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Rice farming for climate change adaptation in the Northeastern United States

Chuan Liao[a], Jenny Kao-Kniffin[b,c], Matthew Reid[d], Wendong Zhang[e], Precious Tshabalala[c], Erik Andrus[f], Zachary Butler-Jones[b], Jordan LaPoint[b], Shuai Zhou[a], Radine Rafols[a], Seongmin Shin[a], Mai Ichihara[a], Autumn Pereira[b], Natalia Butler[g], Ying Tu[a], and Susan R. McCouch[h,1]

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In response to challenges posed by climate change, rice farming emerges as a strategic adaptation in the agriculture sector in the northeastern United States. Cultivating rice can diversify farming practices, create new sources of income, improve water management, and provide habitats for wildlife, enhancing the sustainability of agricultural systems and rural economies. However, challenges such as methane emissions from rice paddies and the risk of metal(loid) contamination highlight the need for adopting best practices in rice cultivation, particularly in land and water management and the selection of suitable rice varieties. By learning from the experience of other temperate rice farming regions and implementing supportive policies, technology, and cooperative frameworks, farming communities in the northeastern United States can learn to navigate these obstacles, ensuring the successful integration of rice farming into its agricultural landscape.

rice | climage change adaptation | sustainability | Northeastern US

Rice for Climate Change Adaptation

The northeastern United States faces escalating challenges due to climate change, including rising temperatures, intensifying precipitation patterns, and mounting flood risks (1, 2). While the effects of flooding in coastal and urban settings have garnered public attention, the increasing threat of floods to crop and livestock farms, as well as to rural communities more broadly, remains an overlooked concern (3–5). Strategies that help farmers diversify their production systems and livelihoods are urgently needed to avoid significant climate-related agricultural losses that disrupt rural economic vitality, threaten the food supply chain, and ultimately compromise food security (6).

Rice (*Oryza sativa*) is a crop that withstands flooding and warmer temperatures, and rice farming encourages improved water management while providing income to farmers and habitat for wildlife. The introduction of cultivated rice to the northeastern United States (Fig. 1), along with other new crops and production technologies, can offer alternatives to current flood-intolerant agricultural practices and help farmers transition toward more climate-resilient agricultural systems. Moreover, rice is a highly adaptable crop, capable of thriving in a variety of soil types and conditions. This flexibility underscores the potential to integrate rice into diverse agricultural landscapes (7).

While cultivated *O. sativa* represents a new crop in the northeastern United States, rice itself is not new to the region. For centuries, American wild rice (*Zizania palustris*) was harvested from around the Great Lakes region of North America (8). Long before maize was introduced into indigenous economies in the northeast, wild rice served as a dietary staple for migratory hunter-gatherer cultures (9, 10). Considered a sacred food by native peoples, wild rice was highly valued for its long, nutritious black grains (11, 12). In contrast, the production of maize required intentional planting and saving of seeds annually, cultivation practices that were slowly adopted along with increased sedentism by native populations. Today, as we consider introducing cultivated rice (*O. sativa*) to complement major crops like maize in northeastern US agriculture, we are, in a sense, coming full circle by introducing a new version of an ancient grain that aligns with the region's history.

Economic, Social, and Environmental Benefits of Small-Scale Rice Production

Here, we propose the introduction of cultivated rice (*O. sativa*) in the northeastern United States as a complement to, not as a replacement of, current agricultural practices which are increasingly challenged by a changing climate. The entire rice production system and its associated supply chain, once established, can generate a wide range of economic, social, and environmental benefits (Fig. 2).

Author affiliations: [a]Department of Global Development, Cornell University, Ithaca, NY 14850; [b]Horticulture Section, School of Integrative Plant Science, Cornell University, Ithaca, NY 14850; [c]Cornell Cooperative Extension, Cornell University, Ithaca, NY 14850; [d]School of Civil and Environmental Engineering, Cornell University, Ithaca, NY 14850; [e]Dyson School of Applied Economics and Management, Cornell University, Ithaca, NY 14850; [f]Boundbrook Farm, Vergennes, VT 05491; [g]Department of Natural Resources and the Environment, Cornell University, Ithaca, NY 14850; and [h]Plant Breeding and Genetics Section, School of Integrative Plant Science, Cornell University, Ithaca, NY 14850

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[1]To whom correspondence may be addressed. Email: srm4@cornell.edu.

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Fig. 1. Small-scale, temperate rice farming system at Boundbrook Farm in Vergennes, Vermont. Image credit: Kevin Burget (photographer).

Rice farming can generate new sources of income and expand and diversify markets throughout the food supply chain. In 2022/2023, Americans consumed approximately 4.6 million metric tons of rice, contributing to the steady demand for this staple grain (13). Particularly when marketed regionally as a specialty crop, rice has demonstrated potential to yield promising economic returns (14). Growing demand for specialty rice, driven by trends in tourism, culinary curiosity, and regional brewers, presents local farmers with profitable new opportunities. The region stands to gain by expanding the rice supply chain, creating jobs, linking communities, and diversifying revenue streams. Rice appeals to health-conscious consumers because it is a naturally gluten-free grain. While often eaten as polished white rice, the consumption of unpolished brown-, red-, or purple-pericarp rice offers nutritional advantages, including higher levels of minerals such as iron and magnesium, along with bioactive compounds, such as flavonoids, carotenoids, and phenolic compounds that contribute to antioxidant properties (15). Value-added products, such as individualized packets of locally grown brown, black, red, or white rice, restaurant offerings with locally grown ingredients, sushi made from locally grown rice varieties, or regionally brewed rice-wine or sake, can cater to high-end markets, thus amplifying profitability (16). This aligns with the fact that 95 percent of all sushi consumed in the United States is made with US-grown rice, and 80 percent of all the rice consumed in the United States is also domestically grown, further emphasizing the market potential for regionally produced rice (13). As culinary preferences evolve, the demand for locally sourced premium ingredients, especially around major urban centers such as New York City, will also increase. Across the United States, a long-term growth in rice consumption has been documented, fueled by changing demographics, and a growing demand for gluten-free and rice-based products (14, 17).

The adoption of small-scale rice cultivation can also diversify the agricultural landscape and bring new vitality to rural communities. Over the past several decades, the number of farms in the United States has decreased while farm size has steadily increased, raising concerns about the marginalization of smallholder farmers and the long-term sustainability of agriculture (18, 19). The US Secretary of Agriculture, Thomas J. Vilsack, aims to change this dynamic by investing in regional infrastructure and new markets for small farms (20). In this context, specialty rice cropping in the northeastern United States is worthy of consideration. The specialized labor demands coupled with reduced land requirements present a counternarrative to the "bigger is better" mindset, emphasizing the potential to build a balanced and diverse agricultural sector. Developing technical, marketing, and community support for small-scale rice farming can help attract a new generation of farmers who are open to new ideas, crops, ways of farming, new markets, and cuisines at a time when access to farmland becomes a significant barrier for many (21). Opening up new agricultural opportunities that attract new talent, energy, and vision brings value to rural communities and can help revitalize local and regional development.

Rice farming, while primarily recognized for its agricultural output, also delivers a host of environmental benefits. Well-managed rice paddies, generally recognized as a type of managed wetlands, provide a myriad of environmental benefits (22–24). Wetland environments can decrease the risk of downstream flooding thanks to their high capacity to absorb and retain water (25). Given the forecasted increase in water level and extreme weather events in the coming decades (26), these environments can act as an important landscape feature to reduce the risk of downstream flooding and ensure resilience of rural communities in the northeastern United States. The controlled irrigation and drainage systems used in rice farming help manage water resources and provide benefits for soil health, including regulating water flow, retaining nutrients, and minimizing soil erosion. While water levels in rice paddies must be carefully managed throughout

Fig. 2. Envisioned economic, social, and environmental benefits from rice production in the northeastern United States.

the season, rice differs from other major cereal and vegetable crops in that it has internal aeration mechanisms that make it well adapted to growing in water-logged (anaerobic) conditions. In fact, many rice varieties have growth controls that allow plants to withstand 3 to 4 d completely submerged in water, with some varieties bred to withstand submergence for 7 to 14 d (27). This means that rice paddies in hydrologic communication with streams can temporarily store floodwater, further reducing downstream flood risk. Rice paddies also hold potential for improving water quality at the landscape level, particularly when integrated into farms as vegetated buffer strips or constructed wetlands. These systems can decrease the release of excess nutrients, such as phosphorus and nitrogen, from farms into nearby streams. While traditional best management practices like buffer strips have been challenging for farmers to adopt due to insufficient incentives, rice paddies on these buffer strips offer a unique opportunity to align economic interests with environmental benefits. Acting as a nutrient management tool, strategic placement of rice paddies could help offset phosphorus runoff and nitrogen leaching, reducing the risk of harmful cyanobacterial blooms in waterways (28–30). Although more research is needed to quantify these water quality benefits at scale, the well-known role of wetlands in nutrient removal, as "kidneys of the landscape" (24), suggests that rice cultivation can provide meaningful landscape-scale improvements in water quality.

Another noted benefit of wetland environments, including rice paddies, is their ability to effectively sequester carbon, which is especially prominent in wetlands in the northeastern United States (31). Over time, rice paddies tend to accumulate soil organic matter (SOM), which enhances carbon sequestration and promotes nitrate removal through processes such as heterotrophic denitrification. Studies of a chronosequence of rice paddy soils have shown that older paddies, under cultivation for extended periods, accumulate higher SOM levels due to the stabilizing effect of soil saturation (32, 33). This increase in SOM not only contributes to carbon storage but also supports overall soil health and nutrient cycle. Additionally, enhanced carbon storage in rice paddies could serve as an economic incentive for farmers, potentially enabling them to claim carbon credits as tangible evidence of their environmental contributions (34, 35).

Flooded rice fields provide essential habitats for diverse and endangered wildlife, particularly waterbirds (36). Existing research indicates that over 100 wetland-associated bird species (87% of 120 documented) utilize rice fields in North America, a significantly higher number than are found associated with other major crops, and many of these species are of high conservation interest (37). These diverse wetland habitats offer breeding grounds, foraging areas, and stopover sites for migratory birds, contributing to biodiversity conservation. Both wild and managed fields of rice in the northeastern United States could serve as crucial stopover locations for waterbirds during their migration along the Atlantic Flyway. For instance, a 0.4-hectare rice paddy in Upstate New York (42.51°N, 76.33°W) has attracted over 110 bird species since January 2024 (38), providing

Fig. 3. The rice paddy system in Freeville, New York provides habitat to support the Semipalmated Sandpiper (*Calidris pusilla*). The species is a conservation focus, with population declines in the past 30 y. Image credit: Paul Herwood (photographer).

crucial habitat for several threatened shorebirds. Among these is the Semipalmated Sandpiper (*Calidris pusilla*) (Fig. 3), a species of high conservation concern due to its steadily declining population over the past 30 y (39, 40). Therefore, the availability of flooded rice paddies can provide critical feeding and resting sites for waterbirds on their long-distance journeys (41).

The practice of integrated rice-duck, rice-crawfish, and rice-fish farming generates additional socioeconomic and environmental benefits (42, 43). Ducks act as natural pest managers, feasting on insects and weeds, while fish, crawfish, or ducks in the field promote organic nutrient cycling, enhancing soil health. In Louisiana, rice-crawfish farming is widely practiced, generating important economic and environmental benefits for rice farmers. Interestingly, the economic value of the crawfish has surpassed that of the rice, yet rice paddies remain essential for providing the necessary habitat for the crawfish (44, 45). This highlights how initially novel systems can evolve into successful models over time as farmers adapt and manage them. Such integrated farming systems offer a visionary blueprint for practices that enhance biodiversity and ecosystem vitality while simultaneously elevating agricultural yields (46–48). However, scaling these systems more broadly in the northeastern United States will require innovations in research and practice to assess their suitability in this new agroecological landscape, with careful attention to factors such as topography, soil, climate, and ecological compatibility. At the forefront of this movement in the northeastern United States is Erik Andrus of Boundbrook Farm in Vermont (49). Once his rice seedlings become established in the spring, he releases 85 to 100 ducklings per acre into his flooded rice paddies to establish a symbiotic system that allows him to profitably harvest both ducks and rice. This example underscores the bottom–up, farmer-led innovation that drives the development of such systems, with farmers experimenting, adapting, and eventually incorporating complementary components such as ducks or crawfish once the foundational crop, rice, is established.

Challenges of Initiating Rice Farming

A notable challenge to rice farming globally concerns methane emissions, which account for an estimated 9% of global anthropogenic methane (50). This is primarily due to rice being cultivated in seasonally flooded paddies, where limited oxygen favors the proliferation of microbial groups which use less efficient terminal electron acceptors, such as methane-producing methanogens (Fig. 4*A*). While much of the methane traveling through the soil and water columns is oxidized to carbon dioxide by methane-consuming soil microbes (methanotrophs), methane can also be transported to the atmosphere through the rice aerenchyma system, effectively bypassing methanotrophs. Globally, the rice aerenchyma system serves as the major pathway for methane release from rice paddies (51, 52).

Advances in methane control could help rice paddies become net carbon sinks and reduce greenhouse gas emissions. One such practice is Alternate Wetting and Drying (AWD), which involves mid-season drainage that saves water, aerates soils, increases the abundance and activities of methanotrophs, and decreases methanogenesis, thus reducing methane emissions by up to 80% without impacting yield (53–55). Rice can also be grown in raised beds with drip irrigation, and as long as the soil remains aerobic (not waterlogged), the system emits virtually no methane into the atmosphere (Fig. 4*B*). Although practices to reduce methane emissions in rice paddies may result in increased carbon dioxide release, these efforts still reduce the climate warming potential of the gases released from the system, as the global warming potential of methane is 27 times that of carbon dioxide over a 100-y timeframe (56, 57). Nonetheless, these practices may increase nitrous oxide production (58, 59), though large reductions in methane emissions under AWD often result in a net reduction in the total global warming potential of joint methane and nitrous oxide emissions (60–62). Appropriate nutrient management is critical to ensure that these practices provide a net climate benefit. Further, breeding of short-season, temperate-adapted varieties of rice holds promise for reducing greenhouse gas emissions in wetland rice production (63). Such breeding efforts focusing on root exudates and architectural features that promote the growth of methanotroph populations can enhance the oxidation of methane in the rhizosphere (Fig. 4*C*) (64, 65). By coupling environmentally sound water and soil management with rice varieties that support methane-mitigating microbial communities, and by advancing breeding efforts toward such traits, rice production in the northeastern United States can become part of the climate solution rather than exacerbating the problem.

The potential for contamination from metal(loid)s such as arsenic, lead, cadmium, and mercury in rice production poses significant risks to environmental sustainability and human health. These toxic substances can accumulate in rice plants if present in the soil, water, or fertilizers used during cultivation, especially in areas previously affected by open-pit mining, intensive phosphate fertilizer application, arsenic-based pest controls, or electronic waste disposal (66). Arsenic, in particular, represents a major concern due to its natural occurrence in many soils and its higher uptake by rice under

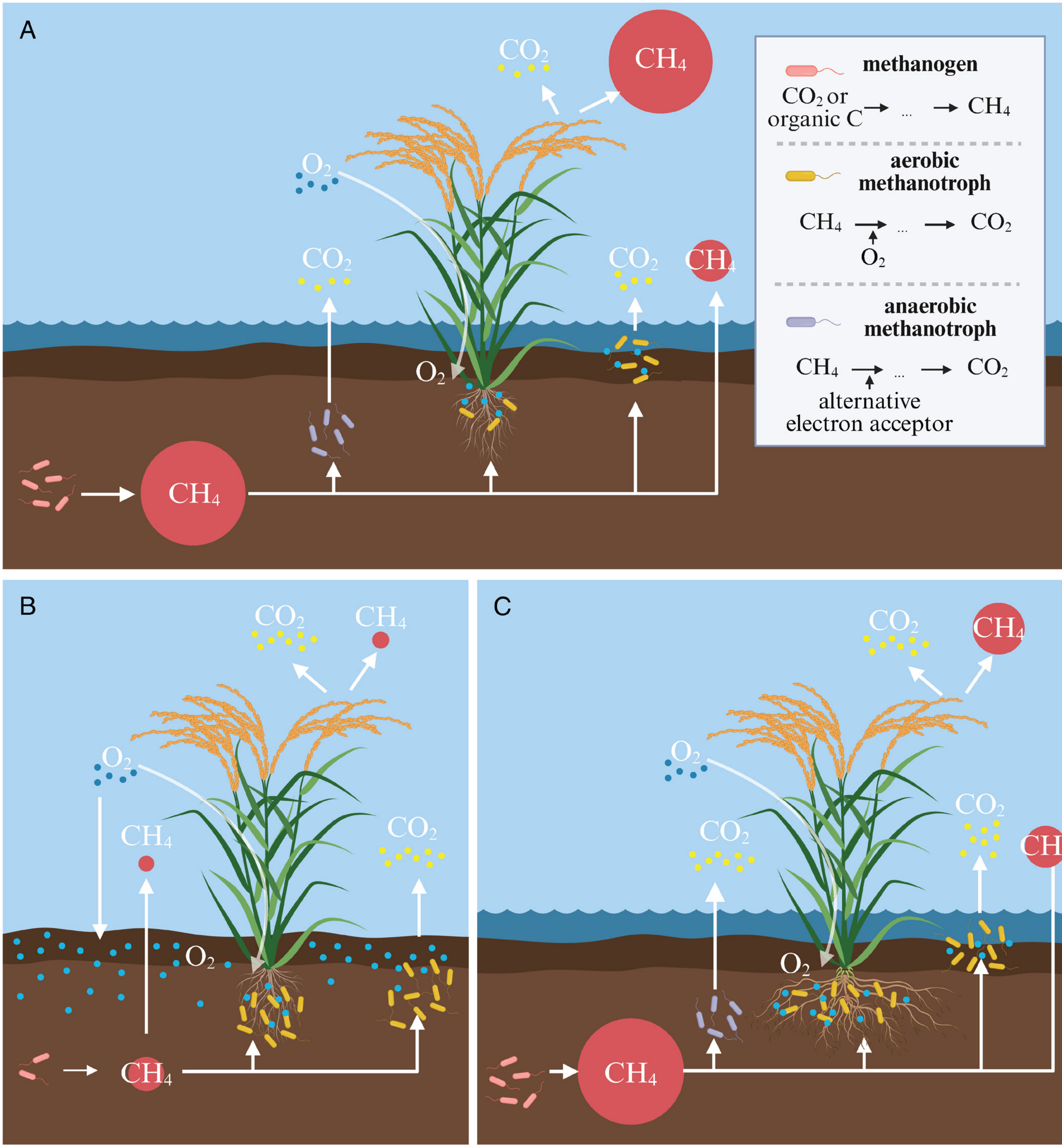

Fig. 4. Methane cycling in three rice production systems. (*A*) Anaerobic rice paddy system: Methane (CH_4) is produced by single-celled methanogens and can be oxidized to carbon dioxide (CO_2) by bacterial or archaeal methane-consuming (methanotroph) populations before reaching the atmosphere, released directly to the atmosphere through the rice aerenchyma system (internal air channels linking roots and shoots, involved in transporting oxygen to roots under flooded conditions), or released via ebullition or diffusion through the soil and water column. Methanotroph populations are primarily active in the rhizosphere, where oxygen diffuses from rice roots. (*B*) Aerobic rice system: Aerating soils, either temporarily (AWD) or permanently (raised-bed system or drip irrigation), can reduce methane-producing (methanogen) and increase methane-consuming (methanotroph) soil microorganisms, as oxygen is distributed throughout the soil profile; (*C*) Engineered rice system: Methanotroph populations can be increased by plant breeding efforts targeting root exudates and architectural features that stimulate the growth of methanotroph populations in the rhizosphere and/or microbiome manipulation, which lead to more methane being captured and oxidized before releasing into the atmosphere as CO_2. Gas fluxes are indicated by arrows, and relative abundances of CH_4, CO_2, and O_2 in the soil matrix are represented by the size and number of the red (CH_4), yellow (CO_2), and dark blue (O_2) circles, respectively, though sizes are not to scale. Figure created in BioRender by Autumn Pereira.

flooded, anaerobic conditions—a result of arsenic being mobilized from the reductive dissolution of iron oxide minerals (67). Growing rice in aerobic (nonflooded) soils (i.e., in raised beds with drip irrigation) minimizes the likelihood of arsenic accumulation in rice grains, and AWD methods recommended for mitigating greenhouse gas emissions from paddies can also be effective at decreasing bioavailability and grain accumulation of arsenic through the oxidation of iron and sequestration of arsenic on surfaces of iron oxide minerals in soil (55, 68, 69). Concentrations of inorganic arsenic, the most toxic form of arsenic, can be further decreased by installing high-intensity drains in rice paddies (70). While there has been some concern that AWD can increase grain cadmium concentrations, these effects are minimal in locations with low levels of soil cadmium (71, 72). Decisions around implementation of AWD to control grain arsenic uptake should also consider potential impacts on nutritionally important micronutrients like zinc, iron, and copper (72). Another potential approach for decreasing arsenic mobilization as well as methane emissions is to use nitrate-contaminated groundwater or tile drainage from other parts of farms to irrigate paddy fields. Nitrate oxidizes ferrous iron in soil to ferric iron oxides, effectively sequestering arsenic on iron oxide mineral surfaces and repressing methane emissions (73). This approach would also provide water quality benefits by reducing nitrate concentrations in groundwater that discharges to streams and could offset synthetic fertilizer needs, though it will be important to assess impacts on emission of nitrous oxide as a denitrification intermediate.

Introducing rice as a new crop in the northeastern United States requires strategic interventions to address both technical and sociocultural challenges. Currently, farmers interested in growing rice in the region may be challenged to find sources of locally adapted rice seed, information about appropriate cultivation practices, access to small-scale machinery, as well as specialty markets for locally produced rice. The region's farmers, alongside their agricultural service providers and commercial partners, are generally unfamiliar with small-scale rice farming methods and techniques, including the engineering and preparation of man-made flooded fields, raising, and transplanting of rice seedlings, and the management of crops and soils in a flooded system. Most farmers will not have access to the specialized machinery required to complete these tasks. Moreover, the introduction of rice also introduces the possibility of new pests and pathogens, requiring careful monitoring and preventative management practices guided by epidemiological considerations. Some farmers or service providers may thus be hesitant or even apprehensive to get involved, given that paddy-rice farming differs significantly from more familiar European dryland farming approaches. Meanwhile, rice farming, being a labor-intensive agricultural practice, faces an additional challenge with the exodus of farmers in rural America (19). This highlights the need to attract a new generation of younger farmers interested in adopting and maintaining rice production, celebrating the advantages of rice as a food, as a climate-resilient crop, as a component of biodiversity, and as an integral part of the region's natural ecosystem.

Although rising demand for rice is a promising outlook, farmers must also be aware that participating in national and global rice supply chains has economic pressures attached. The national rice market is currently dominated by growers in the Mississippi Delta, the Gulf Coast (long-grain rice), and California (medium- and short-grain rice) where they typically compete in a consolidated, industrialized agrifood system (74). Extensive research has documented the precarity of small-scale growers in specialty sectors like organic crop production and the inequities embedded within national-scale commodity exchanges (75). California's organic industry, for example, has been described as an oligopsony at the top (i.e., a small group of buyer firms). For smaller operations, making the farm their primary source of income can be difficult, reflecting the economic challenges that new rice growers may encounter (76, 77). In the absence of price premiums, the costs of production may overwhelm the benefits (78).

Pathways toward Rice Adoption

To encourage the emergence of small-scale rice production in the northeastern United States, federal, state, and local support mechanisms are crucial, especially in the early stages. Policy interventions can highlight the public health benefits of rice as an unprocessed, gluten-free grain, its contributions to environmental sustainability and conservation of biodiversity, and its potential to expand social and economic opportunities in agricultural communities. Both federal and state government policies, along with incentives, civil society programs, and extension staff training, are vital for facilitating the adoption of rice. Such support will nurture the northeastern rice farming movement by helping to foster a sense of community, minimizing agronomic and economic risks, creating local and regional markets for specialty rice, and preparing pathways for scaling into national value chains. For example, in 2019, New York State's enactment of the Climate Leadership and Community Protection Act, aiming for net-zero carbon emissions by 2050, highlighted agriculture, including rice farming, as a key area for development toward climate resilience. Supportive programs, like the New York State Climate Resilient Farming Program (79) and USDA's Environmental Quality Incentives Program (80) also offer technical and financial assistance crucial for adopting new farming techniques and mitigating upfront capital investments and uncertainties.

Another practical approach to overcome the challenges of rice farming in the northeastern United States involves establishing local farmer cooperatives, with participatory variety trials and breeding efforts aimed at directly addressing growers' needs and developing market opportunities for rice farmers in the northeastern United States. This initiative is exemplified by a recent collaboration between a small network of rice farmers, researchers, and Cornell Cooperative Extension, designed to advance small-scale temperate rice cultivation (81). This collaboration focuses on sharing best practices, expanding access to appropriate seed stocks, and making available specialized equipment for every phase of production, from solar-powered greenhouses for seedlings to machines for transplanting, harvesting, and threshing. The cooperatives can also play a role in demonstrating sustainable postharvest straw management practices. For instance, farmers can be directed to chop rice straw into small pieces during grain harvest using small combines and incorporate it back into the soil as green manure. This practice enhances soil texture and fertility, contributing to a more sustainable farming system (82). Additionally, rice straw can be utilized in value-added applications, such as rice paper or biofuel production, creating new revenue streams for farmers.

Agricultural companies, particularly those dealing with equipment and seeds, will play a crucial role in overcoming the technological barriers to small-scale rice farming in the northeastern United States. The limited availability of suitable machinery for small-scale operations presents a significant barrier, but equipment dealers and manufacturers can address this issue by sourcing or developing specialized, compact, and versatile rice-farming equipment, which is essential for maximizing productivity and making efficient use of limited agricultural space (83). By importing or designing locally produced versions of these machines, these companies can help position rice farming as a viable and profitable agricultural opportunity in the region. Equally important is ensuring the availability and distribution of clean, pathogen-free seeds to prevent the spread of pests, diseases, and weed seeds. Seed cooperatives, in collaboration with agricultural companies, will be critical in producing and distributing certified clean seeds, reducing pest and pathogen risks and supporting the successful expansion of rice cultivation in the northeastern United States.

Economically viable small-scale farms throughout the northeastern United States demonstrate resourcefulness by producing and selling a wide range of products through farmers' markets and community-supported agriculture, highlighting the importance of specialty markets and local buyers (84). Securing sufficient market share for locally grown rice, whether through creating new local markets or engaging in the specialty rice industry, is essential. The growing consumer demand for sustainable foods, which can be sold at a premium, represents a significant economic opportunity. And nationally, northeastern rice farmers may become vital in sustaining an increasingly precarious rice supply due to California's chronic drought and low reservoir levels, which have significantly depressed rice production on the west coast (14). It is thus necessary to prepare a scaling pathway into national value chains so growers can navigate the complex systems of trade that are often dominated by large-scale ingredient buyers, corporate brands, and retailers.

The long history of small-scale rice cultivation in Asia offers a wealth of knowledge about water management and rice farming techniques that would benefit growers in the northeastern United States. Well-developed networks of canals, dikes, and reservoirs have been designed to capture, hold, and distribute water efficiently in rice-growing countries like Japan, Korea, and China (85). In Japan, the multifunctionality of rice paddies extends beyond food production and is widely acknowledged to include flood control, groundwater recharge, and erosion mitigation, delivering significant environmental as well as economic value (86, 87). This exemplifies how rice paddies can act as effective green infrastructure, reducing the need for costly engineered solutions (88, 89). Expertise in soil and water management will be crucial in the northeast, where erratic precipitation patterns and increased risk of flooding threaten traditional rain-fed agriculture.

To address the challenges of an aging population and labor shortages in rural areas, Japan, Korea, and China are also implementing measures to attract younger, more educated farmers through supportive policies, training in smart farming technologies, and cooperative farming models (90–92). Policies in Korea emphasize the integration of ancient farming traditions with modern techniques to improve soil fertility, biodiversity, and water management (92). Similar initiatives blending ancient wisdom with modern perspectives will be needed to support a new generation of farmers willing to invest time, energy, and resources farming rice in the northeastern United States.

Identifying rice varieties that will thrive in the temperate climate zone of the northeastern United States, with its short growing season and diverse soils, would also benefit from an international perspective. Rice varieties bred for the southern United States and California rice industries do not reliably flower or set seed in the northeastern United States. In contrast, rice varieties bred in Hokkaido, Japan, and northern China, at latitudes more similar to the northeastern United States, have been found to be productive and are available in the United States through the National Plant Germplasm System of US Department of Agriculture. These older Asian rice varieties provide a valuable starting point for developing a rice industry in the northeast, but investments in rice breeding and varietal selection processes will be needed to improve the climate-adaptation, greenhouse gas emission potential, stress-resilience, and grain quality required to support a productive, nascent rice industry in the northeastern United States.

Conclusion

As we envision the future of agriculture in the northeastern United States, rice farming represents a strategic pivot. It goes beyond efforts to simply adapt existing systems to a shifting climate. Rather, it opens the door to a broader consideration of new crops and cropping systems that can be tailored to local needs, enhancing the diversity, resilience, and sustainability of regional agricultural systems. The goal of this paper is to lay out a conceptual framework for small-scale rice cultivation and emphasize that future research must incorporate more data on production strategies, costs, benefits, profitability, and market potential to ensure that rice cultivation in northeastern United States is both viable and sustainable. To bring this vision to fruition will require harnessing cutting-edge technologies, supportive policies, and overcoming cultural apprehensions about a changing agricultural system. We must also recognize global concerns about greenhouse gas emissions from rice paddies and commit to water and soil management practices that mitigate emissions and contribute to environmental solutions. The landscape we aim to foster will not only improve livelihoods for small-scale producers but also promote climate-resilient farming solutions, more diversified markets and food systems, and enhanced ecosystem services. Ultimately, rice fields in the northeastern United States can serve as living laboratories that foster agricultural innovation in the face of climate change while supporting biodiversity and ecosystem services.

Data, Materials, and Software Availability. There are no data underlying this work.

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