Land Use Policy 70 (2018) 289–297

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Farmer selection of sources of information for nitrogen management in the US Midwest: Implications for environmental programs

D. Stuart[a,*], R.C.H. Denny[b], M. Houser[b], A.P. Reimer[c], S. Marquart-Pyatt[d]

[a] Sustainable Communities Program and School of Earth Sciences and Environmental Sustainability, Northern Arizona University, SBS West, Room 274, 19 W. McConnell PO Box: 6039, Flagstaff, AZ 86011-6039, United States
[b] Department of Sociology, Michigan State University, 509 East Circle Drive, Berkey Building, Room 316, East Lansing, MI 48823, United States
[c] Michigan State University, Kellogg Biological Station, 3700 East Gull Lake Drive, Hickory Corners, MI 49060, United States
[d] Department of Sociology & Environmental Science and Policy Program, Michigan State University, 417A Berkey Hall, East Lansing, MI 48824-1111, United States

ARTICLE INFO

Keywords:
Nitrogen
Pollution
Agriculture
Corn
Trust
Information

ABSTRACT

Nitrogen fertilizer has increased crop yields, but in many regions inefficient use has also resulted in water pollution and greenhouse gas emissions. Attempts to address these environmental issues focus on education and the adoption of more efficient practices. To understand why inefficient use of nitrogen fertilizer persists, scholars have examined factors influencing management decisions including sources of information. Drawing from personal interviews and a mail survey of corn farmers in the Midwest region of the United States, this study goes beyond research that identifies what sources of information are important and examines how different sources are weighed and combined, why some sources are more influential than others, and what organizations and individuals farmers trust given the many private and public sources of information available. We find that most farmers combine several different sources of information to guide their nitrogen fertilizer decisions, private sector sources are highly influential, and that seed and fertilizer suppliers have successfully established trust with farmers through individual relationships with salespeople and crop consultants. These findings suggest that education programs to address environmental degradation associated with nitrogen fertilizer may be more successful if they involve input suppliers.

1. Introduction

Synthetic nitrogen (N) fertilizer is a key input in contemporary agricultural production. Through its application to agricultural fields, global crop yields have improved substantially, allowing for a significant increase in the earth's human carrying capacity (Smil, 2002). However, inefficient N fertilizer application has led to significant environmental issues. In the United States (US), N that escapes from agricultural fields contributes to high nutrient concentrations in surface waters resulting in hypoxia (Ribaudo et al., 2011), drinking water pollution (Gupta et al., 2000), and is the primary source of nitrous oxide – a greenhouse gas 300 times more powerful than carbon dioxide (EPA, 2015). In the US, the majority of N fertilizer is applied for corn production in the Midwest region (Ribaudo et al., 2011; USDA, 2015).

Management strategies have been developed with the potential to significantly reduce N loss and mitigate negative environmental consequences (CAST, 2004; Davidson et al., 2012). These strategies include modifying the formulation, timing, and placement of N fertilizers to improve efficiency and minimize escape to the environment (Robertson and Vitousek, 2009). Despite the number of approaches available and ongoing education programs, US corn farmers are generally not using strategies to increase N use efficiency (Ribaudo et al., 2011). Efforts to understand this trend include examining how farmers make N application decisions and what influences their decisions. This study focuses on Midwest corn farmers and how information sources influence decisions about N management. We find that while farmers are diverse in their use of information, most rely on fertilizer and seed suppliers for information and, despite some skepticism, many trust these sources over university extension recommendations based on trust established through personal relationships over time. This reliance on industry-based information sources to guide N fertilizer application has important implications for efforts through government agencies and universities to address pollution from agricultural N loss.

* Corresponding author.
E-mail addresses: diana.stuart@nau.edu (D. Stuart), rchdenny@msu.edu (R.C.H. Denny), houserm9@msu.edu (M. Houser), apreimer@msu.edu (A.P. Reimer), marqua41@msu.edu (S. Marquart-Pyatt).

http://dx.doi.org/10.1016/j.landusepol.2017.10.047
Received 11 May 2017; Received in revised form 7 September 2017; Accepted 25 October 2017
Available online 06 November 2017
0264-8377/

2. Information sources and agricultural decision-making

An increasing number of studies have explored farmers' use of information to make within- or between-season management decisions (e.g. Arbuckle et al., 2015; Hoag et al., 2012a,b; Weber and McCann, 2015). Examining the extent to which information is used—i.e. the what and how—can help us understand current decision-making as well as how information may be used to encourage farmers to use efficient management strategies more often and more extensively. Education remains a primary policy tool to address environmental issues associated with agriculture in the US (Stuart and Gillon, 2013). This strategy requires understanding not only what information sources farmers use, but how and why they choose these sources, whether they trust them, and how they combine these sources with other information to inform their decisions. As we use the term here, *information sources* refers to social sources that directly recommend management strategies to farmers, such as university extension, private sector crop advisors, and seed and fertilizer suppliers.

Previous studies indicate that farmers consult a range of sources for general information or specific recommendations related to seasonal N management decisions including: farm industry suppliers and dealers, such as fertilizer and seed dealers; university extension; private crop consultants; friends, family and other farmers; farm magazines and publications; and farm events or product demonstrations (Luloff et al., 2012; McBride and Daberkow, 2003; Stuart et al., 2012). While they may be used at different frequencies and for different reasons, studies suggest that farmers are engaging with multiple sources to guide N management decisions (Stuart et al., 2012; Weber and McCann, 2015). Survey results reveal that corn farmers primarily use private sector recommendations, including from seed and fertilizer suppliers and/or associated consultants to guide N management (Arbuckle and Rosman, 2015; Osmond et al., 2015; Stuart et al., 2012; Weber and McCann, 2015).

A growing number of studies have examined relationships between farmers' management decisions and the particular sources of information they use (e.g., McBride and Daberkow, 1997, 2003; Osmond et al., 2015). Specific to N management, studies suggest that the information source farmers utilize can influence their use of nutrient management practices, including the use of precision nutrient application technology (Daberkow and McBride, 1998; McBride and Daberkow, 2003), N soil testing and plant tissue sampling, N inhibitors (Weber and McCann, 2015) and N application rate (Stuart et al., 2012). While this research has demonstrated farmer dependence on external sources of information and possible relationships between behavior and information source, less is known about *how* farmers perceive and utilize nutrient management recommendations and *why* they prefer specific sources over others.

A few studies have suggested trends regarding what influences farmers' selection of information sources to guide decision-making. Some findings indicate that the decline in funding for university extension paired with the growth of private-sector innovations and the strengthening of intellectual property rights has made extension information less credible compared to private vendors (Luloff et al., 2012; McBride and Daberkow, 2003; Prokopy et al., 2015). One study suggests that farmers are highly skeptical of recommendations from private vendors, specifically fertilizer suppliers, as their information may be biased to reflect their financial interest in selling more, not less, N fertilizer (Stuart et al., 2012). The type of information farmers seek may also play a role in what information sources they rely on. Extension and other public sources of information have been found to be more trusted when farmers are interested in conservation issues, such as those related to soil and water (Mase et al., 2015).

While the studies reviewed above indicate that farmers use multiple sources of information and suggests that some are valued or trusted more than others, research is needed to further understand *how* and *why* farmers prefer, combine, and utilize specific information sources to guide their decisions on N fertilizer application. Research to date has primarily used surveys to explore the use of particular information sources by US corn farmers in making their N management decisions. However, this research has not been detailed enough to understand the ways that farmers perceive and trust different information sources and how different sources are weighed and combined. In this paper, we use a mixed methods study of corn farmers in three Midwest states to better understand which sources of information farmers consult and why and how information is used when making N fertilizer application decisions. We seek to examine how this information is used so that our findings may inform current and ongoing policy and management efforts to address agricultural N pollution. While other studies have identified *what* information sources farmers use this study uniquely also examines *how* they are used and *why* they are used (instead of other sources), resulting in more insights to guide pollution reduction efforts.

3. Methods

To explore how farmers process and use N management recommendations from different information sources and why some sources are preferred over others, we examined qualitative data from 154 personal interviews with corn growers in three Midwest states. We completed 53 interviews in Iowa (IA), 51 in Indiana (IN), and 50 in Michigan (MI). Interviews were conducted between May and December 2014. The majority of interviews were done in person on-farm, with a small number conducted over the phone. Almost all interviews were audio recorded with the permission of the participant.

Initial interview participants were primarily recruited through university extension and other state resource professionals, with a reliance on snowball sampling after initial contacts. Snowball sampling is considered a good method to contact subjects who are difficult to access (Faugier and Sargeant, 1997), such as farmers. Across all three states, 48% (N = 74) of interviewed farmers were contacted through university extension, 34% (N = 53) through snowball sampling, 13% (N = 20) through state or federal conservation offices or programs (e.g. Soil and Water Conservation) and 5% (N = 7) were contacted through various other relevant sources (Soybean Association, Practical Farmers of Iowa and field days). Farm sizes of interviewed farmers ranged from 170 to 14,000 acres.

A semi-structured interview guide was constructed to focus on farmer and farm characteristics, N management information sources, influences on N use, and awareness and perception of water pollution and climate change. We focus here on farmers' responses to questions in the information sources section of the interview guide, including: what sources farmers' consulted when making N management decisions; whether they actively sought out information about N management; and what information sources most influenced their decisions. Interviews lasted between 22 min and 2.5 h. Upon completion, interviews were transcribed and analyzed using NVivo software. To ensure reliability and internal validity of our codes, we used an iterative coding procedure. Our first round of coding was organized based on question response categories to break down the larger qualitative dataset. We then coded a subset of the interviews and compared between coders, adjusting categories as necessary to ensure congruence between coders. Coders periodically compared notes while coding the remaining dataset, particularly where there were uncertainties. Once the initial coding process was completed, we coded the subset of the data pertaining to use of information sources. We used an open coding approach with this data subset, where we individually read through the data and identified broad themes about information source use (e.g. type of information source, frequency of use, etc.). As a research team, we compared notes and refined the themes into more specific coding categories. Following this open coding process, we used an axial coding approach as a team to connect themes and identify new cross cutting themes that emerged. This iterative and collaborative coding process allowed us to compare notes and identify coding themes collectively