



Green Lands
Blue Waters



Our Journey to a Transformed Agriculture through Continuous Living Cover

**Why continuous living cover
crops and cropping systems,
and a human-centered,
equity-focused approach to
their implementation, are
imperative and exciting, and
how this can look on the
agricultural landscape**



A Paper by Green Lands Blue Waters and its Network

Executive Summary



Most of us can agree that the agricultural landscape should mutually sustain human and natural communities over the long term. And yet, we cannot deny today's ecological conditions as a result of how we farm most of our acres in the United States: high levels of soil erosion and loss of topsoil; water quality impairment from agriculture-related pollutants in ground and surface waters; and agriculture's contributions to climate change.

Our individual and collective goals have also long been about more than food and natural resources. Agriculture is about good lives for people. And so, agriculture needs to engage in straight talk on equity and justice. In particular, we need to acknowledge a history - and the enduring nature - of systematic discrimination, stolen land and broken treaties, slavery, and denied economic opportunities for Native Americans and farmers of color, and take meaningful steps to make it right.

Overall, farm systems that create human and ecological resilience are those that reintegrate plants and animals on the land and that create opportunity for all humans and communities to benefit, including those who have been long excluded. **The crops and cropping systems that offer the most promising way forward share a common characteristic with each other and with the prairie and forest ecosystems that preceded them on the landscape: they provide Continuous Living Cover (CLC).**

Deep-rooted perennials and other continuous living cover crops can be planted today to produce positive outcomes for the landscape moving forward. This includes strategies like agroforestry, perennial biomass, perennial forage, perennial grains, cover crops, and the integration and stacking of these practices. The reintegration of more diverse cropping systems into row crop country is critical. Diversity leads to resilience. This is true in our cropping systems and in social terms. Human diversity and diverse agricultural landscapes are not independent of one another; in fact, if we ever want to fully embrace either of these, we must embrace them both simultaneously. **The central idea of this paper is that CLC, implemented equitably with people and communities at the center, can bring about both environmental and social changes sorely needed in agriculture. Envision agriculture as a solution.**



How might we achieve the bold and sweeping changes to agriculture that we are suggesting?

Large-scale change is needed to address complex and intractable problems. As with many things, these changes spark to life and become most visible through the actions of committed individuals on the ground. Across the paper, you'll read the stories of people and organizations making change possible today and embracing the idea that human diversity and diverse agricultural landscapes must be recoupled and nurtured together to support a new future for agriculture.

Both grounded individual efforts and collective pressure on big system levers are required to bring about a new agriculture. We offer these key strategies to support a more equitable agricultural landscape where continuous living cover abounds. This paper describes how...

We need to...

1. Support today's farmers
2. Create opportunities for tomorrow's farmers
3. Equip the next generation of agricultural professionals
4. Increase funding for research and development of new crops and cropping systems
5. Activate the system levers of markets, policy, and investment capital; and implement with a cross-sector, networked approach

This paper is not a policy brief or a marketing strategy. It is not an in-depth analysis of agriculture, biologically or socially. It is about stories. It's an endeavor to provide a cross-sectional look at guiding principles in action, examples of inspiration, and lessons learned from the past.

Read stories from the heart of Iowa, like how farmer Mark Peterson was gobsmacked by the results of adding cover crops to one of the lowest fertility areas of his farm or how the Severson Family was able to bring another generation back to the farm with the extra income from re-integrating livestock. Hear how an aunt-to-niece land transfer at Singing Hills Dairy is building a bridge for equitable land access and creating space for Black Minnesotans on the farm. Learn about stewardship practices on the Tsunhehkw[^] farm on the Oneida Nation in Wisconsin and about how the Intertribal Agriculture Council provides technical assistance and support for Native producers across the county. Hear from young scientists E. Britt Moore and Hannah Stoll about their plans to equip the next generation of agricultural professionals. Read about policy innovation in action, like the Illinois Fall Covers for Spring Savings program that took off at lightning speed in its second year, hitting full enrollment with farmers from across the state within 24 hours.

Get inspired by the stories of these and many other champions for a new agriculture.



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Green Lands Blue Waters (GLBW) convened the following group of leaders to develop and shape this paper. Green Lands Blue Waters is a vision for profitable agriculture based on keeping the soil covered productively year-round: farming with Continuous Living Cover. More information on our networked approach to landscape-scale change can be found at greenlandsbluewaters.org

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Landscape Scale Change – A Networked Approach

Green Lands Blue Waters and partners are conducting essential research, improving the genetics of old and new crops, translating knowledge into Continuous Living Cover farming systems, developing new extension and outreach capacity, working in farm fields, shaping policy, building profitable markets for new crops, and changing the narrative around what's possible through agriculture. The value of Continuous Living Cover farming comes in yields and profits, but also in improved soil health, cleaner water, new economic opportunities, diverse agricultural communities, more wildlife, reduced risk, and resiliency in the face of a changing climate.

www.greenlandsbluwaters.org



Making the case for Continuous Living Cover (CLC) agriculture and a human-centered approach to implementing it



The journey to a healthier agriculture on the human and ecological landscape

Agriculture is a journey. This is a rare example of a statement that, conceivably, all agriculturalists at all times in history might agree with. The work is never done: there are always fresh challenges and fresh opportunities around the corner, tomorrow, next year, and next generation. Though we often disagree on the details, sometimes sharply, most people involved in agriculture throughout the world would likely agree on a general set of goals: provide food, resources, and a livelihood for the household and the community; contribute to the healthy short- and long-term functioning of the ecosystem a farming system is embedded in, while protecting and building up the natural resource base; and deal fairly with neighbors. Also, on one level or another, everyone acquainted with farming knows that every system accumulates both successes and failures, and that the latter can't be hidden forever. The critter will get through the bad spot in the fence sooner or later – probably sooner. The little gully will become a big gully. Farming is largely a process of identifying and expanding on the successes, and grappling with and fixing the failures.

American agriculture has generated its share of successes: abundant food for many, an ethos of stewardship for those who choose to partake in it, and an enduring sense of hope about the future. We've become increasingly conscious of ways we have fallen short: soil and water degradation not yet reversed, agriculture serving as a net contributor to climate change, loss of farms and rural community vitality, an aching history of racial inequities that reverberate and continue today, and a loss of resilience in the face of environmental and economic disruption. But since time immemorial, farming has been about getting up the next morning and doing what needs to be done – about taking the next step on the journey, and then taking the step after that. This paper contemplates what the work plan for tomorrow morning might be.

The crops and cropping systems that offer the most promising way forward share a common characteristic with each other and with the prairie and forest ecosystems that preceded them on the landscape: they provide continuous living cover (CLC).

To build healthy and resilient landscapes and a stable climate, we suggest that the next steps in the journey involve rethinking the extractive nature of today's dominant farming systems and reshaping who is part of agriculture and who benefits.

Overall, farm systems that create human and ecological resilience are those that reintegrate plants and animals on the land and that create opportunity for all humans and communities to benefit, including those who have been long excluded. The crops and cropping systems that offer the most promising way forward share a common characteristic



with each other and with the prairie and forest ecosystems that preceded them on the landscape: they provide continuous living cover (CLC).

Continuous living cover systems are an example of putting diversity to work. While existing crop sequences may include as few as one or two summer annual grain crops, like corn and soybeans, the CLC approach offers many opportunities for additional functional diversity: perennial crops and winter annual crops, harvested or unharvested, that can be integrated into the cropping system to ensure full vegetative cover on the soil surface and living plant roots below the surface for most or all of each year. Continuous living cover options include perennial forages, nut trees, winter annual cereal grains and oilseeds, and new perennial grain crops, as well as unharvested cover crops and tree windbreaks that integrate with existing cash crops. The result? CLC cropping systems have many valuable functions benefiting the farming landscape. They can substantially reduce soil erosion, nutrient losses to ground and surface waters, and net greenhouse gas (GHG) emissions, while increasing soil health and water infiltration, and generating more revenue streams.

Perennial crops and winter annual crops, harvested or unharvested, can be integrated into the cropping systems to ensure full vegetative cover on the soil surface and living plant roots below the surface for most or all of each year.



Kickapoo River, WI - Credit: Anne Queenan

The ecological and physical benefits of CLC don't end at the farm gate, or even the county line. Clean drinking water and the benefits of biologically healthy surface waters are important for people everywhere, and reduced nutrient and sediment loading from agriculture directly improves those resources. People everywhere also benefit from stable hydrology and stable climate - CLC agriculture can increase water storage in fields, reduce flooding, and contribute to climate change mitigation while reducing a wide range of negative impacts on public infrastructure spending and human health.

Diversifying the crops and products coming off of farms offers opportunities to rekindle jobs and economic activity throughout the food and agriculture supply chain, in rural communities and urban areas alike - especially if opportunities for making strategic choices about localization or regionalization are pursued, and especially if equitable options for cooperative or community-centered enterprises are on the table. Introducing CLC crops to the landscape is also an opportunity to start reorienting agriculture to prioritize a more balanced, nutritious, and wider range of food products - especially if accompanied by food systems reforms to ensure equitable access to healthy food.

Continuous living cover agriculture offers a powerful solution set for increasing the ecological performance of agriculture while providing abundant food. Yet our individual and collective goals have long been about more than food and natural resources. Agriculture is about good lives for people. And so, agriculture needs to engage in straight talk on equity and justice. In particular, we need to acknowledge a history - and the present - of stolen land and broken treaties, slavery, and enduring dispossession of land and economic opportunity from

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Taking steps to level the playing field is important in addressing a legacy of racial discrimination, as well as easing the way for all new and aspiring farmers.

Native Americans and from Black farmers, and take meaningful steps to make it right. One of the most urgent needs and barriers for new farmers is land access. Farmland ownership is an overwhelmingly white proposition in the U.S. Black, Indigenous, and People of Color (BIPOC) communities often lack the capital and access to fair credit to purchase land or even to rent it. Both public and private approaches to addressing this land access problem are

needed. Taking steps to level the playing field is important in addressing a legacy of racial discrimination, as well as easing the way for all new and aspiring farmers.

Equitable access to resources and opportunities is important. It is also most critical and urgent that agriculture listen and learn from the stewardship knowledge of millennia that some descendants of Indigenous people present on this land across history and other people of color now in the U.S. continue to actualize, demonstrate and honor. Many roots of the CLC approach originated in these knowledge systems and they must be at the table.

If we take a human-centered approach to implementing CLC, maybe we can make the next leg on the journey of agriculture an especially successful one - and maybe we can all go together.



Greenley Research Center, MO - Credit: Ranjith Udawatta



Continuous Living Cover: the key to healthy soil, water, and climate

The Continuous Living Cover concept



Credit: The Land Stewardship Project

Mainstream U.S. agriculture has often faced substantial challenges in achieving conservation results, even when desired. As white settler agriculture displaced Native American agriculture and land stewardship, and forests and grasslands were replaced by grain crop fields, the result was accelerated soil erosion and loss of soil carbon – with immediate consequences for soil health and, as we now know, follow-on consequences for climate. As tillage intensity, artificial drainage, and the use of synthetic fertilizers increased in the 19th and 20th centuries, consequences mounted: increased local and regional flood control issues due to altered hydrology, increased water quality impairment due to nutrient loss to ground- and surface waters, and increased greenhouse gas (GHG) emissions.

The soil, water, and climate resource base on which our current system of agriculture depends was thousands of years in the making. Depending on geography, what is now farmland was created by 10,000 years to millions of years of soil development under diverse perennial vegetation, grazing ruminants and predators, followed by centuries to millennia of Native American stewardship. The original stewards of these lands emphasized managing perennial forest and grassland ecosystems for increased food production along with relatively low-disturbance production of a diversity of annual crops, usually interspersed with perennials in space and time. The cropping systems that currently occupy most U.S. cropland acreage could not be more different: continuous production of one or two annual crop species and livestock removed from the land. The starkness of this difference in functional ecology helps explain why our efforts to add a handful of annual commodity grain crop best management practices (BMPs) in



Credit: The Land Stewardship Project



isolation, such as reduced tillage and changes to nitrogen fertilizer rate and application timing, often fall far short of producing the conservation outcomes we need. We need a more decisive intervention, one that braids together lessons from Native American working lands management, from aspects of earlier generations of white settler farming systems - such as a larger diversity of crops integrated with livestock, and from modern agroecological farming and research: continuous living cover.

The CLC concept - incorporating perennial crops and sequencing annual crops into cropping systems in order to maintain year round living vegetative cover aboveground and living roots below ground - is a simple one. But its effects are potentially profound. The largest benefits come from perennial crops, which can provide intervals of zero soil disturbance ranging from two years (in the case of perennial forages incorporated into a short segment of an annual crop rotation) to decades (in the case of tree crops) and which produce an abundance of root biomass. Perennial crop solutions are not yet available for all economic niches that need to be filled on farms, but CLC approaches using cover crops, rotations, or winter-annual crops can also supply significant benefits when integrated with summer annual crops. Applications include everything from adding a single year of a cover crop to a corn-soybean rotation to systems integrating multiple harvested winter and summer annual crops in a double or relay cropping system, to grazing cover crops, or shifting land to pastures for grazing.



Pennycress - Credit: Katherine Frels

Continuous living cover provides an agricultural diversity that integrates additional species into cropping systems in a strategic manner to fill critical missing pieces of ecological functionality. It results in living vegetation in the right places at the right times to take up fertilizer nutrients before they are lost as water pollution. It likely puts carbon deep into the soil rather than emitting it as a greenhouse gas. It slows erosive rainfall helping to prevent soil detachment, formation of gullies, and flood damage to roads and infrastructure. CLC is an agricultural toolkit that can be employed in any number of ways to the benefit of soil, water, and larger ecosystems. When done right, the environmental impacts stretch far beyond the soil, rippling off farms and across communities.



UMN undergraduate student Chyna Williams in a Kernza® perennial grain field – Credit: Jacob Jungers





Key Continuous Living Cover Cropping Strategies

An extensive toolbox of CLC crops and cropping systems is available to use in a wide range of situations. One way to organize that toolbox is in terms of five key CLC strategies promoted by Green Lands Blue Waters.¹

Agroforestry



Agroforestry is a land management approach that integrates trees and shrubs with plant and animal farm operations. A commonly-used definition identifies five types of agroforestry: silvopasture, alley cropping, forest farming or multi-story cropping, windbreaks, and riparian forest buffers. The common theme of all these practices is that they involve positioning a strategically sized and placed subset of the agricultural system into tree cover. This can bring disproportionate benefits back in the form of conservation impacts and increased productivity of other crops in the system. When an agroforestry cropping system involves harvested tree crops, such as fruit and nut trees, it can provide supplemental economic returns, or can become the central economic activity in the field. Well-managed agroforestry systems bring a high level of conservation benefits in general, but notably in climate change mitigation. Out of all perennial crop options, tree crops have a uniquely high potential to store carbon in standing biomass – tree trunks, branches, and roots in the soil. This provides easily assured carbon sequestration, sidestepping the complexities involved in managing and measuring soil carbon.

Perennial Biomass



Perennial biomass crops are grown and used for renewable energy. They can be grown as cover crops, perennial grasses, and short-rotation trees. Many of these plants can be used as forage for livestock. While not widely produced for energy needs now, perennial biomass crops offer future opportunities for a renewable energy source with ecological benefits. The conservation benefits provided by herbaceous perennial biomass crops are similar to those provided by perennial forages, discussed below. Woody biomass crop benefits are likewise similar to those provided by other tree crops. Woody plants, however, require managing the harvest with great care to avoid introducing a window of high vulnerability to soil erosion and other problems.

Perennial Forage



Perennial forage refers to land planted with perennial plants that feed livestock, including grasses, legumes like alfalfa and clover, and other herbaceous species. Carefully managed grazing or hay production can benefit the environment by improving soil health, reducing runoff and soil erosion, creating wildlife habitat, sequestering carbon, and conserving resources. One standout characteristic of well-managed perennial forage crops is the ability to produce extensive root systems that provide highly assured benefits for soil health and water quality, and potential for substantial soil carbon sequestration. Well-managed rotational grazing of ruminants can benefit farmers by improving the quality and production from these systems.

Perennial Grains



Unlike annual grains, perennial grains are crops that are alive year-round and are productive for more than a year. They can have deeper root systems and longer growing seasons and therefore absorb and hold more rainwater and better capture nutrients – leading to less erosion and runoff of soil and nutrients into water supplies. Compared to annual crops, perennial grains may maintain and capture more carbon in soil, require smaller amounts of fertilizer and herbicide, and reduce or eliminate the need for tillage. Perennial grain crop options are just beginning to emerge, with early-stage varieties of intermediate wheatgrass Kernza® (*Thinopyrum intermedium*) perennial grain in limited production in the Midwest and other parts of the U.S. More than half a dozen other perennial grain crops are under development around the world,² with researchers aiming to combine conservation benefits – traditionally only obtainable from perennial forages and tree crops together – with a level of productivity and food quality historically only available from annual grains. Perennial grains may be grown in a dual-purpose grain and forage system, providing management benefits and multiple revenue streams.

Cover Crops, Winter Annual Crops, and Rotations



A variety of options exist for adding CLC to existing annual crop rotations when converting a field to permanent perennial cover is not possible. Cover crops are legumes, grasses, or other plants grown to maintain and improve a farm's natural resource base, as well as the broader surrounding ecosystem. While the cover crop role is most often filled by annual species, increasing attention is being placed on developing options for perennial cover crops, also known as mulch crops: short-stature perennials that annual grain crops can be interplanted into each year. There are also promising harvestable winter-annual oilseed crops currently in development that can be grown in a double or relay cropping system. For example, field pennycress (*Thlaspi arvense*) and winter camelina (*Camelina sativa*) can provide the conservation benefits of traditional annual cover crops, but can also be harvested and sold as another crop in a farm's portfolio. Finally, perennial forages or perennial grains can be placed into rotation with annual grain crops, providing two or more years of perennial cover in the system. Well-managed rotational grazing of ruminants may prove to be helpful in managing these systems and provide another revenue stream.

On-Farm Integration and Stacking of CLC Practices

On the farm, these strategies rarely operate in isolation. An integrated, whole-farm system is the goal. All of these strategies offer paths to get there and any individual farm often “stacks” several of these practices, arranging them in a mosaic structure or rotating them sequentially on the same piece of land to capture maximum benefits. These integration efforts are a key stimulus for innovation on the part of farmers and scientists. Definitions periodically need to expand to encompass these innovations. Prairie strips in the middle of fields, herbaceous perennial buffer practices at the edge of fields, and perennial cover crops are all examples of integration and stacking.

Outcomes from CLC agriculture

Outcomes for soil

The starting point for resilient, healthy soils is addressing soil erosion – by first slowing and ultimately reversing it. Soil erosion reduction efforts in the U.S. have largely stagnated since 1997,³ and most agricultural systems are still losing soil significantly faster than new soil is being formed.⁴ Continuous living cover systems can deliver superior erosion reduction outcomes,⁵ because they not only provide superior aboveground vegetative cover relative to conventional annual systems that leave crop residue on the soil surface, but also provide a greater abundance of living roots belowground. Benefits are enhanced when combined with reduced tillage such as strip-till or no-till. This is particularly relevant for fighting two erosion pathways of greatest concern for the Midwest: rill and ephemeral gully erosion.⁶ Fields converted to perennial grassland or tree cover are at least 10 times more likely to experience soil formation that exceeds the rate of soil erosion,⁵ the true benchmark for long-term



Healthy Soil - Credit: Anne Queenan



Gully erosion - Credit: Anne Queenan

sustainability. CLC systems also deliver outstanding outcomes for soil health and soil quality, including traditional indicators like porosity, aggregate stability, and nutrient availability, as well as fostering a favorable environment for beneficial soil microorganisms and soil organic carbon content.⁷⁻⁹ Recent research has underscored that the core idea behind CLC – diversity that works – is beneficial with respect to soil quality, finding that adding perennials and cover crops to annual crop rotations provides greater soil carbon benefits than adding the same amount of diversity in the form of additional summer annuals.^{10,11}



Outcomes for water

Continuous living cover systems are arguably the paramount water quality intervention available in agriculture. Adding perennials or winter annuals to a cropping system can increase crop uptake of soluble nutrients like nitrogen, resulting in decreased leaching and contamination of groundwater.¹²⁻¹⁶ Through decreasing the rate of surface runoff and soil erosion,⁵ CLC systems also reduce sediment loading of surface waters, with associated soil-bound nutrients.¹⁷⁻¹⁹ Meanwhile, increased infiltration and soil water storage result in better ability of agricultural land to buffer flooding events,^{20,21} which provides improved outcomes not only for rural and agricultural stakeholders, but for urban residents and everyone who has a stake in reducing flood damage to public infrastructure.



Salem Creek, MN, filled with sediment - Credit: Erin Meier



St. Croix River, MN/WI - Credit: Anne Queenan





Kernza Field , MN - Credit: Brad Gordon

variability in exactly how much carbon can be stored in perennial grassland systems or how long that carbon may last, especially if perennial management changes.²⁷⁻³⁰ Well-managed rotational grazing of perennial grasslands, for example, has been shown in some situations to be carbon neutral or negative.³¹⁻³³ Annual CLC practices provide much smaller carbon benefits.^{34,35} Although the greatest attention has been focused on understanding carbon emissions and drawdown, CLC agriculture also might be a large leverage point in the form of reducing emissions of trace gases with high global warming potential, particularly nitrous oxide (N₂O). While the research in this area is very new, any cropping system, especially those such as perennial grasslands that are very effective at taking up nitrogen fertilizer and preventing excess leaching into soil or waterways, could result in lower N₂O emissions.^{33,36} CLC crops and practices offer a variety of opportunities for increasing nitrogen uptake and for biological nitrogen fixation in the field.³⁶⁻³⁹ Additionally, CLC crops, especially perennials, often perform better in extreme weather events and can help farmers and communities adapt to climate variability.



Perennial Grazing on Cates Family Farm, WI - Credit: Susie Theis

Where agriculture can contribute any carbon drawdown to the climate change mitigation effort, CLC crops maximize that potential. Agroforestry practices have the largest potential to sequester stable quantities of carbon aboveground in tree trunks and branches, with longevity of that stored carbon depending on management details²². Long-term perennial grassland cover can also sequester large amounts of carbon in the soil over time²³⁻²⁵ and appropriately selected and managed perennial crops provide very extensive root biomass inputs.²⁶ While perennial grassland is one of the most promising avenues for carbon sequestration, there is unfortunately a high degree of



Outcomes for communities and total system resilience

Ultimately, an agriculture based on continuous living cover can deliver increased resilience system-wide: healthier ecosystems, less dependence on external inputs, less vulnerability to weather extremes, greater crop and landscape diversity, a broader spectrum of economic opportunities and - when implemented with equity top of mind by and for a diverse range of people - a more tightly woven social fabric and strengthened communities.^{40,41} Every human being on the planet depends on the health of our shared ecosystems. While promoting positive ecological and biophysical benefits does not in any way automatically ensure positive social benefits, the connection between human health and environmental health is undeniable. The central idea of this paper is that CLC, implemented equitably with people and communities at the center, can bring about both environmental and social changes sorely needed in agriculture. Imagine for a moment all the ways that agriculture can be a connection point between vibrant communities and thriving environments; envision agriculture as a solution.

The central idea of this paper is that CLC, implemented equitably with people and communities at the center, can bring about both environmental and social changes sorely needed in agriculture.

While promoting positive ecological and biophysical benefits does not in any way automatically ensure positive social benefits, the connection between human health and environmental health is undeniable. The central idea of this paper is that CLC, implemented equitably with people and communities at the center, can bring about both environmental and social changes sorely needed in agriculture. Imagine for a moment all the ways that agriculture can be a connection point between vibrant communities and thriving environments; envision agriculture as a solution.

What the transition to CLC looks like on the ecological landscape



Corn & Alfalfa – USDA NRCS; Biomass Planting – Steve John; Cattle grazing – Land Stewardship Project; Agroforestry – Dave Hanson; Joia Food Farm; Interseeded Cover Crop – Keith Hartmann

Every journey starts with the first step. The appropriate first – or next – step toward increased CLC adoption will vary from farm-to-farm and from region-to-region. On some farms an initial foray may be adding a winter annual cover crop or a winter small grain cash crop to an existing annual crop rotation. Other farms may be ready to start or expand grazing of ruminant livestock on permanent pasture or on cover crops, or to begin alley cropping with harvested or unharvested tree crops.

Farmers who are ready for more intensive CLC practices could move into intensive rotational grazing on permanent pastures, possibly involving silvopasture (the deliberate integration of trees and grazing livestock on the same land), and possibly in the context of premium grass-fed markets for beef cattle or other ruminants. Annual crop rotations could be extended with two or more consecutive years of a perennial forage or, for some growers, Kernza® perennial grain. Potentially lucrative fruit and nut crop markets are available for farmers willing to transition to intensive agroforestry and horticultural crop production. As we consider the varied ways that CLC can be introduced onto a farm, let's also consider the importance of opening the possibility of CLC to a wider set of farmers - including socially disadvantaged farmers - by intentionally supporting land access as well as expanded definitions of and access to knowledge, training, and mentorship opportunities.



New perennial crops and markets are on the horizon. If public agencies and the private sector fully commit to funding accelerated research and development, these crop options could offer farmers increasing opportunities over the coming years. They combine the benefits of staple food and feed grain crop production with the large conservation benefits of perennial cover and have the potential to rapidly scale up a decade or more from now. In the nearer term, two new winter annual oilseed crops from the mustard family, suitable for double cropping with summer annual cash crops, are making their way toward commercial release to serve biofuel and bio-product markets: field pennycress (*Thlaspi arvense*) - a domesticated version of the familiar winter annual weed - and camelina (*Camelina sativa*).⁴² If and when markets emerge for cellulosic biomass feedstocks for heat, power, transportation fuels, or bioproducts, familiar perennial grass species like switchgrass (*Panicum virgatum*) and novel species like giant miscanthus (*Miscanthus × giganteus*), become viable options for producers.

New perennial crops and markets are on the horizon.

For most ecosystem services, well-adapted perennial crops perform better than even the best annual crop systems. This means that, over the short term, use of existing perennial crop options should be maximized: perennial hay and forage crops, perennial biomass crops, tree crops for specialty fruit and nut markets, and early-stage perennial grain crops for specialty markets. Over the near term, we will still depend on annual grain crops for much of our staple food and feed production. Cover crops, and winter annual cash or grazing crops should be incorporated into these systems to immediately achieve the benefits of CLC.



Pennycress - Credit: David Marks

Achieving long-term sustainability requires a transition to a true perennial agriculture - one based primarily on continuous production of perennial crops - where annuals occupy a decreasing share of total crop acreage. This means that the other short-term action required is to fully invest in the development of perennial staple food crops: perennial grains and improved tree crops. As these new perennial crops gradually become available, the percentage of the agricultural landscape in perennials will increase.



Contoured strips and covered fields, WI - Credit: Anne Queenan

Large benefits can be captured earlier in the transition by placing perennial acres in the most environmentally vulnerable areas. As additional highly productive perennial staple crops become available, they can replace additional annual crop acres. Eventually, the annual grain and vegetable crop acreage remaining can be accommodated on only the flattest, most ecologically-resilient farmland.

In ecological terms, the CLC journey will be one of increasingly healthy soils on farms and cleaner water for rural and urban residents alike. It will be a journey through which agriculture transitions from being a net source of greenhouse gas emissions to a net sink. **Fields that are bare and brown most of the year will become shades of green nearly all year. The ecological challenges experienced today in agriculture are urgent. Nevertheless, we can break up the transition into one or two manageable steps at a time as we move to increase CLC acreage and practices.**



A human-centered approach to CLC: healthy and resilient people and communities

Crops and cropping systems do not exist in a vacuum with respect to social, cultural and equity-related concerns. Equity concerns do not exist in a vacuum relative to the ecological integrity of the landscape. An integrated approach to naming and dismantling extractive and exploitive systems in agricultural and food systems is required. The social pieces are just as important as the crops. Through examples across this paper, we shed light on many inspiring ways to build a better agriculture. As with the ecological rationale for adding diversity to cropping systems through CLC, an equity-centered approach to implementation is an essential ingredient to the success of our endeavors, and a diversity of human

As with the ecological rationale for adding diversity to cropping systems through CLC, an equity centered approach to implementation is an essential ingredient to the success of our endeavors and a diversity of human perspectives must be actively involved and sharing leadership.

perspectives must be actively involved and sharing leadership. Critical to this is broadening the circle of stakeholders whose opinions and perspectives influence and lead the creation of a new system of agricultural policies, practices, and benefits. Because we all depend on soil, it can be a place for finding “shared ground.” This common denominator of soil, the very foundation that our food and agricultural systems are built on, can be used as a platform to bring people from all walks of life and backgrounds together to contribute to an equitable and sustainable food system.

Understanding and acknowledging historical and present transgressions is imperative and is the point of departure for moving agriculture forward. **Land, labor, and capital are primary factors of production in agriculture. All three have been used throughout history – and at present - to concentrate power and wealth.** A reimagined use of all three of these resources is essential to a successful food and agriculture system that serves all. We touch only briefly on equity here as related to race and demographics, equity for farmers and rural communities, and access to healthy food and clean water. But building in equity requires our fullest attention and creativity as we work to shift agriculture.

Racial and cultural equity in our farmer population

Historically, agricultural systems abundant in living plant cover dominated croplands in the U.S. through Indigenous practices that molded the landscape in accordance with distinct values of land stewardship and traditional knowledge systems. However, colonization and displacement of Native Americans from their land brought about violent change to the landscape – away from the way Native peoples stewarded land and produced food and other agricultural products. U.S. government-led land redistribution programs systematically discriminated against all non-White minorities. The entire agricultural history of the U.S. as a country is inextricably linked to slavery and the repercussions are still very much present in the lives of Black farmers.⁴³ We must be upfront about the facts: U.S. agriculture is built and maintained on stolen land with stolen labor. Widespread discrimination by the USDA towards minority communities is well documented and proven through major court cases.⁴⁴⁻⁴⁷ Access to land and capital remains one of the biggest barriers for all farmers, but even more so for BIPOC farmers. Changes to federal farm programs since the 1960s incentivized large-scale production putting farm-related capital further out of reach for many.⁴⁸ Such programs also disincentivized continuous cover. The resulting impacts continue to cause significant harm to both human and crop diversity in the U.S.

Access to land and capital remains one of the biggest barriers for all farmers, but even more so for BIPOC farmers.



The colonial European model of agriculture plowed under much of the ecosystem across what is now the U.S. Native Americans in the U.S. had already created a deeply place-based understanding of ecological systems on these landscapes, with agricultural practices abundant in perennialization and living cover. Many Native American communities are carrying forward and reinvigorating generational stewardship methods. All agricultural practitioners could benefit from listening, learning about, understanding, and supporting these practices in partnership with Native communities. These practices were meant for their respective landscapes in the U.S. It would be beneficial to prioritize understanding them in partnership. To add to this diversity of ideas, there are many immigrant and migrant communities that bring tremendous agricultural expertise to the U.S. Improving access to land and capital is a major tool for supporting the abundance of agricultural knowledge embedded in these communities, many of which are actively focused on rekindling culinary and cultural identities in the U.S. through food production.

Many BIPOC communities have their own traditional food sources and systems that can be reintroduced onto U.S. croplands as part of the CLC movement, while supporting community-based culinary and cultural identity through agriculture. These range from the reintroduction of bison or elk grazing in perennial systems, to plantings of traditional perennial herbs for food and medicine, to planting or wild harvesting tree crops.^{49,50} In this way, CLC systems and food in general may serve as common ground for people from different backgrounds to come together as systems move towards CLC and crop



Schwartz Prairie, MO - Credit: www.HenryDomke.com

diversification. While landscape-scale CLC is implemented largely in agricultural rural areas with broad acreage, urban agriculture can also be an essential connection to food and farming. There are many Native American, immigrant and other communities of color, both rural and urban, that champion the benefits of community-based agricultural initiatives, often with a long-term understanding of and respect for soil health as a primary foundation for successful agriculture. A recent wave of revitalized food-systems-change momentum and organizing around food access and sovereignty continues the thread of past ways towards a more perennialized agriculture. This work is often led by communities intentionally rebuilding their cultural identities linked to agriculture, and can demonstrate a new path forward while chipping away at addressing the structural factors that reinforce racism in agriculture.



Consolidation in our agricultural system is a long-term challenge and the increasing concentration of wealth and ownership does not benefit many farmers or rural communities.

The issues in landowner demographics are not limited to the lack of racial diversity. Eleven percent of the nation's farmers manage over 70% of the nation's farmland,⁵¹ highlighting an acute lack of equity, in broader terms, in the current system. The continuous trend of decreasing farm numbers but increasing farm size over the past half century has exaggerated the issue even further. Consolidation in our agricultural system is a long-term challenge and the increasing concentration of wealth and ownership does not benefit many farmers or rural communities.

Integrating continuous living cover crops into the existing cropping systems across the U.S. can have positive impacts on rural communities. Diversifying farm income streams is one benefit. Continuous living cover crops that are added into whole farm plans could generate more income opportunities for farmers as well as potential roles for other businesses in rural areas such as food processing or seed sales. As one example, growing a winter annual cash cover crop like field pennycress that can slot into the fallow periods between a corn-soy rotation could give farmers the potential to monetize three crops in two years compared to just two crops. While these winter annual examples are still very nascent, in the case of new oilseed crops like pennycress and camelina, in addition to the farmer's potential monetary gain from a third cash crop, rural communities could stand to win. Strategic partnerships early on focused on rural economic development can help boost regional jobs across the supply chain sector and processing industries.



Zenith Tandukar in Pennycress Field

Shifting agriculture to more CLC does not directly equate to wins for farmers and rural communities, though - that takes intentional planning, practice and policy. The crops and the farmers producing them must be bolstered by public investments and policy supports for engendering consumer demand, developing markets, and regionalizing processing and distribution of CLC crops. Consistent and increasing market pull, investment and infrastructure support, over time, can drive adoption to scale, with tremendous benefit to farmers and communities. Strategic regionalization is needed with right-sized beyond-the-farm-gate systems - like transportation, aggregation, distribution, and processing - that are economically viable. Regionalization can offer new CLC farmers access to these markets as well as support related food/agricultural sector employment at a regional level.

Important questions and decisions remain about what businesses and business models will carry these solutions forward, including who will bear risk, who will benefit, and who shares in ownership and decision making control. In order to actualize the social and environmental benefits of CLC, innovative models and partnerships must be cultivated.



Equitable access to fair, healthy food and clean water

Everyone has a right to healthy food and clean water. Today, the U.S. has 39.5 million people living in low income, low food access areas, both rural and urban. It is not easy for everyone to eat fresh vegetables, whole grains, nuts, and fresh, local meats.⁵² Higher risks for diet-related conditions such as obesity, diabetes⁵³ and cardiovascular disease⁵⁴ are associated with lack of access to healthy, affordable food,^{55,56} and much of our agricultural land produces feedstocks that result in an overabundance of cheap food products high in fats, sugars, and calories. Continuous living cover crops and systems are not a simple fix to such complex problems, but most CLC crops are rich in nutritional values, including nuts and berries from tree crops, oils high in polyunsaturated and monounsaturated fats and oleic acid, grass-fed livestock products, and grains that produce flours high in protein and fiber content.



Local grain processing by members of the Artisan Grain Collaborative

It is difficult to deliver CLC food products without a higher price tag. Therein lies a pervasive double bind. Cheap food is very often an indicator that people along the supply chain are not being paid fairly. To fairly pay farmworkers for their labor, the price of food must increase. This leads to challenges with equitable food access. Both sides of this coin deserve consideration as we move forward.

Like healthy food, safe drinking water is a must. Continuous living cover crops, perennials in particular, provide one of the most well-documented ways for agricultural lands to contribute to clean drinking water. An agriculture that is dominated by the CLC approach can be part of the path to better human dietary and public health outcomes.

What the transition looks like on the human landscape

Transition to CLC will need major changes to the current crop and human landscape supported by stakeholders at the individual farm level to the highest levels of government and decision making authority. Food and agriculture systems are intricately linked to our livelihoods, and approaching the necessary transitions at all scales and from all angles will require all hands on deck. A CLC paradigm shift with farmers and practitioners from different backgrounds working together synergistically is not only more likely to promote a more sustainable agriculture, but also a more just and equitable human landscape.



Making it visible - What we need to do and what it looks and feels like



Credits: Oluwakorede Olugbenle, Fahd Majeed, Yasmin Yassin, Benjamin Bishop, Daniel Hayden, Melanie Peterson

How might we achieve the bold and sweeping changes to agriculture that we've been suggesting?

Large-scale change is needed to address complex and intractable problems, and yet - as with many things, these changes spark to life and become most visible through the actions of committed individuals on the ground. In the following sections, you'll read the stories of people and organizations making change possible today and embracing the idea that human diversity and diverse agricultural landscapes must be recoupled and nurtured together to support a new future for agriculture.

Both grounded individual effort and collective pressure on big system levers are required to bring about a new agriculture. We offer these key strategies to support a more equitable agricultural landscape where CLC abounds.

We need to...

1. Support today's farmers
2. Create opportunities for tomorrow's farmers
3. Equip the next generation of agricultural professionals
4. Increase funding for research and development of new crops and cropping systems
5. Activate the system levers of markets, policy, and investment capital; and implement with a cross-sector, networked approach

We need to support today's farmers

All farmers today face many challenges. Farm prices are variable, leaving farm incomes wildly unpredictable from year to year, even while the costs of inputs like seed, herbicides, and machinery repair rise steadily. Changing weather patterns magnify the variability. Farmers may not agree on why, but they know the climate is changing. Some carry a great deal of debt, and wealth held in land or equipment is not available to mediate the year-to-year stress of financial fluctuations.



About 1,000 farmers call Farm Aid's Farmer Hotline annually¹. This means that every day, roughly three farmers, at least, feel so overwhelmed with their finances, their physical or mental health, or their overall stress that they need to talk to someone and actually pick up the phone to a hotline. Even though difficult to track and report,² farmer suicides and struggles with mental health are a reality in rural America. Additionally, our farmers continue to age as a group. Across the country, most farmers are white (95%) and male (64%); the average age of a U.S. farmer is 58.³

Most in the Midwest are growing the status quo rotation of corn and soybeans. Less than 3% of research funding for agricultural land grant universities supports agroecological research.^{4,5} Technical assistance often tends to come from chemical companies or extension agents who have grown up with an agribusiness mindset. In many farm communities, neighbors still raise an eyebrow at those who do something different, whether planting a cover crop or transitioning to organic.

It can be even harder for farmers who don't fit the local norms, who don't come from farming families, or who haven't inherited land. In many regions, the cost of farmland and other capital expenses are far out of reach for new farmers. In particular, Native American farmers, Black farmers, and other farmers of color have experienced land theft and broken treaties^{6,7} for centuries and have faced discrimination from everyone ranging from local businesses to the USDA.^{8,9} Women landowners, and those who are not straight or cisgendered, have also long experienced a persistence of factors that continue to leave them marginalized in agricultural practice and policy.^{10,11}

In 1920, almost a quarter million African-American farmers owned 14% of U.S. farmland. In 2007, after a century of land theft, white terrorism, and rampant discrimination by the USDA,⁸ only ~30,000 of the 2 million farmers in the U.S. are African-American, holding just 0.5% of U.S. farmland. In Illinois, there are only 188 individually Black-owned farms. Iowa has just 45.^{6,12,13} In much of farm country, extension agents and most agricultural professionals tend to be white men, which may add another layer of difficulty for socially disadvantaged farmers.

Nonetheless, farmers are tenacious, sometimes especially if they're bucking the trend. The multigenerational Rademacher Farms in Eastern Illinois uses no-till, CLC, and other practices to improve biodiversity. Over a picture of a sunflower blooming in a multispecies cover crop, their website declares, "Proudly giving the neighbors something to talk about."¹⁴

Despite the pressures, farmers figure out how to do what is best for their land, community, and family, even if some days it feels like mowing uphill. **Increasingly, they are learning how to keep their fields covered and building the health of the soil - concepts that themselves represent a huge shift in thinking from earlier agronomic principles and education.** Today's farmers are learning about soil health^{15,16} and making changes in their practices for all sorts of reasons. Perhaps their yields are down, or they are facing weeds increasingly resistant to herbicides, or they want to insulate their fields from extreme weather.





Credit: Illinois Stewardship Alliance

Kathy and Rick Kaesebier farm 600 acres in central Illinois. For nearly 40 years, they farmed conventional corn and soybeans. But they began to have some unusual problems with their soil, and jumped at a chance to take an intensive soil health course. As they learned about the soil microbiome, they adopted new strategies for addressing their disease and weed pressure challenges. They began experimenting with 20 acres of cover crops, and quickly grew to using them on every acre. Within just five years, they had diversified their four-decade corn and soybean rotation to include wheat, a multispecies cover crop, cattle, Katahdin sheep, layer hens, and honeybees - and a guardian donkey.¹⁵

Not everyone makes as big and fast a leap as the Kaesebiers. No matter where they are in their journey, all of those making a decision to do something different and farm for resilience need support. Curiosity is the first ingredient, but there must be a structure to help farmers nurture their inquiry or it can easily be crushed. Trying new things requires failure, and good support can be the difference between disheartening failure and helpful failure. **We need systems that support today's courageous early adopters in order to build a future where similar choices are the norm.**

This support can take many forms including:

- Learning opportunities, including peer networks, faith, and other communities

Practical Farmers of Iowa (PFI) holds shared learning calls and runs email listservs that provide a safe space to ask questions. Farmers report these spaces help them feel less isolated for trying new things.

- State and federal government and private sector incentives

One example is Iowa's Soil and Water Outcomes Fund.¹⁷ Producers perceive state-based programs as easier to navigate than federal programs, and the state program flexibility can be better tailored to fit farmers' needs. The 2021 EECO Forever Green and Minnesota Department of Agriculture Implementation Program¹⁸ offers 'economic risk payments' and in-field technical support to farmers willing to experiment with planting new crops with demonstrated ability to improve water quality.

- Models and opportunities to co-create a culture of experimentation rather than conformity

Many farmers who have started to farm for soil health say that they're having more fun farming than they have in years because of the learning and experimentation. Farmers report that initiatives such as citizen science projects or PFI's Cooperators Program, which pays farmers to do on-farm, replicated trials of a practice they are curious about, create just as much value by supporting experimentation and curiosity as they do by generating research results.



- Education and support for non-operator landowners (NOLs) and renting farmers

In the Midwest, well over half the farmland is farmed by tenant farmers.¹⁹ The landlord/tenant relationship can be a delicate balance. Landlords may want conservation practices implemented, but tenants may not have the knowledge or interest, or be willing to invest time or effort into land they do not own. Conversely, tenants may want to plant cover crops on their leased land but not be allowed by their landlord. Programs to educate NOLs on the benefits of conservation practices and to support tenant farmers in implementing them, such as those available through American Farmland Trust and Women, Food and Agriculture Network, have shown widespread benefits.^{20,21}



GLBW meeting on non-operator landowners - Credit: Erin Meier



Credit: Connie Carlson



SPOTLIGHT - Tsyunhehkw[^] Farm²²



Tsyunhehkw[^] (*joon-heh-kwa*, “life sustenance”) Farm was started on the Oneida Nation in Wisconsin in the 1950s, though its roots go back millennia.

“The Oneida are known as the first agriculturalists,” says Farm Supervisor Kyle Wisneski. “It is woven in our DNA to be connected to the ground. We lost a lot of old knowledge when the Oneida were forced to move from New York to Wisconsin.” Tsyunhehkw[^] is restoring that knowledge and the community’s traditional foods. It is best known for re-establishing high-protein Indigenous white corn, a traditional staple of the tribe’s diet that is made into over a dozen foods. White corn and other Oneida foods now grow not only at the farm but in more than 75 traditional gardens at people’s homes around the reservation as a result of the farm’s education programs.

Practices at Tsyunhehkw[^] include intensive rotational grazing with a Shorthorn cattle herd. “Although we don’t have the land base or animals, we are recreating the move of bison on the Great Plains, which created the richest soil in North America,” says Wisneski. “The closer we can mimic the bison roaming the prairies, even with cattle, the closer we can get to the Native ecosystem.”

Tsyunhehkw[^] has always been small in comparison to the Oneida Nation Farm, which grows conventional crops and beef, but it has been rapidly expanding, since Tsyunhehkw[^] staff were asked to remediate some land from a manure spill.

Wisneski outlines the process: “We put our cattle on it for the winter and put our native grasses on the 20 acres that were most affected. We let the environment do its thing. The recovery was amazing - we lowered the contamination from 100% to 7%.”

Since then, Tsyunhehkw[^] has recovered more acres that had been conventionally farmed; it is now stewarding over 400 acres. When they are asked to steward new land, Wisneski says, “We let the land rest for a year. The weeds that grow tell us everything we need to know – they show us the soil’s deficiencies.” They graze it in the second year, and then, “We plant sunflowers; when they’re 8-10”, we’ll throw a native grass in there to cover the ground. The sunflowers grow so fast that the grass doesn’t get more than half an inch to an inch tall all year, we’re just looking for cover. We do that for two years. At that point, the land is prime for food production or for our seed bank, that’s when we’ll get the best yield.”



Credit: Kyle Wisneski

SPOTLIGHT - Mark Peterson working with

Practical Farmers of Iowa²³



Credit: Mark and Melanie Peterson

In 2003, as Mark Peterson was trying to decide how to manage the farm he and his wife had just bought, he went to a meeting on organic methods. The presenters were so infectious that he joined their organization - Practical Farmers of Iowa (PFI) - on the spot. While he didn't go organic, PFI taught him about cover crops and soil health, which did determine the direction of the farm. Mark tells more of his story...

"In fewer than 10 years planting cover crops, we have seen an increase in organic matter in excess of one full percentage point. That's a free 20 pounds of nitrogen and an extra inch of water-holding capacity. That's a benefit in two ways: when we have one of these almost-annual 'hundred-year floods,' the ground will absorb an extra inch, and when it's dry, that's an extra inch of water you're holding on to.

"One piece of land hadn't been treated very well prior to us farming it. Our soil agronomist said it was the lowest fertility level that he'd seen in any piece of ground, with a corn suitability rating (CSR) in the 40s (much Iowa farm ground has a CSR in the 90s). We fumbled with it for a few years and then decided to get drastic.

"It was the first piece that we put out with small grains, followed by a multi-species cover crop. I intended to no-till a crop into the cover crop the next spring, but it grew so well that I was nervous about doing that. So, we made the decision to bring a neighbor's cattle in and process the cover crop into these nice cow pies. They did an awesome job of it. Now we graze all of our multi-species cover crop; I think it's key to get the biology of the manure.

"We did no-till corn into it the next spring, followed by no-till soybeans, and corn again the following year. And that second year corn crop was slightly over 200 bu/acre! On this very low-CSR ground. I was gobsmacked, to say the least. It was unbelievable."

SPOTLIGHT - Illinois Fall Covers for Spring Savings Program

More and more states are investing in soil health through incentive programs. After neighboring Iowa rolled out a successful cover crop insurance program in 2019, Illinois soil health advocates worked with the governor and legislature to pass a similar measure. The Illinois Fall Covers for Spring Savings (FCSS) program, started in 2020, gives farmers a \$5/acre discount on their crop insurance premiums for every acre they plant to cover crops. The program took off: in its second year, it was fully enrolled within 24 hours. Requested acres rose by more than one-third from 2020 to 2021, from 113,000 to 185,000 acres, with 70% of applicants new to planting cover crops.



Credit: Anne Queenan

Advocates pushed again for an expansion of FCSS for the 2022 season, concerned that people will give up on the idea of cover crops if they can't get into the program. While applicants requested 185,000 acres in the program's second year, there was only funding for 50,000 acres. On June 1, 2021, the Illinois General Assembly approved a state budget that increased the Partners for Conservation Fund and doubled FCSS to 100,000 acres.²⁴

Midwesterners know the one-mile-square grids of the countryside. One of those grid sections (actually called a *section*), contains 640 acres. If you were to drive a 40-mile stretch of road, seeing the sections on both sides planted to cover crops, you would have seen 50,000 acres. That's about the distance of Chicago, top to bottom. Even jumping up to 200,000 acres only covers 160 miles of sections. That's cover crops on one trip from the bottom to top of Iowa. To cover the whole state, you'd need 150 trips. Only 149 more trips to cover...



Credit: Russ Gesch

We need to create opportunities for tomorrow's farmers

It has been said that the best time to plant a tree is 20 years ago; the second best time to plant a tree is right now. The same goes for training new farmers - those who will farm for resilience now to create a healthier future.

The average age of farmers has increased in each of the last several USDA Agriculture Censuses, as young people face the challenges discussed above and either can't see a way to get into farming or can't make ends meet doing it. The best time to invest in support for a new crop of farmers was 20 years ago. And in fact, seeds were planted then, with new programs in sustainable agriculture and related fields established at universities. The students in those programs are now teaching today's students and making recommendations for today's policies. The second best time to support new farmers is right now.

Systems-level support is needed to equip a generation of diverse new farmers to farm holistically and achieve multiple benefits of production.

This support must not only be for farmers to learn and implement ecosystem-oriented agricultural practices, it must be systems-level support, recognizing that new farmers – like all human beings – are embedded in families, communities, and cultures that all come with webs of assets and challenges, and access to farming should be equitable for all. This will include addressing the obstacles outlined above, such as access to land and agricultural capital, with a goal of equipping a generation of diverse new farmers to farm holistically, drive new markets, achieve multiple benefits of production, and steward natural resources. But how do we get there?

Here are some examples of what the framework could include.

- Create holistic pro-family, pro-worker, human-centered policies.

There was a period of several generations in the U.S. when farm labor in the Midwest and Great Plains was based on the nuclear and extended family. In general, men worked in the fields, women worked in the house and garden, and children provided additional labor. This model has become much rarer in the last few generations. Today, more than half of farmers have a primary occupation in addition to farming.¹ Farming is a job, and as such, farmers have the same needs as all workers, including access to affordable healthcare, childcare, and retirement. Gaining access to health insurance and other benefits is one oft-cited reason for one person working off the farm. Along similar lines, given the number of new farmers trying to enter the field out of college rather than from a farming background, the National Young Farmers Coalition calls for student debt to be forgiven for farmers after 10 years of work, mirroring similar programs for nurses, teachers, and other public service professions.

- Repair historic and current harms and inequities.

Centuries of land theft, enslavement, unjust laws, and discrimination have meant that BIPOC communities, those whose land and labor built the country, on average have much lower rates of generational wealth and access to land and resources than white people do. This simply means that not all Americans are at the same starting line today. Those who have been kept back by inequities built into the system need those obstacles addressed and repaired. The 2021 Justice for Black Farmers Act is a start; introduced in Congress by Senator Cory Booker (D-NJ), it proposes sweeping measures to restore some of these harms, with land grants, training programs, and other support for Black farmers, as well as assistance for other socially disadvantaged farmers. Similar state-level measures have been



introduced in North Carolina, Delaware, Ohio, and other states. The 2021 American Rescue Plan included \$5 billion in debt relief and other support for Black and socially disadvantaged farmers.

- Support farmer-led ownership, marketing, and decision-making.

Farmers need to have a voice in industry-level decisions. Business models that allow farmers to lead the development and direction of markets they are involved in, rather than being subject to the decisions of large-scale buyers or sellers, can be a way for farmers to pool resources and share costs, risks, and rewards. **Some of the oldest and strongest cooperatives were developed by Black farmers in the American South when southern businesses refused to buy their goods. Working together, they developed relationships with northern businesses and shipped their goods in bulk across the Mason-Dixon line.**

Cooperative sharing of risk and rewards can also ease the transition to a new or less-common crop or system (for example, the newly formed Perennial Promise Growers Cooperative organized around Kernza perennial grain) and generally build and improve market access (such as the cooperatively-pooled grassfed beef and pastured pork sold under the Wisconsin Meadows label).

- Invest in farmer education at all levels.

University-based extension educators must have opportunities to learn about CLC practices themselves, in order to be able to teach them to growers. For example, the Kernza®CAP Grant (more information below) has a specific objective to develop an “Extension Toolkit” for extension educators to learn the basics about Kernza agronomics, implementation, and marketing and in turn host their own public education sessions.



Dennis Mutwiri, UMN MAST student - Credit: Lois Braun

Field days and on-farm learning allow farmers to learn from each other as well as extension educators. Farmers are generally more willing to adopt a new practice if they see it working on another farm.

Technical assistance for farmers can help to underwrite costs of experimental practices. This is available from a variety of sources, including the federal Natural Resources Conservation Service (NRCS), state-level Soil and Water Conservation Districts (SWCDs), other state or local programs (such as the Minnesota Agricultural Water Quality Certification Program), farm incubators, and assistance serving specific communities (such as the Intertribal Agriculture Council - IAC). However, sometimes policy decisions limit adoption of practices even within these programs; for example, the programs and assistance available through NRCS and SWCDs are not always able to incorporate CLC practices. And so, developing policies and retooling programs to encourage CLC is also needed to pair education and practice opportunities.



SPOTLIGHT - Breslin Farms⁴

Molly Breslin has 80 acres in production on a 100-acre farm in Ottawa, Illinois. She and her father, John, started the farm 11 years ago on land that has been in Molly's family for generations. To take advantage of the flat central Illinois land and existing equipment, they began with row crops - but moved beyond the typical way of doing business in central IL. The farm is certified organic, and grows yellow and heirloom corn; soybeans; dry beans; sunflowers; small grains including wheat, rye, and oats; and cover crops.

Molly has been sole proprietor for several years and now has a toddler and another job, all of which has made her think about why she farms: "Is it to steward the land for the future or to maintain the farm as a business with yield and profit as the main aim?"

The second job gives her the flexibility to consider taking some of her land out of cash-crop production and cover cropping it, as an investment - in long-term soil building.

Additionally, she says the coronavirus pandemic, "Illuminated that systemic, government-led organization of and support for things like child care, health care, and education is absolutely essential" to the future of farming. "If we want more people – and especially more women – in farming, which is essentially a risky gamble of an industry, we need to address some of the huge barriers to entry and ensure farmer stability."

Whether in farming or anything else, she says, "We shouldn't have to take out enormous personal loans to start a business. Wealth gaps created and exacerbated by decades of structural discrimination mean that many people can't get in at all. Addressing these systemic issues is essential for people doing all kinds of work. Without that, as a nation, we are less resilient in the face of any kind of crisis."



Credit: Molly Breslin

SPOTLIGHT - Singing Hills Dairy/ Grow a Black Farmer⁵

Lynne Reeck has stewarded Singing Hills Goat Dairy in Minnesota for 27 years. Her niece, Lizy Bryant, grew up in small-town Minnesota, and has apprenticed with her since 2020 in preparation to take over the business and land. Bryant also intends to create an agricultural and artistic retreat space for Black Minnesotans at the farm.

She reflects, “So many Black folks and other people of color who are drawn to farming don’t even have the access to explore it that I did. I want to create a more accessible path.” In Minnesota, 84% of the population and 99% of the farmers are white, while 7% of the population and just 3% of farmers are Black.^{2,3} In the uprisings following the murder of George Floyd in Minneapolis in May 2020, Bryant connected with the Midwest Farmers of Color Collective, whose members are pursuing ideas of a safe farming space for Black Minnesotans.



Credit: Yasmin Yassin

Reeck, in her late 60s, had planned to leave farming in 2019. But, Bryant says, “like for many small farmers, there’s not a cushion of wealth,” for a farm transfer, so Reeck is continuing to work, holding the land, and training Bryant until they can complete the transfer.

“It’s a challenge and it’s an exciting moment,” says Bryant. “There’s an incredible energy among Black emerging farmers and farmers of color, and there is opportunity as baby-boomer farmers are retiring, many without children who want to take over the farm. The bridge is equitable land access. This is the moment to harness all these calls for reparations, for equitable redistribution, and for addressing our weak food systems.”

SPOTLIGHT - George Boody and the Severson Family⁶ on reintegrating livestock in row crop country

George Boody, former Executive Director of the Land Stewardship Project for 23 years, is currently a Senior Fellow with the School of Agriculture Endowed Chair in Agricultural Systems of the University of Minnesota College of Food, Agricultural and Natural Resource Sciences, managed by the Minnesota Institute for Sustainable Agriculture. Boody's focus in this position is to connect with farmers who are reintegrating livestock into their row crop operations, and to learn from and communicate their experiences. This project will feature many farmers who are actively diversifying their operations and making changes to support multiple generations on the farm.



Credit: Grand View Beef

Boody shares, “There are numerous barriers that prevent farmers from adopting continuous living cover (CLC) practices on their land, perhaps the first of which starts between the ears. Willingness to experiment is important, and after that, farmers also need relationships with other farmers and landowners, technical support, policy changes that favor CLC and livestock integration, markets for their product, and financial resources.”

“Over 20% of the land in the corn belt is considered ‘marginal’ in economic or ecological terms. Some of this marginal land is perfectly suited for reintegration of cattle. For example, in the Blue Earth River Basin of Minnesota, existing small to mid-size beef cattle drylot feeding operations would be a great target for re-integration of livestock into row crops. These feedlot cattle are mostly confined, but not in large CAFOs (concentrated animal feeding operations). They could be moved onto cover crops or corn stalks for a few months out of the year to cut down on feed costs to the farmer and simultaneously add CLC to their operation in a very economically viable way.”



Credit: Grand View Beef

Additionally, integration of CLC and cattle into row crop country can provide extra income that allows multiple generations to return to the farm. Take, for example, the Severson family of south-central Iowa. Troy and Beth Severson own and operate a hay, corn, soybeans, and cow/calf operation. When their son Knute and daughter-in-law Amanda wanted to return to the farm, the integration of a 100% grass-fed beef operation was what allowed these families to begin to increase their earnings on the land. Knute and Amanda moved back to Iowa to start their business, Grand View Beef, purchasing steer calves from Troy and Beth’s cow/calf operation. Despite being faced with substantial initial investment and a steep learning curve, their investment is gaining traction and now able to pay for itself and the land occupied by the

cattle. Meanwhile, the Severson family continues to try new practices, like converting more corn and soybean acres to pasture, as it is now economically viable for their operation; they also actively support other farmers looking to diversify their operations in similar ways.

Our society, in this moment, has reached a critical inflection point. We are faced with the complex systemic challenge of nourishing people while also nurturing the land that sustains us. The next generation of agriculture professionals will need to envision, embrace, and effectuate landscape-scale transformation if we are to achieve a sustainable agricultural system.

To meet the challenges ahead, we need practitioners who are equipped to support farmers in practices that sustain our lands and natural resources for the benefit of future generations. We also need researchers trained to explore the ways in which CLC and other sustainability practices can be environmentally, economically, and socially beneficial to farmers and communities as a whole. In short, it's all-hands-on-deck.

Diversity leads to resilience in both ecological and human systems. Implementing CLC practices can, however, prove challenging for farmers. Barriers to implementation can manifest as a lack of technical know-how, lack of equipment and financial resources, and general aversion to the risks associated with trying a new practice - by farmers, but also their landlords, lenders, insurers, and other invested parties.

Winter cover crops, adding small grains back into farm rotations, and managing perennial pasture for livestock all increase ecological diversity on the landscape, but there is another type of diversity that matters. Currently, we are missing out on the immense knowledge base of communities who have long histories of land stewardship but have been systematically excluded from and marginalized within formal agricultural research and education. Engendering a



Source: Hannah Stoll

The talent pool that U.S. professional agriculture draws from is far too narrow. Too many individuals and communities are not involved in agriculture. In 2019, the majority gender of professionals and students in agronomy, crop science and soil science societies were male (72%), with just over a quarter of this demographic as female (26%). Ethnically, these members were primarily white (83.6%) versus non-white (16.4%).¹

Why? In some cases, what's missing is an opportunity to gain exposure to or learn about agriculture. In many cases, systemic barriers exist to access and engagement. Lack of involvement in agriculture for communities of color is a result of sweeping and enduring challenges including lack of access to land, capital, and markets, as well as historical trauma and ongoing racial violence in rural communities. While education cannot overcome all of these barriers, it is one important starting point for diversifying agricultural professions.

We can, as academics and practitioners of the agricultural and the environmental sciences, re-imagine and realize systemic actions to intentionally incorporate new talent - actions like the following:

- Begin classroom and outdoor agriculture learning as early as elementary school and extend throughout high school
- Offer different on-ramps, entry points, and pathways in a new learning ecosystem
- Mentor with inclusive teaching practices as the norm rather than the exception
- Sustain investments in higher education student retention
- Break down false assumptions about expertise, respecting different ways of knowing and valuing both learned and lived intelligence and understanding
- Value farmer knowledge and support co-learning and strong communication between farmers and researchers or other agricultural professionals
- Recognize and elevate agricultural expertise, particularly in communities systematically excluded from academic institutions
- Hire community knowledge holders to provide training and education that complements more traditional academic curricula
- Co-create interwoven channels of cultural influences to shape and adapt with the paces and changes in agriculture



PS180 NYC students planting herbs - Credit: Aaron Reser

To be clear, these actions are not a panacea to the homogeneity of agriculture, however, they are a good place to start. We have it within our power to advocate for these changes and to offer our time and expertise to build lasting partnerships with schools in marginalized communities.



Diversity among agriculture professionals is an absolute necessity to ensure a resilient and sustainable agricultural system. A society that ignores the boundless potential of its diverse population does so at its own peril. How many like George Washington Carver² have slipped through the cracks of society due solely to our acquiescence to the flagrant lack of agricultural education opportunities in urban schools?

Partnering with marginalized communities to help develop the latent talent of our diverse population prepares us to meet the sustainability challenges of the 21st century through building a diverse pool of agricultural professionals that will help build a more resilient, diversified agricultural landscape. In other words, human diversity and diverse agricultural landscapes are not independent of one another; in fact, if we ever want to fully embrace either of these, we must embrace them BOTH simultaneously.

Human diversity and diverse agricultural landscapes are not independent of one another; in fact, if we ever want to fully embrace either of these, we must embrace them BOTH simultaneously.

Tomorrow's agriculture professionals will need to possess a diversity of communication strategies, academic training, and lived experiences to take on the colossal tasks required of them. The success of our agricultural system will depend on our collective ability to bring all of our resources to bear to meet the challenges that face us. The remarkable diversity of our society, along with the diversity of our CLC crops and cropping systems, are among the most powerful resources that we, as a nation, possess. The sooner that our actions and priorities align with this basic truth, the better an agricultural system we will be able to pass down to our children and our grandchildren.



UMN Research Associate Prabin Bajgain at the Minnesota State Fair - Credit: Kanjani Shukla Bajgain



SPOTLIGHT - Dr. Britt Moore



Dr. Britt Moore is a soil scientist with a passion for teaching and mentoring. Growing up in Chicago, Britt's first exposure to agriculture was through attending a magnet school, Chicago High School for Agriculture Sciences (CHSAS). This school choice was initially made as a way to better prepare him for college. By graduation, Britt found that agriculture was fascinating and that many of his interests in science overlapped with agricultural studies. After studying Agricultural Science and Biology at Truman State University and completing an M.S. in Sustainable Agriculture at Iowa State University, Britt became a high school science teacher.

"Teaching high school students in an under-resourced, urban school was an eye-opening experience," recalls Britt. "I taught environmental science. I thought it was important to help my students understand the connection between the environment, food, and agriculture." His first lesson on food and the environment began by asking the class where food comes from. "They looked at me as though I asked the most stupid question they'd ever heard and replied, "food comes from the grocery store!" These students had

never been to a farm or had an agriculture class. They had never been directly exposed to agriculture, so how would they know? If I was not there with them as their teacher, they would never have been asked to think about the connection between food and agriculture in their public education."

Britt's experiences are a testament to the importance of exposing *all* youth to agriculture. Diversifying our agricultural landscapes can only be fully successful when we diversify the faces of agriculture. He recently wrote in the Green Lands Blue Waters Civic Scientist Series³:

"A society where People of Color are full and equal partners in the food system, from farm to fork, is a goal that (agriculture) should aspire to - transitioning towards greater inclusion is possible; however, we must possess the willingness and creativity to actualize this change. Structural change cannot happen in the absence of direct, thoughtful engagement to address the needs and concerns of marginalized communities."

SPOTLIGHT - Hannah Stoll, Ph.D. student



Hannah Stoll, a Ph.D. student in Plant Breeding and Genetics at the University of Minnesota, is as passionate about teaching as she is about science. Synergizing these interests, she now promotes inclusive science education. Growing up in central Illinois, Hannah first experienced agriculture as a corn pollinator. The drudgery convinced her that she'd never touch corn pollen again. Fate, it seems, is not without a sense of humor. Just a few years later she found herself in a maize genomics lab in college, once again working with corn.

After a bachelor's degree in Crop Sciences at the University of Illinois, Hannah earned an M.S. in Hybrid Wheat Breeding and Genetics at the University of Nebraska-Lincoln. She was now ready to help diversify agricultural landscapes through scientific research and educational outreach on perennial grain crops.

Through her talent for teaching, she's become a vital part of the 'circle of support' movement aimed at diversifying the faces in agriculture. These services are dedicated to inclusive education both in and out of the classroom. One small example is a new partnership between U of MN graduate students and local bakeries in St. Paul, MN. Cookie Cart is a local business providing teens with work, life, and leadership skills through employment and training in urban nonprofit bakeries. Applied Plant Science graduate students are now working with these young people. They talk about how the flour they use to make cookies gets from the field to the bakery, identifying new career opportunities along the way.

Hannah's clarion call for greater inclusivity in agricultural education is well-summarized in a piece she recently authored for the Green Lands Blue Waters Civic Scientist Series⁴.

"Extending the (education) recruitment pipeline would highlight new voices and lead to more diversified leadership in the agriculture industry. A thriving, diverse student body opens the floor to world-changing discussions. My hope for these students is that they will move on to be an innovative cohort of agriculture professionals, leading to actual systemic change in agriculture. I take heart in the future of agriculture as a more equitable environment for people of color and individuals from all backgrounds to thrive."

SPOTLIGHT - Intertribal Agriculture Council



The Intertribal Agriculture Council (IAC) was founded in 1987 to pursue and promote the conservation, development, and use of their agricultural resources for the betterment of fellow Native American people. The IAC actively integrates technical assistance (TA) to connect Native American producers and Tribes to USDA programs, services, and educational opportunities. These opportunities range from lessons in soil health in collaboration with the Natural Resources Conservation Service (NRCS), Indian Land Tenure Foundation (ILTF), and universities, to building youth agricultural curriculum and grant opportunities, to conservation planning through outreach. In addition to connecting Native American producers with resources, the IAC also amplifies its voting members' voices to collectively advocate for federal and state agricultural policies that better serve the needs of Native communities.

In Northwest Washington, the integration of TA kept sibling farmers Shawna Kalama and Wyatt Wiltze of the Yakama Indian Nation Reservation from going under in difficult times. The COVID-19 pandemic wreaked havoc on cattle prices, threatening a loss for their hay and cow/calf operation. The IAC's TA program connected them with the Coronavirus Food Assistance Program and a Small Business Administration grant. In doing so, it saved their operation. The IAC's successful integration of technical assistance demonstrates how vital TA support is to the continuation, sustainability, and profitability of agricultural systems. Moreover, IAC's work has shown the importance of having specialized TA programming and staff devoted to serving the needs of specific communities.



Mount Adams near Yakama Territory, WA – Credit: Jim Vallance, public domain

SPOTLIGHT - Moses Momanyi, Dawn2Dusk Farm & Kilimo



Credit: Dawn2Dusk Farm

Entering the agricultural system as a beginning farmer is fraught with challenges that would be difficult for anyone to overcome. This is especially true for those who have immigrated to the Midwest. They face overwhelming economic, cultural, and networking barriers. Integrating these communities into a robust ‘circle of support’ is proving to forge lasting relationships with other emerging immigrant farmers. We *all* benefit from their Indigenous food knowledge and sustainable land management practices from across the globe. A most inspiring example in the Upper Midwest comes from Moses Momanyi, co-owner and operator, along with Lonah Onyancha, of “Dawn2Dusk Farm” in Cambridge, Minnesota.

Moses has been both a recipient and the provider of technical assistance (TA) for emerging farmers in the U.S. When he first came to the U.S. from Kenya, he wanted to farm, just as he had done with his family in rural Kenya. With no access to credit, no experience with large-scale, conventional row crop agriculture, and no professional support network, he was determined to once again work the land. After joining a farm incubator and tirelessly working a night shift job for five years, Moses saved money, gained experience, and established

good credit. He was then connected to a USDA loan program for under-resourced farmers.

Dawn2Dusk Certified Organic Vegetable Farm officially started. In 2020, Moses and Lonah formed their own farm incubator, Kilimo. It supports African immigrant farmers in Minnesota on topics related to access to land, business classes, networking, field days, and individualized coaching.

Meanwhile, Dawn2Dusk Farm is providing nutritious, locally grown produce to communities in the Twin Cities. Moses also works with other TA providers to incorporate more continuous living cover practices onto their farms. As an emerging farmer leader, he has pursued USDA Sustainable Agriculture Research and Education grants to purchase equipment that will help him and other emerging farmers expand the use of conservation tillage and winter cover crops on their land.

Through his ‘circle of support,’ Moses is directly integrating diverse peoples and practices into the U.S. agricultural landscape. His story exemplifies how diversity feeds resiliency in our communities through equitable access to culturally appropriate food, and the implementation of sustainable, resilient farming practices.

We need to increase funding for research and development of new crops and cropping systems

The importance of funding research for CLC systems is perhaps best emphasized by understanding how research funding shaped the systems in place today. Vast expanses of commodity corn and soy are not accidental; nor is the fact that this year alone, U.S. farmers are predicted to plant the second highest amount of corn and soy in decades – 179 million acres.¹ These statistics are the outcomes of national agricultural policy, supported by massive research and development efforts for large-scale production agriculture, that disincentivizes continuous cover and separates crops and livestock. A major challenge today for small to mid-sized farms with diversified cropping systems is they've missed out on generations of research and development.

Historically, public food and agricultural spending on research and development was comparable to private expenditures from the 1970s to the early 2000s. Since then, private investment has risen dramatically (~\$12 billion) while public spending has reduced or remained static (~\$4 billion), a ratio of nearly three to one in 2013 dollars according to a 2019 study.² The rise of corporate-controlled research has effectively privatized a large proportion of what was formerly under the realm of public investments. Fewer research priorities are designed to benefit the public, as corporate research tends to focus on commodity crops with the greatest short-term profit potential. These crops pose very little financial risk as they are already supported by established supply-chains, markets, and policies.



Credit: USDA National Agroforestry Center



Hazelnut pod - Credit: Dave Hanson

Important USDA Farm Bill programs support CLC, including Sustainable Agriculture Research & Education grants (SARE) and NRCS conservation programs. The vast majority of USDA funding, however, does not support sustainable agriculture elements such as reduced inputs or the incorporation of agroecological principles. Approximately 10% of the 2014 USDA Research, Education and Economics (REE) budget, \$294 million, went to projects related to these topics. Agroecological CLC strategies received an even smaller percentage of support in 2014, including agroforestry, complex rotations, or rotational grazing. This represents less than 2% of the total REE budget.³

Knowing this, we cannot expect systems to change without a concomitant change in research funding. **Current USDA research funding allocation does not fully address what we will need in the future: cropping systems that support soil health, water quality, other ecosystem services, while aiding in the transition to renewable fuels, improved community vitality, and an equitable food supply.**





Daniel Hayden, University of Wisconsin Madison, PhD Student, Comanche, Pawnee, Muscoque Creek.

One reason basic research is so essential to agriculture is because it mediates risk for the farmer, especially with novel crops or systems. New agricultural crops and systems need to be tested thoroughly in research and on farm environments before professional management recommendations can be made and before significant farmer adoption can be expected. Farmers need a range of diverse options that meet their unique needs and constraints. This includes variables such as land, soil type, climate regime, economic considerations, and labor availability.

Also, farmers are understandably hesitant to adopt a new crop or system if it does not qualify for crop insurance. Crop failure can mean financial ruin. USDA Risk Management Agency (RMA) and Federal Crop Insurance Corporation (FCIC) insurance products for CLC crops are an important part of moving them onto the landscape. But this requires multiple years of agronomic, yield, location, and price data and well-tested systems based on high-quality plant material.

On the human side, a more inclusive agriculture will develop a more diverse farming community. We need systems that meet a range of cultural needs. This includes the way research develops these

systems. Equally important, we must maintain open channels from farmers to researchers, providing opportunities for collaboration and feedback about on-farm testing and what farmers need. Agricultural research is a dynamic cycle.

When advocating for new and expanded research priorities, we must also be mindful of the changing climate. In March 2021, the USDA called for public comments on the “Executive Order on Tackling the Climate Crisis at Home and Abroad” (Docket Number USDA–2021–0003).



University of Illinois Switchgrass - Credit: Erin Meier



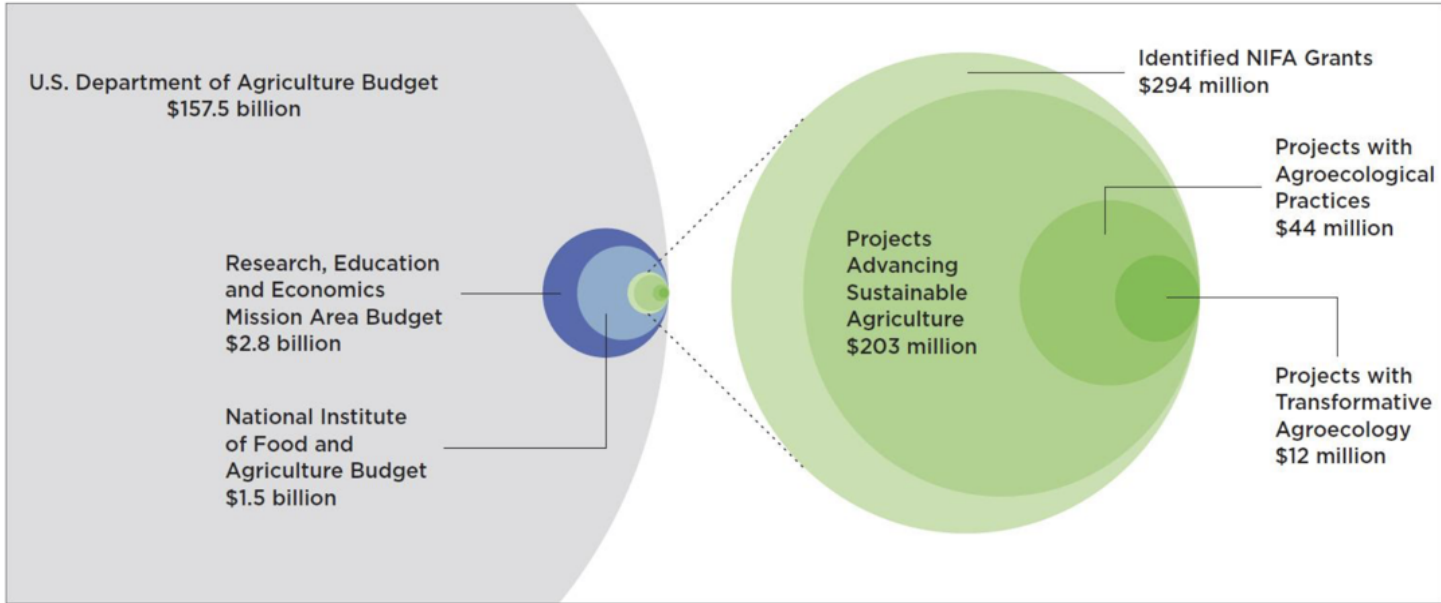


Cates Family Farm, WI – Credit: Susie Theis

Expanded public funding for research to develop crops, cropping systems, and integrated livestock systems that can adapt to changing temperature and precipitation patterns is needed. Crops and practices that may have worked well in one region may no longer be viable due to our changing climate. Suitable conditions for corn and soy may continue to move northward, for example. This can bring about a variety of challenges for farmers in the traditional U.S. corn belt. Rather than funding research and infrastructure shifts that try to maintain those same crops in place, funding should prioritize different crops and farming

practices that are better adapted to new conditions. And, again, such transitions provide an opportunity to build accessible entry points for small to mid-sized, BIPOC, and women farmers.

The initiatives highlighted in figure 2 are exciting examples of the kind of interdisciplinary, cross-sector research on CLC and agroecological systems that can help us meet all of these goals together.⁴



Agroecology funding in the context of the total USDA budget, 2014. The lack of a focused investment in this area threatens the nation’s food and farming system.

Figure 2. Agroecology funding in the context of the total USDA budget, 2014

Note: Agroecology funding in the context of the total USDA budget, 2014. Reprinted from Counting on Agroecology: Why We Should Invest More in the Transition to Sustainable Agriculture by Union of Concerned Scientists, November 5, 2015. <https://www.ucsusa.org/resources/counting-agroecology>. Reprinted with permission.



SPOTLIGHT - Sustainable Agricultural Systems Coordinated Agricultural Projects (SAS CAPs)

A project of the USDA, the Agriculture and Food Research Initiative (AFRI) Sustainable Agricultural Systems Coordinated Agricultural Projects (SAS CAP) aim to transform the U.S. agricultural system with interdisciplinary and collaborative projects, taking a visionary approach to address current needs while anticipating future environmental, social, and economic impacts, mitigating potential future challenges, and delivering societal benefits. This long-term, cross-sector approach will allow CAP studies to address complex topics that other projects cannot. Focus areas include sustainable agricultural intensification, climate adaptation, value-added innovation, and food and nutrition translation. Major expected outcomes include improved access to safe, nutritious, and sustainably produced agricultural products as well as improved quality of life and economic opportunity for rural Americans and others involved in food and agriculture. In addition, these projects help fund graduate and undergraduate research opportunities and train agricultural workers.⁵

a. Kernza®CAP

The Kernza®CAP is a five-year, \$10 million grant funding continued development of intermediate wheatgrass (Kernza® perennial grain), which saw its first commercial release in 2020 with the variety MN-Clearwater. The KernzaCAP is led by multiple partners at the University of Minnesota and The Land Institute with a full project team that includes researchers, nonprofit organizations, topic specialists, farmers, industry partners, and others across a number of states and institutions. The project has six main objectives: advance germplasm and trait evaluation; enhance agronomic and on-farm knowledge; improve environmental quality; engage education, extension, and policy; develop supply chains and economic drivers; and intentional integration. There is a strong project focus on whole systems thinking, acknowledging that perennial crops must be coupled with supportive policies, education and behavior change, market pull, and a reexamination of equity and emphasis on community-driven regionalized economic models to truly activate transformative change.



Credit: Jacob Jungers

b. IPREFER (Integrated Pennycress Research Enabling Farm & Energy Resilience Project)

IPREFER is a five-year, \$10 million grant funding research focused on increasing winter pennycress production through agronomic and genomic methods and developing the supply chain, especially addressing post-harvest seed management. This project also aims to develop education and extension networks to boost adoption and profitability by training farmers, workers, and scientists. IPREFER includes collaborators at six Midwestern universities, the USDA, the Agricultural Utilization Research Institute, McLean County SWCD, and CoverCress Inc. as a commercial partner. Beginning in 2013, CoverCress Inc. has done extensive research to develop CoverCress, an improved variety of pennycress that is ideally suited for production of edible oil, biofuel, and high-protein feed. Since joining the IPREFER project in September 2019, CoverCress Inc. has secured \$13 million in additional research and development funding and contributes essential work on both agronomic and value chain development.



Credit: David Marks

Pennycress is a prime example of collaborative success. Considered a weed for centuries, it is now a recognized agricultural crop in both Illinois and Minnesota after less than a decade of intense breeding and domestication efforts. Significant efforts in trait discovery in pennycress were spearheaded by Dr. Ratan Chopra and Dr. David Marks, and led to the identification of key domestication traits that are being integrated into elite pennycress varieties. This progress offers farmers both new economic opportunities and a system that helps protect their soil and water resources.

c. Grassland 2.0

Grassland 2.0 is a five-year, \$10 million dollar grant focused on supporting profitable farms and healthy people, emphasizing that we can have both thriving, diverse communities as well as clean water, flood mitigation, climate stability, and biodiversity. It requires a paradigm shift from a model that maximizes yields of shallow-rooted plants through fossil fuel inputs and soil disturbance to one focused on well-managed



Credit: Elizabeth Spratt

grazing on perennial grasslands, restoring many of the natural prairie ecosystem services like clean water and wildlife habitat. Grassland 2.0 highlights the need for all stakeholders to be a part of the movement: farmers using sustainable practices, processors and distributors who contribute to value-added supply chains, and consumers buying grassland-based meat and milk, as well as policies and incentives to support needed changes. Some specific examples of action items are for farm input suppliers to develop and market products that help restore grasslands without harming the environment; for policy makers to support transformative, rather than incremental change; and for consumers to shift demand from grain-fed meat and dairy to grassland products. Grassland 2.0 also connects farmers interested in grazing with resources and training.



Boone River, IA - Credit: Eileen Bader

Grassland 2.0 is led by UW-Madison and supported by a team that includes researchers, nonprofit organizations, topic specialists, farmers, industry partners, and others across a number of states and institutions.

SPOTLIGHT - Illinois Regenerative Agriculture Initiative (IRAI)

Begun in Fall 2020 and based at University of Illinois Urbana-Champaign, IRAI is a partnership between the Department of Crop Sciences, the College of Agricultural Consumer and Environmental Sciences, University of Illinois Extension, and the Institute for Sustainability, Energy, and the Environment. This innovative, cross-sector partnership is sponsored by Chicago-based family and community foundations working together through the Fresh Taste initiative. Fresh Taste aims to support fair, healthy, affordable, and sustainable food systems in the Chicago region and has granted over \$32 million for food system projects between 2007 and 2017. Select Fresh Taste foundations are prioritizing collaborative approaches with research partners like the Illinois Regenerative Agriculture Initiative. IRAI is focused on building collaborative relationships between key actors in the food system network. Drawing on their research power and strong community relationships, IRAI partners emphasize collaborative, actionable research to improve and develop resilient food systems that are both productive and profitable, contribute to food security, and support vibrant human communities and natural systems. In 2021, IRAI will begin accepting proposals for seed grants from interdisciplinary teams of Illinois researchers and food system stakeholders that address soil health, on-farm biodiversity, or community health and resilience.



SPOTLIGHT - The Forever Green Initiative (FGI)

FGI is a joint program of the University of Minnesota and the USDA Agricultural Research Service focused on developing new crops and high- efficiency cropping systems, emphasizing those that will improve natural resources and provide new economic opportunities. A shift to these types of cropping systems is essential for Minnesota to meet its water quality goals. Forever Green connects plant breeding and genomics, agronomics, food science and utilization technology to develop not just new crops and systems, but supply chains and markets to support them. Projects include all five CLC strategies: agroforestry; perennial grains, forage, and biomass; and rotations and winter annuals. Examples include intermediate wheatgrass for Kernza® perennial grain production, silphium, winter oilseeds like camelina, cold-hardy hazelnuts, high-value botanical products, and traditional crops like alfalfa, winter barley, and summer annual grains that can be incorporated into crop rotations.



Camelina – Credit: Russ Gesch

Funding for CLC-focused transdisciplinary research and networking initiatives like the SAS CAPs, Illinois RAI, Iowa STRIPS (Science-based Trials of Rowcrops Integrated with Prairie Strips), and the Forever Green Initiative is critical because all of the other factors involved in getting CLC on the landscape – infrastructure, policy, people – are dependent on having high-quality plant materials available and a base of established agronomic and agroecological knowledge. But, **without policy support, a viable supply chain, and grower and consumer interest, even the most promising new crop or system cannot succeed.**

We need to activate the system levers of markets, policy, and investment capital; and implement with a cross-sector networked approach

The predominance of a few row crops on our agricultural landscape is not by accident. And we will see changes on the landscape when, as a society, we make choices to build new systems.

In concert with supporting farmers, agricultural professionals, and crop and grazing research and development as discussed above, we also need to activate the system levers of markets, policy, and investment to make change possible. To move these many pieces together, and well, **requires a cross-sector, human/community-centered, networked approach.** Markets, policies, grower knowledge and leadership, and system-level capacity can be co-developed to support widespread adoption of CLC.

A strategy of measured technology transfer for CLC is critical - where markets, policies, grower knowledge and leadership, and system-level capacity are co-developed to support widespread adoption of CLC systems. If we want new agricultural technologies that deliver climate, water quality, and soil health benefits, plus opportunities for all farmers and new markets for nutritious food ingredients, this will require other actors and sectors - including the public - to share the risk and build supportive systems.



Building markets for CLC crops

Perhaps the clearest and most direct way to get farmers to consider planting a new crop is to have a strong market demand for that crop.

The development of high-quality, reliable supply of a new grain, for example, must be paired with a plan for it being taken up by the market. Comprehensive market development must assist in ensuring that early-adopter growers have the right equipment, adequate scale, and sound experience in production and marketing. Without deliberately designed and resourced support systems, farmers absorb all the risk which is likely to result in some combination of poor quality, inconsistent supply, and/or supply that balloons far beyond demand. All of these issues have the potential to limit or destroy successful commercialization and scaling of new crops, and result in fewer benefits across the triple bottom line - environmental, financial, social.

Moving a new crop smoothly through the many critical pieces involved with developing a stable early market, let alone scaling that market, is no easy task. New crops like Kernza® perennial grain need robust and sustained market development for years to develop and maintain consumer demand, especially if there is a significant price premium on products.

Markets need to be supported and scaled by:

- Tracking and providing high-quality market information (i.e. yield, supply, quality, pricing, etc.) to current and prospective sellers, buyers, and stakeholders so actors can make informed decisions
- Developing robust, effective marketing - an 'all hands on deck' market development and wrap-around end-use research and development support
- Pricing that accounts for the risks of early adoption, environmental benefits, and early-stage of development (i.e. yield), while striking a balance with what pricing supply chain businesses can realistically pencil out, and ultimately, with what values-aligned consumers are willing to pay
- Ongoing development and dissemination of research-based information to all market players



Millet - Credit: Elizabeth Kaestner



SPOTLIGHT - Learning from early market development of Kernza® Perennial Grain

Kernza® perennial grain is the registered trade name of the grain from a grain-producing intermediate wheatgrass (*Thinopyrum intermedium*) registered by The Land Institute. This cousin of annual wheat has been grown throughout the U.S. to provide fodder for livestock and nesting cover for certain bird species, as well as to stabilize the soil for erosion control. Now, it's being domesticated as a grain for human food.

Intermediate wheatgrass can be grown as a “multi-functional” crop, yielding various commodities as well as ecosystem services. Kernza grain is a wheat-like perennial grain that can be used as an inclusion in foods like baked goods and beer or can be used as a whole grain like barley or rice. This is a new, quickly evolving crop. As of spring 2021, there are currently 42 Kernza growers and 3500 acres in the U.S. with research ongoing in 11 other countries.¹

The market right now for Kernza can be characterized as new, small, and growing. The 2020 crop is being marketed presently and it is expected to be sold into the seed and grain market at solid profits, especially given the potential of intermediate wheatgrass/ Kernza as a dual-use crop for grain and forage. Supply chain models and grower experience suggests that $\frac{1}{2}$ to $\frac{2}{3}$ of production costs can be recouped on forage alone. In 2021, the total grain supply is expected to grow three to five fold to about 300,000-500,000 lbs total in Minnesota and the Upper Midwest. Production can scale up from there based on market demand.²

In the Upper Midwest, all prospective growers without a marketing plan are introduced to Perennial Promise Growers Cooperative (PPGC), an emerging coop of Kernza growers forming to support mutual success with Kernza on farm and in the market. Growers are not obligated to join PPGC, and PPGC is not obligated to accept new growers. It is up to all of them to decide whether to collaborate. Staff at The Land Institute and the University of Minnesota strongly prefer growers with a clear marketing plan, prospective buyer, or experience marketing differentiated grain crops so they are not left out on a limb come harvest. In other areas of the country, groups like Sustain-a-Grain are emerging to deliver a high-quality supply coming out of Kansas and the Great Plains.

In 2020, an award-winning public benefit corporation (B-corp) start-up, Perennial Pantry, formed around buying, processing, and marketing Kernza grain and flour direct-to-consumers, wholesale, and is now on Minnesota grocery cooperative store shelves. In 2020, in the midst of the pandemic, they sold Kernza to thousands of customers in 46 U.S. states. Kernza beer is on tap and on menus at several breweries and restaurants. It is being prototyped in



Credit: Mette Nielsen

products by dozens of bakers, restaurants, millers, and food companies. Every major maltster in Minnesota is testing Kernza presently. Smaller, high-profile food companies like Patagonia Provisions are marketing Kernza products, as are household-name Consumer Packaged Goods (CPG) companies like General Mills. Major CPG ingredient supplier Healthy Food Ingredients has a dedicated Kernza line in Valley City, North Dakota and is actively processing and acquiring Kernza as needed. For experienced seed growers, high-quality Kernza seed (+85% germination) will be in demand and is a niche market opportunity. European and Canadian partners are eager to grow, test, and market Kernza. Like any market, all of these buyers are cost-conscious to some degree. So, it is up to Kernza growers and buyers in the marketplace to determine what they believe to be mutually acceptable fair pricing. The University of Minnesota (UMN) has developed transparent pricing tools to help all actors understand the costs involved.

The challenge is to produce a high-quality supply that meets, but does not exceed, demand. The Kernza growers will need support through locally-accessible technical assistance (TA), supportive policy mechanisms, and market access. The best thing states new to Kernza can do right now is 1) identify well-positioned early-adopter growers to pilot commercial Kernza production (20 acre minimum) and 2) begin developing capacity (i.e. staffing, policy, markets, etc.) to support success for those growers.

Kernza has been developed as a new crop with the spirit of ushering in an entirely new paradigm for agriculture - crops that provide not only staple food for human consumption but also environmental benefits.

New perennial crops need this type of new thinking on markets, supportive policy, circular economics, investment and ownership. Who will own, control, and benefit from Kernza and future new perennial crops? A team of sustainability transition “intermediaries” from The Land Institute and the University of Minnesota (Forever Green Initiative, Green Lands Blue Waters, and others) have facilitated the work described above in recent years and are now embarking on developing a commons-based framework for Kernza growers, supply chain partners, end users, and others to directly govern the growth and direction of Kernza in the marketplace, perhaps through alternative ownership structures, such as Steward Ownership. Scaling Kernza requires innovating farm to end use chains to be more fairly distributed and equitable.

Advancing supportive policy for CLC crops

Our agricultural system has been fostered and reinforced by myriad policy choices. When it comes to agriculture, whether it is basic research or direct payments to growers or crop insurance, we get what we pay for as a society. While policy has a tendency to reinforce existing systems, it is also an essential leverage point for transformation to a more healthy, sustainable, just agricultural system. Policy can be changed and amended, reenvisioned and reinvented, but it takes a concrete set of ideas, organized grassroots people power, and the political will to make it happen. Let it not be a failure of effort or imagination that holds us back. We can, and must, shape new policy if we hope to bring about a new agricultural landscape.

Federal, state and local policy will be needed to advance CLC. Government at all levels can help move CLC crops forward, with both “carrot” and “stick” policy strategies.

One key way policy can support a transition to CLC is to reduce risk. Risk cannot be eliminated, but it can be managed. The incorporation of CLC into state and federal agricultural policy architecture such as federal crop insurance and NRCS practice standards is a long-term goal for helping growers manage risk and compensating growers for ecosystem



services delivered by CLC. Short-term, local and state cost-share, risk reduction, and ecosystem payment programs can serve as a bridge to long-term strategies. Policy approaches require intentional design to minimize unintended consequences and/or market distortions that hinder long-term success of CLC.

With recent stressors and vulnerabilities, such as fluctuating commodity pricing and tariffs and a global pandemic, risk is being felt at new and different levels. This is prompting a fresh, deep look at avenues of risk mitigation and the need for policy to support diversification of agricultural landscapes with CLC crops and cropping systems that offer new economic opportunities and environmental benefits.

There is an urgency to develop CLC options for the farmer and a wealth of opportunities and strategies to do so. Policy must create the space for CLC options today with an eye towards changing systems over the long term. We might especially consider avenues such as shorter-term funding incentives to de-risk early farmer adoption of new crops and cropping systems, thoughtfully stimulating the supply and demand side of a crop's market while avoiding unintended consequences, as well as the current proliferation of strategies to monetize ecosystem services through carbon markets and other payment programs. Examples of these include partnership with RMA and dedicated data collection to develop crop insurance policies for new CLC crops as discussed previously; expanding the use of conservation set-aside programs beyond environmental benefits to allow harvestability of perennial landscapes; or a supply-side approach with a mandate on an industry - say, airline fuel - to stimulate a biofuels market for perennials or crops like pennycress and camelina.³ As a follow-on to this last example, the federal renewable fuel standard mandate requiring oil refineries to purchase ethanol is expiring in 2022, and it is likely that future year-by-year purchasing requirements will be lower. Seeing that up to 40% of corn fields in the U.S. produce for the current ethanol market, we have an opportunity to build supports and markets to thoughtfully transition many, many farmers and acres to other crops.⁴

Peter LaFontaine with Friends of the Mississippi River offers this policy lesson in a nutshell: "We've reached an inflection point where researchers and agronomists are introducing the new crops and farming methods that underpin the whole promise of continuous living cover systems. But like a living organism, these things need a hospitable environment to reach their potential, and that's where policy comes in. With the right policy incentives, we can give farmers and their market partners the ability and motivation to shift toward CLC models. Agricultural production and supply chains don't transform quickly, however; they're bound by principles of supply and demand just like any other sector, and we need to ramp up both of those factors in tandem. The next few years will be crucial to increase seed stocks, scale up acreage, build customer familiarity with CLC products, build supportive infrastructure, and generally create a virtuous cycle of investment and viability. Right now, all of that is possible, if theoretical. The goal is to make those possibilities feel inevitable."⁵



SPOTLIGHT - Savanna Institute's Tree Crop Commercialization Program

What's holding back agroforestry adoption in the Midwest? Whether it's designing a new mechanical harvester, helping hazelnut farmers aggregate, or designing a mobile processing hub for elderberries, the Savanna Institute's Tree Crop Commercialization Program focuses on identifying bottlenecks to agroforestry adoption and finding solutions to those limits.

Savanna Institute's staff dig deep into the best research around individual tree crops and then journey throughout the Midwest talking with farmers and others within the value chain to understand the assets and challenges facing the industry. Each year they produce an impact investment report focused on a different crop and use these reports to try to catalyze investment in tree crop industries. For example:

Impact investing in the Midwest hazelnut industry.

In the face of climate change, we need transformative solutions that transcend the fundamental challenges of annual crops. Perennial staple crops are one solution. Hazelnuts, in particular, present a timely economic and environmental strategy in the Midwest U.S. While the existing \$7 billion global market for hazelnuts is on track to double this decade, this crop's latent potential lies in its ability to supplant soybeans as a staple source of protein and oil. *Credit: American Hazelnut Company*



If adopted broadly, hazelnuts could help reverse agriculture's role in climate change. Over 1,500 Mt carbon (~30% of annual U.S. carbon dioxide emissions) could be sequestered in woody biomass alone if hazelnuts replaced the existing 84 million acres of soybeans across the Midwest.⁶

Coordinated, integrated capital and investment is needed for CLC

New supply chains for new crops and cropping systems provide a number of opportunities for investment of all kinds - private, public, philanthropic, and impact. Socially responsible investing and impact investing continue to grow overall, as do investments in activities that improve the environment and address the impacts of climate change. According to the Forum for Sustainable and Responsible Investing (U.S. SIF) *Report on U.S. Sustainable and Impact Investing Trends for 2020*, **“Sustainable natural resources and agriculture ranked as the second most heavily weighted environmental issue for institutional investors, affecting almost \$2.2 trillion in assets, a 95 percent increase since 2018.”**⁷ To best direct this surging interest and capital, a strategic, integrated approach that coordinates and appropriately targets different forms of capital along the agricultural value chain is of great interest and importance to transforming agriculture at farm and landscape scales. Work at organizations like Croatan Institute and Delta Institute identifies linkages between financial and agricultural value chains. One framework is aligning soil-based risk, return, and impact metrics into financial transactions, including lending and underwriting. Such an approach is bolstered by growing consumer demand for products that promote healthy soils. Private investment is complemented and catalyzed by capital from philanthropic and government sources so that all points along emerging, diversified value chains are strong: farmers, production, storage, processing, and distribution. A simple way to think about this is using public capital for public concerns and private capital for private interests.

A corresponding framework at the farm level is what agricultural economist Jon Winsten refers to as **‘baskets of incentives.’**⁸ Sales, ecosystem service payments, cost-share payments, grants, and loans - a mix of public and private sources - comprehensively planned and deployed for farm businesses support farmers to change and improve production systems over time. Multiple, established programs and financial instruments supporting many farmers, operating along with strong markets, can together provide the economic momentum that leads to landscape-scale transformation, resulting in diversified streams of farm products and environmental benefits long term.

Equity and distributed control must be kept top of mind in the design and implementation of supportive CLC infrastructure like investment channels, policies, and markets - so benefits and wealth are shared and not concentrated as they often are in programs supporting agriculture today. The design process must ask such questions as: Who benefits? What types of farmers, entrepreneurs, and investors does this serve? Are opportunities easily accessible for small to mid-sized, BIPOC, and women farmers and a range of markets that are built for CLC products and production values and diversity in agriculture? How are non-operator landowners accounted for who may directly benefit but not cycle those benefits back into the farm, farmer, and locale? Could benefits be scaled incrementally at first for early adopters, new farmers, or other clientele to bridge the gap to a more stable point of individual and aggregate production? Who makes decisions about risks and metrics, and how are decisions driven by long-term benefits to landscape, health, and local communities?



Agriculture is a journey

To enliven a healthier agriculture on human and ecological landscapes, **it is time for a new way forward.** Some would say it's high time. Let's explore many paths together - sharing leadership across many people with wildly different perspectives but with aligned goals of long term viability of farm fields and the vibrancy of farmers, eaters, communities, and the ecological webs that support life - locally and globally.

We get a flavor of these paths through the stories we've shared here. Join farmers like Molly in Illinois and tireless champions of sustainable agriculture like George in Minnesota. Work with community stewards like Kilimo and the Intertribal Agriculture Council. Reach out to your closest university ag researchers and nonprofit experts; they want to collaborate and support you!

Find the path that works for you and join us.



Endnotes

Endnotes for Making the Case for CLC agriculture and a human approach to implementing it

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Suggested citation for this paper:

Green Lands Blue Waters. Our Journey to a Transformed Agriculture through Continuous Living Cover. <https://greenlandsbluwaters.org/wp-content/uploads/2021/08/OurJourneyToTransformedAgThruCLC-GLBW2021.pdf> (2021).

