Building Soil Fertility with GMCCs

Much of this content drawn from "A proven alternative to shifting agriculture: worldwide experience with green manure/cover crops" (Roland Bunch)

Stacy Swartz

What are Green Manures? Cover crops?

What are Green Manures? Cover crops?

"A species of plant, often but not always leguminous, whether a tree, bush, vine or crawling plant, which is used by a farmer for one or several purposes, at least one of which is that of maintaining or **improving soil fertility** or **controlling weeds**."
Roland Bunch

- Green manures are those used for the primary purpose of improving soil fertility
- Cover crops are those crops used for the primary purpose of controlling weeds

Mucuna puriens

Velvet bean

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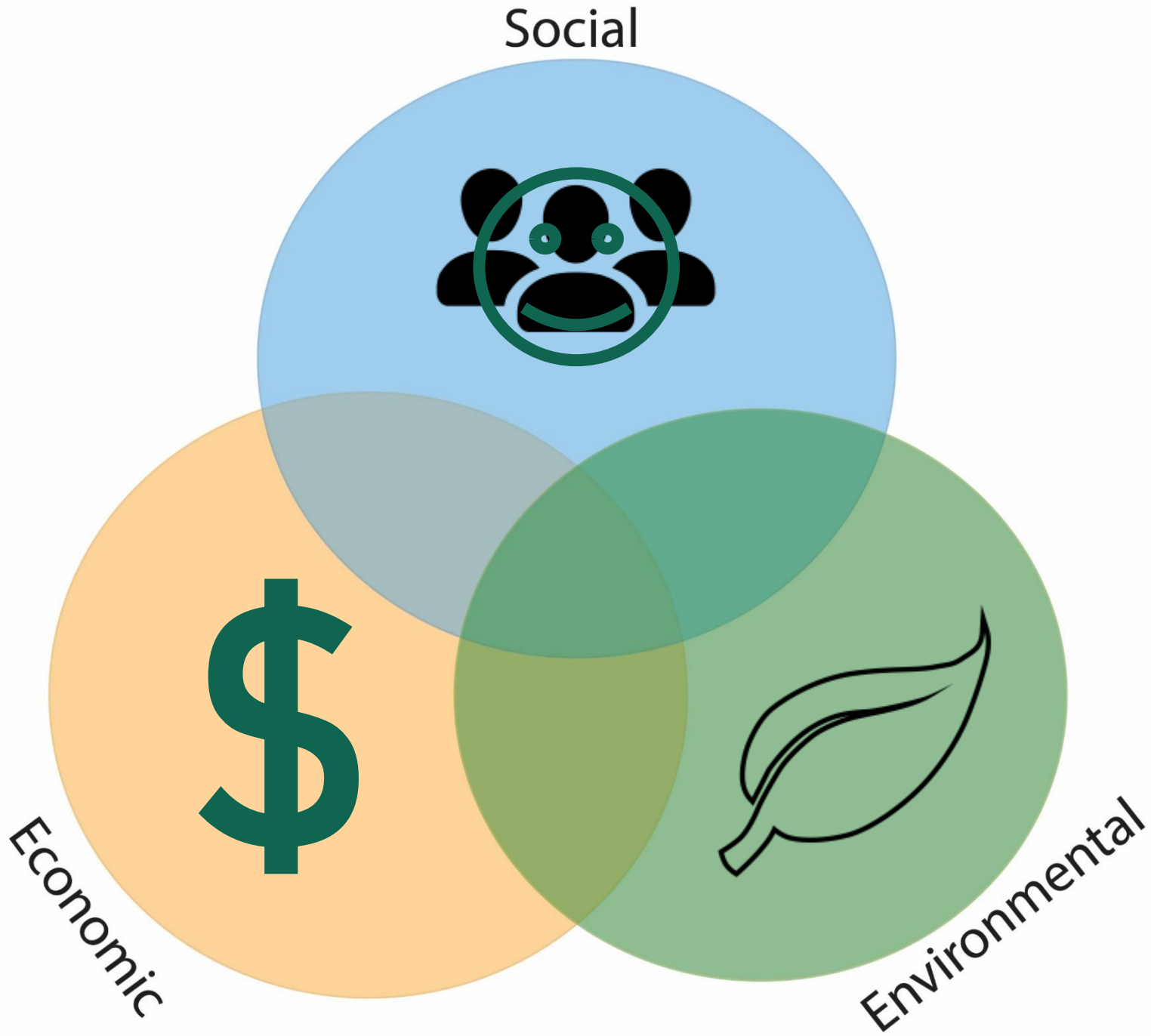
Community Gathering

Soil advocate

Farmer advocate

Concerned advocate – No GMCCs



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Vigna unguiculata

Cowpea/niebe

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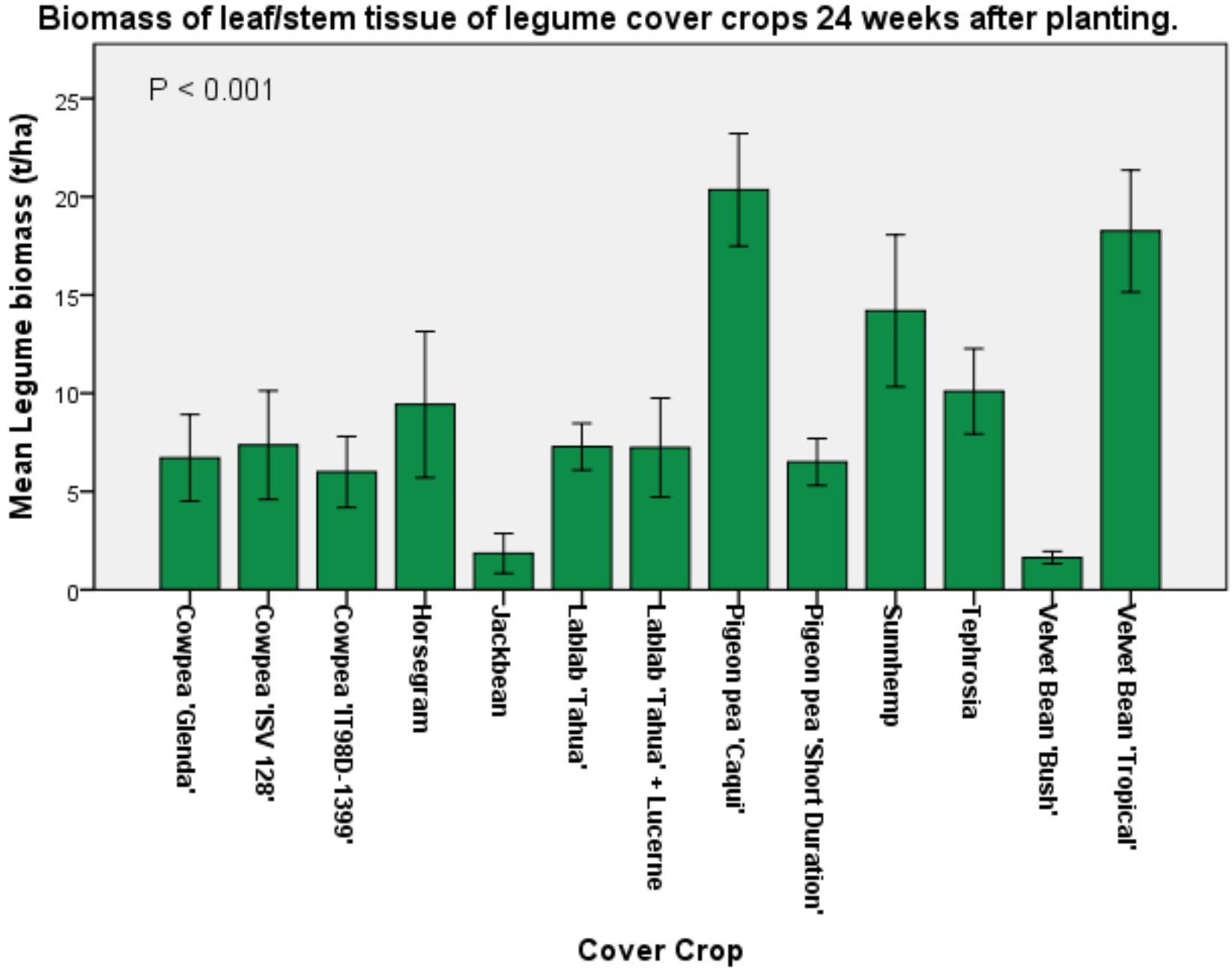

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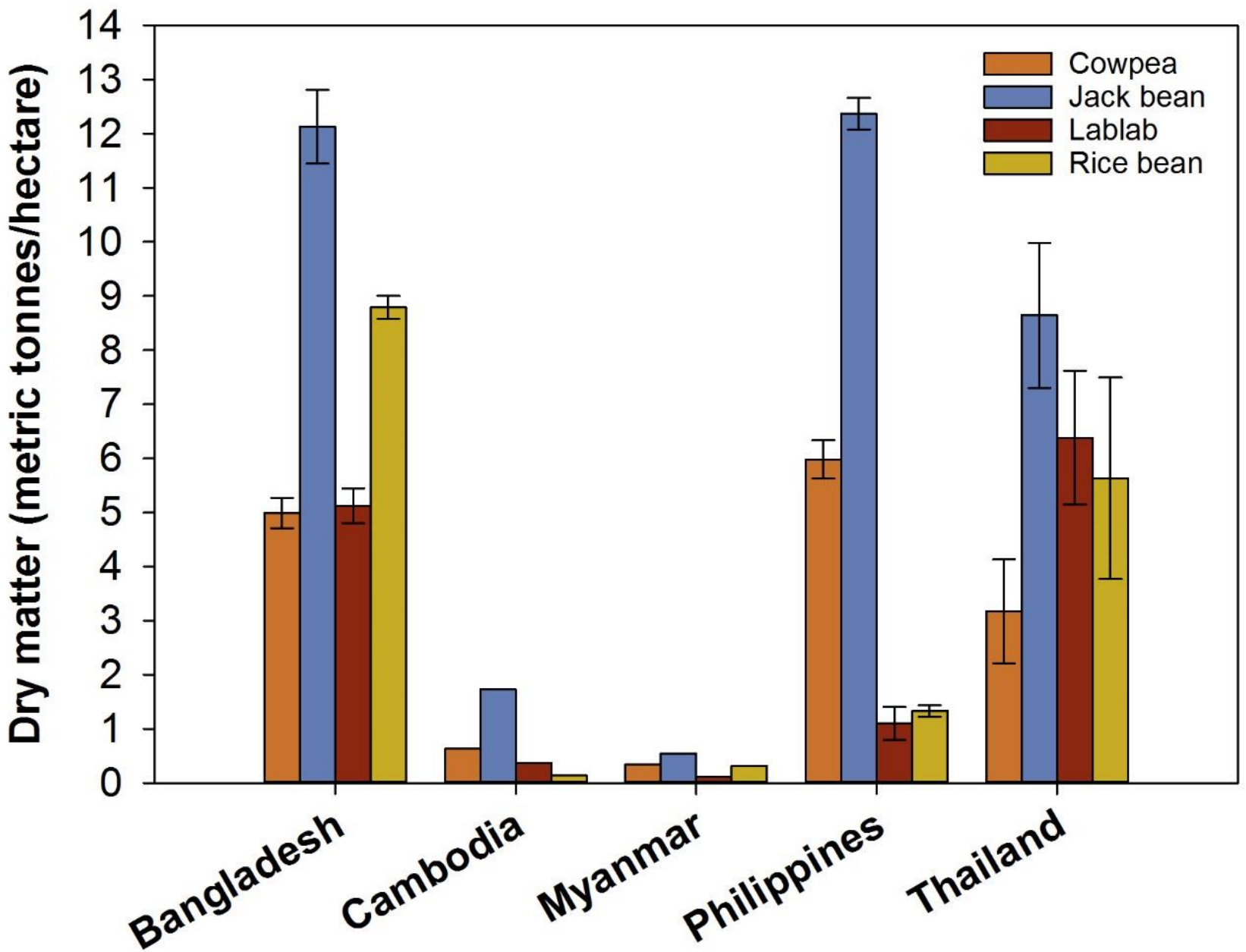
Dry matter (metric tonnes/hectare)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Cowpea
Jack bean
Lablab
Rice bean
Bangladesh
Cambodia
Myanmar
Philippines
Thailand

Lablab purpureus

Hyacinth bean

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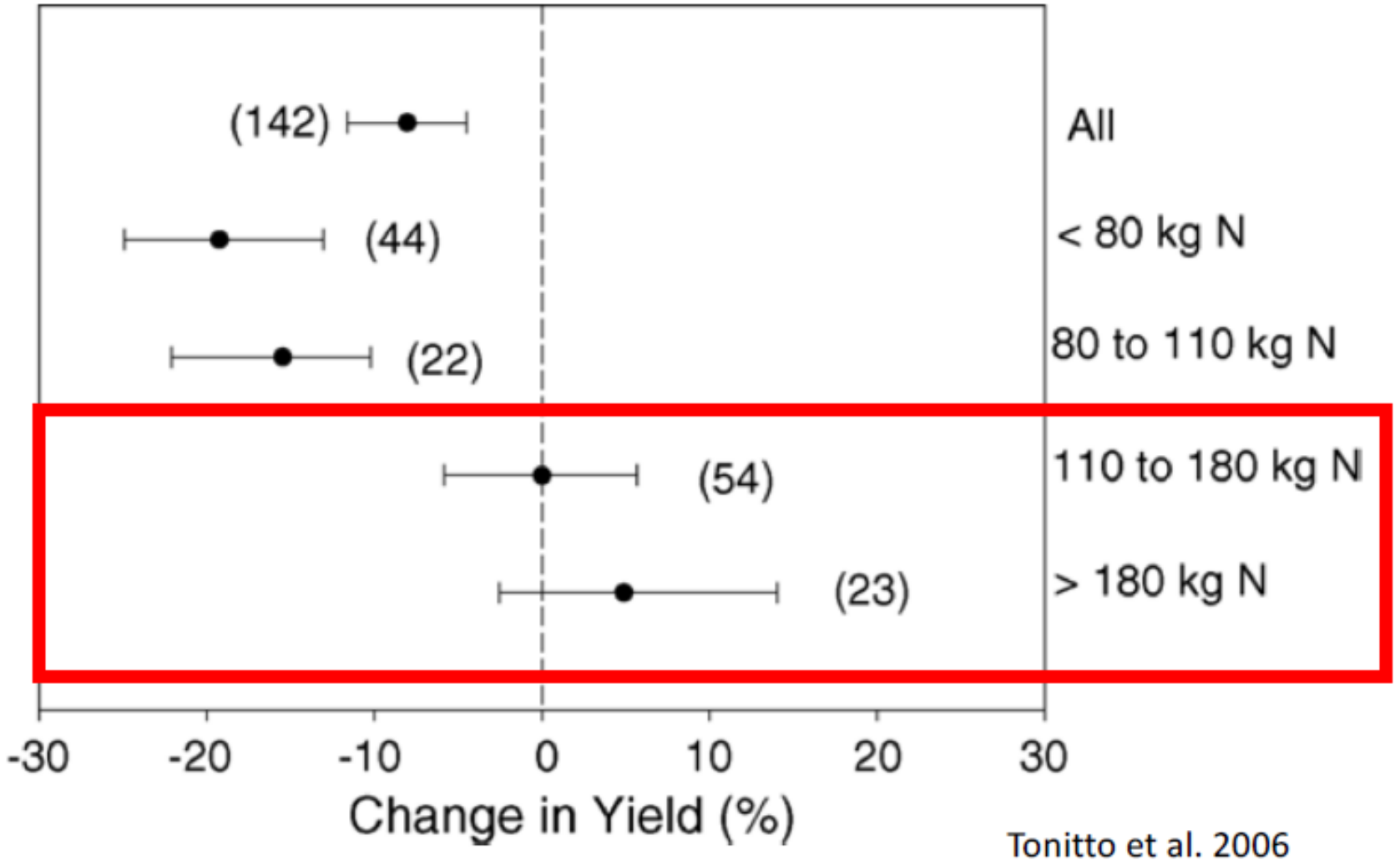
How much N fixation do you need for a yield benefit?

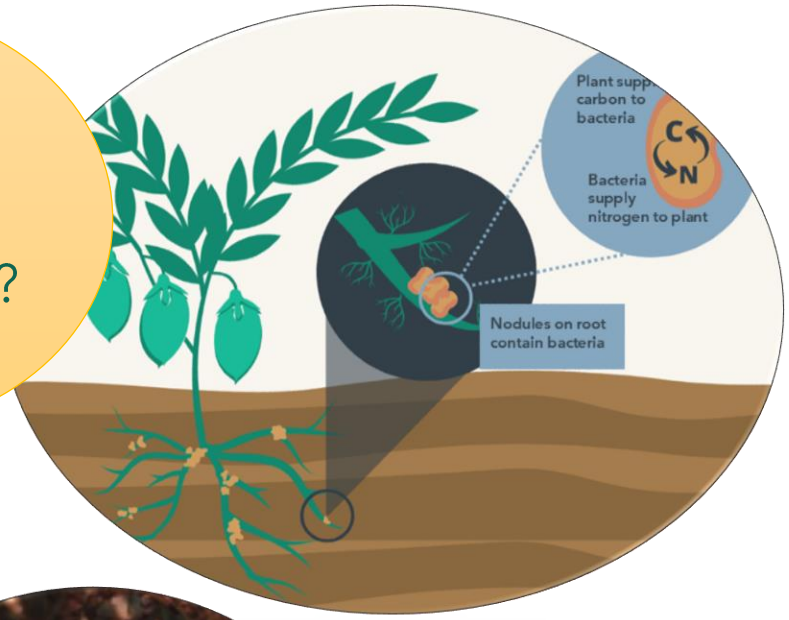
Comparable yields if cover crop N uptake is > 110 kg N ha^{-1}



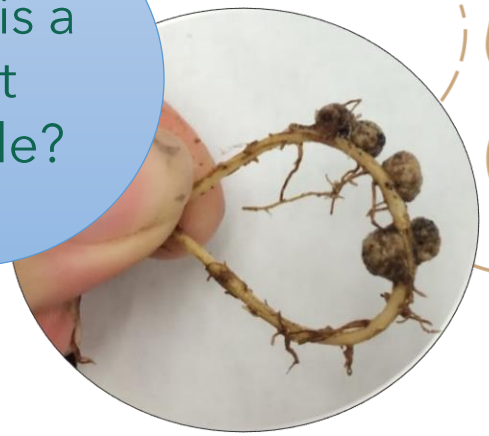
Tonitto et al. 2006

Root Nodules

What is a symbiotic relationship?

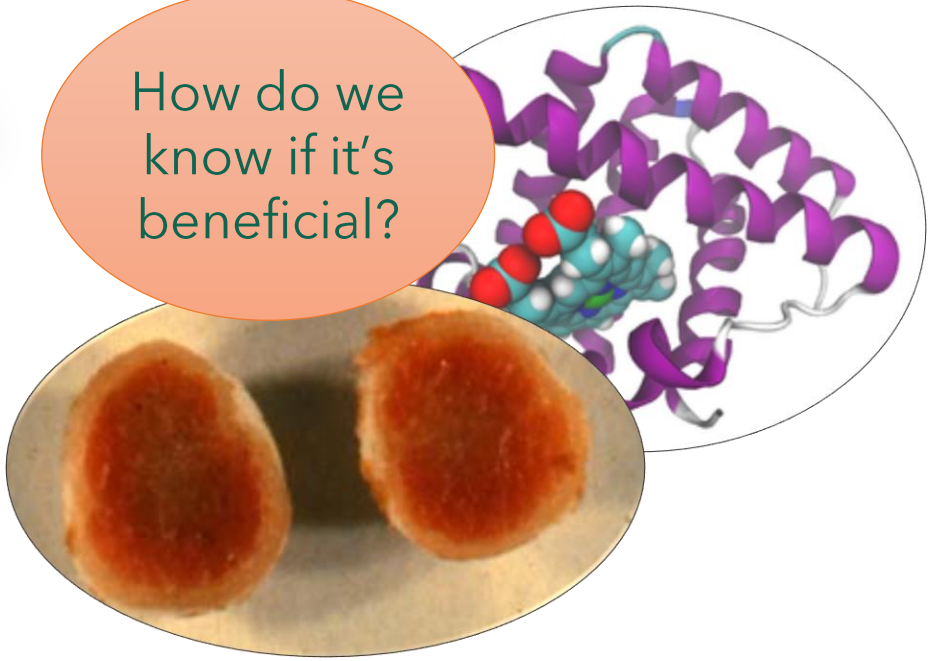


What is a root nodule?



What's the difference between a nodule and galling?

How do we know if it's beneficial?



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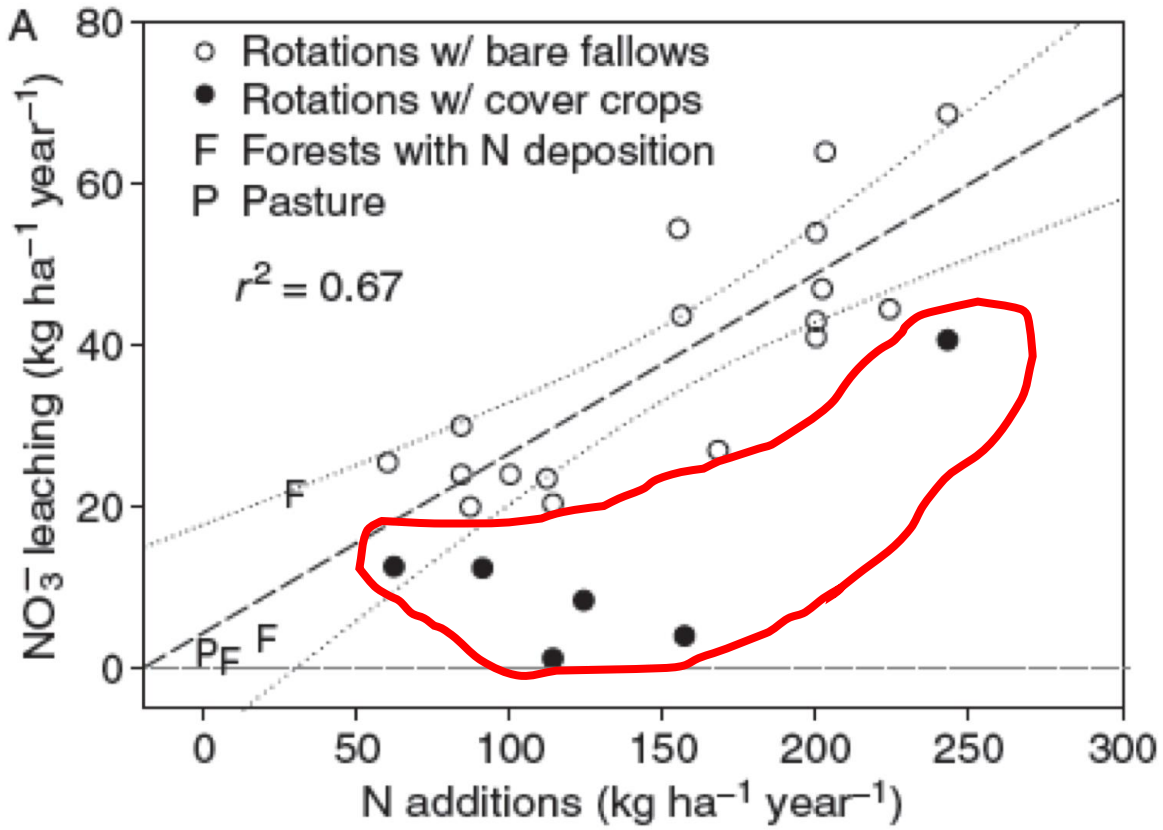
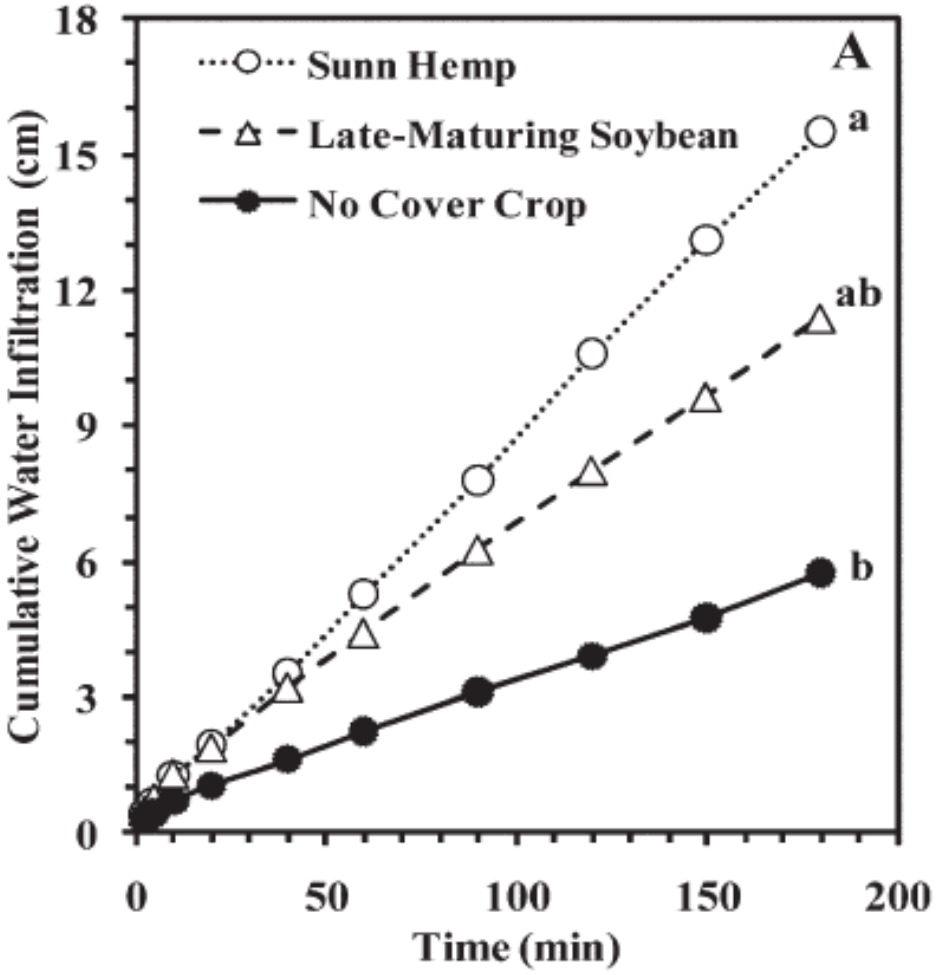
Do GMCCs really…

reduce nitrate leaching



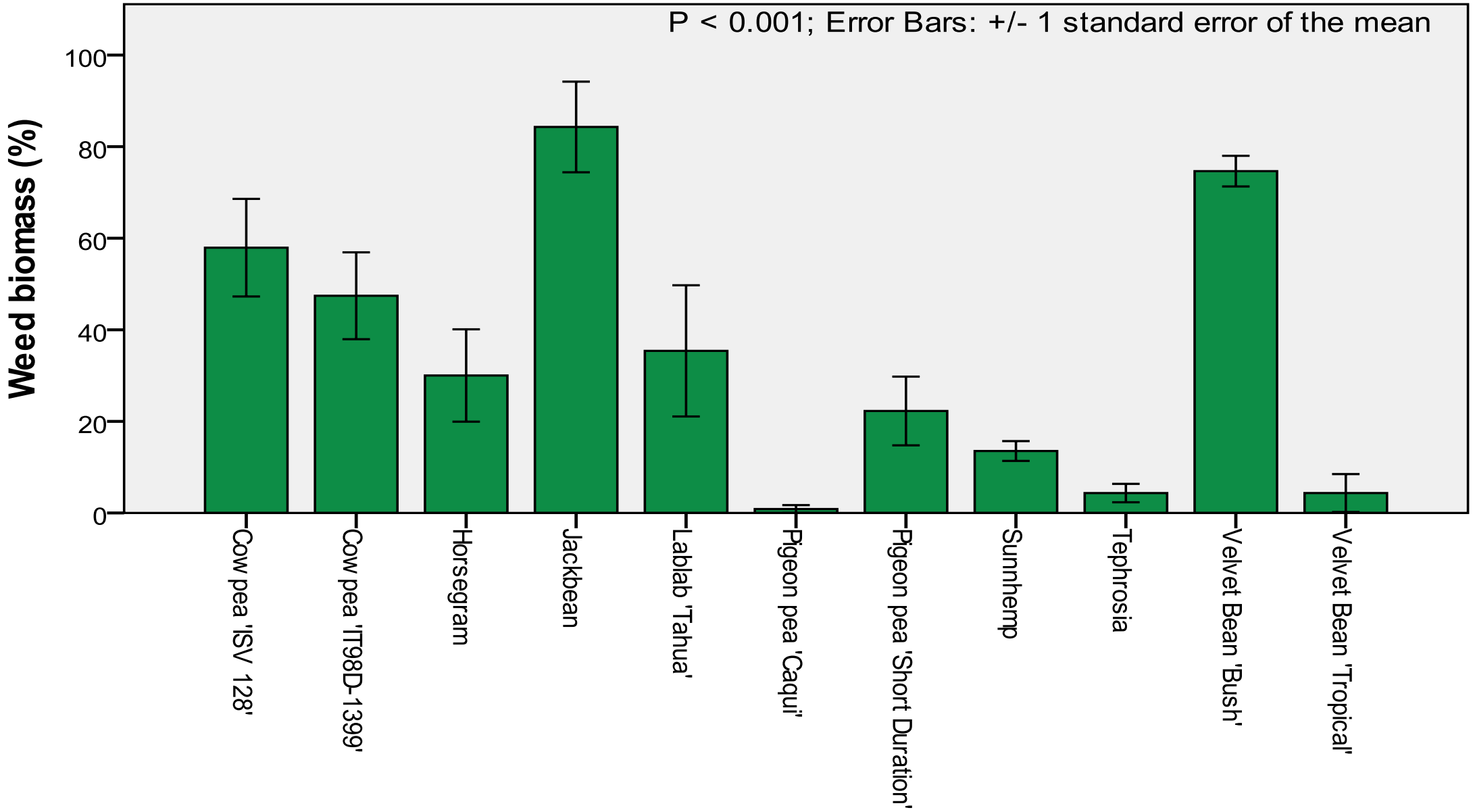
Drinkwater and Snapp 2007

Increase water infiltration



Blanco-Canqui et al. 2011

Percentage of above-ground biomass (legume + weed), within one square meter, comprised of weeds. Data taken 6 months after seeding the leguminous green manure cover crops in the field on 14 October 2010.



Sorghum biocolor var. sudanense

Sorghum
Sudan Grass

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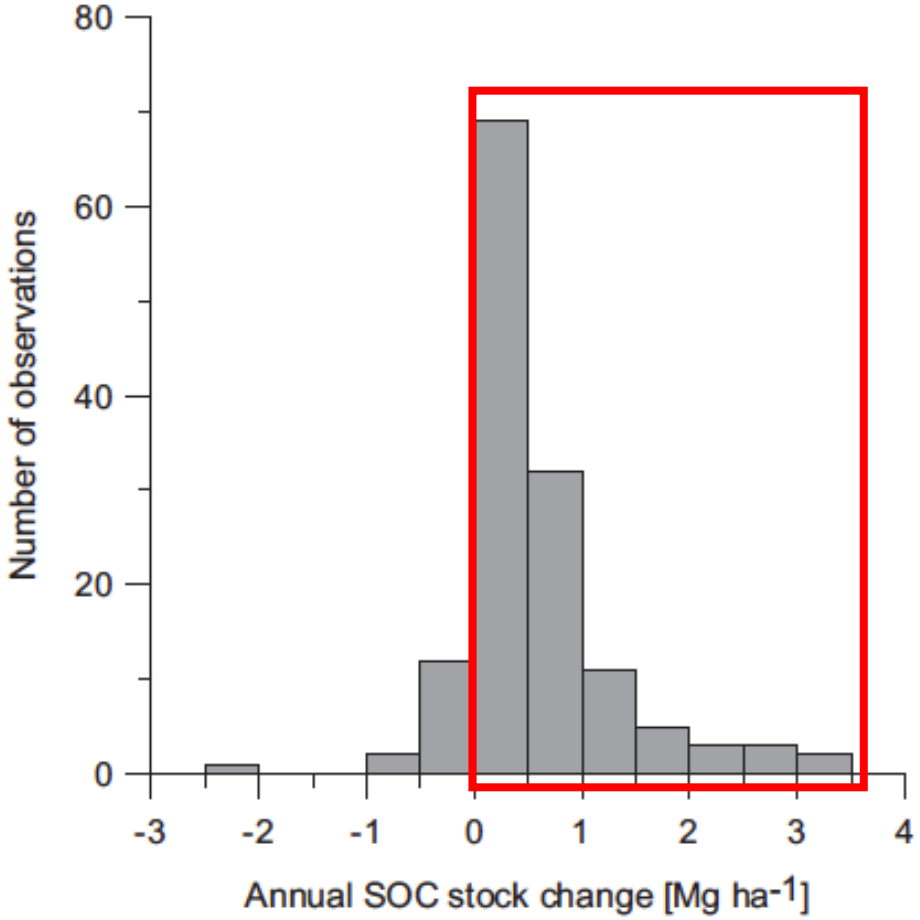
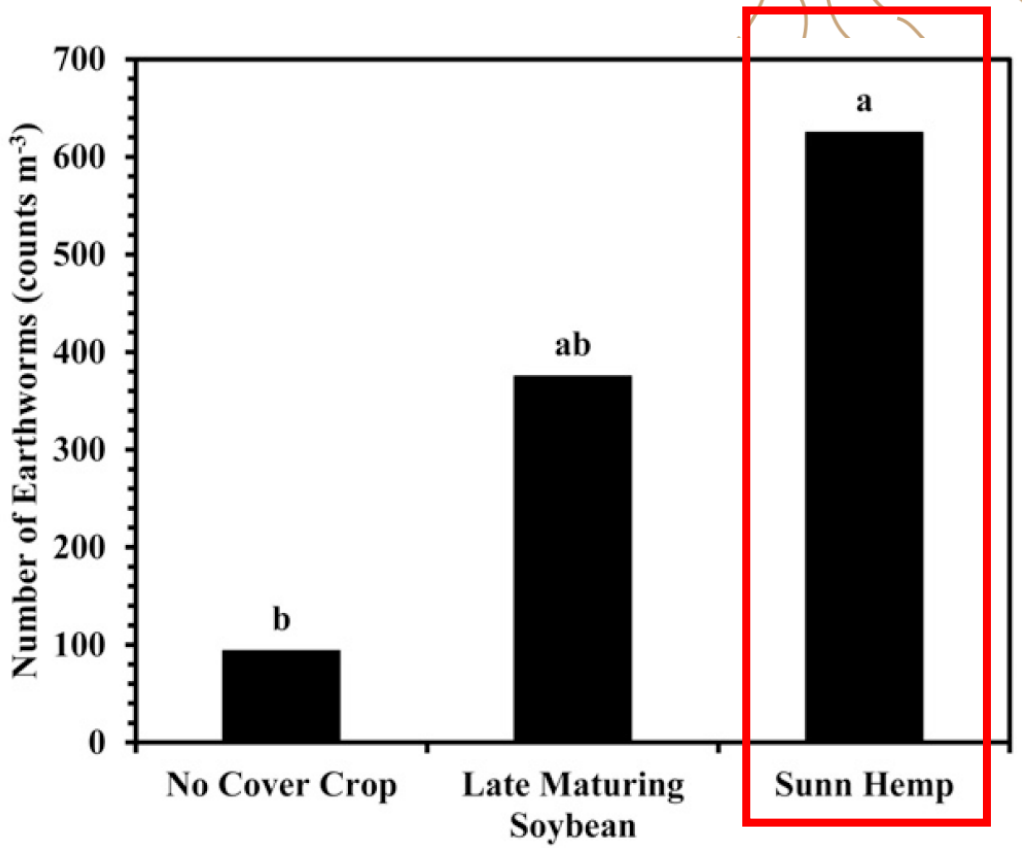
Do GMCCs really…

Increase soil organic Carbon



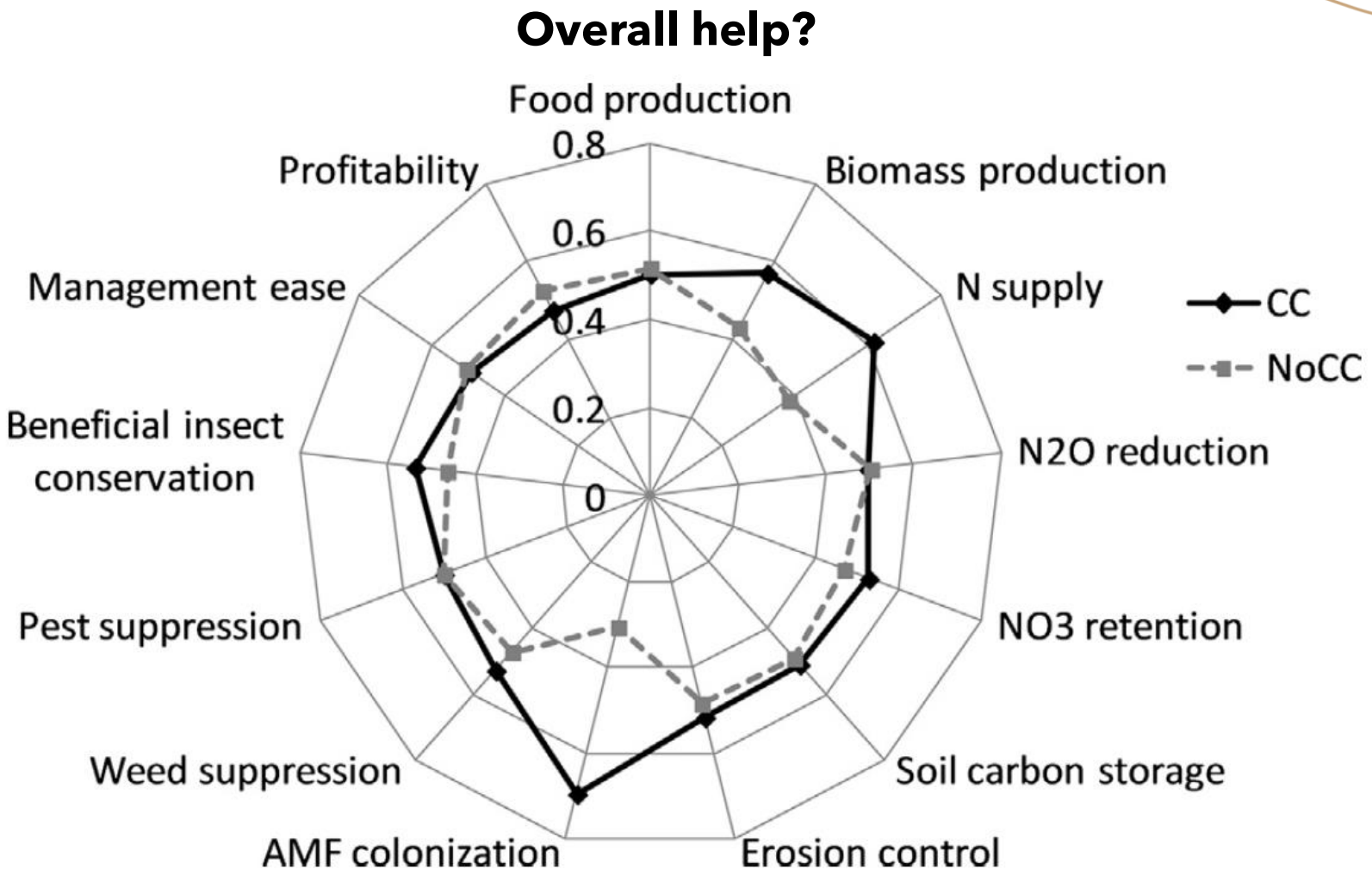
Poeplau and Don 2015

Increase soil life



Blanco-Canqui et al. 2011

Do GMCCs really…



Schipanski et al. 2014

Minimizing Risk, Maximizing Benefit

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Keys to Success

- Minimize opportunity cost
  - Pick ones that are edible
  - Intercrop (e.g. with coffee or maize)
  - Rejuvenate wasteland
  - Grow with fruit trees
- Minimize inputs
  - Produce own seeds
  - Avoid using inoculants
- Must have low labor cost
  - Less labor in weed control
- Must fit into existing farming systems
- Must have one major benefit besides improving soil
- Choose one sure success for niche/context
- Be sure not to introduce pests/invasives

Soil surface cover vs. soil incorporation

- **Soil incorporation:** plowing in the organic biomass while N concentration is at its highest
  - Common practice in temperate areas
  - Prevents losses of N to the atmosphere
  - Lose the possibility of seed harvest for grain
- **Soil cover:** leave residues on soil surface
  - Recommended for tropical soils
  - Protects against intense heat
  - Lose N to volatilization

Research plot in South Africa illustrating biomass
(in this case 13 metric tons/ha dry)

Crotalaria juncea

Sunn hemp

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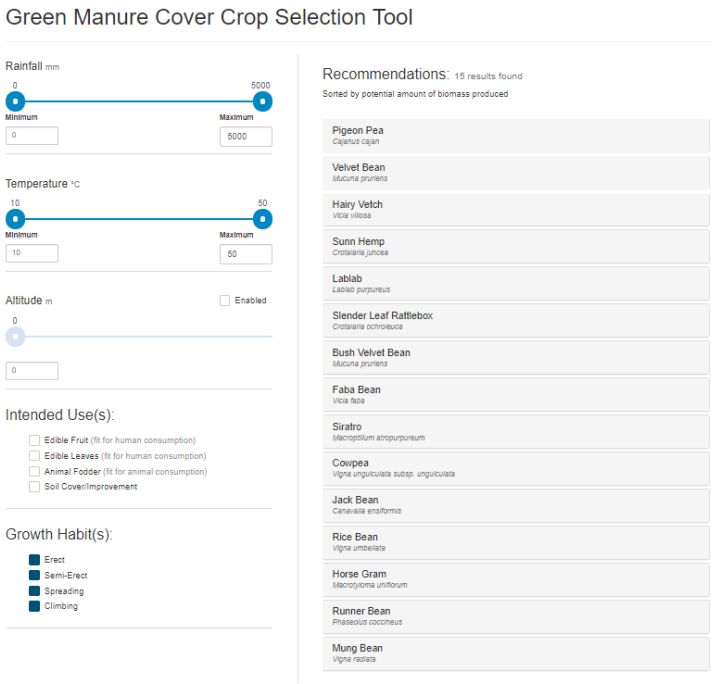
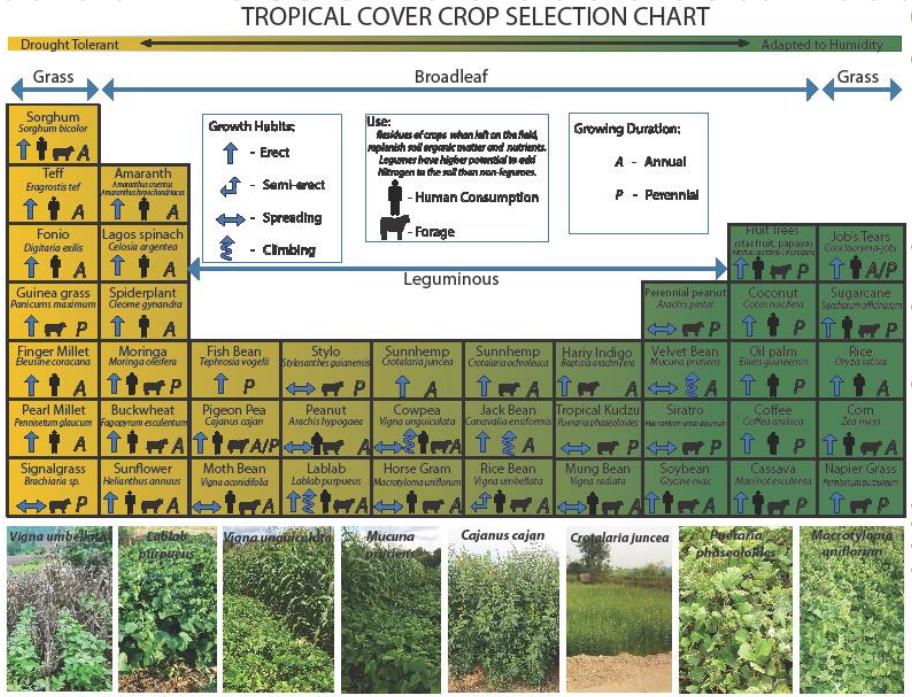
Intercropping with legumes - competition

- Both legume and cereal crop plants need light as well as soil moisture and nutrients
- Legume crop can act as a "weed"
- Ways to minimize competition
  - Adjust plant spacing
  - Adjust planting time of cereal crop vs. legume
  - Plant crops that utilize resources at different times or zones in the soil profile





ECHO GMCC Tools and Resources!

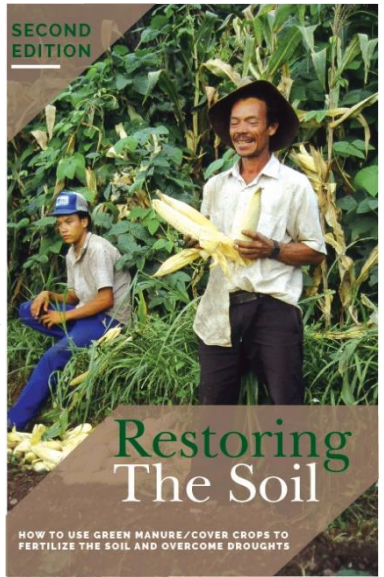


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Photo Credit: Kimberly B. Duncan


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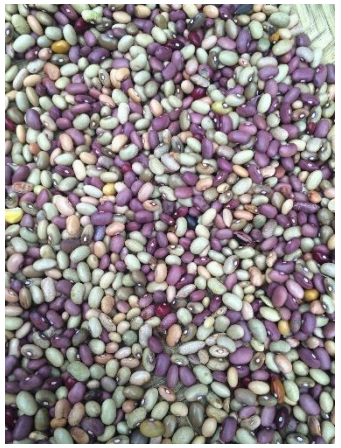
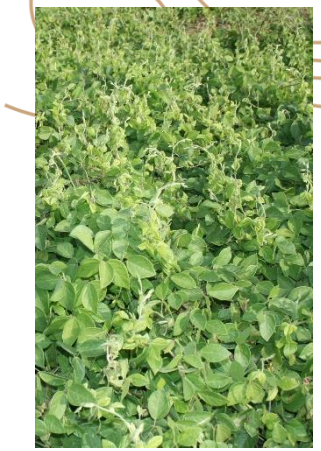
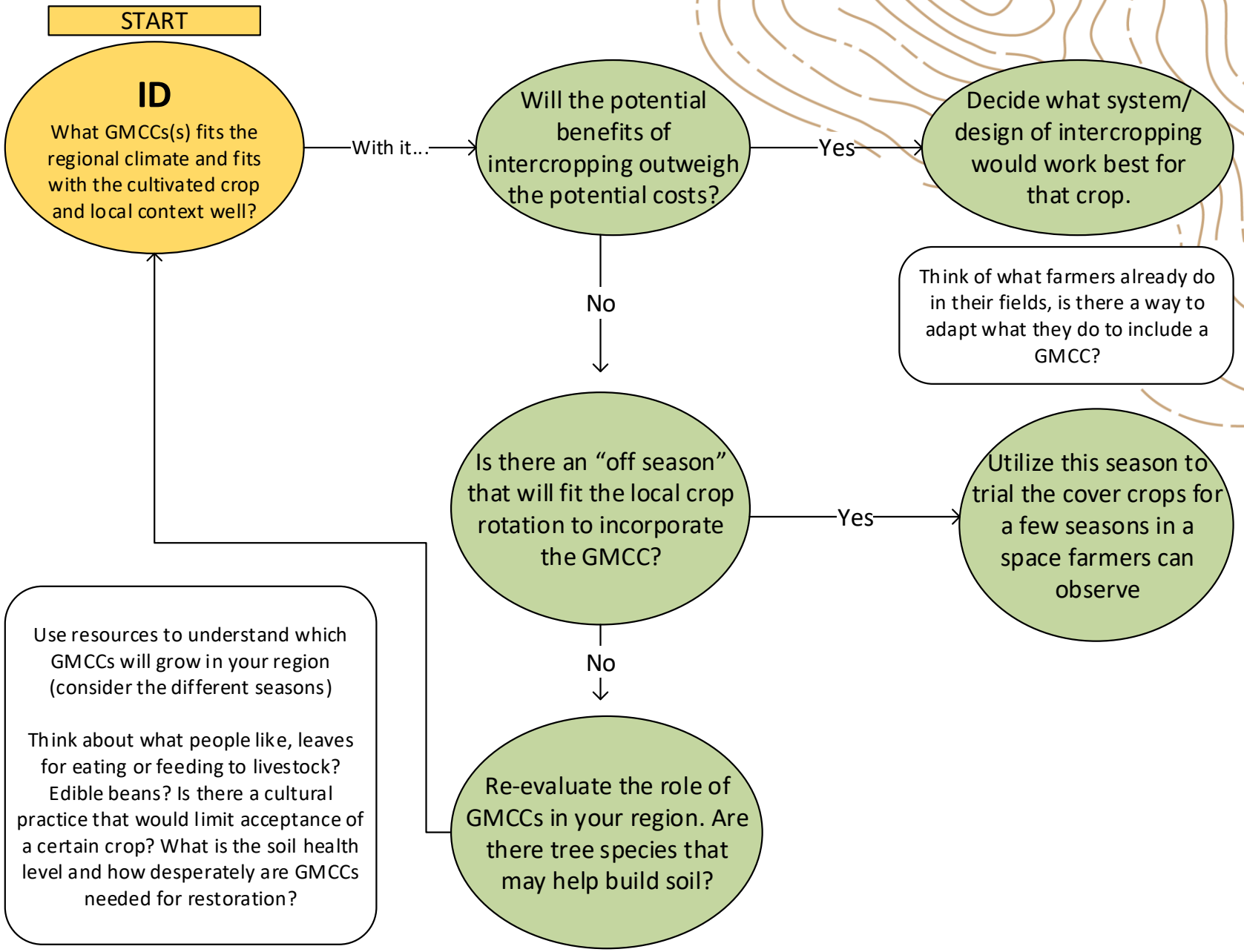




Incorporating GMCCs in your context



Resources

General information

Green Manure Crops (ECHO Tech Note 10)

An Introduction to Soil Fertility (ECHO Tech Note 57)

Nutrient Quantity or Nutrient Access? A new Understanding of How to Maintain Soil Fertility in the Tropics (EDN 74)

The Use of Green/Manure Cover Crops for Relay Cropping in Northern Thailand (AN 10)

Vegetative and Agronomic Technologies for Land Husbandry (EDN 89)

Roland Bunch, Five Years in Africa (EDN 131)

Techniques utilizing GMCCs

A "2:4:2" Maize/Legume Intercropping Pattern (EDN 133)

Conservation Agriculture in East Africa: An Update (EAN 1)

Conservation Agriculture in Areas with High Rainfall (EDN 127)

Use of Legume Cover Crops in Orchards or Plantations (EDN 46)

Inoculation of Leguminous Crops and Trees (EDN 101)

Cornell University website, Conservation Agriculutre: Global Research and Resources

Farooq, M. H.Kadambot, and M. Siddique (Editors). 2015. Conservation Agriculture. Springer International Publishing Switzerland

Save and Grow, a book (available as a PDF download) on an ecosystem approach to sustainable agricultural intensification that encompasses CA

Matusso, J.M.M., J.N. Mugwe, and M. Mucheru-Mana. 2012. Potential

Crop-specific information

Cowpea: Spotlight on Multi-Purpose Varieties (EDN 122)
Crotalaria juncea, a promising green manure crop for the tropics (AN 3)
Lablab purpureus: A new Staple Crop for the Sudano Sahel (TN 73)
Dolichos lablab: A Legume that Feeds People, Animals and the Soil (EDN 82)
Further Support for the Use of Lablab in Dry Areas (EDN 119)
Tephrosia: A Multipurpose Tree for Gm/CC, Soil Conservation and IPM (*EAN 2)*
Cowpea: Living Mulch under Maize (EDN 123)
Rice Bean – *Vigna umbellata*: Another amazing green manure/cover crop (EDN 83)
Success with Velvet Bean in the Republic of Benin (EDN 43)
Sesbania rostrata: A green manure production system for rice (EDN 75)
Various Plant Information sheets for individual gm/cc
Fact sheets on many legume species available online through Grassland Species

Profile, Tropical Forages, Winrock (nitrogen-fixing trees), Ecocrop (FAO), and Feedipedia

Soil fertility, soil life and GMCCs

Bunch, R. 2012. Restoring the Soil: A Guide for Using Green Manure/Cover Crops to Improve the Food Security of Smallholder Farmers. Canadian Foodgrains Bank

Marjatta E., J. Mureithi, J. Mureithi, and R. Derpsch. 2004. Green manure/cover crop systems of smallholder farmers: experiences from tropical and subtropical regions. Kluwer Academic Publishers.

Anderson, S., S. Gundel, B. Pound, and B. Triomphe. 2001. Cover crops in smallholder agriculture: lessons from Latin America. London: ITDG (Intermediate Technology Development Group).

Hoorman, J.J. and R. Islam. Understanding Soil Microbes and Nutrient Cycling. Ohioline (Ohio State University Extension)

Dick, W.A., and J.L. Hatfield. 2001. Sustaining soil fertility in West Africa: proceedings of a symposium sponsored by Divisions S-4, S-8, and A-6 of the Soil Science Society of America and the American Society of Agronomy: the papers were presented during the annual meeting in Minneapolis, Minnesota, 5-9 November, 2000. Madison, WI: Soil Science Society of America.

Handbook for Integrated Soil Fertility Management, Africa soil health consortium. 2012. Edited by Thomas Fairhurst.