Applying the principles of Data Feminism in agricultural research leads to more transformative outcomes (15 words)

# Abstract (70 words, at 78)

Agricultural research reflects complex institutional and interpersonal relationships that have historically been, and continue to be, subject to power imbalances. Recently, the Data Feminism framework was developed to aid scientists in understanding and addressing power imbalances inherent in their work. We present evidence that its application in agricultural research concomitantly fosters creativity and leads to more transformative outcomes. Many researchers already practice Data Feminism; formalizing those efforts will make the work more intentional, visible, and in time, ubiquitous.

# Introduction

Power may be defined as a relationship through which one can obtain one’s will even in the face of resistance from others(CITE). Agriculture involves the cultivation of land to produce food; as the former becomes a prerequisite for the latter, power dynamics emerge. Indeed, over thousands of years and across civilizations, agriculture has enabled, fomented, and reflected power hierarchies(CITE). It follows that the interpersonal and institutional relationships upon which agricultural research is built mirrors those artifacts, with potentially profound ethical and social consequences. This is not unique to agricultural research; global recognition of the need to intentionally examine how power interacts with science has spurred the creation of new academic fields(CITE). While social scientists have long recognized these interactions(AllenSachs), technical scientists are increasingly being asked to consider the context of their work. There have been calls for and attempts to codify reflexivity in the fields of food studies and agroecology(CITEagroecologyeuropedeWitNickLiebmanthing), but it remains a formidable task in agriculture. We believe the recently developed Data Feminism frameworkCITE, which targets technical scientists, is particularly well-suited to support agricultural researchers in this pursuit. The framework is rooted in empirical studies of power and emphasizes intersectionality, or the inability to study dimensions of power in isolation (XX). It is action-oriented and domain-agnostic, and D’Ignazio and Klein’s (2020) work has been highly cited in numerous disciplinary contexts. To our knowledge, it has had limited interpretation in the context of agriculture, though a recent study evaluated the National Agricultural Statistics Service (NASS) agency of the United States Department of Agriculture (USDA) on their data reporting practices through the lens of Data Feminism(CITERISSING).

We posit that explicit application of the data feminism framework would positively contribute to research creativity, stakeholder participation, and agricultural sustainability writ large. To support this thesis, we discuss the application of Data Feminism themes (power, reciprocity, and framing) in the research process, with accompanying example activities and demonstrably positive outcomes (Table 1).

### Table 1. Summary of paper structure

|  |  |  |
| --- | --- | --- |
| **Data feminism-derived theme** | **Research phase(s)** | **Agricultural research activities** |
| Research for the public good should seek to equalize power | Hypothesis generation and study design | Technical audits, listening to and serving the margins, incorporating other ways of knowing |
| Farmer-researcher relations should be reciprocal | Conducting and implementing research | Compensation, metrics for success |
| All research is values-informed | Analysis and dissemination | Co-existence of multiple truths, diverse framing as a strength |

The goal of this paper is to interpret the Data Feminism framework in an agricultural setting, demonstrate its utility, and serve as a resource for more intentional work in this area. Our perspectives are strongly framed by our collective experiences in the agricultural systems of the United States (US), and specifically of those in the maize-producing areas of the Midwest. However, while the specifics of a given system vary, we believe the topics are universal. This is not meant to be a comprehensive review of power issues in agriculture, nor a thorough documentation of efforts to address those issues. Rather, our hope is that this perspective supports technically trained agricultural scientists in connecting their work to its broader societal implications and in sculpting that work to contribute to a more equitable society.

# Research for the public good should seek to equalize power

Central to Data Feminism is the fact that power is unevenly distributed and experienced in this world and rectification requires intentional examination and interventionCITE.This foundation is particularly relevant in agriculture; overarching features such as labor exploitation(both historicalCITE and modernCITE), Native land dispossession(CITE), and selective land ownership rightsCITE render power inequities deeply embedded in agricultural systems. Research seeking to support public good requires an understanding of how that research passively endorses or challenges power artifacts. However, power is a complex topic with dedicated scholars, so this pursuit may feel daunting to the average scientist. To aid non-experts in contextualizing their work, Data Feminism applies Collins’ (1990) matrix of domination to elucidate where and how power inequities may manifest, and therefore clarify how they may be challenged. To demonstrate its application, we present an adaptation of the matrix with select examples from modern US agricultural systems (Table 2).

### Table 2. Domains through which power may be expressed and experienced (adapted from Collins 1990)

|  |  |  |
| --- | --- | --- |
| **Domain** | **Description** | **Select examples of uneven distribution or experience of power from modern US agriculture** |
| **Structural domain** | Laws and policies that distribute power | Racially tiered implementation and funding of US land-grant university system(Croft2019Sharp2004Martin2018); discriminatory design of US land heirship laws(Deaton2007Baily 2022); discretionary implementation of eminent domain laws (Fraley) |
| **Disciplinary domain** | Entities that implement and enforce (or fail to implement and enforce) laws and policies distributing power | USDA credit granting discrimination based on race and gender(Carpenter2012); systematic exclusion of groups via USDA NASS census collection formats(Pilgeram2020Dentzman2020); barriers to participation of American Indian lands in NRCS programs(Johnson2019) |
| **Hegemonic domain** | Entities that circulate ideas related to who has power | Gendered expectations for land ownership and management(Carter); public extension and conservation programs focused on top-down, technical solutions(Belshaw1979Johnson2021); focus on Western science in agricultural curriculums(Snively2001) |
| **Interpersonal domain** | Individual experiences, expression, and awareness of who has power | In- and out-group mentalities in agricultural practitioners(KnissXXXX), gendered experiences of fieldwork and farmer interactions(Chiswell2016); gender biases in agricultural students(Basche2020) |
| USDA - United States Department of Agriculture; NASS - National Agricultural Statistics Service, an agency responsible for collecting and reporting information related to agricultural production within the USDA; NRCS - Natural Resource Conservation Service, an agency that provides technical and financial assistance to land owners | | |

To help agricultural researchers envision how their work may integrate into a larger effort to rebalance power in one or more domains, we present three research activities with attendant examples of positive experiences.

## Technical audits

By leveraging their scientific training, agricultural scientists have great potential to contribute to documentation of issues in the four power domains (Table 2). A series of studies documented significant soil degradation and crop yield losses following the required remediation accompanying underground pipeline installation (Brehm2022aBrehm2022bEbrahimi2022aEbrahimi2022b). By quantifying long-term impacts on productive agricultural land (a globally limited resource), this research challenges laws (structural domain) allowing pipeline installation companies to impact landowners, farmers, and the public without fair compensation. As an example from the hegemonic domain, university nutrient application recommendations have traditionally been generated using top-down, siloed experiments with little transparency or opportunity for the public, farmers, or even other scientists to provide input. A recent study challenged the appropriateness of this arrangement, exposing flaws in traditional experimental designs that render them unable to deliver meaningful recommendations(Miguez2022). This occurred against the backdrop of stakeholders demanding more accountability with regards to agricultural nutrient management(CITE). In response, in 2022 the state of Iowa launched an ambitious effort to democratize and support horizontal knowledge exchange in generating nitrogen recommendations(IowaNitrogenInitiative). As part of the initiative, farmers volunteer (see Reciprocity section) to perform nitrogen rate trials in their own production contexts, and the data is collectively pooled to drive transparently calculated recommendations and support public model development. Similarly, in 2022 a grassroots farmer organization, Practical Farmers of Iowa, launched a regional program paying farmers (see Reciprocity section) to test nitrogen rates of their choice using replicated trials and sharing their results with the public(CITE). These efforts represent an exciting shift in the hegemonic power universities traditionally exercise in generating nutrient recommendations, addressing a crucial component of agriculture’s environmental impactCITE.

## Listening to and serving the margins

Conducting research that is inspired by and supportive of those who have been institutionally excluded is another effective means for agricultural scientists to challenge power (hegemonic and interpersonal). Institutional exclusion can manifest through multiple avenues, including individual characteristics (e.g., gender, race, ethnicity, age, language, sexuality, formal education level, technology use, socioeconomic status)Leslie2019Carter2019Pilgerum2022Pfammatter2023Shih2009) and farm-level features (e.g., production system, degree of farm mechanization, farm location, farm size, market participation)(Wheeler2008Belshaw1979). This systemic and cultural exclusion often translates to exclusion from agricultural research activities. For example, in 1987 a group of farmers formed Practical Farmers of Iowa as a peer-to-peer learning community, partially in response to feeling neglected by the Land Grant’s extension systems(CITE). Years later, one of those farmers’ low-input systems inspired the design of an influential crop diversification experiment (PFIsomethingDavis2012Huntxxx). More recently, Latino farmers in the Midwest have little institutional support, and in response Practical Farmers of Iowa launched a Latino Engagement program (<https://practicalfarmers.org/programs/agricultores-latinos/>). Researcher involvement with the Women Food and Agricultural Network(WFANXX) similarly inspired scientifically fruitful activities with women land owners (AngiesCitations). By serving institutionally excluded groups, agricultural researchers leverage their privilege to help build legitimacy within the margins (deWit), and by listening, they can gain rich scientific insights.

## Legitimizing other ways of knowing

‘Multiple ways of knowing’ originates in Indigenous epistemologies but has migrated into common vernacular. It recognizes the diverse means through which individuals and groups understand the world around them, including empirical observation and logical reasoning, but also personal experience and cultural traditions, among others. In dismissing knowledge originating outside of traditional scientific methods, scientists wield power by reinforcing the dominance of a single scientific paradigm and limit the potential contribution such knowledge can have in enriching scientific understanding(Peltier2018). It follows that by utilizing non-traditional measurements, agricultural scientists can honor multiple ways of knowing within a scientific framework. An apposite example is USDA NASS reporting of a ‘workable field day’, defined as day where weather and field conditions allow producers to work in fields a major portion of the day (NASS <https://www.nass.usda.gov/Publications/National_Crop_Progress/Terms_and_Definitions/index.php#days>). It has a scientific underpinning (Earl1997) but represents a deeply personal interaction between the farmer and the land that has evaded modelling attempts(Huber2023). Workable days survey data is commonly used in extension, but to our knowledge has had limited use within scientific frameworks(thing). In an example of challenging hegemonic power around knowledge generation, Practical Farmers of Iowa recently launched a study wherein farmers will quantify their experiences with cover cropping through the metric of workable field days (<https://practicalfarmers.org/2024/04/putting-soil-to-the-test/>CITE). This will not detract from nor undermine the scientific publications relating cover cropping to changes in soil-water dynamics; it will enrich it by producing results that are based on another, meaningful way of knowing(Robertson2001). This is an area ripe for creativity, with interesting efforts appearing in soil and agricultural system health(Gage2015MaederXFreidrichson2021MarshallTeaBagMaybe).

# Farmer-researcher relations should be reciprocal

The *way* research is done presents opportunities to redistribute power more equitably. For over a century, experimental plots managed by researchers have been the workhorse of agricultural research. As agricultural research evolves, opportunities for blending research plots with farm fields to perform more statistically powerful and relevant public research in collaboration with farmers abound(IgancioLailaStone2016Lacoste2021Laurent2022). However, these arrangements require careful consideration to support equitable and fair power relations.There are numerous guides for farmers when conducting on-farm research (Chaney2017StefanList), but there are fewer resources suggesting best practices for the scientists, researchers, and organizations they collaborate with. A recent publication provide excellent guidance on working with communities and organizations in general (deWit2022). However, we feel the farmer-researcher collaboration merits explicit attention for agricultural scientists.

## Compensation

The context for farmer involvement in research can vary widely(Toffolini2022Jackson-Smith2023). While much work has been done to describe collaboration contexts, the topic of compensation is seemingly taboo - to our knowledge there are few studies on mechanisms for farmer compensation, and even fewer exploring how those mechanisms influence collaboration dynamics(CitetheOne). This omission is problematic; research participants should always be compensated, and the form this compensation takes is particularly germane to the topic of power.

It is common for farmers to be compensated by *the experience and knowledge gained from the activities*, *access to research findings*, *better productivity*, or a similarly non-tangible exchange. In its most egregious forms, this arrangement is elitist, extractive, and disrespectful. We acknowledge individual researchers may be constrained in their access to unrestricted grant money to pay collaborators, but they are often coming from institutions with well-funded endowments. Research participants may view the researcher as representative of said institution, and therefore without an offer of fair compensation, may reasonably intuit a devaluation. Moreover, failing to provide compensation further exacerbates historical biases, favoring well-resourced farmers in access to on-farm research activities.

Granting agencies clearly have a role to play in supporting fair compensation for farmer participation in research. While some grant funders allow for farmer-participant support, to our knowledge none require it. To assist researchers in compensating farmers in ways that equalize opportunities and power distributions, funding sources should explicitly require tangible renumeration of farmers for their participation in research projects, and provide associated funding categories to support it. This is in the best interests of everyone involved; fair remuneration supports formation of equitable partnerships that are more likely to be sustained in the long-term. For example, the grassroots organization Practical Farmers of Iowa has a robust farmer cooperator program that is still in operation after more than 30 years, a fact they attribute in part to their policy of monetarily compensating farmers for their participation in on-farm research (but see Metrics for Success section). The Iowa Nitrogen Initiative (see Technical Audits section), for comparison, was not allocated money for farmer-participant compensation, and they have capacity for more participants than they can secure. While research on farmer compensation and project outcomes is scarce, blending of monetary compensation with other forms that support learning, sharing, development, and growth are likely to be most effective (Thornely1990Liebig1999Lailas), and could be used to specifically support institutionally-excluded groups’ needs (e.g., childcare, language interpretation). The authors provide examples of blended compensation packages that coincided with high participant satisfaction in supplemental files as a resource (Supplemental file X).

## Metrics for success

In addition to compensation, both researchers and farmers should aim for relationships defined beyond simple transactions. We believe many researchers strive to build rich relationships with their farmer collaborators, but often lack metrics to help them articulate and measure that success. Building on recommendations from various sources (DIgnazaioCarterRoesch-McNallyAgroecologypaper), we suggest the following four broad metrics be incorporated into project evaluations:

1. Was trust was built?
2. Were power and resources shared?
3. Did learning occur in both directions?
4. Were both entities transformed as a result of the collaboration?

Incorporating these metrics *a priori* can help guide activity planning, and help ensure anticipated outcomes are aligned within a relationship of reciprocity. The success of this type of model can again be demonstrated by the longevity of the Practical Farmers of Iowa (hereafter shortened to Practical Farmers) on-farm research program, which has been in place since 1987. Practical Farmers has continually refined their post-program participation surveys, and the current form quantifies outcomes in the four metrics (see SFX). As these questions have become metrics for success, Practical Farmers has designed their program to support these metrics, resulting in highly satisfied participants(PFICan), translating to more consistent funding. Other researchers and entities likely utilize some form of these metrics, but to our knowledge they are not widely employed by granting agencies or at an individual researcher level. file).

# All research is values-informed

The feasibility (or even desirability) of objectivity in science has long been debated, and recent discussions highlight its role in colonialism, racism, and other forms of oppression(X). Today, many disciplines embrace interpretation, plurality of methods, critical reflexivity, and fallibilism as inherent in the pursuit of knowledge, while still valuing the foundations of empirical evidence and systematic investigation. Rather than pursuing objectivism (and insinuating it is possible), Data Feminism acknowledges that all research is framed by the background, values, and experiences of the researcher. In a Data Feminism framework, this is desirable.

## Coexistance of multiple truths

A book written to illustrate how underlying value systems shape individuals’ approaches to complex global challenges unwittingly uses agricultural research as its backdrop. ‘The Wizard and the Prophet’ (CITE) explores the worldviews of Norman Borlaug and William Vogt, two white, Western men coming from divergent backgrounds, as they work on agricultural topics during the 20th century. Borlaug, raised on a Midwestern US farm, experienced the rural transformation that grew from the introduction of tractors. Borlaug researched ways to leverage technology to increase food production, an effort that contributed to a larger collection of innovations referred to as ‘The Green Revolution’ and for which Borlaug won a Nobel Peace Prize(CITE). Vogt began his life in a rural area surrounded by unbuilt environments, but moved to the city and witnessed the urban development of his place of birth. Vogt’s research emphasized the need to live within ecological limits and formally developed the concept of ecological carrying-capacity(CITE) as well as a model for environmental activism that is still used today. Borlaug and Vogt were both scientists, but their divergent approaches and conclusions were shaped by their personal values and experiences. The differing motivations do not invalidate their truths, but rather demonstrate how multiple truths can co-exist.

## Diverse framings as a strength

In the context of policy making, the acknowledgement of multiple truths, such as the coexistence of abundance and starvation, is understood as an inherent complexity in addressing multi-faceted issues(Stone2022). In this context, the broader the set of realities that are available, the more complete the overall picture becomes, and concomitantly the possibility for more equitable solutions. Scientists who acknowledge and navigate the existence of multiple truths are better equipped to provide solutions that do not preferentially disadvantage vulnerable groups(Jordan). Although the worldviews of Borlaug and Vogt are divergent, they represent two American males of European descent, demonstrating how even classical delineations such as race and gender portend very little regarding value systems, and lends us to imagine the insight that would be gained from adding more framings. Today, an increasing availability of diversely framed reflections concerning the Green Revolution have led to significantly more nuanced understandings of the motivations behind and impacts of the Green Revolution (PBSserieshttps://www.pbs.org/wgbh/americanexperience/films/man-who-tried-to-feed-the-world/

others). As calls for a ‘second Green Revolution’ proliferate(XX), the ability of society to leverage diverse voices is a prerequisite for success. For example, recent research on weed management exposed novel research questions that emerged only when all value framings were taken seriously (MacLaren2020Weisberger2024). Similarly, progress in understanding complex topics such as herbicide use(Kniss), climate impacts of ethanol production(XXHill2022), and organic agriculture(Wilbois2019Swedishthing) can only come by building scholarship informed by diverse framings.

# Conclusions

In this paper, we demonstrate how agricultural scientists can uniquely contribute to examining, challenging, and redistributing power, and that intentional application of the principles of Data Feminism positively impacts research creativity, stakeholder participation, and agricultural sustainability writ large.