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July 19, 2022

Good afternoon Chair Khanna, ranking member Norman, and members of the Subcommittee. My name is Rachel Schattman, and I serve as an assistant professor of sustainable agriculture at the University of Maine, Maine's R1 research, land- sea- and space-grant institution. My area of expertise is agroecology, which is the study of agriculture and ways to balance production with impacts to natural resources and society. The overarching goal of my work is to support farmers to be more resilient in a changing climate while protecting natural resources. I have worked on farms, both dairy and vegetable, since I was a teenager. I owned and operated my own farm for over ten years in Vermont, and I have also served for almost four years as a postdoctoral scholar with the USDA Northeast Climate Hub, prior to beginning my current position. Before I begin, I'd like to say thank you to Representative Khanna for the invitation to testify, and the National Sustainable Agriculture Coalition, for its assistance in making my appearance today possible.

The United States plays an important role in addressing both food security and climate change. Agriculture sits at the nexus of these two issues, which some have called *wicked problems* due to their pernicious effects, and the complexity of their causes and their solutions. And, indeed, as one of the largest agricultural economies in the world, it is imperative that we strive to limit the degree to which agriculture contributes to climate change, leverage best practices so that farms help mitigate climate change, and ensure food security in the United States and globally. I believe we can rise to these challenges by investing in U.S. agriculture strategically, using both established and new federal policies and programs, which is what I am here to speak with you about today. This is not a zero-sum game. These solutions can work for farms, they can work for consumers and communities, and they can work for the environment. And in fact, through agriculture we have unique opportunities to help mitigate climate change in ways not possible in other industries or systems.

Problems

Let me clarify the challenge we face relative to food security, and specifically domestic food security. Someone is considered *food secure* when nutritious food is consistently available, accessible, in a form they can and want to use, to the degree that they can lead a healthy and active life. However, more than one out of ten people in the United States is classified as *food insecure*. Furthermore, we know that food insecurity is directly affected by social, economic, and environmental disruptions and disasters. The University of Maine is a partner in the National Food Access and COVID Research Team (NFACT). Through this research partnership, my colleagues and I have shown that, in many places across the country, food insecurity spiked as a result of the pandemic. In Maine, for example, we documented a 35% increase in food insecurity in 2020 compared with the year prior to the onset of COVID-19. Households with children under the age of 5, and Black, Indigenous, and communities of color experienced greater rates of job loss, and an associated decline in food security during this historic period [1]. Not only was this true in Maine, but also in most of the other NFACT study sites across the country.

The COVID pandemic is one example of a disruption that can have disastrous consequences for the most vulnerable among us and their ability to feed themselves; climate change also poses threats to our domestic food security, and global food security as well. For example, recently heavy rainfall caused a significant flood at the Abbott Nutrition plant in Sturgis, Michigan, contributing to shortages of specialty infant formula across the country. As the mother of a 6-month-old baby who needed specialty formula during this past half a year, I can tell you that it was surreal to have family and friends in three different states scouring grocery store shelves for a food that was necessary for the health and well-being of my child. This highlights that farms are not the only part of the

food system that are vulnerable to climate change. From food production to food waste, and all the steps in between, disruptions driven by climate change have real and tangible consequences. However, for the remainder of this testimony, I will speak directly about agriculture, given the focus of this hearing.

Here are two examples of how changes in the climate have affected different agricultural industries in the U.S. First, increased average temperatures are associated with a decrease in yield in staple grains. It has been shown that a 1°C (1.8°F) increase in average temperature leads to an 8% to 10% decrease in corn yield, and a 9% decrease in rice yield. To put this into context, the National Atmospheric and Oceanic Administration (NOAA) reported in June of this year that average temperatures have increased 0.32°F (0.18°C) per decade since 1981, and in 2021 the surface temperature of Earth was 1.51°F (0.84°C) warmer than the 20th-century average, which was of 57.0°F (13.9°C). It was also 1.87˚F (1.04°C) warmer than the pre-industrial period (1880–1900) [2]. In other words, the climate has already changed enough for us to start to see decreases in crop yields, if all other things are held constant. The decrease in grain crop productivity has not been noticeable to many, however, due to technological advances brought about by agricultural research, such as precision agriculture, irrigation, and improved crop genetics. However, if temperatures continue to increase, as we anticipate they will, it is unclear how long these improvements will continue to offset the biophysical limits of crops.

A second example of how climate change has a notable effect on U.S. agriculture can be found by looking at non-citrus tree fruit. Increasing minimum temperatures affect fruit bearing trees, such as apples, peaches, pears, and plums. Warm periods in the spring (sometimes called a "false spring") can cause early bud development. When these false springs are followed by killing frosts, they can decimate a year of fruit production, as was the case in Michigan in 2012 [3], in West Virginia four years in a row between 2014 and 2018, and in many other parts of the Northeast and upper Midwest. This phenomenon also affects perennial fruit crops like wild blueberries, an important commodity in Maine. Meteorologists have coined the term *weather whiplash* to describe rapid temperature swings. This is just one of the ways in which climate change affects perennial tree fruit and other fruit, but it does a good job of illustrating how we must look beyond annual average temperatures, and consider how climate (often talked about in 30-year+ time frames) affects weather patterns (anything shorter than 30 years). I will paraphrase my colleague Dr. Daniel Ward, a Cooperative Extension pomologist from the Rutgers Agricultural Research and Extension Center, who said: *It's not about whether farms lose a crop in any given year, but about how many years a farm can sustain losses.* The number of years from which a crop can be harvested from a fruit tree is heavily influenced by temperature, and every year that yield is lost changes the math for a fruit producer.

These are just two simple examples, but each agricultural sector in every region of our country will be affected by climate change in some way, and many already are struggling. This is a long-term problem. Even if we were to stop putting greenhouse gasses into the atmosphere today, we would see temperatures increase throughout this century and beyond, with cascading effects on precipitation and other weather patterns. These weather patterns, in turn, affect the balance of *agroecosystems*, which are the communities of plants (cultivated and not cultivated), insects and animals (both pests and beneficials like pollinators), diseases (affecting plants, humans, and other animals), and, importantly, the interactions between all of these. The need to adapt to climate change is here, and will likely intensify as the century progresses. Though there are many uncertainties associated with what the future holds, because of research that has already been conducted we know enough right now to support farmers as they adapt to a changing climate, build resilience into their farm operations today, and anchor thriving U.S. agricultural industries.

We can do this through unwavering support for sustainable, regenerative agriculture. To farm *sustainably* means that we grow food, fiber, and fuel in a manner that does not undermine our ability to do so in the future. To farm *regeneratively* is to do this in a way that has a positive effect on natural resources; this term is often used in the context of sequestering carbon, improving soil health, or improving water quality through agricultural management activities. Specific practices guided by these principles include reduced or no tillage (meaning that the soil is not turned over), cover cropping (the planting of a non-harvested crop to keep soil covered and reduce erosion), crop rotation (which improves soil health), and integration of livestock into cropping systems (which can increase soil organic matter, and localize nutrient generation/use). These practices also have the added climate mitigation co-benefit of sequestering carbon in soil when they are implemented over an extended period of time. Other agricultural practices, such as managing manure (through biodigestion and flaring) and amending animal feed (to improve digestibility of ruminant feed, so livestock like cows will produce less enteric methane),

alternative wetting and drying of fields (in rice production), and using only the most efficient fertilization practices have the benefits of reducing nitrous oxide and methane emissions. These two greenhouse gasses are 298 and 25 times more powerful than carbon dioxide over the first 20 years in the atmosphere, respectively [4,5].

Climate change adaptation is not a straightforward task, and there is no one "right" way to do it. Rather, the best adaptation for any given farm is going to depend on the particularities of that farm. Adaptation could mean trying a new practice or suite of practices. It could also mean changing an existing practice that may have worked previously but no longer does so, or discontinuing something that isn't working at all. Farmers must remain agile. In a recent training on the social sciences of conservation that I developed for the USDA Natural Resources Conservation Service (NRCS), I used the example of a small- or medium-scale dairy operation. In this example, a hypothetical dairy farmer could make one or more small changes to improve profitability (and maintain economic and ecological viability) in the face of climate change: They could change their feed ration, investing in new herd genetics, or shift to selling heifers instead of milk. Or they could make large-scale changes that fundamentally alter the business, such as shifting to value-added processing and becoming a cheese maker, significantly increasing their land base or size of their herd, or even exiting farming. My point is that adaptation can manifest in many different ways depending on the farmer, the operation they run, and the context in which they are running it. The other thing to point out is that when a farmer adapts to change by trying something new, the change rarely is isolated to one practice or improvement. Land management, whether you're talking about cropping, ranching, or forestry, is about working in a dynamic system. A change over here is going to create ripples throughout the whole business or operation.

Support for farms to pursue sustainable and regenerative practices, and *keep using them* has been provided in a limited way by federal programs, and in a patchwork way by states (for example, state programs in Maryland and Vermont that offset the cost of cover crop seed), and supported by both research and outreach organizations like federal research agencies, Agricultural Experiment Stations, and Cooperative Extension services. Private industry has also stepped in to supply information through private certified crop consultants and others who provide for-profit services, and also some larger food companies. These efforts are excellent examples of how to move forward and expand adoption of sustainable and regenerative agriculture, and they have provided valuable opportunities to try out new, climate-centered outreach and education programs and incentives. However, these efforts have been piecemeal, and are not universally accessible to U.S. food, fiber, and fuel producers. For agriculture to meaningfully contribute to addressing climate change, we need a unified, federal approach.

Solutions

To design and deliver agriculture-based solutions to address food security and climate change, we must ask ourselves two questions. First, "what are the primary threats to agriculture posed by climate change, and to what degree will U.S. farms be affected?" I've already given examples of a few of these threats, but I wish to emphasize that solutions must be tailored to specific challenges, and that the needs of different agricultural industries will vary. The second question is "what tools do we have at our disposal to promote agricultural practices that are good for farmers, good for ecosystems, and good for the national and global food supply?"

We've already discussed some ways in which climate change will affect agriculture, and I have tried to focus on specific examples so that it is clear how nuanced these challenges and their solutions are. The fact is, we know a lot about how to help farmers adapt to a changing climate, and we also know where we can get the most bang for our buck when it comes to climate change solutions through agriculture. We must invest in practices to reduce methane and nitrous oxide emissions, and sequester carbon. We need to avoid grassland conversion, we need to use more cover crops in rotation with cash crops, and we need to invest in alley cropping and nutrient management [6]. We need to invest in sustainable use of water resources, whether that is through efficient irrigation, water source development, or growing crops that require less water overall. Perhaps most importantly, we need to drastically reduce our use of fossil fuels in food production (and in food systems overall) by investing in renewable energy sources, developing and adopting widespread energy efficiency practices, and by using fertilizers judiciously and only when and where needed. These principles are applicable to farms of all scales, from tiny to large; organic and non-organic; serving local, national, and global markets.

Ultimately, farmers are the ones who make decisions about what practices do and do not make sense for their operations. In spite of overwhelming evidence that the use of regenerative agriculture practices (e.g. reduced or

eliminated tillage, cover cropping, crop rotation, and integration of livestock) can improve climate resilience while increasing profitability, many farmers have been slow to adopt these practices. For example, cover cropping was used on less than 13% of cropped farms in 2017, according to the USDA Census of Agriculture [7]. Of course, this leads to the obvious question – why? A lack of one-on-one support may explain why adoption of regenerative practices remains low. Additionally, not everyone is aware that change is necessary, and some still hold the perspective that "if it ain't broke, don't fix it." This is changing, however. More and more often, farmers are taking note of drought, heat, and shifts in seasonal temperatures, and all of these changes are leading these communities to realize that they cannot continue to farm in the same way as their predecessors.

One reason farmers struggle to adapt to climate change, and also contribute to climate mitigation at a rate that would be desirable, is that farms must be profitable to be sustainable. An investigation conducted by my research group, in collaboration with General Mills, the University of Nebraska Lincoln, and American Farmland Trust, has looked at adoption of regenerative agriculture practices among wheat farmers in Kansas. Our preliminary findings show that farmers in that industry often view new agricultural practices as a financial risk, which some are willing to take and some are not. Farmers involved in our study voiced a desire for education and technical support when it comes to *how* to integrate these practices into their existing farm management approach. Our findings also suggest that farmers can more effectively transition to regenerative and sustainable management when they have access to educational programs that are regionally specific; include support from technical service providers who have knowledge of both the practices in question and the region's growing conditions; and peer support and knowledge exchange with and from other farmers who are also using regenerative practices.

These farmers would also clearly benefit from financial assistance, either in the form of payments for ecosystem services, or broader, more accessible cost-share style payments. *Ecosystem services* are defined as "the benefits that people derive from functioning ecosystems" [8], and include things like clean air, clean water, and a regulated climate. Payments for providing these services through agriculture would mitigate the risk of farming in a new way. In addition, farms using practices that provide these agricultural and ecosystem benefits are more resilient to the effects of climate change, as these practices generally require less water, fewer fossil fuel-based inputs, and potential improvements to soil health.

How to best structure payment for ecosystem service programs is a matter of great debate, however. These programs have the difficult task of garnering farmer interest and participation, generating ecosystem services, and being efficient to execute. My research group has found that among Kansas wheat growers, payment programs for practicing regenerative agriculture could be a useful tool for expanding adoption, which could contribute to widespread climate adaptation and mitigation. In a study nearing completion, our team has found that among farmers who are interested in implementing a regenerative practice (but who have not already done so), many report that farmer perspectives on payments are diverse. Some report that they would need to be compensated at a rate of $15/acre or more. However, between 14% and 29% report that they would require no compensation (this varied depending on the practice). Farmers who responded to the survey who were interested in practices like *livestock grazing cover crops* and *managed grazing*, 40% and 38%, respectively, indicated that payment programs would increase their interest in the practice, while an additional 38% and 44% reported that payment *may* increase their interest [9].

Interviews with a smaller subset of Kansas wheat farmers further investigated how long farmers would expect to be paid for these practices. Our findings suggest that some producers see payments as a bridge, and after the benefits of the practices are realized the payments may no longer be necessary. One farmer we interviewed explained, "I think if we're doing all those things (regenerative practices) … we ought to be making enough improvements on the land to help the bottom line," and another offered that payments "can help the bottom line and help us be sustainable, but, in reality, if this works like we're being told it's going to work, it shouldn't matter. Profitability should return to the farm, just from … producing good crops with less inputs." The survey results corroborate these statements: Farmers reported being highly motivated to improve profitability and soil health on their farms, two overlapping and intersecting motivations that can be leveraged through policy as a win-win for agriculture, food security, and the climate.

When it comes to quantifying public goods like carbon sequestration, scientific assumptions must be clarified and measurement reliability should be addressed to ensure that payments are fair and equitable. From the preliminary research conducted by my group, it seems that programs that pay for ecosystem service *outcomes* (e.g. the amount

of carbon sequestered) will likely be less efficient to run than programs that pay farmers directly for *practice use*. This does not diminish the need to assess ecosystem service provision over time, but rather allows us to allocate valuable resources (i.e. time and funding) toward incentivizing adoption and long-term use of sustainable and regenerative agriculture. Compensating farmers for the ecosystem services that they generate is an important tool in our climate change response toolkit, especially where farmers need financial support to make the transition to more regenerative practices.

The efficacy of farming practices known to be sustainable and regenerative has been explored and evaluated across the country, on a variety of important food crops and at a wide range of scales. The value of this research is impossible to overstate, and it's very important to advocate for continuation of funding that supports further research in this vein. Indeed, it's been shown that the use of sustainable and regenerative practices can improve yields and increase soil health and quality, all while improving the farmer's bottom line. It is possible to farm in this manner whether on a half-acre community garden in Brooklyn, a 40-acre vegetable farm in Maine, or a 10,000-acre wheat and cattle farm in Kansas. What regenerative farms have in common is that they strive to keep plant roots in the ground, keep the soil covered, minimize soil disturbance, and increase microbial diversity and soil organic matter and carbon, and by doing so provide a template for farming into the future.

What's next?

In order to help farms adapt to climate change in a meaningful way, we need to heavily invest in agricultural research, and leverage and expand educational programs, technical assistance, and financial assistance for farmers. Additionally, it is crucial to invest in professional development opportunities for *agricultural advisors*, defined as anyone who provides professional services and information directly to farmers. This entails developing sector-specific, regionally specific, and tailored offerings for both farmers and advisors. Some of this work has already begun through the recent increases in funding for conservation planning of the USDA Natural Resources Conservation Service (NRCS), and the Risk Management and Farm Service Agencies. I am particularly excited by the proposed *conservation stewardship bundles*, which would integrate suites of agricultural climate mitigation practices into the NRCS Conservation Stewardship Program, and the support for multiple *agroforestry centers* to complement the existing National Agroforestry Center in Lincoln, Nebraska. These two recommendations are among several, well-considered and research-based approaches recommended by the Select Committee on the Climate Crisis in their June 2020 report [10] and also included in the Agriculture Resilience Act (H.R. 2803) put forward by Congresswoman Pingree of Maine, and co-sponsored by this Subcommittee's chairman. Passage and funding of the initiatives included in the Agricultural Resilience Act would accelerate our ability to adapt to and mitigate climate change through agriculture.

As an Experiment Station-based researcher, a former agricultural Extension educator, and a former commercial farmer, I have learned that we need to listen to farmers about what works best from them, while ensuring that the tools and programs we offer are flexible enough to make room for innovation and new ideas. This means broadening access to programs that support both established and new farmers, and expanding the scope of existing programs to ensure broadscale participation. By doing so, we can make greater progress toward eliminating structural exclusion that has historically limited the participation of women, Black, Indigenous, and farmers of color in federal agriculture programs. This entails reevaluating the amount of time that farmers are eligible for programs, and recognizing that on-farm changes that contribute to climate adaptation and mitigation will occur in stages and at all scales.

I have tried to address this in my own work through a three-tiered approach. In 2021–2022, I piloted a program through the University of Maine, in partnership with the USDA Northeast Climate Hub, the Rutgers Climate Change Institute, and many other collaborators from across the Northeast Region. This program, the *Climate Adaptation Fellowship* [11], enrolled vegetable and small fruit growers and the agricultural advisors who work with them in a partnership. Working together, pairs of "Fellows" completed on-farm risk assessments and adaptation planning, put key adaptation approaches in place, and engaged in peer-to-peer learning. This trifecta led to innovation and creative solutions that far exceeded my expectations as program facilitator. Fellows also did their own outreach to other farmers in their communities, presenting at meetings and conferences, writing newsletters and blogs, and hosting on-farm experiments and demonstrations. This program was developed after careful research my colleagues and I conducted on the small number of curricula available that address climate change adaptation and mitigation planning in agriculture [12], and it is our hope that we can offer this program biannually. My group is already working with partners, including two USDA Climate Hubs, the American

Farmland Trust, the USDA National Agroforestry Center, and Michigan State University, to launch the next iteration of this program with four additional cohorts of farmers and agricultural advisors. I am telling you of this effort to emphasize that adoption of climate adaptive and mitigative farming practices is not just about research, outreach, education, and funding. It's also about relationships, and fostering learning communities.

Farms of all shapes and sizes should be acknowledged for their contributions to climate change adaptation and mitigation. When I owned and managed my own small-scale diversified vegetable farm in Vermont, I was inspired and energized by the way my fellow growers thought about and addressed climate challenges: from designing energy-efficient greenhouse systems built into the sides of hills, to developing their own equipment for small-scale no-till systems, these farmers were always trying to think about the climate problem in a new way. As a researcher at the University of Maine, I have been fortunate to work with industry partners like General Mills and Wyman's that bring significant resources to bear on understanding and addressing the climate change challenges faced by growers in their industries. For example, General Mills is one of the first companies in the U.S. to pilot a payment for ecosystem services program, coupled with intensive one-on-one education program and technical support for farmers, and Wyman's (the largest retailer of wild blueberries in the U.S., and the second largest frozen fruit brand) has recently invested in a new research partnership with the Maine Agricultural and Forest Experiment Station to investigate the effects of increasing temperatures and changing precipitation on small fruit crop performance and health. These efforts demonstrate a recognition that new opportunities are coming online, where private, public, and institutional partners can work together across scales to address climate change and food security. These partnerships should be fostered and celebrated, so we can together move toward better outcomes for our country and the planet.

Conclusion

There is no question that more can be done to ensure that farmers are engaged and supported to pursue climate adaptation and mitigation projects. As I noted earlier, sustainability, regenerative practices, and climate change adaptation and mitigation look different in different regions, in rural areas and urban areas, in different agricultural sectors, and for farms of different scales. These differences are driven by the particular pressures farmers face, and their social, ecological, and economic contexts. Support for farmers who wish to pursue sustainable and regenerative agriculture in different regions, sectors, and scales can include continued support for critical research to expand the climate toolbox, direct funding to producers, technical assistance, outreach and education, and peer-to-peer learning. We have many established mechanisms for offering this kind of support, though these mechanisms should be made more robust if we are serious about facilitating a widespread transition to climate adaptation and mitigation across the country. To make additional progress, we need to adopt the kind of initiatives that have been put forward by Congresswoman Pingree in the Agriculture Resilience Act, explicitly integrate climate adaptation and mitigation into Farm Bill conservation programs, and maintain climate change as a priority in this critical legislation.

We also must ensure that federal agriculture programs are available to all who steward the land. In addition to being a matter of science, climate change is invariably a racial, gender, and economic justice issue, as the negative effects of climate change will fall disproportionately on those who can least afford it. I urge the committee to look at the strategic planning work that USDA Northeast Sustainable Agriculture Research and Education (NE-SARE) has done in recent years to integrate justice, diversity, equity, and inclusion into their grantmaking. The time to build equitable access to federal support into the Farm Bill and other programs is now, and by doing so reduce barriers to accessing that support, specifically for programs that address agriculture and climate change.

What is at stake if we fail to address these issues, with the level of nuance and specificity that different types of farms require? We have an instructive example in the disrupted supply chains associated with the COVID-19 pandemic and recent extreme weather events, which significantly challenged our ability to get food to those who need it. To minimize the future harm to our country, we should bring federal policy to bear on extending and expanding how U.S. agriculture adapts and mitigates climate change. The health and well-being of our people and the agroecosystems that feed us demand it.

Acknowledgements

I would like to thank Sara Kelemen (University of Maine Agroecology Lab) for her contributions to this written testimony, and to several individuals for their review: Samantha Warren, Joan Ferrini-Mundy, Diane Rowland, Margaret Nagle, Patrick Rowe, and Richard Taylor.

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