The Nature Conservancy

Working Together Toward More Sustainable Dairy Production

A collaborative approach to achieve economic and environmental benefits for people and nature

Roadmap for a Sustainable Dairy System

Why? The Nature Conservancy developed this document as a roadmap for corporate action to protect and regenerate nature and climate and to support economic well-being and healthy communities. The document was developed with a U.S. focus.

Who? Downstream companies in the dairy supply chain who have set GHG emissions reduction goals, have customer and investor demands to reduce emissions, and are interested in tackling climate change and the impacts of agriculture.

Source: TSC Dairy Supply Chain Diagram © TSC 2020

Contents

Section 1 The Role of U.S. Dairy

USDA Photo

Pressures on the Global Food System Are Rising

Food Systems

An Uncertain Future

Our global food system is facing growing demand, resource constraints, shifting consumer preferences and new challenges from climate change.

60%	Increase needed in world food production to keep pace with demographic change
65m	Acres annually undergoing conversion or abandonment
40%	Gap in the amount of water available vs. demand in 2030[1]
10 - 25%	Crop yield declines expected to be widespread by 2050 due to climate change

Dairy Can Be Part of the Solution

The Nature Conservancy (TNC) believes the US dairy industry has a valuable role to play in protecting and restoring lands, conserving biodiversity and water resources, providing food, and reducing and mitigating GHG emissions.

TNC seeks to work with and empower dairy supply chain actors—the caretakers of the animals, the land, and the waters.

TNC Priorities

Tackle Climate Change

Protect Land and Water

Provide Food and Water Sustainably

Role of U.S. Dairy in a Sustainable Food System

Production of all dairy in the U.S. accounts for 17% of total agricultural GHG emissions.[2,3]

The gases of most concern are methane (from belching, flatulence, and manure) and nitrous oxide (from manure, fertilizer and soil management) which both have greater warming potential than carbon dioxide.

Most of dairy's impact on water quality results from nutrients and manure, which may be improved through better management practices.[4]

While dairy production can be a significant source of nutrient pollution, it can also create an efficient system where the same nutrients are cycled repeatedly.

Production of animal feed* contributes significantly to the environmental footprint of dairy.

Irrigation in feed production is responsible for >95% of ground and surface water consumed to produce dairy.[3,5,6]

Feed production is responsible for at least 20% of emissions, primarily from fossil fuel use, nitrous oxide from manure and fertilizer management.[7,8]

(*Animal feed like corn, soybeans, & alfalfa)

Section 2 | The Role of The Nature Conservancy

USDA Photo by Preston Keres

About The Nature Conservancy

Creating a World Where People and Nature Thrive

TNC is a leading global conservation organization with a mission to protect the lands and waters on which all life depends.

Our strength starts with our team.

400 scientists

79 countries & territories

4,000 conservationists

50 U.S. states

1 Million dedicated members

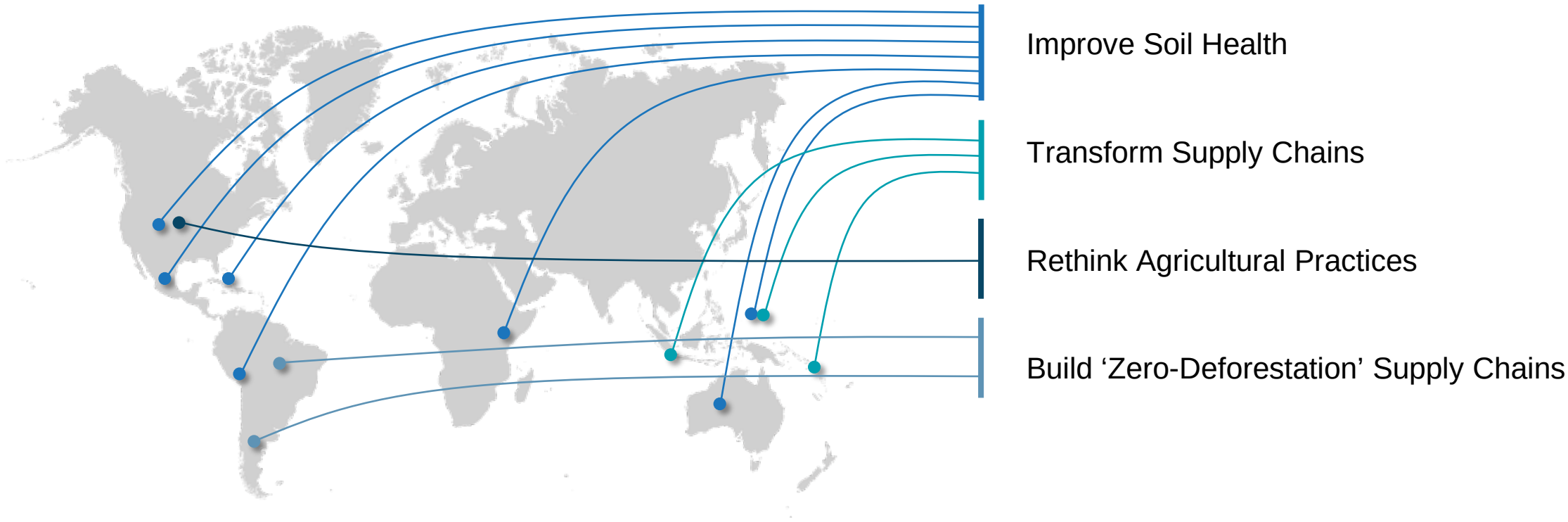
1,300 prominent volunteer leaders

A Far Reaching Network

of leaders in the conservation community

We Support Producing Food & Water Sustainably

We work with farmers, ranchers, fishers and water managers to create sustainable supplies of food and water, reduce negative environmental impacts and support livelihoods.



Our Global Agriculture Priorities

PROTECT HABITAT

Develop supply chain commitments to prevent deforestation and incentives to redirect agriculture expansion

RESTORE DEGRADED LAND

Soil health and grazing practices to optimize productivity and conservation of agriculture landscapes

SECURE FRESHWATER

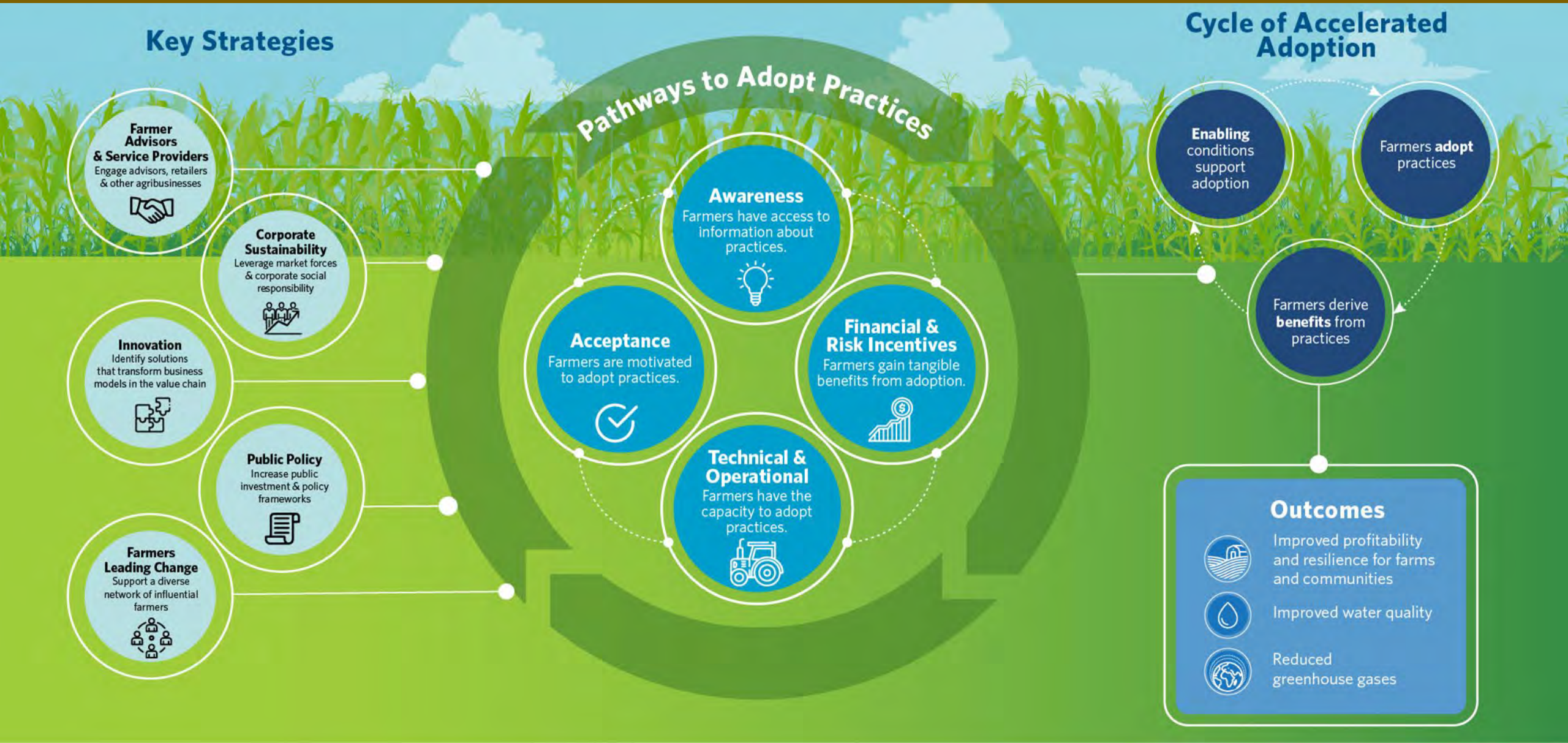
Apply science, policy, and new business models to solve water quality and quantity issues at the basin level

CLIMATE SMART

Farm and ranch management practices which reduce or sequester GHGs, increase productivity and resilience to climate change

The Nature Conservancy's

North America Agriculture Strategy



We Understand Farming & Ranching

TNC's North America Farm & Ranch Holdings

- 378 properties
- >500,000 acres total
- 24,000 cropland acres
- >480,000 acres grazing

The Nature Conservancy—which owns more than 500,000 acres of U.S. grazing lands and has helped to conserve millions more through easements and collaborative management—has worked for years to develop strong, trusting relationships within the ranching community and the beef supply chain. We use our lands to work with and support neighboring ranchers and to develop and test cutting-edge, science-based management practices.

Section 3 | Vision and Definition

TNC's Vision for Sustainable Dairy

Nature. People. Water. Land. Livestock.

Sustainable dairy production:

1. Avoids [or prevents] land conversion
2. Supports or restores native vegetation and wildlife, using pesticides judiciously
3. Supports clean and abundant water resources
4. Emits the fewest possible GHGs
5. Protects or enhances soil health
6. Efficiently uses resources along the value chain
7. Prioritizes animal health and well-being
8. Uses antibiotics judiciously
9. Supports economic livelihoods and helps communities thrive
10. Uses fair and equitable labor practices

Detailed Definition of Sustainable Dairy Production

	Outcome	Practice Example (Not an inclusive list)
Environment	1. *Avoids [or prevents] land conversion* 2. *Supports or enhances native vegetation and wildlife, using pesticides judiciously* 3. *Supports clean and abundant water resources* 4. *Emits the fewest possible GHGs* 5. *Protects or enhances soil health* 6. *Efficiently uses resources along the value chain*	1. Dairy production and feed sourcing does not create pressure for deforestation; native grassland/prairie conversion is avoided in the U.S. (no production on land that has been cleared of native vegetation in the past 10 years); keeps lands intact; critical habitat is conserved. 2. Manure management and grazing plans are implemented (where applicable) that promote nutrient use efficiency, protect sensitive areas from nutrient overload, and use methods to ensure that wildlife and pollinator habitat is protected. Edge-of-field practices such as riparian buffers and two stage ditches are utilized to protect water and provide benefits to wildlife and people. For pasture, a grazing management plan is implemented that improves vegetation condition and wildlife habitat and provides a nutritious and productive source of forage; rotational/intensive grazing is practiced where feasible. 3. Erosion reduction practices are widely adopted - buffer strips, grassed water ways, and filter strips are widely used; cover crops, reduced tillage, and other conservation agriculture practices; Cover crops are planted after corn silage harvest 4. Feed mixes and additives provided for cows to reduce enteric methane. On farm energy efficiency measures are taken for milk pumping and storage, cooling cows, other uses. 5. Feed is sourced or produced on land where practices to maintain or improve soil health are implemented: reduced/no-till, cover crops, crop rotations; rotational grazing, 4Rs of nutrient and manure management. 6. Efficient processing and food waste reduction strategies are implemented (e.g., energy efficiency, extended shelf life processing).
Livestock*	7. *Prioritizes animal health and well-being* 8. *Uses antibiotics judiciously*	7. Implementation of animal welfare best practices including zero tolerance for animal abuse; producers follow cattle care and handling guidelines and strive to provide a high level of health and wellbeing in accordance with the Five Freedoms of Animal Welfare. 8. Antibiotics are used in accordance with Judicious Use Principles as to avoid antibiotic resistance in humans and animals, cumulative effects of resistance, and reduction in soil health and microbial diversity due to waste ending up in soil.
People	9. *Supports economic livelihoods and helps communities thrive* 10. *Uses fair and equitable labor practices*	9. Workers throughout the supply chain are treated with dignity and operate in safe working conditions; farmers are supported to keep land intact through intergenerational transition, etc. Provides people with a nutritious source of protein. 10. Operation has a diversity, equity and inclusion plan in place and regular employee audits.

*** Beyond scope of TNC's expertise but important aspects of Sustainable Dairy**

Section 4 | Improvement Opportunities

USDA Photo by Preston Keres

TNC has Identified Key Improvement Opportunities

DAIRY PHASE	IMPROVEMENT OPPORTUNITY	CLIMATE	WATER QUALITY	WATER QUANTITY	BIODIVERSITY
FEED PRODUCTION	**NUTRIENT MANAGEMENT:** following the "4Rs" principle, "right source, right rate, right time, right place"	●	●		
	SOIL HEALTH PRACTICES: cover crops, crop rotation and reduced tillage	●	●	●	●
	REDUCED WATER/ENERGY CONSUMPTION: irrigation equipment, precision, timing, pumping efficiency	●		●	
	EDGE OF FIELD PRACTICES: riparian buffers/harvestable buffers, grassed waterways, fenced waterways and stabilized water-crossings, silvopasture, range plantings, prairie strips, wildlife habitat, etc.	●	●	●	●
	PRESCRIBED/PLANNED GRAZING: optimized grazing, rotational grazing, etc. (where applicable)	●			
	AVOIDED CONVERSION: crops not produced on land that has been cleared of native vegetation in 10 yrs	●	●	●	●
MILK PRODUCTION	**FEED ADDITIVES:** to reduce methane production from enteric emissions (e.g. tannins, essential oils, etc.)	●			
	FEED COMPOSITION: specific feed rations and supplements designed to to reduce enteric emissions, improve digestibility of feed, and/or increase milk production	●	●		
	MANURE MANAGEMENT: technologies/practices in manure collection, treatment, and storage (e.g. digesters, separators, composters, covers, etc.) and use (e.g. nutrient management)	●	●	●	
	TECHNOLOGY/INNOVATION: automatic milking systems, activity monitors for cattle, selective breeding, vaccines to reduce enteric emissions, etc.	●			
ALL	**USE OF RENEWABLE ENERGY AND ENERGY EFFICIENCY UPGRADES**	●			
	CONTINUOUS IMPROVEMENT AND ADAPTIVE MANAGEMENT (ability to show year over year progress toward better environmental outcomes)	●	●	●	●

- New research and technology is constantly emerging; this list should be updated regularly to reflect the latest state of knowledge
- Not listed in order of impact
- Magnitude of impact and uncertainty will vary by practice and are influenced by local context. Evidence related to key improvement opportunities is provided at the end of this document.

Why Feed Production?

In 2019, ~50 million tons of feed (not including harvested forages) was consumed by dairy cattle in the U.S. This represents ~19% of total livestock and poultry feed consumption. By far the most common feed used was corn, which makes up about 40% of the typical dairy ration. Dried distillers grains (DDGs), a byproduct of the distillation of corn for ethanol production, comprise another 16% of dairy rations.[9]

Producing this corn (and other feed commodities) drives a significant proportion of the climate, water, and biodiversity impacts the dairy supply chain, including ~20% of the GHG footprint[7] and >90% of the ground and surface water use.[3] Additionally, microbes and excess nutrients in dairy manure that is used to fertilize feed crops can contaminate ground and surface waters, reducing water quality.[10,11]

This is particularly important in regions where a large proportion of feed is produced on the dairy because these farmers have an opportunity to implement best practices themselves.

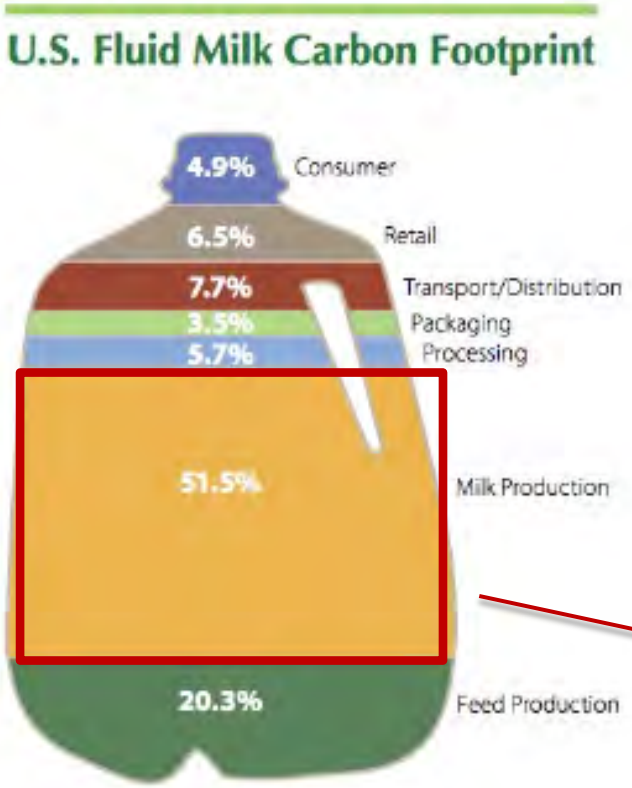
Select Feed Production Opportunities

Row Crop Agriculture; Corn, Soybean, and Alfalfa Production

Improvement Opportunity	Description
 Nutrient Management	Encourage improved nutrient management practices (4Rs-source, rate, time, & place), including optimized use of manure.
 Soil Health Practices	Encourage the planting of cover crops (that can be used for feed), a more diverse crop rotation and reduced tillage.
 Reduced Water/Energy Consumption	Encourage improved irrigation management (equipment, precision, timing), pumping efficiency and using renewable energy as fuel for pumps.

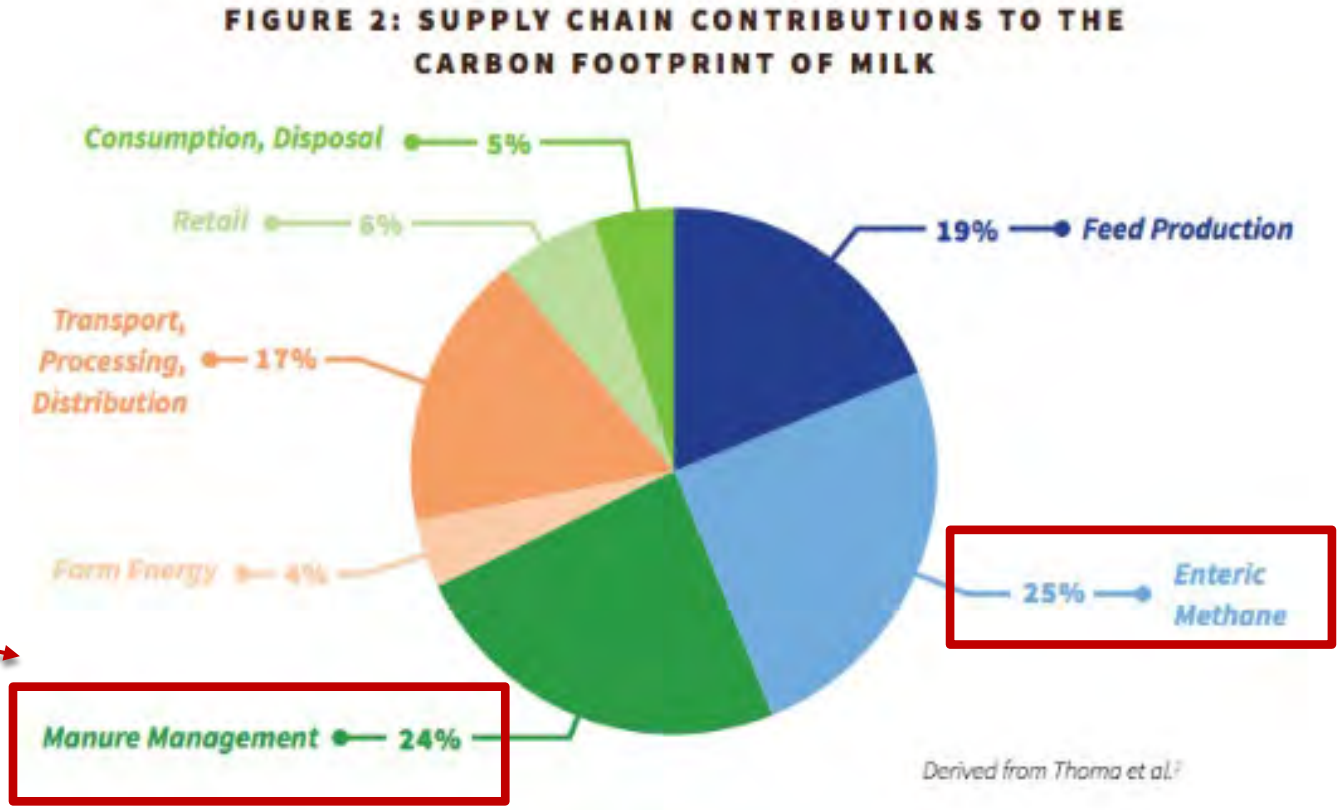
* Other opportunities like improved plant genetics (e.g., varieties with improved nutrient use efficiency or yield stability traits) and avoided land conversion are important but not included because drought resistant varieties are already widely adopted in the US and avoided land conversion is less relevant in the US than in land conversion frontiers such as Brazil and Argentina. Additional opportunities such as buffer and pollinator strips, alley cropping, and other on-farm habitat conservation should be considered on a site-by-site basis.

Why Milk Production?



Greenhouse Gas Emissions for U.S. Fluid Milk: Contribution by Supply Chain

Total CO_2e emissions of fluid milk = 17.6 lbs. per gallon of milk[1] (2.05 kg CO_2e/kg milk consumed)



The Milk Production phase of the dairy supply chain accounts for over half of the total carbon footprint of U.S. fluid milk. Of that roughly 50%, approximately half can be attributed to enteric methane and half to manure management.

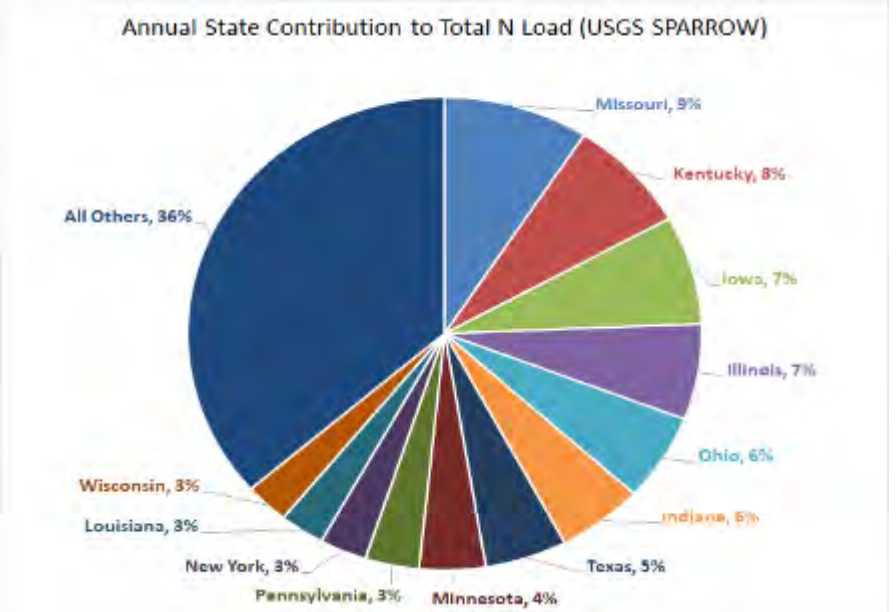
Select Milk Production Opportunities

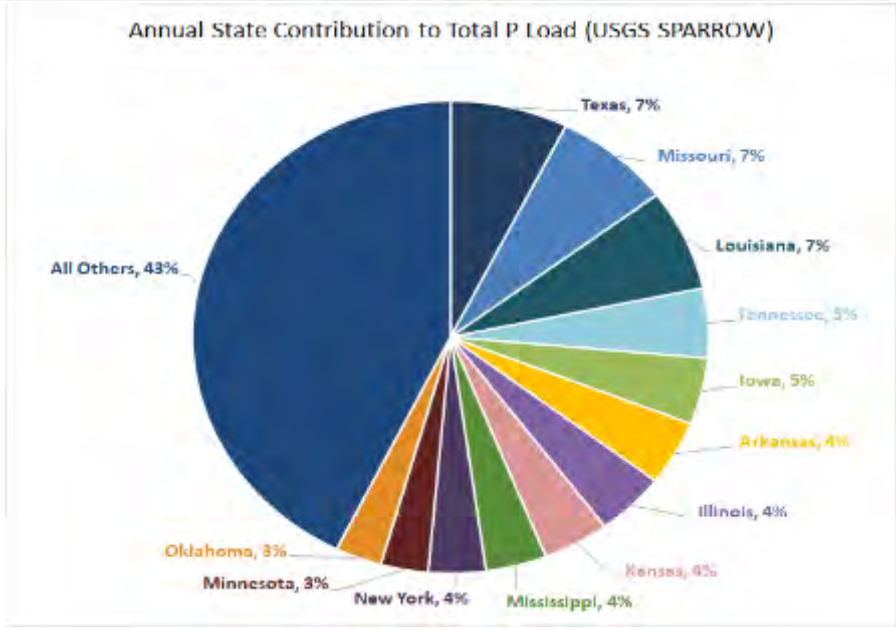
Dairy Farm Operations

Improvement Opportunity	Description
 Feed Additives	Include specific compounds or products as a component of feed rations to reduce rumen fermentation and the amount of methane produced by animals.
 Feed Composition	Include alternative feed components in rations to directly reduce enteric fermentation (e.g. *Brassica* spp., high-lipid feeds) or improve digestibility of feed (e.g. amylase-trait corn).
 Manure Management	Use of best practices in manure collection, treatment, storage, and application (e.g. digesters, separators, composters, covers).

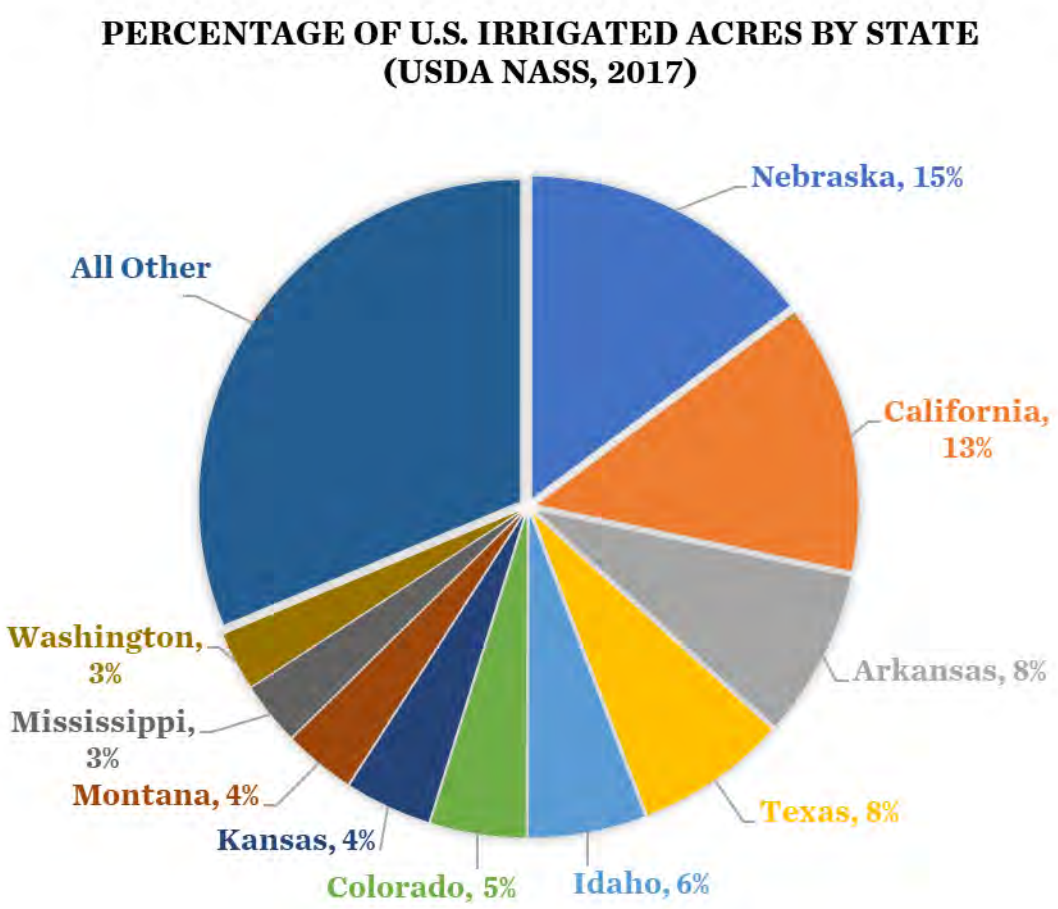
Opportunities to Mitigate Water Quality Impacts

- **In-field practices**
  - Reduced tillage
  - Cover cropping
  - Tile drain management
  - Diverse rotations/ crop rotation
- **Barnyard management**
- **Nutrient Management 4Rs**
  - Manure management technology (low disturbance injection, nutrient recovery tech, precision /variable rate application, rotational grazing, pasture management)
- **Edge-of-field practices**
  - Buffers
  - Setbacks
  - Livestock exclusion
  - Constructed wetlands
  - Grassed waterways
  - Ox-bows





Opportunities to Mitigate Water Quantity Impacts



Water consumption/GHG emissions can be mitigated by:

1. Improving irrigation efficiency (equipment, timing, precision)
2. Improving pumping and chiller efficiency for the milk parlor
3. Fuel switching (including renewable energy)
4. Managing plant demand (e.g. drought-tolerant varieties)
5. Conservation agriculture practices to improve soil water holding capacity

Benefits:

- Climate: Reduced GHG emissions; resilience due to adoption of drought-tolerant varieties
- Water: Reduced water consumption

The Nature Conservancy

Section 5 | First Steps of Implementation

The Time to Act Is Now

- As the **global population** is expected to reach more than 9 billion by 2050, agriculture production will need to increase by 60 percent to meet projected demand, which has enormous implications for ranchers, grazing lands, farmers, and land use (FAO, 2017).

- **Companies** are seeing the critical importance of reducing the impacts of their supply chains. Beef represents the single largest source of greenhouse gas (GHG) emissions in the animal agriculture sector with significant opportunities for mitigation along the value chain (i.e., Scope 3).

- The majority of **consumers** state sustainability is important and over half claim a willingness to pay slightly higher prices for sustainable products. Trust is an important driver of sustainable purchasing decisions and consumers look to NGOs such as TNC as a credible source for sustainability information.

- As pressures rise, we are seeing more and more farmers and ranchers going out of business. TNC seeks to create sustainable and economically viable systems that **keeps working lands intact**. We believe farmer participation is vital and the financial and technical support for changes they need to make in management approaches a necessity.

TNC Is Here to Help

TNC is looking to partner with additional companies that are interested in:

Leading on Climate by…

Piloting of feed additives like 3NOP and adopting feed additives that are introduced to the market.

Piloting/adopting low-GHG feeds and alternative feed components.

Determining the potential for manure management best practices on a site by site basis and implementing with operators.

Implementing proper nutrient management practices (4Rs-source, rate, time, & place), including appropriate use of manure.

**Many practices have both climate and water benefits*

Leading on Water by…

Implementing improved irrigation management (equipment, precision, and timing).

Adopting In-field practices such as reduced tillage, cover cropping, and tile drain management.

Adopting edge-of-field practices such as **b**uffers, setbacks, livestock exclusion, constructed wetlands, grassed waterways, ox-bows, etc.

Piloting/adopting drought-tolerant varieties.

**Many practices have both climate and water benefits*

Leading in the Supply Chain by…

Driving improved traceability and transparency in the complex supply chain by requiring more information about where suppliers buy their inputs.

Requiring feed suppliers to participate in TNC principles implementation, which highlights improvement areas (soil health, nutrient management) and provides useful data to growers.

Promoting farm-level improvements: providing incentives and recognition, supporting peer learning, etc.

Supporting needed science, research and monitoring to ensure triple bottom line outcomes and transparency.

Section 6 | TNC Case Studies

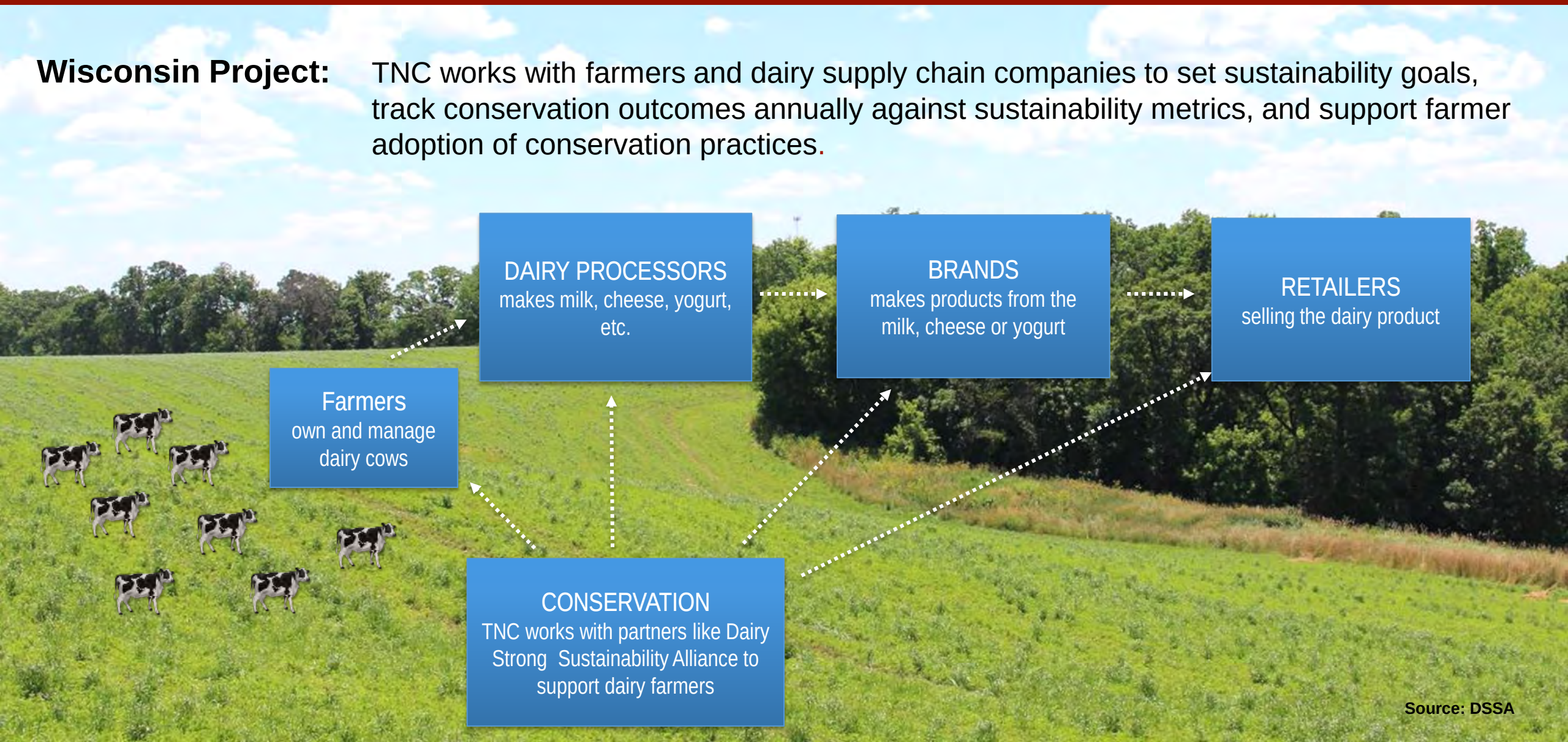
Case Study: Milkshed

Description: TNC is providing dairy processors and global brands support (funding and technical expertise) program to track continuous improvement on dairy farms and the implementation of sustainability efforts and programs.

What We Did	Output	Outcomes *(in progress)*
Enabled farmer groups to develop and implement programs they develop as a group.	Five farmer groups have expanded offerings and resources to help producers.	e.g., Soil health improvements on X acres, # of GHG emissions reductions plans in place, # farmers empowered

Partnership Approach: Milkshed

Wisconsin Project: TNC works with farmers and dairy supply chain companies to set sustainability goals, track conservation outcomes annually against sustainability metrics, and support farmer adoption of conservation practices.



Source: DSSA

Case Study: Demonstration, All Acres for Our Water

Step 1

Set Targets

- Overall, get enough practices on the ground in optimal locations to achieve a 20% reduction in N & P loading
- Use modeling and precision ag data to set targets for:
  - Infield BMPs- 4R nutrient management, precision manure management, cover crops, reduced tillage, perennial crop rotations
  - Edge of Field BMPs- grass waterways, buffers, working wetlands, working grasslands

Step 2

Target Incentives

- Target existing programs to provide short-term incentives to accelerate BMP adoption
- Create a new long-term incentive for improved stewardship through the launch of an Ecosystem Services Market Consortium pilot
- Create incentives for ag retail to invest in soil health services and equipment

Step 3

Engage Farmers

- Utilize traditional and create new pathways for promoting BMPs and incentives to farmers
- Soil and Water Conservation Districts, Dept of Ag, NRCS, etc.
- Engage and create incentives for ag retailers to engage their customers
- Industry organizations and CPGs

Step 4

Measure Success

Use modeling and sustainability metrics tools like the Field to Market FieldPrint Calculator to measure, aggregate, and forecast future water quality improvement based on practices implemented

Contact Us

Learn how
The Nature Conservancy
can help your company meet
its sustainability goals.

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Protecting nature. Preserving life.

USDA Photo by Preston Keres

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Evidence & Resources for Key Improvement Opportunities

Feed Production

- AgEvidence: explore 39,000+ data points demonstrating the impact of specific feed production practices on climate mitigation, crop yiel ds, soil health, and water quality in the U.S. Corn Belt
- Dell et al. 2022. Challenges and opportunities for manureshed management across U.S. dairy systems: Case studies from four regions. Journal of Environmental Quality. https://doi.org/10.1002/jeq2.20341
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Milk Production

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- Alltech E-CO2. A shift to a robotic milking system has helped one Devon dairy improve health and performance and has also driven down the farm's carbon footprint, reports Dairy Farmer.
- NRCS Feed Management 592 Practice Standard and related resources (e.g., Dairy Cattle Extension)
- Niles, M.T. & Wiltshire, S. 2019. Tradeoffs in U.S. dairy manure greenhouse gas emissions, productivity, climate, and manure management strategies. Environmental Research Communications 1(7): 075003

All

- Renewable Energy Production on Dairy Farms: https://ag.umass.edu/crops-dairy-livestock-equine/fact-sheets/renewable-energy-production-on-dairy-farms