Removing Barriers and Creating Opportunities for Climate-Resilient Agriculture by Optimizing Federal Crop Insurance

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Executive Summary: Climate change is devastating global agricultural and economic systems. Nature-based solutions that promote conservation agriculture can address these challenges while mitigating climate change. We propose a pilot crop insurance and research program in the U.S. Northern Plains to promote practices that enhance farm soil health, income, and resilience while mitigating climate change. Such a program could inform nationwide adoption of such practices. We specifically propose eliminating requirements for fallow to insure wheat, funding development of regionally-adapted leguminous crops, and incentivizing whole farm insurance over single-crop yield-focused offerings to promote economic growth and climate-resilient practices. The policies extend across a spectrum of cost, legislative burden, political capital, and time-scales for implementation and impact, offering a balanced and gradual transition to conservation agriculture. Adopted jointly, these recommendations improve farm resilience to climate change by promoting soil health and crop diversification while reducing emissions.

I. Climate change and agriculture

i. Financial cost of climate change in agriculture

Increased temperatures and extreme weather events of the past decades are expected to worsen, with projected temperature increases of 1 to 3°C by 2050 (Ray et al. 2015; Hatfield and Takle 2014). While temperature increases might lengthen certain crops' growing seasons, the overall effect of climate change will increase crop failure and reduce yields (Lobell and Gourdji 2012; Wienhold et al. 2018).

Many farmers purchase crop insurance managed by the U.S. Department of Agriculture (USDA) as protection from devastating crop loss, and taxpayers cover ~60% of premium costs for this Federal Crop Insurance Program (FCIP) (Bryant and O'Connor 2017). Under a 2°C warming scenario, economists estimate the tax-burden for payouts to increase by $3.7 billion (Tack, Coble, and Barnett 2018). Cost increases are exacerbated by the increasing value of insured crops, which leads to greater liability to taxpayers (Bryant and O'Connor 2017). Efforts to optimize FCIP are, therefore, economically important.

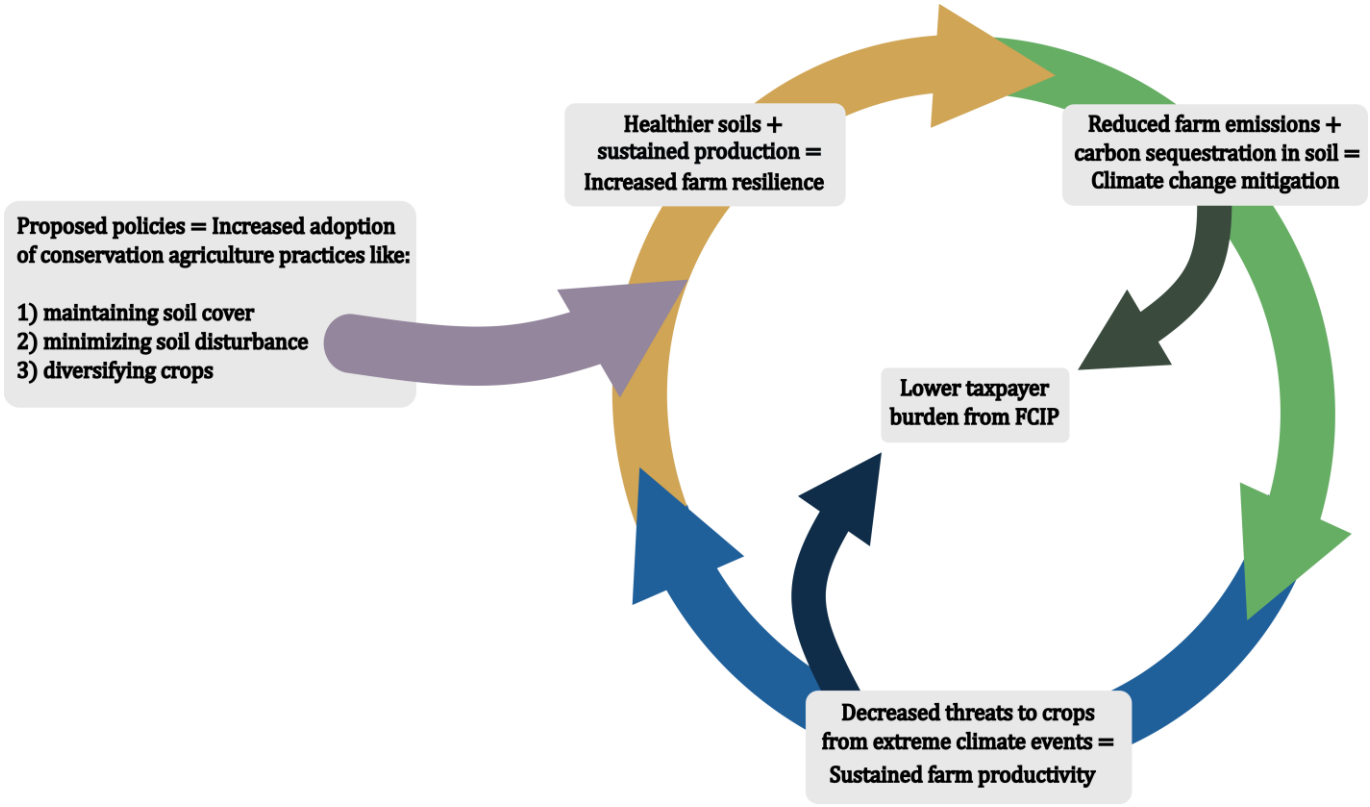

Figure 1: The proposed policy options would modify U.S. Department of Agriculture research funding and aspects of the Federal Crop Insurance Program (FCIP) to enhance conservation agriculture. Through a feedback loop, these changes would lead to food systems becoming more resilient to climate-induced extreme events, potentially lower costs of FCIP, and mitigate climate change through reduced greenhouse gas emissions and carbon sequestration.

ii. Synergy between conservation agriculture and climate change mitigation

Agricultural practices and climate change are linked (Fig. 1). Farming practices such as monocropping, fallow, and tillage have degraded soils, making them more dependent on energy-intensive management and susceptible to crop loss (Sanderman, Hengl, and Fiske 2017; Tilman et al. 2002). The extreme climatic events that characterize climate change also threaten continued ability to cultivate crops (Hunter et al. 2017). Thus, there are clear feedbacks between agricultural practices and climate change.

Conservation practices, on the other hand, can rebuild soil health. For example, diversifying crops, maintaining soil cover, and minimizing disturbance can restore soil structure, facilitate nutrient cycling, and promote carbon sequestration (Robertson et al. 2018; Knowler and Bradshaw 2007). Specifically, the formerly grassland soils of the Northern Great Plains offer potential climate change mitigation because poor management has led to the depletion of more than half the original soil carbon, consequently providing the opportunity to rebuild soil carbon through conservation practices (Lal 2018; Kern and Johnson 1993). Incremental increases to soil carbon are a significant, affordable, and agronomically beneficial means of greenhouse gas (GHG) reduction (Chenu et al. 2019). Enhancing soil carbon can also increase crop yields, farm resilience to extreme events, and lower FCIP payouts (Kane et al. 2021; Bowles et al. 2020; Oldfield, Bradford, and Wood 2019). Thus, conservation agriculture is an effective nature-based solution to climate change because practices that increase soil health simultaneously mitigate climate change (Bossio et al. 2020).

II. Imperative for focusing on semi-arid region and legumes for diversification

Our recommendations focus on the semi-arid Northern Great Plains due to compelling evidence of the benefits of conservation agriculture in this region and the historical practice of the USDA to implement reforms to FCIP after testing in a localized region (Hamilton 2020). This area frequently experiences drought and extreme temperatures, making it prone

to FCIP payouts (U.S. Government Accountability Office 2015). As climate change is expected to expand semi-arid regions and intensify these events, farmers in other geographic regions will increasingly be faced with similar environmental challenges (IPCC 2019). Simultaneously, the funding and capacity of plant breeding programs in the U.S. have declined, forcing plant breeders to focus on maintaining infrastructure rather than diversifying crops (Coe et al. 2020). Few crop breeding programs exist for legumes, yet legumes offer great potential to offset fertilizer use while enhancing soil health and carbon sequestration (Rubiales et al. 2015; Cernay et al. 2015; Peoples et al. 2009; Jensen and Hauggaard-Nielsen 2003). We thus focus our recommendations on this region and specifically target legumes for regional crop development. If effective in reducing FCIP costs and improving agriculture resilience on a regional level, our recommendations could be scaled nationally.

III. Strategies and policy options to promote conservation agriculture

As climate change threatens agriculture and amplifies financial burdens on farmers and taxpayers, urgent modifications to FCIP and USDA research funding that promote nature-based solutions are imperative. We suggest this be implemented as a pilot program due to the precedent that the USDA uses pilots to trial reform measures (Hamilton 2020).

We recommend three specific changes:

1) Eliminate county-level fallow requirements
2) Fund research and market development for regionally-adapted legumes to provide suitable fallow alternatives
3) Phase out single-crop, yield-based coverage and incentivize whole farm revenue protection

If adopted, these policies would reduce GHG emissions, improve soil health and farm income, and confer greater resilience to climate change (Fig. 1).

i. Eliminate county-level fallow requirements for wheat to promote soil health and crop diversification

In the early 20th century, agriculturalists advised farmers to stabilize winter wheat yields by implementing fourteen months of bare fallow to store water in the soil before planting (Peterson et al. 2020). Decades of research have shown, however, that the fallow does not store water efficiently (Nielsen and Vigil 2010). Fallow periods also promote erosion, soil carbon and nutrient loss, and limit soil water-holding capacity. Thus, fallow periods can reduce farm resilience to extreme events (Rosenzweig and Schipanski 2019).

The rise of no-till farming, in which the crops are planted without plowing, has allowed many farmers to plant a productive crop annually without summer fallow periods. This practice thus protects soil from erosion, increases soil carbon, and leads to greater overall yield and income (Peterson et al. 2020; Rosenzweig, Fonte, and Schipanski 2018). The adoption of more frequent and diverse cropping practices, however, has been hindered by FCIP policy that requires fallow prior to sowing wheat to insure the crop (Rosenzweig, Carolan, and Schipanski 2019).

Farmers in Colorado and surrounding states already recognize the advantages of cultivating diverse crops and curtailing fallow. More than 0.5 million hectares reduced the frequency of summer fallow by incorporating more frequent short-season crops between 2008 and 2016, for example, by shifting to a wheat-corn-fallow rotation (Rosenzweig and Schipanski 2019). The reduction of fallow has resulted in an estimated 9% increase in grain production, an $80 million increase in farm income, and a 3% reduction of annual GHG emissions from the Colorado agricultural sector—equivalent to emissions from 70,000 passenger vehicles (Rosenzweig and Schipanski 2019). Broader elimination of fallow is limited by FCIP, whose coverage varies by county: 78% of eastern Colorado counties require fallow before planting wheat to be eligible for crop insurance. **Removing the fallow requirement would promote more frequent and diverse crops with the potential to increase regional grain production by 25%, raise farm income by 26%, and almost completely offset GHG emissions caused by dryland (non-irrigated) grain** (Rosenzweig and Schipanski 2019).

Advantages

- Removing the fallow requirement would provide greater farmer autonomy, allowing them to select the best strategies for their farm and climate. It would permit farmers to crop continuously—a practice that has been shown to benefit soil health, yield, and farm income—while concurrently mitigating climate change through

reduced net GHG emissions and increased soil carbon sequestration (Jensen et al. 2012)
- Efforts to promote soil health can increase agricultural yield and therefore reduce taxpayer risk through FCIP
- Changes to existing policy requirements can be made at no cost of implementation

Disadvantages
- Fallow can enhance yield the year wheat is harvested, though it reduces yields averaged over a rotation cycle (Nielsen, Lyon, and Miceli-Garcia 2017), so trade-offs between long- and short-term benefits must be considered
- Barriers beyond FCIP requirements influence grower adoption of conservation agricultural practices. Additional policy changes are also required to achieve resilient agricultural systems

ii. Fund research and market development for regionally-adapted legumes to provide suitable fallow alternatives and increase crop diversity

The variety of crops planted in the U.S. is decreasing (Crews, Carton, and Olsson 2018). From 1945 to 2007, the Corn Belt acreage devoted to corn and soybean increased from 29% to 80% (Claassen, Langpap, and Wu 2017). FCIP incentivizes planting a small number of commodity crops in excess of domestic need, exacerbating crop homogenization, depressing commodity prices, and making food systems vulnerable (Beckie et al. 2019; Bryant and O'Connor 2017). Suitable alternatives are urgently needed. Moreover, removal of fallow requirements, per Recommendation 1, will further drive the need for suitable alternatives to fallow.

Historically, the emergence of a new crop is preceded by significant public investment in research, crop breeding, and market development (Zander et al. 2016; Cernay et al. 2015). For example, USDA-funded research led soybean yield to double since 1965, and USDA-developed corn varieties made it possible to plant in northern regions previously too risky to sow due to cold and dry conditions (Anderson et al. 2019; Plant Breeding Working Group 2015). This research led to increased yields and nutrition and furnished the seeds utilized by private corporations today. In addition, other countries have successfully increased farm diversification and economic opportunity by investing in crop breeding and marketing (Maaz et al. 2018). Canada invested CAN$18 million in the 1970s to develop the edible oilseed canola, which resulted in CAN$1 billion in benefits to growers and a return on investment to taxpayers of over CAN$700 million (Brewin and Malla 2012). These investments have led to success, in part, because they developed crops for specific climate regions. Hence, we propose similarly scaled investments to research regionally-adapted pulse[1] crops for the U.S. Northern Plains.

Alternative crops could benefit local economies while conferring many ecological benefits from diversification (Petersen-Rockney et al. 2021). For this pilot program, legumes offer the greatest potential, as they have short growing seasons (minimizing water use), enhance nutrient cycling, boost subsequent crop yield, reduce reliance on fossil-fuel-based fertilizers, and provide a protein-rich food source (Stagnari et al. 2017; Zander et al. 2016; Crews and Peoples 2004). Additionally, many legumes could be bred for intercropping, which would allow for simultaneous forage [2] and grain production and have the potential to enhance carbon sequestration (Wahbi et al. 2016; Li et al. 2001; Li et al. 2014; Drinkwater, Wagoner, and Sarrantonio 1998). Grain rotations that include legumes have been shown to use 12-34% less energy, and pulses use 35-60% less fossil energy compared to grain crops (Jensen et al. 2012). Despite these benefits, there is only one legume variety trial and no research levee in the region (Jacob, Carrasco, and Schwember 2016; Rubiales et al. 2015).

Currently, farmers considering legume agriculture are also limited by lack of infrastructure for storage and shipping. Public investment in infrastructure and marketing, however, can lead to increased crop diversity, as demonstrated by increased pea planting following the construction of a publicly funded granary in western Nebraska (Stepanovic et al. 2016). **Therefore, we recommend that the USDA allocate funding to sustained research and market development for regionally-adapted legumes as an essential step towards resilient agriculture.**

[1]Pulse crops are leguminous crops harvested for their dry seed and tend to have a short growing period.
[2]Forage crops are grown for the edible plant tissue (i.e., leaves and stems, not grain) as animal feed.

Advantages

- Public investment in crop breeding and market development has potential for a high rate of return (Rubiales et al. 2015).
- Current lack of funding in regionally-adapted legumes means that moderate investments may provide substantial gains (Rubiales et al. 2015).
- Increased legume cropping would promote soil health and carbon sequestration.
- Diverse alternatives for a fallow period would increase the impact of the FCIP fallow requirement elimination (Recommendation 1).

Disadvantages

- Long-term investment in research, infrastructure, and market development requires sustained resources and political will.
- Mitigating rapid and catastrophic consequences of climate change requires action at a pace faster than that of research and market development.

iii. Phase out single-crop, yield-based coverage and incentivize whole farm insurance

Most FCIP products insure individual crops based on yield history rather than farm income (Hamilton 2020). The emphasis on yield and penalty[3] for any management that may compromise yield in the short-term, such as cover or continuous cropping, has led farmers to focus on a few high-value, high-yield crops that rely on high levels of inputs (e.g., fertilizers and herbicides) at the expense of long-term soil health and resiliency (Hamilton 2020). Additionally, the current structure of FCIP may discourage planning for extreme events, such as increased frequency and duration of drought and elevated temperatures. A study found insured corn was 67% more prone to extreme heat than uninsured corn (Annan and Schlenker 2015), suggesting that uninsured farms were more proactive in protecting against this common cause of crop loss, for example by planting at a crop density likely to provide a yield even under hot, dry conditions. Rather than insuring single crops based on yield, an alternative is to insure farm revenue, thus removing the emphasis on particular practices or crops while still protecting farms against devastating losses (Hamilton 2020).

The 2014 Farm Bill created such an insurance option called Whole Farm Revenue Protection (WFRP), though less than 2% of growers participate due to reluctance to change and unfamiliarity with the program (Mulik 2017). **Incentivizing WFRP while phasing out subsidies for single-crop insurance could promote holistic planning and risk-management while reducing barriers to diversified rotations** (Beckie et al. 2019). WFRP also offers an opportunity to develop a definition of a "good farming practice" that includes protection and regeneration of soil health, addresses GHG emissions reduction, and prioritizes or requires crop diversity, as is done in the European Union's Common Agriculture Policy (Meynard et al. 2013).

As the WFRP program has been in place with little adoption, **we recommend that the USDA develop specific guidelines for how to transition between programs in collaboration with farmers and relevant member-based organizations**. Genuine opportunity to inform policy and incorporate long-term planning into what constitutes a "good farming practice" could promote farmer buy-in for such a transition, improve the quality and efficacy of FCIP, and enhance adoption of conservation agriculture (Lovett 1999). Ultimately, shifting to WFRP while incentivizing conservation agriculture will reduce cost of insurance offerings by building farm resiliency (Beckie et al. 2019; Bryant and O'Connor 2017).

Advantages

- WFRP is an existing FCIP option that eliminates many of the institutional drivers towards monoculture and energy-intensive agriculture. Thus, no new programs or funding mechanisms are required to transition away from single-crop policies.
- Collaboration with growers about WFRP policies can encourage adoption of conservation agricultural practices.
- Increasing subsidies for WFRP while gradually reducing subsidies for single-crop insurance would provide a transition period for growers to adopt different agricultural practices while reducing taxpayer risk to rising costs of FCIP.

[3]Any practice that does not meet the Risk Management Agency's (RMA) description of a "good farming practice" could lose coverage. A good practice is one that "produce[s] the insured crop and allow[s] it to make normal progress toward maturity and produce at least the yield used to determine the production guarantee or amount of insurance" (RMA 2016, 33).

Disadvantages

- This approach may be met with resistance, as insurance agents with established customers are reluctant to promote WFRP, given its reliance on tax records instead of yield history. Insurance companies currently require more documentation for WFRP than single-crop insurance, such as proof of markets and receipts for fertilizer and herbicide, to satisfy what insurance agents consider "good farming practices," though such receipts are not requested for other insurance policies. The additional paperwork and research for specialty crops creates an additional bureaucratic burden that impedes adoption by many commodity farmers that could be eliminated. This transition would require collaboration with growers and careful planning to be politically feasible.

iv. Synergistic benefits of combined policies

Alone, each recommended policy change is an improvement over the status quo but will not achieve the goal of creating climate-resilient farms. We propose three changes as key elements of a pilot program in keeping with USDA tradition (Hamilton 2020) so they can be ground-tested, modified, and scaled effectively. Together, these changes address bureaucratic obstacles, provide a range of short- and long-term solutions, and promote economic and agricultural sustainability (Fig. 1). **The policies extend across a spectrum of cost, legislative burden, political capital, and time-scales for implementation and impact, offering a balanced and gradual transition to conservation agriculture. Adopted jointly, these recommendations improve farm resilience to climate change by promoting soil health and crop diversification while reducing GHG emissions.**

Changes may be met with resistance by individuals and organizations unconvinced of the value of crop diversification or the need to adapt to climate change. A successful transition demands creativity and collaboration. This multifaceted solution is more likely to shift deeply-ingrained practices, however, by creating new opportunities and fewer restrictions on grower decision-making. Furthermore, while the proposed investment in research and market development requires long-term commitments, rates of return can often reach 12-40 to 1 (Malla and Brewin 2019). In combination, these improvements will reduce taxpayer burden to provide farm revenue protection in the face of increasing extreme weather events by improving agricultural resilience.

IV. Policy recommendation

We propose the synergistic combination of changes to FCIP as the most sustainable long-term solution. The USDA can evolve the FCIP to support climate-resilient agriculture by (1) eliminating county-level fallow requirements, (2) funding research and market development for regionally-adapted legumes, and (3) phasing out single-crop, yield-based coverage while incentivizing whole farm insurance. As the rising costs and risks of extreme weather threaten agricultural sustainability, the USDA must act quickly to adjust its far-reaching FCIP program to support practices that reduce fossil energy use and promote soil health and climate resiliency through nature-based solutions.

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