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Investing in the transition to sustainable agriculture

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ABSTRACT

Ecological impacts of industrial agriculture include significant greenhouse gas emissions, loss of biodiversity, widespread pollution by fertilizers and pesticides, soil loss and degradation, declining pollinators, and human health risks, among many others. A rapidly growing body of scientific research, however, suggests that farming systems designed and managed according to ecological principles can meet the food needs of society while addressing these pressing environmental and social issues. The promise of such systems implies an urgent need for increasing the scope and scale of this area of research – agroecology. Notably, agroecological systems have been shown to reduce input dependency and therefore related research is unlikely to be supported by the private sector. Yet, the amount of federal funding available for agroecology has remained unclear. To address this gap in knowledge, we identified projects beginning in 2014 from the USDA Current Research Information System (CRIS) database and searched key sections of project reports for major components emphasizing sustainable agriculture, including agroecology. Components were grouped into four levels according to their focus on: improving system efficiency to reduce the use of inputs (L1), substituting more sustainable inputs and practices into farming systems (L2), redesigning systems based on ecological principles (L3: agroecology), or reestablishing connections between producers and consumers to support a socio-ecological transformation of the food system (L4: social dimensions of agroecology). We identified 824 projects, which accounted for $294 million dollars: just over 10% of the entire 2014 USDA Research, Extension, and Economics (REE) budget. Using a highly conservative classification protocol, we found that the primary focus of many projects was unrelated to sustainable agriculture at any level, but the majority of projects had at least one relevant component (representing 52–69% of analyzed funds, depending on whether projects focused exclusively on increasing yields were included). Of the total $294 million of analyzed funds, 18–36% went to projects that included a L1 component. Projects including components in L2, L3, or L4 received just 24%, 15%, and 14% of analyzed funds, respectively. Systems-based projects that included both agroecological farming practices (L3) and support for socioeconomic sustainability (L4) were particularly poorly funded (4%), as were L3 projects that included complex rotations (3%), spatially diversified farms (3%), rotational or regenerative grazing (1%), integrated crop-livestock systems (1%), or agroforestry (<1%). We estimated that projects with an emphasis on agroecology, indicated by those with a minimum or overall level of L3, represented 5–10% of analyzed funds (equivalent to only 0.6–1.5% of the 2014 REE budget). Results indicate that increased funding is urgently needed for REE, especially for systems-based research in biologically diversified farming and ranching systems.

1. Introduction

While industrial agriculture has proven highly productive, it has simultaneously generated environmental and social impacts of global concern (Kremen and Miles, 2012). Agriculture affects everything from greenhouse gas emissions to biological diversity, water quality, soil erosion, pollination services, carbon sequestration, human health, livelihoods and food security (Zhang et al., 2007; Perfecto and Vandermeer, 2010; Tilman et al., 2011; Hayes et al., 2011; Tscharntke et al., 2012). At present, industrial agricultural practices are contributing to the degradation of key ecological processes that underpin life on Earth, driving climate change, loss of biosphere integrity, destructive land system

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changes, and the eutrophication of oceans from phosphorus and nitrogen fertilizers (Liebman & Schulte, 2015; Steffen et al., 2015; Tilman et al., 2001; West et al., 2014).

Agroecological farming systems, including biologically diversified systems, have been found to be capable of meeting global food needs sustainably and efficiently (Gliessman, 2014). Recent quantitative syntheses and meta-analyses demonstrate that these systems can outperform chemically managed monocultures across a wide range of globally important ecosystem services while producing sufficient yields and reducing environmental externalities (Kremen and Miles, 2012; Lundgren and Fausti, 2015). Indeed, in some instances, agroecological farming systems can produce equivalent or higher yields than conventional and monoculture agriculture while enhancing ecosystem services and profitability (Davis et al., 2012; Kremen and Miles, 2012; Seufert et al., 2012; Skinner et al., 2014; Ponisio et al., 2015; Prieto et al., 2015).

Despite its promise, research and development related to agroecology has been thought to command less than two percent of public agricultural research funding in the United States and less than one percent globally (Carlisle and Miles, 2013; Niggli et al., 2014; Lipson, 1997). Thus, farms and ranches based on agroecology – the application of ecological principles to the design and management of agricultural ecosystems – have achieved high levels of environmental performance and productivity, even with minimal funding, offering an impressive return on public investment. Therefore, when combined with significant policy and organizational support, more robust agroecological research programs appear to offer the most pragmatic approach for successfully fulfilling the human right to food while restoring environmental quality in the face of global climate change and rapid environmental degradation (Dalgaard et al., 2003; Altieri and Nicholls, 2008; Reganold et al., 2011; Fernandez et al., 2013; Gliessman, 2000; MEA, 2005; De Schutter, 2014; IPCC, 2014; Bommarco et al., 2013).

The objective of this analysis is to quantify and analyze recent US public funding for sustainable agriculture research, particularly to projects incorporating agroecology. Because elements of sustainable agriculture and agroecology could be funded through a variety of available funding streams, we evaluated research projects that received grants through a wide set of existing federal programs. A primary goal of this research is to identify the scope of a highly promising opportunity: federal investment in agroecological research, education, and extension.

2. Materials and methods

2.1. Research, Extension & Economics Funding in the United States Department of Agriculture

To identify projects funded by the United States Department of Agriculture (USDA) Research, Extension & Economics (REE) Mission Area, we used the "Advanced Search" function of the USDA CRIS (Current Research Information System) database (http://cris.csrees.usda.gov/). This database is managed by NIFA (National Institute of Food and Agriculture) but includes reports on all projects funded through the REE Mission Area. To develop a baseline understanding of current sustainable agriculture funding, we searched for all projects with a start date in 2014, the most recent complete year. For this study, we focused on three key fields available from CRIS: the Non-technical Summary, Objectives, and Approach. We assumed that critical components of the funded projects would be mentioned in at least one of these three report sections.

Projects funded through the ARS (Agricultural Research Service), which supports internal research within the USDA, are reported in CRIS with minimal text and without funding amounts. Therefore, this analysis focuses only on the funding granted externally through NIFA, which includes a wide variety of funding programs that concentrate on a range of topics. Because each funding program solicits proposals through a publicly available Request For Application (RFA, USDA, 2015), certain topics are specifically encouraged. However, in this analysis we assume that projects funded through any program could (or, likewise, may not) contain elements of sustainable agriculture or agroecology. Finally, since our analysis focused exclusively on successfully funded projects, it cannot reveal the existing demand for funding in these research areas.

2.2. Defining sustainable agriculture

We defined sustainable agriculture using Gliessman's taxonomy of "levels" of practices from a spectrum supporting socio-ecologically sustainable food systems. The levels instrumental to this analysis are: improving system efficiency to reduce the use of inputs (L1), substituting more sustainable inputs and practices into farming systems (L2), redesigning systems based on ecological principles (L3: agroecology), and re-establishing connections between producers and consumers to support a socio-ecological transformation of the food system (L4: social dimensions of agroecology) (Gliessman, 2014). Based on these categories, we developed a list of relevant subcategories (34 total) and detailed definitions as necessary (Table 1, Appendix A).

A fifth level of sustainable agriculture described by Gliessman (2014) describes the establishment of an equitable, participatory, and just food system that is built upon the farm-scale practices of L3 and the food relationships supported by L4. Level 5 ideas fall outside the scope of current public funding and therefore our analysis, but systems-based research at Levels 3 and 4 provide the foundation for this needed change. In this study, we loosely identified projects within this category as those that contain components from both L3 and L4. To determine whether socioeconomic supports were being connected with L2 practices, we also identified projects that contained components from L2 and L4.

Not all projects funded by the REE Mission Area address the need for a more sustainable agriculture. Therefore, we classified all remaining projects according to whether they either addressed environmental and social exernalities ("symptoms") of the current agricultural system or whether they were unrelated (Table 1).

2.3. Metacategories

We identified metacategories of interest that were applicable to all projects and that we used to filter results for more in-depth analyses. These categories included projects related to aquaculture and seafood, biomaterials (including biofuels), organic agriculture, breeding, academic conferences or symposia, and funding other smaller research projects. We also identified projects funded through one of four specific NIFA funding programs: Organic Research and Extension Initiative (OREI), Organic Transitions (ORG), the Specialty Crop Research Initiative (SCRI), and Agriculture and Food Research Initiative (AFRI). Note that the 2013 lapse in the Farm Bill resulted in no funding to OREI in that year, but funds granted in 2014 were part of this analysis.

2.4. Coding methods

Subcategories and definitions (codes) were developed iteratively by both internal and external reviewers to ensure clear and consistent application to the analysis. All projects were imported as separate cases into QDAMinerLite (http://provalisresearch.com/products/qualitative-data-analysis-software/freeware/). To avoid bias based on word count and redundancy, all codes were used at most one time per case.