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Abstract There is a large literature on technology adoption and environmental management in agriculture. Included in this literature are debates about the role world view or attitudinal variables play in adoption decisions, and whether smaller farms or larger farms exhibit superior environmental performance or differ in commitment to environmental values. In this paper we attempt to extend the literature in this area by proposing and measuring discrete environmental management approaches among sixty-six farmers in Northern New York. Using key informants interviews, purposeful sampling of farmers and a mail survey we find two environmental management types: (1) the larger-scale conservation farmer; and (2) the alternative/ecological farmer.

Keywords ACAP · Technology adoption · Environmental management · Farm scale

Introduction

There is an extensive literature on adoption of farming practices or technologies designed to reduce the environmental impact of farming. The vast majority of these studies seek to isolate specific causal or associative relationships between explanatory variables of interest and farming practice or technology adoption dependent variables. And in fact, a farmer's decision to employ a particular agricultural practice can be influenced by many variables. For example some authors have considered access to particular information or technologies (Ajayi 2007; Blesh and Barrett 2006; Loftus and Kraft 2003; Thomas et al. 1990). Others have considered community norms (Rickson Saffigna and Sanders 1999; Blake et al. 1997; Saltiel et al. 1994) and perceived profitability (Hopkins and Johansson 2004; Soule 2001; Saltiel et al. 1994; Lockeretz and Madden 1987). A number of authors have also suggested that there may be a relationship between producer worldview and the farming practices he/she employs (Allen and Bernhardt 1995; Beus and Dunlap 1990; Buttel and Gillespie 1988; Jacob and Brinkerhoff 1986). Beus and Dunlap's (1991) alternative-conventional agricultural paradigm (ACAP) scale has been used on several occasions to provide a framework for assessing adherence to alternative and conventional agricultural paradigms among groups of farmers. This growing body of literature demonstrates that there may, in fact, be relationships between paradigms or attitudinal variables and practice. For example, a sample of organic farmers in Saskatchewan held stronger environmental values than their conventional counterparts (Abaidoo and Dickinson 2002). Conventional farmers in Australia were less likely to describe themselves as "working in harmony with nature rather than against it" than were practitioners of organic agriculture (Rickson et al. 1999). Among farmers surveyed in Nebraska, adherents to conventional and alternative worldviews generally had production practices that correlated with their particular worldview (Allen and Bernhardt 1995). A survey of Washington State farmers found that the farmers that adhere more strongly to the conventional agricultural paradigm have higher reported pesticide use than those who are more strongly identified with the

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alternative agricultural paradigm indicating different approaches to environmental management (Beus and Dunlap 1994). Another survey of Washington State farmers showed that those who practice organic agriculture are more likely to accept environmental regulations, sacrifice profits for sustainability, and have concerns about genetically-modified crops than are conventional growers. This research further supports the suggestion that there is a differing worldview (or value orientation, as they describe it) between the two groups and that these worldviews can influence the adoption of various types of environmental management practices (Glenna and Jussaume 2007).

On the other hand some studies find that attitudinal variables are not as strong predictors of environmental farming practice adoption as age, gross farm income and information sources (Korsching and Malia 1996). And Lasley et al. (1990) found that support for the idea of low-input farming did not correlate with employment of practices to reduce chemical inputs. Clearly more research on the nature of these relationships is indicated, both for its contribution to social theory (Jackson-Smith and Buttel 2003) and because of its agricultural policy implications (Chouinard et al. 2008; Abaidoo and Dickinson 2002; Allen and Bernhardt 1995; Beus and Dunlap 1993).

Another variable believed to be an important determinant of farming practices is farm scale. The adoption of rBST on Wisconsin dairy farms is strongly related to farm scale (Barham et al. 2000), as is the likelihood of adoption of other forms of agricultural biotechnology (Breustedt et al. 2008; Wilson et al. 2005; Fernandez-Cornejo Daberkow and McBride 2001), although the latter is not consistently in one direction. Other farming practices that are related to farm scale include the use of conservation programs (Lambert et al., 2007), use of precision agriculture technologies (Fernandez-Cornejo et al. 2001), and crop rotation (Soule 2001). Some studies suggest that smallholders may have greater overall concern for the environment than larger holders (Schneider and Francis 2006; D'Souza and Ikerd 1996; Lasley et al. 1990), while others find the opposite (e.g., Soule 2001). Tavernier and Tolomeo (2004) suggest a strong relationship between the practice of sustainable agriculture and farm size, but their assertion is based on an attitudinal measure: the answer to the question "Should agroforestry, organic agriculture and other sustainable land-use systems be a priority area for research and extension education"?

In other work on the topic, Welsh and Hubbell (1999) found that operators of larger-contract confinement hog farms adopted environmental practices at a higher rate than smaller-independent confinement hog farms. But the smaller independents maintained smaller herd sizes on larger acreages of croplands, thus reducing the need to manage intensively the hog manure produced on the farm. The authors conclude that the different types of producers manage the environment differently but not necessarily better or worse than the other. These findings suggest that environmental management is a relative concept among different types of farms and farm operators. Likewise, Jackson-Smith and Buttel (2003) argue that the ACAP scale may not be useful for discriminating among samples of farmers selected from the population at large. Instead ACAP might be useful for discerning patterns of farmer behavior that cannot be explained using demographic or structural variables. And that it is not likely "… value commitments [on behalf of farm operators] will shape the adoption and use of structurally and environmentally-related agricultural technologies in consistent directions Jackson-Smith and Buttel (2003), p. 528.

In this paper we use data obtained from a mail survey of 66 farmers in Northern New York to extend the dialogue on environmental management beyond debates over the relative efficacy of certain types of variables (e.g., economic profitability measures versus attitudinal variables versus socioeconomic status indicators) or farm size (e.g., smaller versus larger) as predictors of environmental management. Rather we explore the concept of that there exist different strategies or systems of environmental management in production agriculture. Such systems might be discrete and composed simultaneously of attitudinal and farm structure variables and environmental management practices. In this vein we seek to address the following research question. *Can different strategies of environmental management be measured among farmers expressing an interest in minimizing the environmental impact of their operations?*

Data, methods and analysis

Participants in an undergraduate research seminar in Environmental Studies at St. Lawrence University in Canton (St. Lawrence County) New York compiled a list of producers who had worked with Cornell Cooperative Extension on environmental management issues by interviewing county cooperative extension staff. That is, we queried key informants on environmental management issues related to agricultural production to obtain names of information-rich cases (i.e., knowledgeable and interested farm operators) in a purposeful sampling procedure. As Harper (2001), p. 27 explains,

> Sociologists as important to the forming of qualitative methods as Herbert Blumer reinforce the idea that a small number of well-informed informants are, in fact, a better sample than much larger samples of minimally involved subjects.

And according to Patton (1990), p. 169

> The logic and power of purposeful sampling lies in selecting information-rich cases for study in-depth. Information-rich cases are those from which one can learn a great deal about issues of central importance to the purpose of the research, thus the term purposeful sampling.

In purposeful sampling, information-rich cases are selected for in-depth study, and the size and specific cases depend on study purposes. Information-rich cases are cases where one can learn a great deal about matters of importance to the researcher. Therefore, rather than randomly sample from lists of local farmers, we used the key informants of the local extension staff to develop a list of area farmers that had expressed a specific interest in environmental issues related to agriculture. We believe that by collecting information and data from these individuals and using interpretive and descriptive research methods to analyze it, we will learn a great deal about how different types of producers approach environmental management. By definition, our analytical approach is less predictive than descriptive, and hopefully tells a rich and informative story that can inform research in other geographic regions.

We mailed 220 surveys to St. Lawrence County, New York farmers identified by the key informant strategy. Sixty-six completed and useable surveys were returned, and eight farmers responded that they no longer engaged in commercial agriculture. This resulted in a response rate of about 31 percent. The response rate is low if the intent was to survey large numbers of randomly-selected farmers. However, it can be interpreted as another step in purposeful sampling of invested and informed cases, as those farmers more interested in the topic completed and returned the survey. Since our research method is qualitative in its design, and descriptive and not predictive in its analytical approach, the 31 percent response rate is not a limitation to overcome.

The survey instrument covered a number of issues including farm structure, attitudes toward biotechnologies and organic agriculture, and whether the farmers currently use a number of conservation farming practices promoted in the region by cooperative extension and other agencies. We also asked the farmers to select a sales category from this list that most accurately reflects their annual farm sales to provide an indicator of farm size: 1 = <$10,000, 2 = $10,001–$20,000, 3 = $20,001–$30,000, 4 = $30,001–$40,000, 5 = $40,001–$60,000, 6 = $60,001–$80,000, == $80,001–$100,000, 8 = $100,001–$200,000, 9 = $200,001–$300,000, 10 = $300,001–$500,000, 11 = $500,001–$750,000, 12 = $750,001–$1 million, and 13 = >$1 million.

We asked farmers to respond to the following two Likert scale items by selecting a number from 1 to 5 where 1 equals strongly agree and 5 equals strongly disagree: "I am supportive of organic agriculture" and "Agricultural biotechnology is currently making important contributions to agricultural sustainability." Finally we had farmers select from this list of conservation farming practices which they employed on the farm: reduced tillage, legume rotation for fertility enhancement, certified organic production, intercropping, use of pest-resistant crop varieties, use of cover crops, cultivation to control weeds and reduce herbicide use, pest scouting in place of calendar pesticide treatments and crop rotations to break pest life cycles. Table 1 lists the selected variables and the means and standard deviations of the respondents for each. The data in Table 1 shows that both organic agriculture and biotechnology tended were perceived favorably on average by the farmers in our data set. In addition, the conservation farming practices varied widely in adoption rates. For instance, about 70 percent of respondents used crop rotations to break pest life cycles, 48 percent scouted for pests and only 20 percent employed intercropping.

Regarding farmer demographic and farm structure variables, Table 2 compares the purposeful sample with St. Lawrence County (SLC) farms and farms in New York State (NYS) for selected variables. On average the farms surveyed were smaller than SLC and NYS farms, with the average farm sale averaging from $40,000 to $60,000 for surveyed farms and about $105,000 and $121,000 for SLC and NYS farms respectively. However, about 29 percent of the surveyed farms had sales of greater than $100,000 and 12 percent of farms had sales of more than $300,000 (results not presented in tables). Also, surveyed farm

Table 1 Means and standard deviations for selected variables

Variables	N	Mean	Std. Deviation
Farm sales	65	~5.0 (40–60 K)	3.923
Supportive of organics	66	2.09	1.003
Biotech contributes to sustainability	64	2.61	1.341
Reduced till	63	0.44	.501
Legume rotation	63	0.59	.496
Certified organic	63	0.19	.396
Intercropping	64	0.20	.406
Uses pest resistant crop varieties	63	0.30	.463
Plants cover crops	63	0.44	.501
Cultivation to control weeds	63	0.33	.475
Scouting for pests	63	0.48	.503
Crop rotation	64	0.70	.460

Practices are binary (0, 1) variables and means can be interpreted as percentages if multiplied by 100

Table 2 Comparison of selected variables among sample, St. Lawrence County and New York State farms

Variable	Purposeful sample	St. Lawrence County	New York State
Age of operator	50.4	55.5	56.2
Sales per farm	$40,000–$60,000	$105,377	$121,551
% direct marketers	45.3	15.0	5.3
% organic farms	19.0	4.3	3.1
% Sole or Family Proprietorships	80.3	89.6	84.2

operators were about 6 years younger on average than SLC and NYS farms; and surveyed farms were more likely to direct market their products and have organic certification than SLC or NYS farms.

We used the factor analysis procedure in SPSS to discern if the farm structure or size variable (sales), attitudes toward organic farming and biotechnology and the conservation farming practices formed discrete types of environmental management systems. Factor analysis is a statistical technique based on a correlation matrix. Factors are extracted from this matrix using a procedure called principal components analysis which extracts uncorrelated factors (composed of multiple variables) from correlated variables. The extracted factors are listed in order of the amount of variation they explain. The first factor accounts for the greatest amount of variation. A factor matrix illustrates which variables are contained within a factor. If a variable has a coefficient of 0.50 or greater (absolute value), it is assumed to "load" on that factor. Loading means the variable is considered a significant part of that factor (Kim and Mueller 1978). In addition it is common to rotate the principal components solution using a varimax rotation. A varimax rotation is a popular scheme for orthogonal rotation which simplifies the factors such that high correlations will occur for only a few variables, and the remaining variables will have correlation near zero. Varimax rotation is often used in surveys to see how groupings of items measure the same concept (Kim and Mueller 1978). The variables in Table 1 were used in a factor analysis (varimax rotation) to discern how the selected variables tended to correlate or group.

Results and conclusions

Table 3 presents the results of the factor analysis. Two factors emerged that explain 29 percent and 23 percent of the variation in our data respectively. We label these factors Larger-scale Conservation Farming and Alternative/Ecological Farming and argue that they represent discrete environmental management types. The dominant environmental management style is the Larger-scale Conservation Farmer and is characterized by higher sales on average and adoption of the following conservation practices: reduced tillage, legume rotation to enhance soil fertility, planting of cover crops, crop rotation to break pest life cycles, use of pest resistant crop varieties and scouting for pests. The secondary environmental management style is the Alternative/Ecological Farmer and it is characterized by support for organic agriculture and resistance to biotechnology and adoption of the following conservation practices: certified organic production, intercropping and cultivating to control weeds.

Table 3 Rotated component matrix

Variables	Environmental management types	
	Larger-scale conservation farming	Alternative/ Ecological farming
Reduced till	**.661**	−.100
Legume rotation	**.637**	.199
Intercropping	.207	**.751**
Cover crops	**.547**	.428
Crop rotation	**.787**	.275
Certified organic	−.022	**.706**
Pest resistant crop varieties	**.626**	−.198
Cultivating to control weeds	.284	**.604**
Scouting for pests	**.750**	.008
Farm sales	**.659**	−.299
Supportive of organics	.203	**−.668**
Biotech contributes to sustainability	−.300	**.687**

Bold represents significant variables for each factor- absolute value above 0.50

The Larger-scale Conservation Farmer appears agnostic in considering organic agriculture and biotechnology since neither scale loaded on the factor. The fact that farm sales loads positively on this factor indicates that smaller farms which do not adhere to the Alternative/Ecological management style are less likely to employ the conservation practices correlated with high sales. This does not mean that no smaller farms in the area employ the practices, rather that higher sales are correlated with using reduced tillage, legume rotations and other practices.

Our findings indicate that attitudinal variables (or worldview) and farm structure or size variables are correlated with environmental farming practice adoption. However, attitudinal variables are correlated with a different set of practices than farm size. Therefore, a researcher might conclude mistakenly that farm size or attitudes are not reliably associated with practice adoption when they are, depending on the type of conservation practice measured.

Alternative/Ecological farming and the practices it entails (certified organic production, intercropping and cultivating to control weeds) is more ideologically driven than our other environmental management style. This makes sense given the history of skepticism the organic farming community has manifested toward agricultural biotechnologies such as rBST and transgenic crops. In addition, organic certification brings with it some imperatives that likely influence type of conservation practice employed. For example, the prohibition of synthetic herbicides makes it more likely farmers will cultivate to control weeds; and it may be that intercropping is used to provide green manures and out-compete potential weed populations. The Larger-scale Conservation farmers in our study might adopt conservation practices such as reduced tillage because herbicides are an option and specialized tillage equipment is affordable because of their larger sales volumes. In addition, the Larger-scale Conservation farmers might be able to afford to hire labor to scout fields, and larger farms might find it more feasible to rotate crops rather than intercrop. The latter practice of cultivating two or more crops in the same space at the same time can be very management intensive (Andrews and Kassam 1976), and may not make sense on larger farms not attempting to comply with organic certification rules.

Our analysis has described two discrete and extant environmental management styles in Northern New York State. While the sets of practices we found that characterize the two management styles are part of the set of practices promoted as environmentally beneficial or sustainable, we did not measure actual environmental outcomes associated with the different approaches. That is, we cannot say which approach is "better" for protecting or enhancing the environment-locally or elsewhere. However, we believe that our descriptive analysis is important because it can inform research in other regions such that analysts interested in sustainable agriculture might better be able to understand the complex interactions between socioeconomic variables and associated conservation practice adoption.

That is, the extant literature which considers the relationship between farm structure, attitudes or worldview and adoption of environmental practice has not considered sufficiently that multiple environmental management trajectories can exist simultaneously among farmers. Farmers who choose, or are forced, to respond to environmental management issues do so in ways that are congruent with other aspects of their farm structure and management styles. Our study sample was composed of farmers that had sought information from cooperative extension to help them achieve environmental management goals. And our analysis measures discrete sets of environmental management practices that can correlate with attitudes or world views. The implications for agrarian non-governmental organizations, cooperative extension and analysts interested in environmental issues in agriculture are profound. A flexible approach to understanding and promoting adoption of environmental practices is also important. Finally, understanding the relationship between environmental management practices and other aspects of a farming system is critical to realizing widespread use of sustainable production practices.

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