

From Root Zone to Biome: Applying Ecological Principles to Agriculture

Based on the work of Dr. Meagan Schipanski | Department of Soil and Crop Sciences @ Colorado State University

CROPLANDS cover an estimated 11 million square km of the Earth's total land surface. Given this extent, it's important to think about how the crops we choose to grow impact the global ecosystem. Ensuring long-term land health and productivity will require 'ecosystem level' thinking—bringing together principles from biogeochemistry and ecology to maintain biodiversity, soil quality, and ecosystem function.

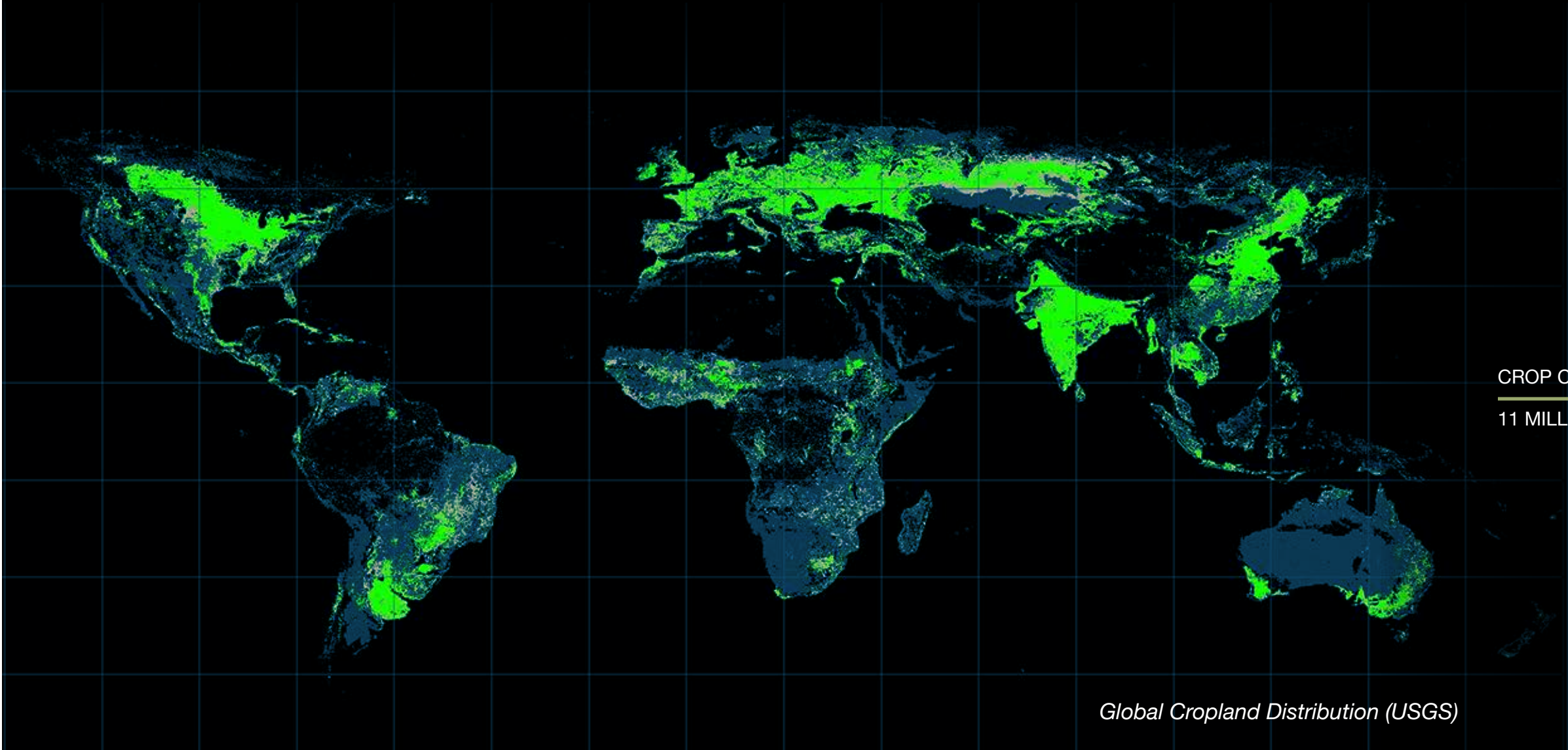
Dr. Meagan Schipanski and her research group at Colorado State University study ways to develop more sustainable and resilient agricultural systems. From investigating impacts of different crop types and cropping systems on biological processes to developing innovative ways to engage farmers and other stakeholders, the primary focus is on maintaining productive crop systems while reducing environmental impacts.

TOTAL LAND SURFACE:

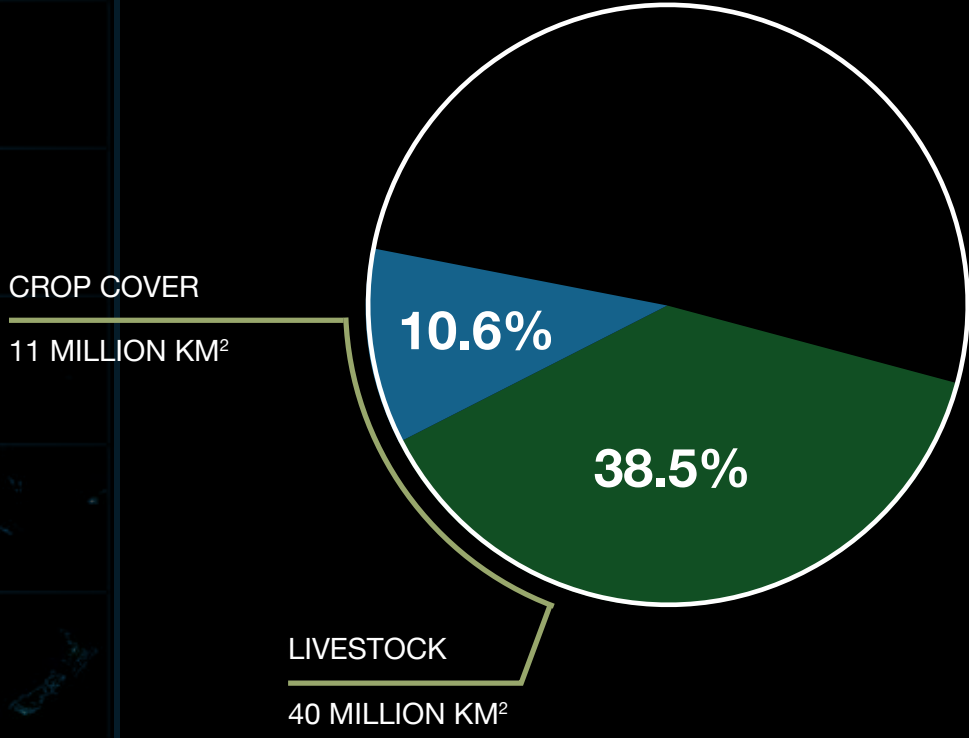
71%
HABITABLE LAND
104M KM²

10%
GLACIERS
15M KM²

19%
BARREN LAND
28M KM²



AG AS A PERCENTAGE OF HABITABLE LAND:



Primary Annual Crop:
Field Corn

Canopy Height: ~12 ft
Roots: Fibrous



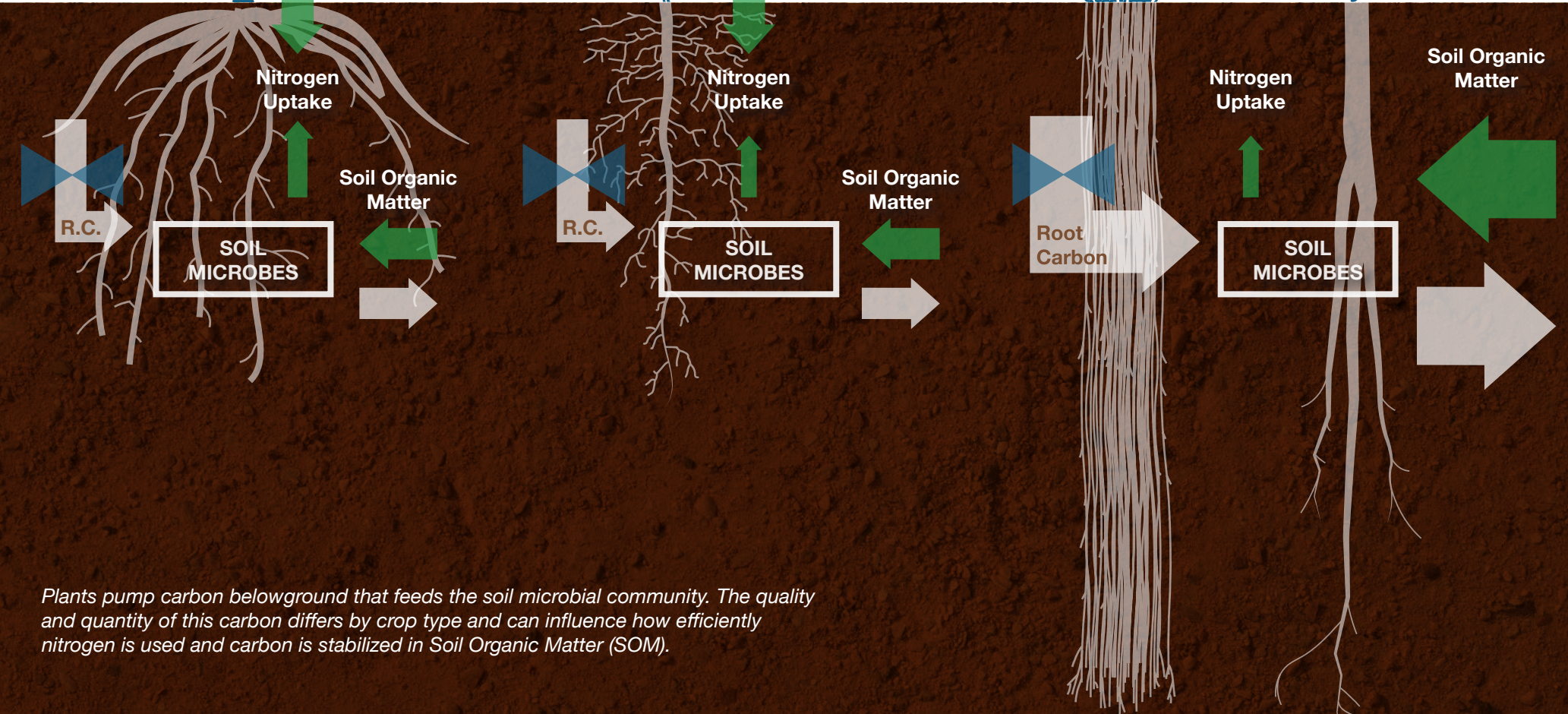
Perennial Legume:
Alfalfa

Canopy Height: ~2.5 ft
Roots: Central tap root



Perennial Grassland:
Native grass, sunflowers

Canopy Height: Varied
Roots: Tend to be more/deeper than annuals



Plants pump carbon belowground that feeds the soil microbial community. The quality and quantity of this carbon differs by crop type and can influence how efficiently nitrogen is used and carbon is stabilized in Soil Organic Matter (SOM).

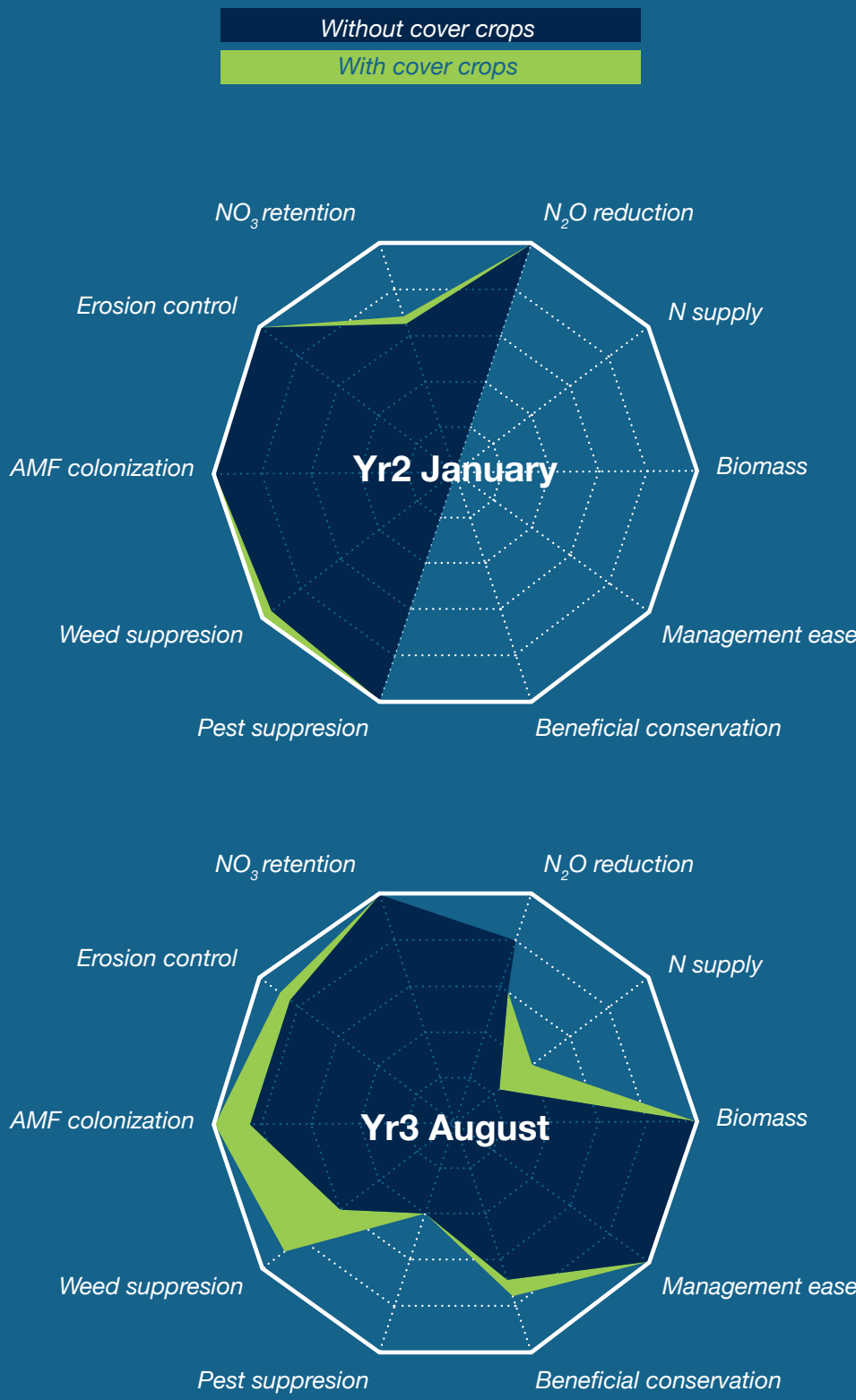
PLANTS AS TOOLS:

Different plant nutrient acquisition patterns, root architectures, and plant-microbial associations impact soil health, depleting or recharging plant-available nutrients. Rotating crops can introduce more diversity into agricultural systems—using plants as tools to improve soil quality. Leveraging cash crop and cover crop traits may help us more efficiently use fertilizers and other resources while providing essential ecosystem services.

LESS NPK? OKAY!

Corn, one of the most widely grown annual crops in the United States, depends on external nitrogen inputs and soil organic matter to support growth. Rotating corn and legumes, like alfalfa and soybeans, introduces different amounts and quality of carbon into the soil than corn alone. There are also windows of opportunity between our annual crops to increase diversity by growing cover crops. Plants can be selected for different functions. For example, legumes partner with soil bacteria to convert atmospheric nitrogen gas to a plant-usable form future crops can uptake.

Looking farther into the future, there is potential to rely more on perennial mixtures of grasses and legumes to provide additional ecosystem services, from increased biomass to biological pest control and wildlife habitat. Longer perennial root systems also stabilize the soil, protecting against erosion.



ABOVE: Instead of letting fields lie fallow, alternating cash crops with cover crops can provide ecosystem services like weed suppression, erosion control, and growth of fungi like AMF that help with plant nutrient uptake. These benefits may take a few years to realize and vary temporally.

OVERCOMING BARRIERS TO ADOPTION:

A HUMAN-FOCUSED APPROACH

To close the gap between research and field applications, it's critical to remember the human perspective. Incorporating sociological interviews into the research process helps determine current practices and primary drivers of land management decisions, which can then be used to tailor communications strategies and research to specific identified needs. This not only builds human support and social capital, but also presents an opportunity to shift mindsets and engage diverse groups in collective action.

Integrating field-scale research into models and decision-support tools is another useful way to increase access to information for end-users. Collaborative efforts like the web-based COMET-Farm™ and Cool Farm Tool, help agriculturalists visualize the impact of different conservation practices on outcomes such as soil greenhouse gas mitigation and can encourage eventual adoption of new methods.

