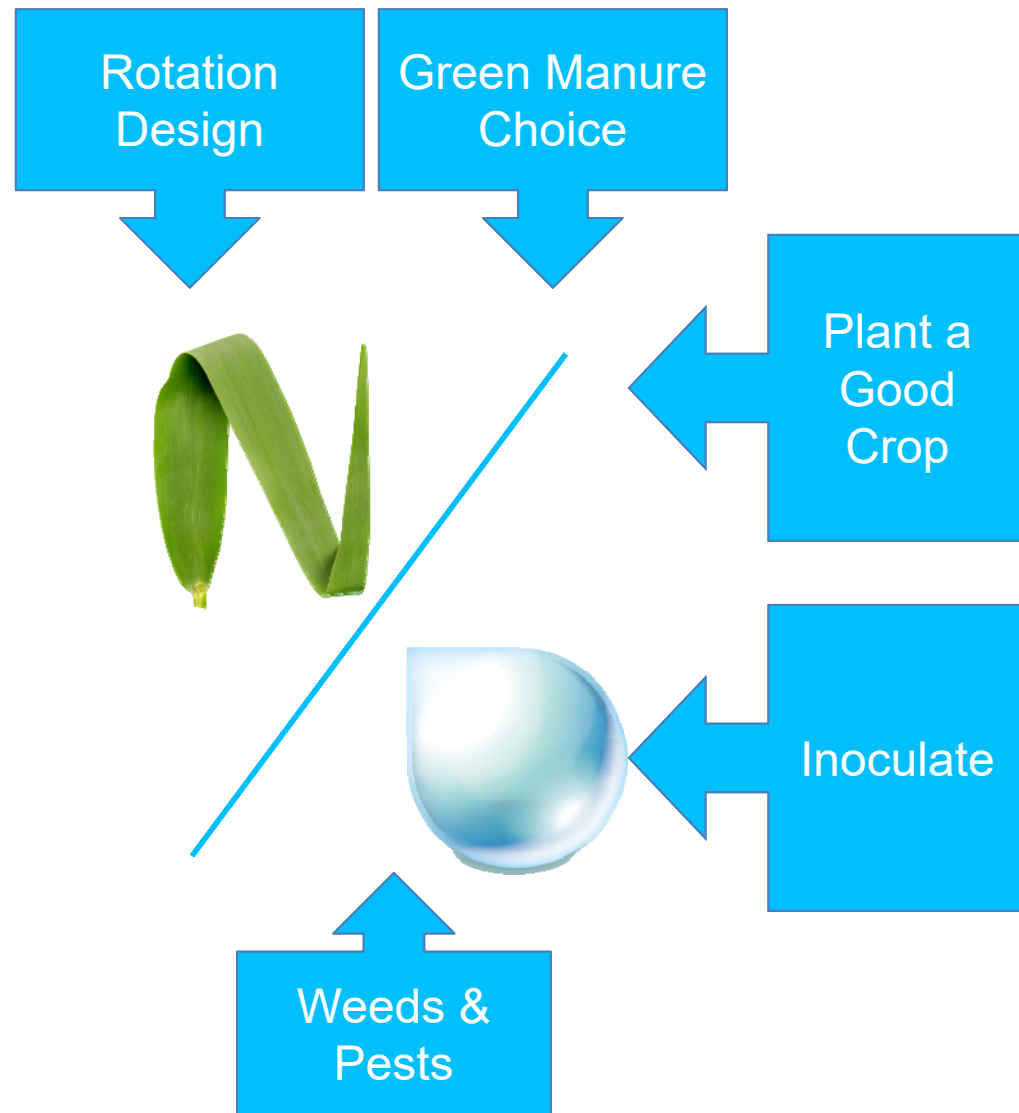
# Green Manure Management



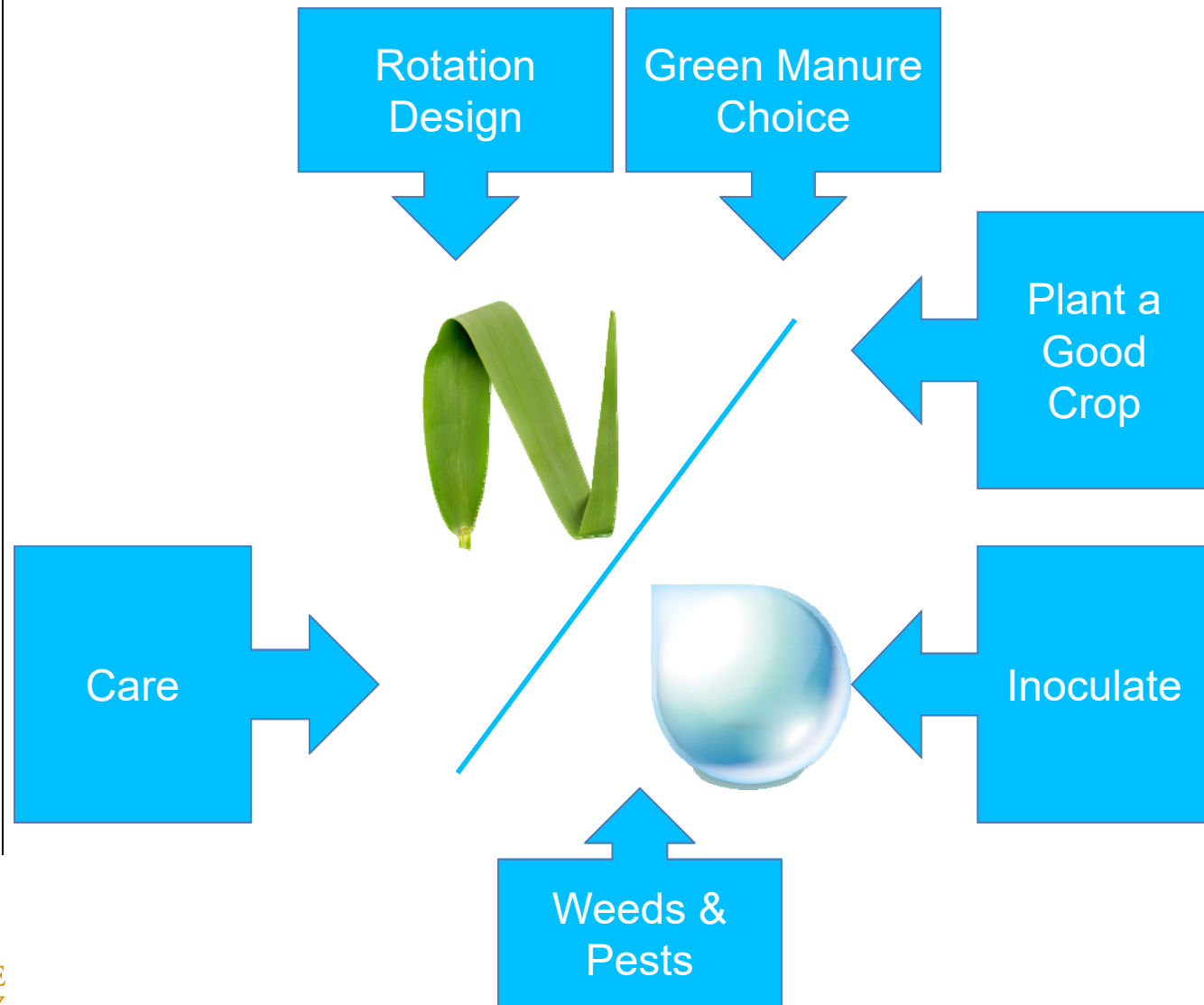
Biederbeck et al. 1993



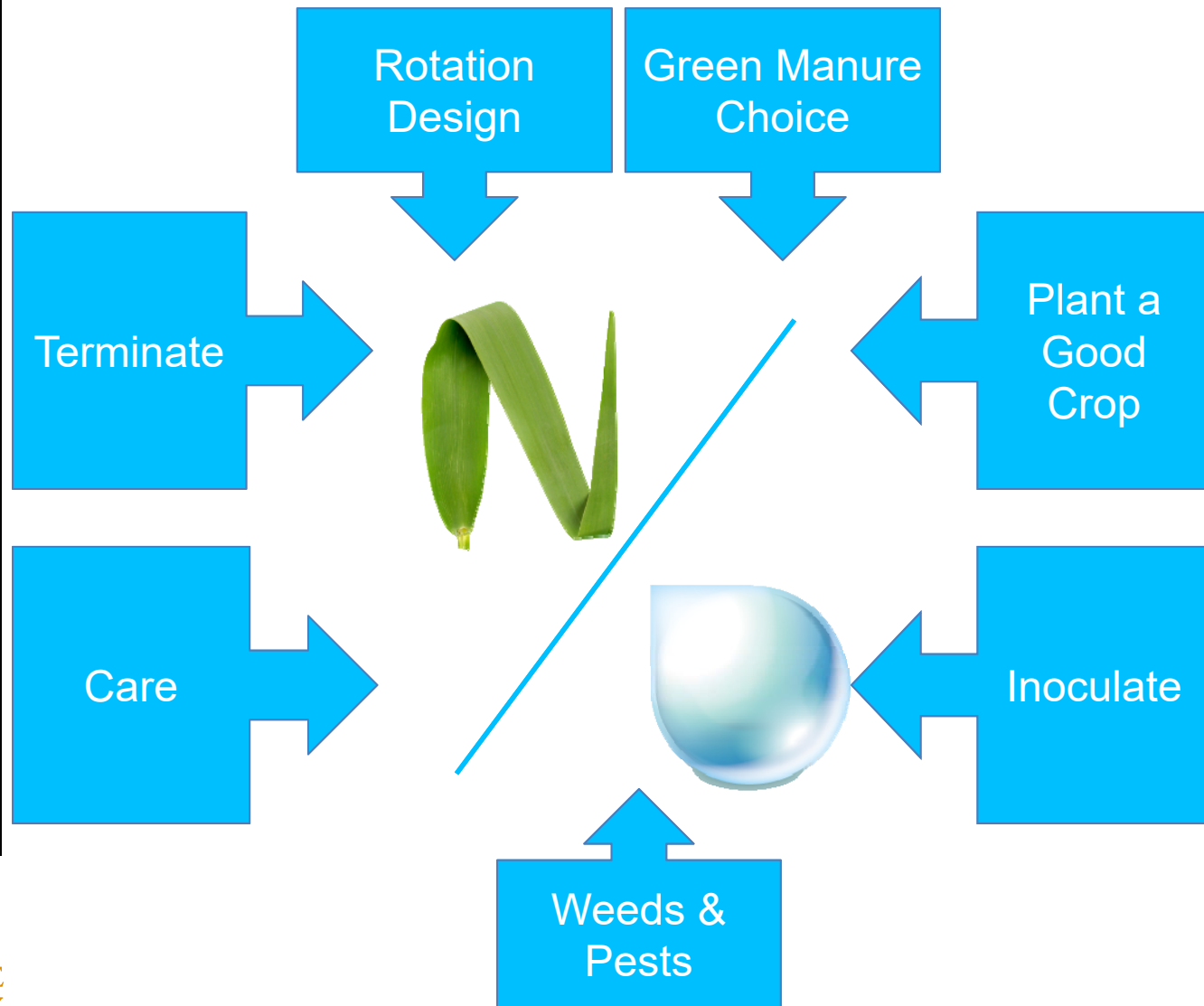
# Green Manure Management



# Green Manure Management



# Green Manure Management



Blackshaw et al. 2010  
Carr et al. 2013  
Cicek et al. 2014, 2015  
Foster 1990  
Halde et al. 2014  
Halde & Entz 2014  
Shirliffe & Johnson 2012  
Thiessen Martens & Entz 2011  
Vaisman et al. 2011, 2014



## Summing it Up

- Nitrogen supplying ability often reflects biomass production
  - Species selection
  - Management
- Consider other factors, whole system
  - Moisture availability for the Prairies
- Importance of getting the information into the hands of farmers



Thank you



Prairie Organic Grain Initiative  
Derek Lynch



# Questions?





# Regional Variation: Species Choice

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## SUITABILITY OF COMMONLY USED GREEN MANURE LEGUMES TO THE MAIN PRAIRIE SOIL ZONES (PDF DOWNLOAD)

Suitability of commonly used green manure legumes to the main Prairie soil zones.

	Brown	Dark Brown	Black	Dark Gray	Gray
<b>Alfalfa</b>	Not recommended High water use	Ok Adapt management to reduce water use	Ok	Best suited	Not recommended Low tolerance of excessive soil moisture or flooding
<b>Red clover</b>	Not recommended High water use	Ok Adapt management to reduce water use	Ok	Best suited Tolerant of high moisture, but may be a short-lived perennial in cold regions	Best suited Tolerant of high moisture, but may be a short-lived perennial in cold regions
<b>Sweetclover</b>	Ok Adapt management to reduce water use	Ok Adapt management to reduce water use	Best suited	Best suited	Best suited
<b>Indianhead lentil</b>	Best suited Adapt management to reduce water use	Best suited	Ok	Not recommended Does not perform well under higher moisture conditions	Not recommended Does not perform well under higher moisture conditions
<b>Field pea</b>	Ok Adapt management to reduce water use and expect lower biomass	Best suited Performs well, but high seed cost	Best suited Performs well, but high seed cost	Ok Performs well, but higher seed cost than some other options	Ok Performs well, but higher seed cost than some other options
<b>Faba bean</b>	Not recommended Requires high moisture availability	Ok Requires high moisture availability, so may not be suited to all regions	Best suited Some indications that faba bean fixes nitrogen even under high soil fertility, but high seed cost	Ok Sufficient moisture, but high seed cost	Ok Sufficient moisture, but high seed cost
<b>Chickling vetch</b>	Best suited Low water use	Best suited Low water use	Ok	Ok	Ok
<b>Hairy vetch</b>	Ok Be cautious of soil water use and high seed cost	Ok Be cautious of soil water use and high seed cost	Best suited Abundant biomass and nitrogen, but high seed cost	Ok Likely not winter hardy in more northern regions, but can be spring-seeded	Ok Likely not winter hardy in more northern regions, but can be spring-seeded

This table provides information based on typical climate and moisture conditions in the five Prairie soil zones. In atypical years, refer to the recommendations for zones with typical conditions closest to what you are experiencing. For instance, in droughty years in the Black or Gray soil zones, refer to recommendations for the Brown or Dark Brown soil zones.