Public Funding for More Efficient Land Use Practices:

Evaluation of USDA's Partnerships for Climate-Smart Commodities as a Catalyst for Private Investment

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Executive Summary

The project is an extension of work done with a climate-focused venture capital fund entering the sustainable land-use space. The United States government has allocated more funding for conservation practices in the agricultural sector to reduce its greenhouse gas emissions.

To provide additional guidance for how venture-backed startups can benefit from these funds during the due diligence process, programs launched as part of the USDA's new Partnerships for Climate-Smart Commodities were evaluated based on their accessibility and potential carbon impact, two critical components of an investment thesis written for investments in the smart farming space.

First, this project considers significant factors impacting farmers' current situation. The agricultural sector is becoming increasingly consolidated, although most are considered family farms. There's an increased reliance on fewer commodities as farmers are contending with increased uncertainty from climate change's impacts. While federal funding for conservation practices has existed for decades, funding is growing more as crop insurance costs increase and the private and public sectors seek to meet greenhouse gas emission targets. With farmers citing yield increases, cost reductions, and confidence in adherence as major factors motivating their adoption of conservation practices, the private sector has created a new market for crop services and smart farming to capitalize on these opportunities.

Second, accessibility was evaluated based on responsiveness to the United States' public comment process. Engagement and references by other engaged parties can be an early indicator of future funding awards. As a result, familiarity with and access to these parties can be one mechanism for investors and startups to pursue while evaluating business opportunities.

Third, impact is evaluated using data and processes similar to those used by farmers and the government. Potential emission drivers evaluated are commodities sold, geographic markets accessed, and conservation practices employed. Using data from the USDA's 2022 Census and an emissions impact tool for conservation practices at the county level, the potential impact of these programs was evaluated and assessed against the accessibility.

Four criteria can be valuable when evaluating startups in the growing smart farming or precision agriculture space: access to engaged stakeholders, focus on certain commodities, complementarity or substitutability with existing conservation practices, and entry into specific geographies.

The process employed here connects public funding accessibility and potential carbon impacts. Investors can apply a similar approach using publicly available information to evaluate potential investments along similar lines used by the government.

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Introduction

Motivation and Objective

The report is an extension of work conducted last year for climate-focused investors on behalf of their venture fund as part of Fuqua's Center for the Advancement of Social Entrepreneurship Initiative on Impact Investing (CASE i3). Seeking to invest in startups operating within the sustainable land-use space and leverage the investor's institutional knowledge about policy, the fund sought a taxonomy of the sustainable land-use space and an investment thesis regarding one of those areas. Our team of seven determined that smart farming and precision agriculture technologies offered some of the most promising opportunities. Favorable policy tailwinds and high potential for greenhouse gas emissions reductions formed part of the investment thesis. However, the link between public funds and carbon impacts is not fully established. This makes it difficult for climate-focused venture funds to identify startups that can benefit from public funding aligned with significantly reduced greenhouse gas (GHG) emissions.

To facilitate this evaluation, this project aims to extend the due diligence process of those parts of the investment thesis. It provides investors and their potential startup investments with two broad means to evaluate startups that seek to leverage policy incentives and maximize carbon reductions. First, it offers investors with an approach to identify key partners that might help access federal agricultural money using responses to USDA's requests for public comments about new policies or rules. Second, it evaluates the impact of GHG emissions on private conservation efforts in a manner consistent with both practitioners and government program administrators using conservation practices familiar to farmers. By taking a similar approach, investors can evaluate and frame GHG emissions reductions in a way that resonates with stakeholders representing two different revenue streams: government funding and end customers (i.e., farmers or producers, their suppliers, and their distributors).

Agricultural Sector Macro Trends

The United States aims to reduce overall GHG emissions by half of 2005 levels.[1] Agriculture contributes about 10 to 15% of the United States' total current GHG emissions.[2] About 40% of American land is used for agricultural purposes.[3] Some of the common contributors to agricultural GHG emissions are land conversion to cropland, manure & soil management, and enteric fermentation (i.e., methane releases from animals).[4] See Figure 1. With levels of agricultural GHG emissions remaining relatively constant during the last decade, ample opportunity exists for the sector to contribute towards these reductions meaningfully.

[1] (The White House 2021)
[2] (Hanson, Itle and Edquist 2024, 1-4)
[3] (United States Department of Agriculture National Agricultural Statistics Service 2019)
[4] (Joiner and Toman 2023)

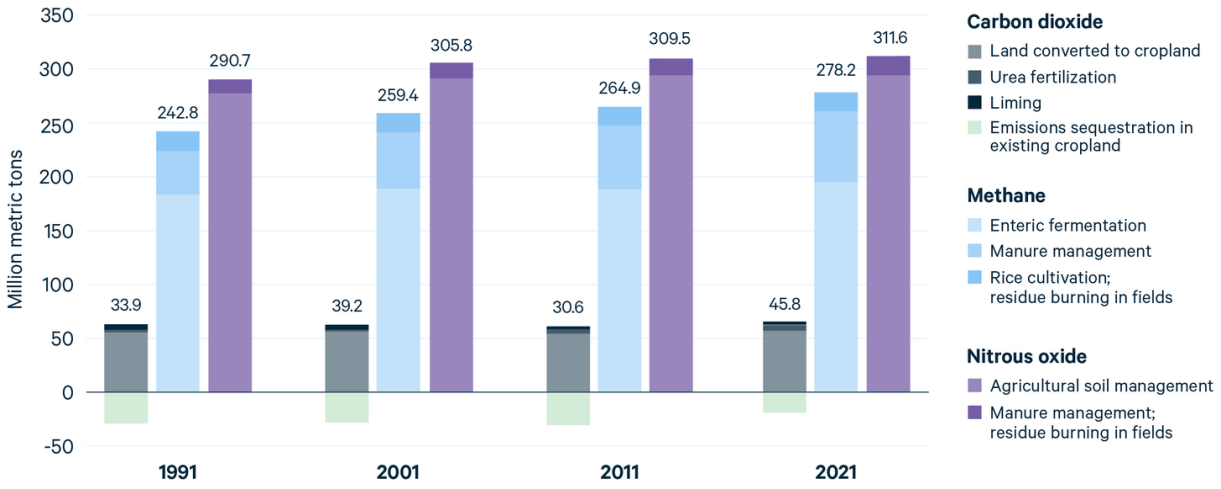

Figure 1: Agricultural greenhouse gas emissions sources, in MMT CO2e (1991 – 2021) [5]

A trend toward increased consolidation has characterized the agricultural sector. From 1935 to 2023, the number of farms has decreased by about 3.5 times, from about 6.8 million to about 1.9 million, with average farm size increasing about 2.5 times, from about 180 acres to about 460 acres.[6] Bigger and fewer farms have given way to a more recent trend, growing fewer crops, as farmers realize increased economies of scale.[7] However, crop specialization can make farmers more vulnerable to economic losses and climate change, as well as reduce biodiversity.[8]

The increasing specialization has resulted in only a few commodities dominating US farm production. Corn and cattle sales totaled over $85B each in 2022, with poultry and eggs, soybeans, and dairy totaling $77B, $61B, and $57B, respectively.[9] These five commodities account for most US farm sales and agricultural GHG emissions.

Commodity production is often related to the size of the farm, with certain commodities, such as hog and poultry, concentrated among smaller farmers who might be more susceptible to climate change's economic impacts. On the high end, farms with sales over $1M in 2015 accounted for about three-quarters of specialty crop and dairy production.[10] On the low end, farms with less than $350,000 in sales accounted for nearly half of hog and poultry production.[11]

Climate Change and Farming

Despite widespread consolidation, family-owned farms account for about 90% of agricultural production, with large public corporations playing a coordination role through their contracts.[12] American agriculture's resilience in the face of weather changes, pest infestations,

[5] (Joiner and Toman 2023)
[6] (United States Department of Agriculture Economic Research Service 2024)
[7] (MacDonald, Hoppe and Newton 2018, 14)
[8] (Bozzola and Smale 2020)
[9] (United States Department of Agriculture Economic Research Service 2024)
[10] (MacDonald, Hoppe and Newton 2018, 11)
[11] (MacDonald, Hoppe and Newton 2018, 15)
[12] (MacDonald, Hoppe and Newton 2018, 47)

and commodity market fluctuations, all of which are exacerbated by climate change, has been attributed to the flexibility and institutional knowledge of these family farmers.[13]

Mitigating agricultural emissions is more challenging due to climate change. According to one study from the United States Department of Agriculture's (USDA's) Economic Research Service (ERS), climate change is expected to have overwhelmingly negative impacts on crop yields, with predicted overall declines of around 8% for soybeans and corn and disproportionately large declines in the Corn Belt states.[14] Eight years later, another study from the ERS that included the previous study's author as a technical reviewer showed positive overall impacts on corn and negative impacts on soybeans, with those impacts distributed unevenly across the United States.[15] The lack of consensus about climate change's impacts complicates farmers' efforts to formulate long-term plans.

Compared to some other sectors that have more significant contributions to emissions, agricultural operations are especially vulnerable to a changing climate, where freezes, heat waves, droughts, floods, and extreme weather can decimate a farmer's livelihood, increase food insecurity, and increase health risks to both farmworkers and farming communities.[16] The fast-changing conditions increase the potential benefits of increased adoption of conservation practices for both farmers and the planet.

Previous USDA Funding for Conservation

The Natural Resources Conservation Service (NRCS) within the United States Department of Agriculture (USDA) started with an act of Congress to confront the challenges resulting from poor farming practices converging with difficult macroeconomic conditions brought on by record drought and the Great Depression.[17] Initially, the project researched best farming practices, mainly pertaining to soil use.[18] Since 1985, the USDA has explicitly linked funding to applying conservation practices recommended by NRCS, which are increasingly focused on GHG emission reductions.[19]

Periodically, the USDA solicits comments from the public when implementing a new rule, seeking scientific and technical guidance, or requesting feedback on notices.[20] The USDA requested comments from the public in 2021 as it considered new approaches to climate-smart practices. Specifically, it sought input about management of GHG benefits, standardization of protocols for implementing and measuring climate-smart practices, and evaluation criteria for programs.[21] These comments ushered in a period of renewed consideration of conservation practices just as funding increased.

[13] (MacDonald, Hoppe and Newton 2018, 47)
[14] (Marshall, et al. 2015)
[15] (Beckman, Ivanic and Nava 2023)
[16] (Environmental Protection Agency 2023)
[17] (Natural Resources Conservation Service n.d.)
[18] (Natural Resources Conservation Service n.d.)
[19] (Natural Resources Conservation Service n.d.)
[20] (Government Services Administration n.d.)
[21] (United States Department of Agriculture Commodity Credit Corporation 2021)

Passed in August 2022, the Inflation Reduction Act (IRA) was hailed as a significant piece of legislation, enabling the United States to make meaningful progress towards meeting its emissions targets.[22] If it achieves its projected emissions reductions, the IRA, coupled with the Bipartisan Infrastructure Law passed the same year, can meet about 80% of the 2030 American GHG emissions target.[23] While the IRA might be better known for its more consumer-facing incentives, including $393.7B investments in energy, $47.7B in manufacturing, and $23.4B in transportation, it also allocated $20.9B to agriculture.[24] Four programs administered through the NRCS captured the vast majority of the IRA's agricultural funding.[25] The major programs receiving additional funding directed to climate-smart agricultural conservation efforts include:

- Environmental Quality Incentives Program (EQIP), which supports the integration of conservation efforts into working lands, was awarded $8.5B;
- Regional Conservation Partnership Program (RCPP), which leverages public-private partnerships for conservation efforts, was awarded $5B;
- Conservation Stewardship Program (CSP), which supports existing conservation efforts, was awarded $3.3B; and
- Agricultural Conservation Easement Program (ACEP), which funds conservation efforts near waterways, was awarded $1.4B.

These conservation programs are already expected to receive $60B in funding based on estimates for the 2023 Farm Bill, which is dwarfed by the expected $170B allocated for commodity relief programs and crop insurance.[26] Conservation practices can help avoid some of the more devastating impacts from extreme weather events that often lead to crop loss compensation through the USDA's crop insurance program.[27] Program costs are expected to increase with climate change, which has already added $27B in crop insurance expenditures from 1991 to 2017.[28]

Partnerships for Climate-Smart Commodities

A new program complementary to the IRA's objectives called the Partnerships for Climate-Smart Commodities (henceforth, PCSC) had been in the works more than a year before its passage. In October 2021, the USDA requested comments for a new climate-smart project aimed at emissions reduction to contribute to fulfilling the goals of President Biden's July 2021 Executive Order 14036 on "Promoting Competition in the American Economy."[29] In February 2022, the USDA announced $3B in funding to launch PCSC and began soliciting proposals.[30] The program selected organizations to serve as "lead partners" of various programs that could coordinate with other "major partners" and farmers to increase adoption of conservation

[22] (The White House 2023)
[23] (The White House 2023)
[24] (Badlam, et al. 2022)
[25] (Sabin Center for Climate Change Law and Environmental Defense Fund 2024)
[26] (Reinsch, Denamiel and Kerstens 2023)
[27] (Risk Management Agency of USDA 2022, 23)
[28] (Garthwaite 2021)
[29] (United States Department of Agriculture 2023)
[30] (United States Department of Agriculture n.d.)

practices for designated communities and commodities. Some of the most common commodities targeted by these programs include beef, corn, soybeans, specialty crops, dairy, and wheat. Lead partners disburse USDA funding to other partners and farmers to implement their conservation programs and measure GHG emission impacts. In addition to increasing agricultural efficiency and decreasing emissions, the program aims to identify scalable best practices and ways to measure and monitor emissions more accurately.

Winners were announced in two tranches: the first tranche totaling $2.8B for project awards between $5M and $100M in September 2022 and the second tranche totaling $325M for project funding from $250,000 up to $5M in December 2022.[31] Proposals for the first tranche totaled over $18B, while proposals for the second tranche totaled $2B, implying funding rates of 15.6% and 16.3%, respectively.[32] According to the USDA, these winners were selected according to the following five general criteria:[33]

- GHG mitigation and sequestration benefits and anticipated longevity;
- Scalability, long-term viability, and ability to provide returns for producers;
- Allocation of benefits to underserved producers;
- Benefits per dollar invested, degree of innovative partnerships, and prior relationships; and
- Measurement of benefits, number of producers targeted, and general technical plan.

Relative to other conservation programs, PCSC facilitates the study of private and public funding's relationship with GHG emissions reductions. Advantages to using this program for studying this include timing, standardized categorization, number of awardees, solicitation for public comments, focus on private market expansion, and emphasis on emission reduction potential. These are each described in more detail below.

First, the government has already awarded money for PCSC. Other programs are awarded funding periodically. For example, IRA money will be allocated through 2026 and disbursed by 2033. With all PCSC partnership funding known, it is possible to holistically analyze the impacts of the entire program and each project without speculating about future awards that could lead to different conclusions. Established players can also have outsized influence over the program, which does not come from carbon impacts or relationships with the larger USDA organization.

Second, each program targets specific conservation practices, commodities, and geographies relevant to reducing GHG emissions and investing in precision agriculture companies. The uniform reporting criteria allow for a standardized comparison between programs. Collecting such standardized criteria to assess other programs' GHG emissions reductions would be more difficult. For example, the NRCS releases state-level information about the acreage and funding dedicated to conservation practices but not commodities.[34]

[31] (United States Department of Agriculture 2023)
[32] (United States Department of Agriculture 2023)
[33] (United States Department of Agriculture 2023)
[34] (United States Department of Agriculture Natural Resources Conservation Service n.d.)

Third, only 141 programs won tentative approval, with 135 ultimately going on to obtain funding.[35] Conversely, the other programs fund hundreds or thousands of entities each year.[36]

Fourth, this program began after a request for comment through the non-rulemaking docket. These comments provide insight into the organizations contributing comments relevant to smart farming practices before the program's finalization. Using this information, one can understand important stakeholders engaged with the government, evaluate whether a submission increased the likelihood of being awarded funding, and gather more information about the motivations and influence of these programs' lead partners. The other programs do not have such comments available from their beginning to analyze them using a similar approach.

Fifth, this program invests specifically in organizations that could be helpful partners for startups and investors alike. The USDA tasks these organizations with creating large-scale market solutions that could be of greater interest to startups looking to disrupt current systems and realize their return goals. The other programs award funds primarily to producers less equipped to realize returns consistent with investors' financial goals.[37]

Finally, the program's objectives align with investors' investment theses incorporating emissions reduction potential. Some Conservation Innovation Grants fund novel solutions to target a specific resource concern, but they often lack scale and only a small number of them identify GHG emissions reductions as the specific area of concern.[38] PCSC does not focus on other benefits, such as water reduction, pollution mitigation, or waste management. The potential for overall GHG emissions reduction touches on all five of the PCSC program selection criteria as its primary aim is to directly reduce GHG emissions. Doing so reduces the complexity of linking funding to GHG reduction potential.

Farmer Sentiments on Conservation Adoption

Conservation practices are techniques that farmers can apply to their farmland to reduce resource use or pollution. One of the most commonly adopted practices is not tilling the soil to prepare for seeding and reduce weeds.[39] In addition to improving soil health, not tilling reduces emissions and costs from fuel, potentially saving over 4,000 gallons of fuel annually from 1,000 acres of land; however, only about 21% of all cultivated cropland adopt the practice.[40] The initial cost of no-till equipment and the learning curve to implement new practices pose barriers to farmers adopting them.[41] However, government efforts appear to have succeeded in increasing conservation practices. Of the farmers who own land protected by the NCRS Farm and Ranch Lands Protection Program (FRPP), 93% use at least one conservation practice, 78% use three, and 61% have an NRCS plan with recommendations for conservation practices on their lands.[42]

[35] (United States Department of Agriculture 2023)
[36] (National Sustainable Agriculture Coalition 2019)
[37] (National Sustainable Agriculture Coalition 2019)
[38] (Natural Resources Conservation Service Conservation Innovation Grants n.d.)
[39] (United States Department of Agriculture Economic Research Service 2020)
[40] (Creech 2017)
[41] (No Till Agriculture n.d.)
[42] (American Farmland Trust 2024)

Studies have shown that cost-sharing programs are the most important motivating factor in adopting conservation practices among all categories of government support.[43] With significant tailwinds from increased use of genetically engineered crops, the growing adoption of conservation practices has contributed in part to an over two-fold increase in the productivity of farms for the 70 years ending 2018.[44] In 2022, farmers applying some type of conservation practice reported that tillage practices and irrigation management and system improvements were their two most widely adopted conservation practices.[45] For each of these, farmers' confidence in following the plan was one of the top two factors motivating them to implement the practice.[46] Conversely, the use of cover crops was the least widely adopted practice, though confidence in following the plan was still one of the leading motivating factors for whether farmers adopted the practice.[47]

Precision matters a lot to farmers. They can experience significant decreases in crop yields by delaying planting only a couple of weeks from optimal conditions, as observed in studies that show corn yields can decrease about 25% if planting occurs two weeks after the optimal planting day.[48] Choosing the optimal planting time is becoming a more significant challenge for farmers as climate change is shifting precipitation and temperature patterns during the growing season.[49] Adopting conservation practices is one way for farmers to mitigate the risks associated with these changes. Two of the most commonly cited reasons for adopting conservation practices, according to a meta-study of papers evaluating economic motivations for adoption, include the potential for decreased costs and increased yields.[50] As more money flows to conservation from the government, both farmers and investors have responded accordingly.

Market for Private Sector Smart Farming and Regenerative Agriculture Solutions

Precision agriculture technology facilitates smart farming techniques through better monitoring and reporting and more efficient use of resources, among other solutions. For example, some startups have products or solutions to monitor soil moisture so farmers can optimize planting and watering. Farmers are increasingly purchasing these solutions to complement their conservation strategy. Smart farming companies can motivate farmers to use their products to protect their revenues through increased yields and decrease costs through more disciplined use of water, land, and energy resources. As discussed, these are important considerations for farmers when deciding whether to adopt conservation practices.

In addition to cost and yield benefits, smart farming solutions can increase certainty for farmers. Remote sensing technologies and data products, two of the leading technologies in the precision agriculture space, have been noted to reduce uncertainty, another primary motivation for farmers to adopt conservation practices generally.[51] Relatedly, the Greenhouse Gas

[43] (Ranjan, et al. 2019)
[44] (Wang, et al. 2024)
[45] (United States Department of Agriculture National Agricultural Statistics Service 2022)
[46] (United States Department of Agriculture National Agricultural Statistics Service 2022)
[47] (United States Department of Agriculture National Agricultural Statistics Service 2022)
[48] (Licht 2021)
[49] (Viner 2023)
[50] (Ranjan, et al. 2019)
[51] (United States Department of Agriculture 2023, 5)

Monitoring & Measurement Interagency Working Group identified "improving conservation activity data," supporting "climate-smart forest carbon decision support systems," and increasing adoption of climate-smart agricultural tools as important near-term activities for the federal government to improve the reporting and monitoring of GHG emissions.[52] Many smart farming startups build their business models around delivering these solutions to farmers and other agricultural stakeholders.

As a result of the market opportunity and increased concern about climate change's impacts on farming, agricultural private market investments have increased during the last decade. In 2022, global venture capital invested $10.6B across 988 smart farming deals, a 13-fold increase over the $0.8B invested across 184 deals ten years prior.[53] At the same time, revenues from the American crop service market increased to $35B at a compound annual growth rate (CAGR) of 8.9% between 2017 and 2022.[54] For context, $35B is about half the USDA's expenditures on conservation efforts and a little less than half what farmers made from poultry and egg sales in 2022.

Methodology and Approach

Research Question and Hypothesis

Climate-focused investors seek to invest in startups within the sustainable land use space that could benefit from public funding and maximize carbon reduction potential, but both are difficult to assess. Evaluating how the USDA awarded PCSC funding and quantified their potential GHG impacts simplifies this challenge. When making investments, these investors could consider two USDA-assessed criteria when making funding decisions: relationships and the predicted carbon reduction impact per dollar invested. Put more simply, they can better understand how the US government allocates funding and how it gauges success.

By evaluating public comments responding to the program's solicitation for comments, investors can gather more information about governments' key industry partners. Additionally, by considering each program's potential carbon impacts, investors can make better investment decisions based on characteristics that drive federal investment, including commodities, geographies, and conservation practices. This can then inform investment decisions using similar criteria in the private capital markets.

Overview of Data Sources

Data were collected from four primary sources of information: 1) crop production data from the USDA, 2) emissions reduction potential from the CarbOn Management & Emissions Tool (COMET), 3) Partnerships for Climate-Smart Commodities winners from the USDA, and 4) comments from entities in response to the USDA's request for information about the program's design from the General Services Administration. Each is described in more detail below.

[52] (United States Department of Agriculture 2023, 14 - 18)
[53] (Pitchbook 2022, 3)
[54] (Dalal 2023, 11)

Commodity Production Data (USDA NASS)

County-level production data comes from the USDA's census of farmers, which is taken every five years, most recently in 2022. Data extracted from the census include the amount of acreage harvested for cropland or dedicated to pasture and total acreage devoted to certain commodities.[55]

Conservation Practice Data (COMET)

The NRSC provides technical guidance to farmers using Field Office Technical Guides (FOTGs).[56] These guides facilitate the implementation of designation conservation practice standards, such as tillage management, crop rotation, and prescribed burning. These practices are codified with a "cps number." Before awarding grant money, officials assess the farmer's land. During that assessment, they conduct a conservation practice physical effect analysis. Some states have different evaluations with modifications to the national template. Some of the broad categories evaluated include: negative impacts on farmers' lands (e.g., wind erosion or plant pest pressure); resource concerns (i.e., how much of a problem these negative impacts are to the farmers based on their water, air, and soil resources); conservation practices currently employed, current land use; and whether the situation is worsening or improving on a scale from -5 to 5.[57] From this evaluation, farmers and specialists devise a strategy to implement various conservation practices, and the NRSC or other state agricultural departments often award farmers grants to offset costs. Conservation practices' impact levels can vary widely depending on current methods employed by farmers, geography, and commodity.[58]

Colorado State University, in partnership with the NRSC in 2013, launched a tool to assess carbon impacts of conservation practices.[59] The planner tool estimates GHG emission impacts at the county-conservation practice-land management policy level.[60] It incorporates data collected using NRDC land cover maps that consider crop mix and land use and data from sensors located on over 100,000 locations to assess irrigation practices, soil health, and climate.[61] Farmers can implement each conservation practice using different land management practices. For example, CPS 340 cover crop can have various impacts, depending on whether farmers employ the practice on no-till versus tilled land, irrigated versus non-irrigated land, or whether the cover crop is a legume that can reduce fertilizer use by 50% or a non-legume that can reduce fertilizer use by 25%.[62] These data provide separate emissions factors per acre based on the land management practice. The emission reduction potential is not further disaggregated by commodity and more specific land use information is available through its farm tool.

Over 80 PCSC programs, accounting for about 60% of all programs, mentioned that they would evaluate the efficacy of their programs using the COMET data in their project

[55] (United States Department of Agriculture 2022)
[56] (Natural Resources Conservation Service Field Offices n.d.)
[57] (Ruffin 2024)
[58] (Ruffin 2024)
[59] (Mills 2013)
[60] (Swan, Easter, et al. 2024)
[61] (Swan, Easter, et al. 2023)
[62] (Swan, Easter, et al. 2023, 33)

overviews.[63] While the USDA is incentivizing alternative approaches to quantify impacts, it also uses COMET to make comparisons across all relevant programs.[64]

Partnerships for Climate-Smart Commodities Data (USDA)

The USDA provides information about lead partners, other major partners, funding amount, states targeted, and conservation practice standards to be employed. While the PCSC requires quarterly reporting on tract-level information about acreage enrolled, crops and livestock covered, and practices implemented, these data, if they exist, are not yet currently publicly available.[65] While the data would have provided additional insights about the programs' successes, it doesn't detract from creating an ex-ante assessment of carbon reduction potential using conservation practice, state-level geography, and commodity, all of which are included in the available data.

Of the 135 projects, 68 were awarded funding in the first tranche for projects valued at between $5M and $100M (i.e., "large" projects). Another 67 were awarded funding in the second tranche for projects valued from $250,000 to less than $5M (i.e., "small" projects). Across the 135 projects, 17 were associated with a lead partner that appeared twice (seven such partners) or three times (one such partner across three different chapters). Therefore, 126 separate entities were allocated funding. Additionally, four lead partners received funding for one small and one large project.

Regulatory Response Information (General Services Administration)

Public comments submitted in response to the October 2022 request for comments are gathered from the regulations.gov website, which the General Services Administration maintains.[66] Relevant information provided included the entity making the submission, general subjects covered, and references to other stakeholders in their comments.

Previous research has used public comments in response to USDA's requests to study other trends and relationships, including a relationship between the frequency of commodities mentioned in those comments and their associated yields[67] and changing topical interests over time.[68] However, none appear to assess whether an entity that submits a public comment is more likely to receive funding for their project relative to those that did not submit a comment, which is considered here.

Data Processing

Public comments on the government regulation website were classified according to the type of entity submitting a comment: citizen, organization, government (tribal, state, national, local), farmer, or employee. Comments were also classified according to their relevance. Comments duplicative of the same organization's prior comments, withdrawn, or questioned the USDA's authority to act without congressional approval were excluded. The organizations

[63] (United States Department of Agriculture n.d.)
[64] (United States Department of Agriculture 2023)
[65] (United States Department of Agriculture 2023)
[66] (United States Department of Agriculture Commodity Credit Corporation 2021)
[67] (Xie 2020)
[68] (Perez and Prasad 2020)

submitted by partners, other stakeholders referencing a lead partner, or any of the lead partner's subsidiaries were counted as having had some contribution. Secondary partners were counted based only on whether they submitted a comment. In total, 378 comments were submitted and are publicly available.[69] After removing duplicate submissions, withdrawals, and citizen comments related to the constitutionality of the USDA's authority to launch the program, 325 were deemed relevant. Of those, 218 were from organizations, and 22 were from governments.

Entities submitting comments were compared against the list of partners awarded funding. They were classified according to whether a lead partner or one of its entities submitted a comment or another entity referenced the lead partner in its submission. These entities were also classified as either academic, for-profit, government, or nonprofits using online searches or, where possible, the entity's classification according to US spending data.[70]

COMET data were aggregated to the county-conservation practice level from the county-conservation-land management program level by taking simple averages and ranges of emissions reduction potential per acre. These data were then connected to the USDA's 2022 census data of acreage harvested or acreage of pastureland for non-crop commodities at the county level. The product of the potential impact per acre and number of acres harvested was calculated and then summed to the conservation practice-state level. Programs with commodities that might overlap in the census data, such as fruit and specific fruit types, were adjusted to avoid duplication.

The information about each of these programs was connected to the COMET data by the conservation practice and state. The COMET data include information about 34 different conservation practice standards. Of those, 28 were used in at least one of the partnership programs. The data also include 40 combinations of various conservation practices that include intensive till to no-till or strip-till (CPS 329), adding legume seasonal cover crop (CPS 340), prescribed grazing (CPS 528), and replacing synthetic fertilizer with compost (CPS 590). These were excluded as their impact, combined with other practices not evaluated alongside others, might have an unanticipated effect on research conclusions. The various partnership programs detail 202 different conservation practice codes. These 202 different conservation practices were simplified to a unique conservation practice standard code. For example, the programs identify 18 alphanumeric variations of 528 – prescribed grazing practices. These were simplified to their general numeric form: 528.

Some of these programs identified over a dozen conservation practices. After they were linked, the top three conservation practices from each program, according to GHG impacts, were identified. This approach assumes that farmers would want to prioritize projects with the most significant potential impact, they would only implement up to three practices, and conservation practice benefits would begin to taper after a certain threshold.

[69] (United States Department of Agriculture Commodity Credit Corporation 2021)
[70] (U.S. Department of the Treasury, Bureau of the Fiscal Service 2024)

Because this methodology might overestimate the impacts of national programs, variations were run limiting to the top five states and the average five states. Programs operating in only one state or one commodity were compared separately.

Findings

For 22 of the 135 programs, the lead partner submitted a comment. For an additional 18 programs, another commenter mentioned the lead partner that was ultimately awarded funding. These results were substantially different for programs awarded in the first tranche for large funding and the second tranche for small funding, with 46% of large programs associated with a lead partner that either submitted a public comment or was mentioned in one. On the other hand, only 13% of small program awardees were associated with a lead partner that either submitted or was mentioned in the public comments. See Figure 2.

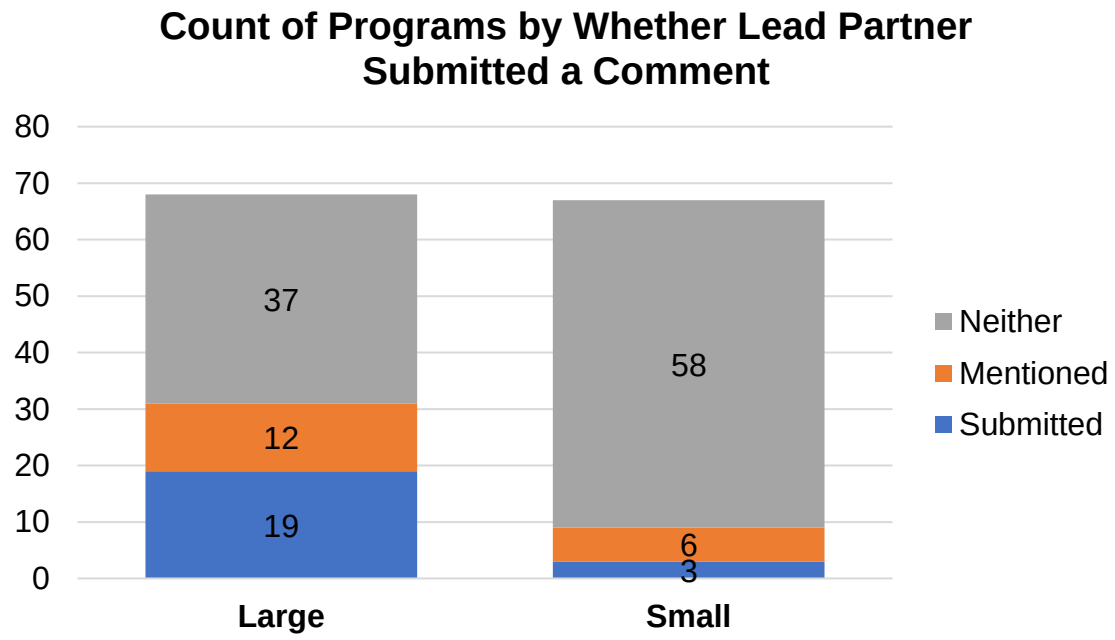

***Figure 2:** Count of Programs by Whether a Lead Partner Submitted a Comment*

There was also variation across whether the lead partner was an academic institution, for-profit company, government entity, or nonprofit organization. Academic institutions were awarded 11 more small programs than large programs, while for-profit companies were awarded ten fewer small programs than large programs. All five of the for-profit programs with a lead partner submission were large, as were 12 of the 14 for nonprofit organizations. Across all entity types, large programs were likelier than small programs to have had a lead partner comment submission or mention. See Figure 3.

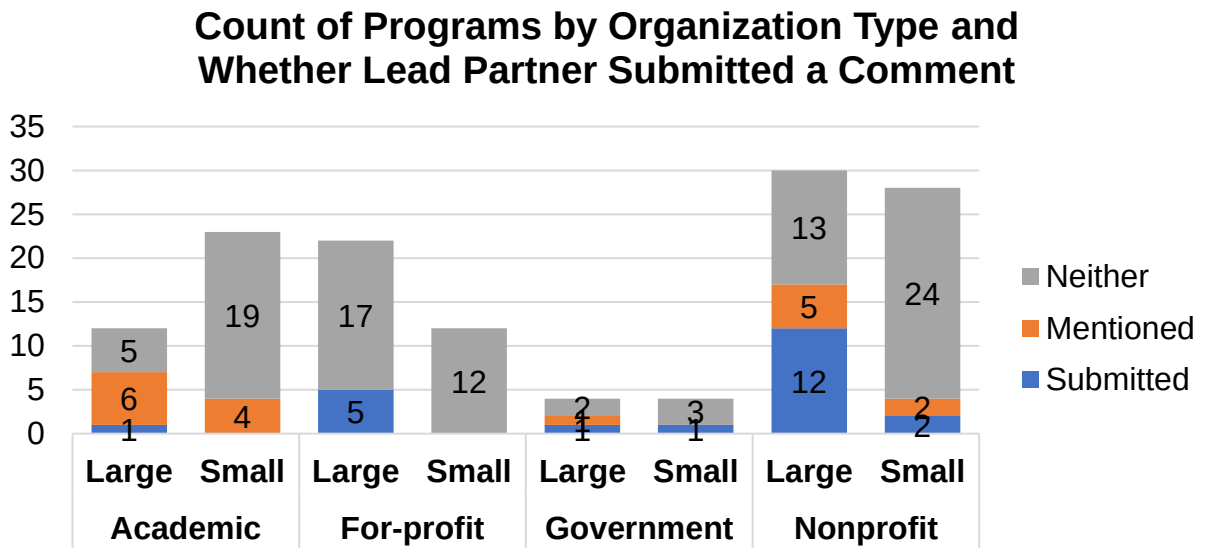

Figure 3: ***Count of Programs by Organization Type and Whether a Lead Partner Submitted a Comment***

Comparing the resulting funding amounts across organization types produce similar patterns. Nonprofits were awarded 46% of funding, for-profit companies 29%, and academic institutions 21%. Across all organizations, more than half (52%) of funds were awarded to lead partners that submitted a comment or were mentioned in another entity's comment. See Figure 4. Results are directionally similar regardless of whether large programs are evaluated independently.

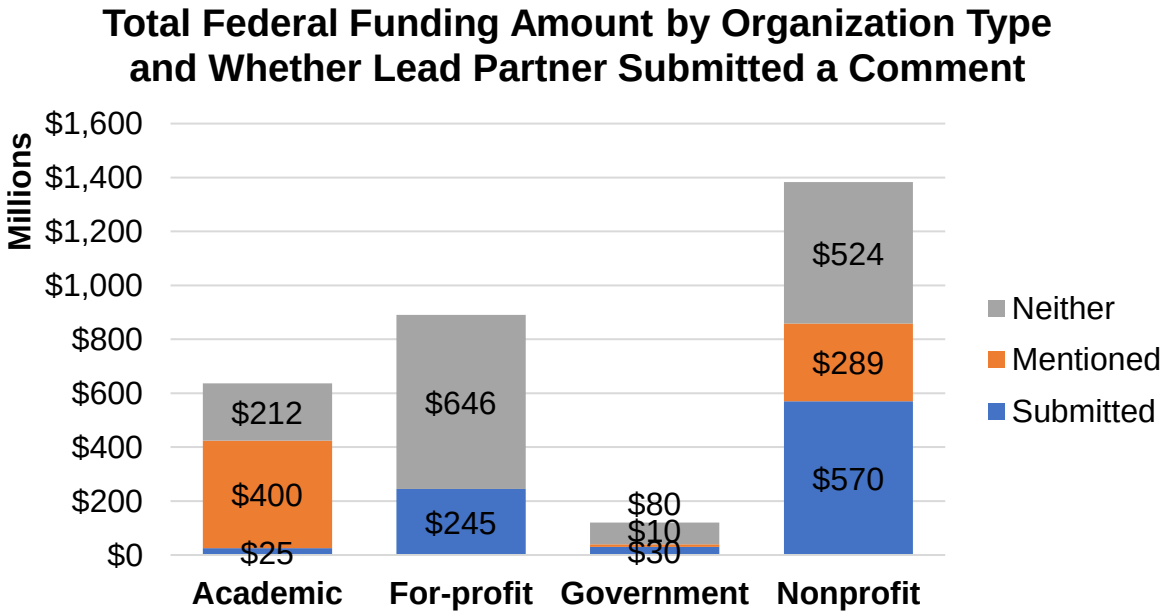

Figure 4: ***Funding Allocation by Organization Type and Whether a Lead Partner Submitted a Comment***

Discussion

Impacts of Public Comments

Public comments provide information about key stakeholders. If an entity submits a comment, it could indicate relationships with the USDA, knowledge about the government funding process, ability to direct government funding initiatives, or signal thought leadership in the space with some level of recognition from the government. Given the disproportionate success in getting funding, these entities are potential thought partners, business partners, or advocates.

Evaluation of AgriCapture, Inc. Using Criteria

Last year, one of the investments that appeared to align with the carbon impact and policy support components of the investment thesis was AgriCapture, Inc. Its mission is "to advocate and implement sustainable land management practices that increase profitability and value, improve soil and crop health, and provides a solution to climate change."[71] Founded in June 2021, AgriCapture was awarded $7.5M through PCSC. The USDA selected AgriCapture as a lead partner of the Climate-Friendly Rice Program, which it launched three months prior.[72] The company works with farmers to use practices that introduce oxygen into the soil to ultimately decrease methane emissions by depriving the methane-producing bacteria of the anaerobic conditions necessary for them to function.[73] The USDA has known that such practices can reduce emissions since at least 2000.[74] Some of the conservation practices that accomplish this are alternate wetting and drying, furrow irrigation, or row rice.[75] The company monitors nitrogen use efficiency and residue management and encourages the reintroduction of the crop into the soil.[76] It then collects satellite data to monitor compliance, samples soil to measure carbon sequestration, and quantifies total GHG emissions reductions from the management practices.[77]

AgriCapture was one of the rare new for-profit companies selected as a lead partner. As the company was founded four months before the call for submissions, it was one of the 17 for-profit companies that neither submitted comments nor mentioned in other comments. However, it also identified eight other major partners, one of which (University of Missouri) had work cited in the public comments.[78] The university was also mentioned in comments responding to the March 2021 request for comments in response to the executive order on tackling the climate crisis at home and abroad.[79]

The program's geographic focus is Arkansas, California, Louisiana, Mississippi, Missouri, and Texas, with only rice identified as the commodity of interest.[80] The program employs company-specific conservation practices of furrow-irrigated rice, alternate wetting and

[71] (AgriCapture 2023)
[72] (AgriCapture 2023)
[73] (Waite and Searchinger 2014)
[74] (Allen 2000)
[75] (Waite and Searchinger 2014)
[76] (AgriCapture 2023)
[77] (AgriCapture 2023)
[78] (United States Department of Agriculture Commodity Credit Corporation 2021)
[79] (Office of the Chief Economist 2021)
[80] (United States Department of Agriculture n.d.)

drying, and pre-season drainage that lack quantification in the COMET data. However, it also uses three more standard conservation practices: 590 nutrient management, 345 residue and tillage management, and 449 irrigation water management.[81] On average, residue and tillage management and nutrient management can have double the impact when applied in Missouri over California. Nutrient management's GHG emissions reductions outweigh those from residue and tillage management. However, Arkansas has over seven times as much acreage dedicated to rice compared to Missouri, resulting a relatively larger potential for total GHG emission reductions.

This company's solutions could have global implications at scale, as rice is a staple in the diet for half of all human beings, particularly in Asia, where 90% of it is harvested and consumed.[82] Rice accounts for 12% of global methane emissions, releasing as much GHG emissions as 1,200 average-sized coal power stations.[83] It is also one of the most water-intensive crops, typically using between 3,000 and 5,000 liters of water per kilogram.[84] Geography and conservation practice drive the GHG and water impacts of rice. Clear GHG emissions implications exist for AgriCapture's solutions based on its target commodity, geographies, and practices. Furthermore, it also identified another major partner that had been mentioned in other public comments related to the program, indicating that the startup found a thought leader in the climate-smart farming space.

Data Limitations

Certain data limitations exist. First, adjustments for productivity could not be applied at the state level, because the USDA stopped collecting that data 20 years ago.[85] This is mitigated by the fact that county-level that incorporates data from nearby sensors would implicitly factor in the current carbon efficiency of the practices employed there as of 2017. Furthermore, the current adoption rates of conservation practices have not been considered. Therefore, the emissions reduction per dollar invested can be considered the maximum potential impact for any given fund and could disproportionately favor practices that are already widely deployed.

Conclusion and Next Steps

Implications

This paper considered how the private sector can use government data to inform how government funds will be awarded and which programs might have the greatest impact on GHG emissions based on the states, commodities, and conservation practices targeted.

It provides another framework for investors to use when evaluating startups. Additionally, it provides new methods for benchmarking those startups. Suppose the solutions seek to compete rather than complement a particular conservation practice. In that case, startups can direct efforts for geographies or commodities where that conservation practice might have a lower predicted impact. Alternatively, suppose cost appears to be a differentiating feature of the

[81] (United States Department of Agriculture n.d.)
[82] (World Wildlife Fund n.d., 6)
[83] (Fleming 2019)
[84] (World Wildlife Fund n.d., 9)
[85] (Wang, et al. 2024)

technology. In that case, this also provides a benchmark for evaluating the impact of GHG emissions reduction per dollar given the startup's target geography, commodity, and conservation practice.

Generally, the framework to evaluate startups has four steps. First, assess the degree to which a potential investment opportunity, or startup, engages with the USDA. If not, then evaluate whether the startup is familiar with key partners identified as highly engaged with the USDA for particular practices, agricultural regions, or commodities. Second, determine how the startup evaluates its target geographic market in the framework of GHG emissions reductions. Third, consider how the startup evaluates its solution versus its most proximate conservation practice regarding GHG emissions reductions. Finally, determine how well the startup can translate its solution's implications for a commodity with sufficiently large GHG emissions impacts. Those implications should also be a function of both geography and conservation practice. Consistency with the information gathered from the identified thought leaders or the startup's communications with the USDA can be used to tie each of the framework's components together.

Potential Next Steps to Refine Analyses

The analyses could be refined with more accurate emissions factors not limited to the county-conservation practice area, impacts from specialty and organic crops, and different geographies. These are described in more detail below.

Refine emissions factors from conservation practices

The emissions factors can be adjusted to test the robustness of the results. These emissions factors can be adjusted based on commodity data, whether that is through an update of the COMET data, adjustments from the best available information, or through the results of the programs funded by this program. For example, in 2024, the USDA updated guidance on GHG flux sources using 2019 IPCC guidance, which it recommended that COMET incorporate into its tool.[86]

Finally, while emissions factors at the county level will implicitly incorporate information about conservation practice adoption rates and farm efficiency, survey data on adoption rates can be explicitly considered here if these data are systematically collected again as they were through 2004. Additional analysis can leverage COMET's emissions factors for combinations of conservation practices to evaluate synergies or duplication between them. Some conservation practices in the COMET data have different impacts depending on the type of land, so information on current land-use practices, such as whether the land is irrigated, can be used to refine the emissions factors used. Other conservation practices employed by these programs are not in the COMET data or are modifications of their associated baseline conservation practices. More information on these emission factors, possibly from the results of this program, can enable more accurate quantification of their impacts. That information will assist decisionmakers in

[86] (Hanson, Itle and Edquist 2024, ES-2)

incentivizing performance instead of practice, which could result in more environmental benefits at lower costs.[87]

Refine commodities

The USDA census data does not collect data on all commodities. However, it will release information about specialty crops in October 2024 and August 2025, which could result in more accurate estimates of the programs impacting those commodities. In addition, the USDA will release surveys about organic commodity production in October 2026, which could influence the most efficient practices to use and resulting emissions factors.[88]

Refine geographies

Geography can be evaluated at levels more detailed than currently available. The primary limiting factor is the need for insight into where these programs will operate in each state. Indigenous people were important stakeholders in this program, but the USDA has not yet released census data for tribal agricultural lands to allow for an evaluation of those impacts. The USDA announced that information will be forthcoming in August 2024.[89] Identifying the percentage of agricultural land owned by tribes in each county can provide a more accurate assessment of programs targeting tribes. The USDA will release data on Puerto Rico and Northern Mariana Islands in July 2024 and February 2025, respectively, which will provide more information for programs that target these territories.[90]

Furthermore, the GHG impact is often a function of current practices, land degradation, climate, and land-use. The USDA tracks the adoption of some conservation practices at the county level in its 2022 Census Data. Using the COMET data at a county level limits its ability to translate to other geographies based on common factors linked to climate change. Tying this data to satellite imagery data through some of the programs being funded could be one route. More granular data at the zip code tabulation area will become available in November of 2024, providing another level of geographic detail that can identify potential markets.[91] The NRCS collects point-based information along with costs of conservation practices, but it does not make this data publicly available to broaden the scope beyond US borders.[92]

Potential Next Steps to Extend Analyses

The approaches used can be extended to answer other questions or incorporate additional information that might be important considerations when conducting due diligence. These include evaluating GHG emissions success of the various programs, global impacts of conservation practices and commodities, specific impacts on marginalized communities, and other ways to consider USDA's relationships. These are described in more detail below.

[87] (Claassen and Weinberg 2006)
[88] (United States Department of Agriculture 2022)
[89] (United States Department of Agriculture 2022)
[90] (United States Department of Agriculture 2022)
[91] (United States Department of Agriculture 2022)
[92] (Whitt 2021)

Evaluate GHG Emissions Success of Program

It's possible that an ex-post evaluation of the programs can be conducted using the 2027 agricultural census because all programs should be over, and 2022 is the year before funds were awarded and, thus before the scale of the impacts materializing. This would be especially helpful if the generalized COMET data were updated with the 2022 and 2027 data, as the current data are limited to 2017 emissions factors. The USDA already intends to rely on the data to evaluate program success, so this type of analysis might be forthcoming and could inform changes to the due diligence approach. Duplication of efforts can also be evaluated based on whether funds from other programs are used for similar purposes with smaller results in the areas in which these programs operate.

Evaluate Global Impacts

While the data used and emissions factors considered are specific to the United States, a similar approach to evaluate emissions impacts of programs and the companies seeking to scale them if more reliable data are produced to tie factors often associated with geography, such as soil health, climate, and current practices, to emissions.

Evaluate Impacts on Marginalized Communities

While the ability to serve underserved producers was one of the criteria for allocating funding, benefits to specific communities were not quantified. One way to account for those benefits is to use the underserved government classification for the entity responsible for the program. Information about whether funds are allocated to underserved farmers, including small farmers or minority farmers, in line with President Biden's Justice40 initiative, might also be helpful in evaluating the reach of programs to stakeholders who would benefit most from assistance.

Evaluate USDA Relationships

Because whether an entity submitted a comment appeared to have a meaningful impact on whether it was awarded funding, more research can be done about what drives this relationship. Past relationships were one criterion for funding being awarded, and submitting a comment could be connected to a past relationship. One could further evaluate whether the content of the comments was related to the content of the submission to see if the entity could have shaped the program's direction. An evaluation of regulatory capture can also be evaluated by considering whether board members of those entities used to work at the USDA and if the program selected might have had a lower impact per dollar spent in an ex-post analysis. Past relationships can also be assessed through public information on past grants and research awards. Previous responses to requests for comment can also be evaluated, especially with respect to requests directly related to this one, such as the USDA's more general March 16, 2021 request for comments on the executive order on tackling the climate crisis at home and abroad that garnered over 1,300 comments.[93] In some rare cases, entities mentioning the lead partner was also a major partner for the program. While other major partners were not considered, similar analyses can be conducted to assess other major partners' relationships with the USDA.

[93] (Office of the Chief Economist 2021)

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