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Article

Considering Structural, Individual and Social Network Explanations for Ecologically Sustainable Agriculture: An Example Drawn from Washington State Wheat Growers

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Abstract: As acceptance of the concept of agricultural sustainability has grown, it has become increasingly recognized that notions of sustainability and how to promote it will necessarily vary depending on the commodity in question. It thus becomes important to investigate how movements towards sustainability are emerging for different commodities. The objective of our paper is to present the results of an analysis of Washington wheat producers that investigates the degree to which interest in sustainability exists amongst those farmers and whether structural factors and farmer personal characteristics are more or less significant than social network factors in explaining farmers' views of possible sustainable methods. Our findings indicate that a measure indicating use of local social networks to gain information is associated with a higher degree of interest in new production methods aimed at improving agricultural sustainability.

Keywords: Agricultural Sustainability; Social Networks; Alternative; Wheat.

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1. Introduction

Discussions about how to promote ecologically sustainable agricultural production systems have moved from the fringe to the mainstream in the United States and around the world. Many observers focus on defining "sustainable," a challenge made more difficult by the realization that a viable

definition must take account of the diversity of situations that exist across agriculture, as well as between agriculture and other sectors of the political economy. That diversity is linked to differences in how particular commodities are produced, the geographies in which they are produced, the particular political-economic structures associated with a given commodity, and the social systems in which the farmers are producing. A first step in developing such a nuanced conceptualization of sustainability in agriculture is to examine the sustainability challenges facing each agricultural sector.

We seek to contribute to the development of a more nuanced conceptualization of agricultural sustainability by examining some of the specific challenges facing wheat farmers in Washington State. Wheat production in Eastern Washington is characterized, as is the case with many other grain crops, by the persistence of family ownership of most of the means of production. This means that analyzing the influences on farmer decision-making is important for understanding how sustainable practices may or may not be advanced in this sector.

Other important characteristics of Eastern Washington wheat farming include: (1) some of the main weed problems are from plants that are, like wheat, grasses; (2) the main producing region is in a hilly region that lends itself to erosion; and (3) a high degree of dependence on export markets. The development of technologies and practices that enable farmers to manage these challenges while maintaining a competitive position in overseas markets is frequently a focal point of conversation when wheat producers gather to discuss the management challenges they face and their potential solutions.

This paper is based on the assumption that the determination of what practices help make agriculture more sustainable must take into account the conditions that are unique to the production of a particular commodity, and that an understanding of those conditions exists in local knowledge [1]. At the same time, we also recognize that interest in sustainability and degree of connection to the networks where local knowledge is stored is never uniform. Thus, the objective of this paper is to further improve our understanding of the role of farmers in promoting a more sustainable direction for agriculture by investigating the extent to which Washington State wheat farmers are interested in a more ecologically sustainable alternative vision of agriculture, and to isolate the factors that are significant in identifying those farmers who would be most likely to pursue such alternative strategies in that particular agricultural sector. In particular, we assess whether structural factors and farmer personal characteristics are more or less important than social network factors in explaining farmers' views of the desirability of a possible alternative vision to the conventional model of agricultural production.

2. Theoretical Perspectives

Sociological research on the development of agricultural production systems, and how these systems interact with processes of social change in rural communities, provides a useful starting point for developing questions about social processes associated with efforts to create more sustainable agricultural production systems. A longstanding tradition within this body of work has focused on isolating the types of farmers who are most willing to adopt new agricultural management practices and technologies, and how this process contributes to increased efficiency on the farm and improved food supplies for society at large [2]. The empirical evidence generated from such studies generally

has found that earlier adopters of new technologies were more likely to have higher educational levels and socioeconomic status [3], which led to the view of such early adopters as "progressive" farmers.

A second tradition utilizes political economy approaches to analyze how structural conditions can restrict agricultural change and development, with corresponding negative social, economic and environmental consequences [3,4]. Such research argues that the causes of economic failure in agriculture are not simply a lack of expertise or desire to become "modern" on the part of individual farmers, but also a product of the history and particular institutional arrangements that arise in contemporary capitalist society [3,5]. Consequently, a research stream has emerged that evaluates how farmers are structurally embedded within the context of an industrially oriented agrifood system [6-9]. A common thread connecting this tradition with research on which types of farmers are "modernizers" is an assumption that the impetus for modern technological change in agriculture originates off-farm.

However, in more recent years, interest has been growing in examining how individual, network and structural factors may or may not play a role in promoting the development of more sustainable alternative agricultural development visions and strategies [10,11]. These studies are not necessarily conceptualizing farmers as completely independent actors, but they do recognize that farmers often look for and engage in strategies to improve their farm management practices while simultaneously coping with structural conditions. This approach is of particular interest to scholars who are trying to understand the processes associated with the utilization of alternative agricultural practices [12-14]. Such a tradition assumes that farmers adopting alternative practices must have a strong motivation to do so, but also need the support of social networks and institutions.

Within this literature on the adoption of alternative agricultural practices, scholars are increasingly emphasizing the importance of farmer networks in promoting transitions to organic and sustainable agriculture [15-18]. Such studies often emphasize that the land-grant university system has traditionally favored conventional agriculture, making it necessary for farmers interested in organic and more sustainable agriculture to conduct their own research and to share the knowledge they generate through interactions with other farmers [15,18]. Research also indicates that farmers recognize that there may be local social, economic, and ecological conditions that can best be addressed through conversations with others who are dealing with the same conditions [15-18]. Morgan and Murdoch [16] go so far as to assert that farmers in the midst of a transition to more sustainable agricultural management must forget how to farm conventionally and relearn how to farm ecologically, and that locally organized farmer networks are crucial for promoting this learning process.

In other words, research in the Sociology of Agriculture is becoming more nuanced in what is being studied and in the conceptualization of the social processes associated with changes in agricultural development towards a system that more directly incorporates practices that are thought to be more sustainable. Not only is the definition of what a "modern" agriculture should look like being contested, but a greater sophistication is emerging in conceptualizations of how the complementarity between individual roles and social processes influences changes taking place in agriculture. Specifically, an increasing body of research is acknowledging that the notion of what constitutes sustainable agricultural development must expand to incorporate a systemic vision of agriculture that is economically, culturally, politically and environmentally more viable and equitable. In addition, agricultural sociologists are recognizing that further agricultural development will not be achieved

without incorporating a conceptualization of how individuals and groups become active agents for change while simultaneously coping with political-economic realities [19].

On the surface, the language of research on the adoption of alternative practices suggests a strong connection to research on early adopters of modern technologies. A striking example of this is Warner's [20] work on the emergence of local social networks devoted to promoting agroecological farming. Warner's description of "leading growers" sounds reminiscent of "progressive farmers." However, the picture that Warner presents of farmers, which is similar to the analyses of farmer characteristics in studies that have examined the adoption of "biologically integrated farming practices" [21] and of no-till agriculture [22], is of farmers who work with other actors in a network to respond to environmental, political and economic challenges. This is not a theoretical image of farmers who are making an individual choice to adopt modern innovations that were developed off-farm, but one of farmers who link with other farmers and non-farmers to actively engage in innovative processes that, at least in part, respond to historical, structural and environmental constraints.

This theoretical shift in the depiction of the role of farmers within the agrifood system is evident in the types of problems investigated and the selection of dependent and independent variables of interest. Rather than identifying and analyzing those farmers who are adopting those innovations that are deemed to be most efficacious at promoting the development of a "modern," industrialized agrifood system, the newer focus is to investigate the development of alternative strategies of agrifood development, such as organic production systems [12,23-25], on-farm environmental practices [21,22,26], post-fordist strategies [27,28] and new international regulatory regimes [29]. The change or outcome under investigation becomes not the *adoption* of a *modern* practice, but rather the possibility for the *creation* of *alternative* agricultural production strategies that include active farmer involvement and that might lead to a revised vision of modernity that is equitable and sustainable.

This change in emphasis is also reflected in the breadth of variables selected to analyze which farmers are more likely to pursue these alternative strategies. In classic adoption studies, the main explanatory interest is in measures that might be thought of as indicators of human and financial capital, in particular the educational, income, and farm size attributes of farmers. Contemporary research on farmers as actors in networks remains interested in these indicators, but adds membership in social networks [20,22], as well as variables that reflect farmers' exposure to alternative views of how to change agrifood systems [30] to the explanatory framework.

By choosing an expanded set of variables, the theoretical debate surrounding the role of farmers in agrifood systems shifts from a comparison of traditional and modern farmers, to a discussion of the degree to which farmers are interested in, and capable of, creating alternatives to the conventional agrifood system. Of course, this general question is complicated by the great diversity in goals and approaches, not only across, but also even within types of alterative strategies, as well as across different commodity systems. Raynolds *et al.*'s [29] discussion of the variety that exists amongst fair-trade approaches is an example of this complexity.

The purpose of our analysis is to contribute to this theoretical dialogue concerning the interplay between farmers' actions and the structural conditions they operate within by asking whether and how farmers are developing an interest in engaging in alternative agricultural practices in Eastern Washington wheat production, which in our particular analysis is measured as an interest in employing on-farm conservation practices and in saving seed for a future planting. The latter is of particular

interest because the purchase on a yearly basis of improved seed varieties has long been emblematic of a modern agricultural practice. Kloppenburg [5] and Pfeffer [31] have described how the USDA historically pushed the adoption of purchased inputs from agribusiness as a means of modernizing U.S. agriculture. Through an analysis of farmer interest in conservation practices and seed saving, we investigate whether the degree to which farmers are interested in adopting either of these practices is associated with indicators of the human capital and social networks characteristics of farmers.

Many studies that incorporate an analysis of social networks in agrifood-system change conduct ethnographic or other qualitative research to depict the rich nature of the social interaction taking place. Our goal is to employ a quantitative approach that evaluates the relative importance of social networks and other theorized predictors of change. In this way, we can assess the relative importance of social network considerations. In particular, we are keenly interested in addressing the following general questions. First, are young, highly educated, larger scale farmers more likely to be the kind of "modern" farmer envisioned in much of the traditional innovation of diffusions research, or are these young, highly educated farmers becoming more interested in "progressive" alternatives, like those farmers envisioned in the work of Warner and others? Second, are these indicators of human capital and size more or less important than indicators of social networks and farmer attitudes about the role of farming in the social structure in predicting which farmers are most likely to be interested in practices associated with a more sustainable agriculture?

The answers to these questions will help us contribute to the theoretical literature on change processes in contemporary U.S. agriculture. We recognize the limitations of using empirical insights based on a study of those who produce one particular commodity in one corner of the United States. On the other hand, as wheat has been an important commodity in world agrifood system trade for over one hundred years [32], and as wheat producers continue to be primarily family based, our analysis will offer one perspective on the possibilities for the plausibility of alternative agrifood system development.

3. Data and Methods

From January through March of 2006, as part of a collaborative project between the wheat breeding program of the Department of Crop and Soil Sciences and the Department of Community and Rural Sociology at Washington State University, a survey of wheat growers in Washington State, USA, was conducted. The primary objective of the survey was to determine whether Washington State University's wheat breeding programs' research priorities reflected the needs of the state's wheat producers.

With the cooperation of the Washington Association of Wheat Growers (WAWG), a total of 1,374 names were drawn from the Association's membership list. Three hundred and seven (307) names were removed from this original sample because of ineligibility, bad addresses and other reasons. In collaboration with Washington State University's Social and Economic Sciences Research Center (SESRC), a sixteen page survey, which was pre-tested on several wheat farmers who were known to team members, was mailed to the corrected sample of 1,067 growers. Questionnaires were sent out in accordance with the procedures outlined in Dillman's [33] Tailored Design Method. Of those wheat farmers who were sent surveys, 553 returned completed questionnaires, for a completion rate of 51.8

percent. An additional 239 ineligible surveys were also returned, which meant that the survey's return rate was 61 percent.

Many of the survey items were designed to assess the degree of farmer interest in a variety of wheat breeding and marketing options. For this reason, Likert scales were utilized throughout the survey, including for the dependent variables of interest for this paper. Given that these variables measure outcomes that are *ordered* into more than two categories, a maximum-likelihood ordinal logistic estimation technique [34,35], provided in the STATA® software package, was utilized to analyze the data.

4. Analysis

In one section of the wheat farmer survey, respondents were asked to evaluate the importance of a list of nine management goals that might influence the success of their farm operation. The responses to several of these statements reflect what we would consider to be traditional, modernist thinking about farming amongst a large percentage of growers. For example, 87 percent of the wheat farmers stated that ensuring high yields was extremely important, while 83 percent responded that lowering input costs was extremely important. Similarly, only 28 percent of the respondents stated that maintaining genetic diversity was extremely important, while 26 percent responded that emphasizing environmental conservation was important. We also note that nearly 60 percent of those surveyed stated that they would plant a genetically modified wheat variety if it were available. This response pattern indicates that a majority of Washington wheat farmers maintain a view of agriculture where the main farming goal is both production and profit maximization.

On the other hand, the fact that a quarter of respondents indicated that considerations such as maintaining genetic diversity and environmental conservation were important on their farms indicates a recognition on the part of many growers of the need to blend environmental with economic considerations in wheat farming. While this should not be interpreted as reflecting a radical interest in environmental issues or a political-economic transformation of the agrifood system, we believe it does indicate that a substantial number of farmers are interested in exploring more sustainable farm management approaches. This way of thinking, at a minimum, recognizes the need to blend environmental and economic factors in farm management

In order to assess which types of farmers were more likely to have an interest in blending economic and environmental dimensions of agriculture, we combined the responses to the two statements on *conservation and genetic diversity* into a single measure for use as a dependent variable in our analysis. The final variable was coded 2 for those who felt that either maintaining genetic diversity and/or environmental conservation were extremely important while also feeling that the remaining goal was at least mostly important (29.5 percent). Respondents who felt that both goals were mostly important (26 percent) were coded 1, and a coding of 0 was used for those who felt that neither goal was extremely or mostly important (44.5 percent) (see Table 1).

Table 1. Descriptive Statistics for all Variables.

	Coding	Percent
Dependent Variables		
-Interest in Conservation and genetic diversity	Not Important =	44.48
	Mostly Important =	26.04
	Extremely Important =	29.48
-Value placed on ability to Save Seed	Not Important =	32.01
	Mostly Important =	38.24
	Extremely Important =	29.66
Independent Variables		
-Age Category of Respondent	Less than 45 =	11.42
	45 to 59 =	51.97
	60 and older=	36.61
-Educational Level	High School =	9.84
	Post-secondary=	35.83
	Baccalaureate or more =	54.33
-Income From Agriculture	Less than 75% =	47.31
	75% or more =	52.69
-Importance of Farm Bureau Meetings to Decision-Making	Not Important =	59.67
	Slight Importance =	28.57
	Mostly Important =	11.75
-Importance of Neighbors to Decision-Making	Not Important =	26.40
	Slight Importance =	32.73
	Mostly Important =	40.87
-Number of Land-Grant University Field Days Attended 2001-2005	Mean =	2.385
	Median =	2.177
	Minimum =	0
	Maximum =	6
- High Yields are Most Important Factor for Determining Farm Success	No =	55.70
	Yes =	44.30
-Saves Own Seed for Future Planting	No =	65.45
	Yes =	34.46
-Respondent's Priority to Development of Perennial Wheat	High =	28.98
	Medium =	41.84
	Low =	29.17
-Local Decline in farm numbers and community has affect on Farm Operation	No =	63.11
	Yes =	36.89
-Current Commodity System should be Maintained	Extremely Interested =	16.15
	Mostly Interested =	51.73
	Slight or No Interest =	32.12

For our second dependent measure of an alternative vision for wheat production, we selected the variable measuring farmer interest in *saving and planting one's own seed*. There has been strong academic interest in the topic of control of the plant breeding process, and of genetic material [5]. As part of our survey, we asked wheat farmers how important it was for them to be able to continue to save and replant seed. Although saving seed was, until the 20th Century, a necessary practice in United States agriculture, in recent decades the purchase of seeds on a yearly basis has become the recommended, conventional practice. More recently, however, maintaining the right to plant one's own seed is being revisited as a right that should be preserved in order to promote a more equitable and viable form of agriculture [36]. So, for this variable, we distinguished between those who view this ability as extremely important (29.7 percent), as mostly or slightly important (38.2 percent), or not important at all (32 percent).

As noted previously, for our analysis, we wanted to contrast the explanatory power of more traditional independent measures of human capital and socio-economic status with variables that could reveal the extent to which farmers rely on different social networks to obtain information about new technologies and production practices (see Table 1). For indicators of human capital, we utilized measures for *age* (those less than 45 years of age (11.4 percent), those between 45 and 59 (52 percent), and those more than 59 years of age (36.6 percent)) and *formal education* (high school degree (9.8 percent), post-secondary training (35.8 percent), and baccalaureate degree or higher (54.3 percent)). For measures of size of farm operation, which we consider to be an indirect indicator of socio-economic status, our challenge was that more than 14 percent of our sample refused to report their farm receipts, and number of acres is a difficult measure to use in analyzing Eastern Washington wheat farming because there is a great deal of natural variability in rainfall in the region. In particular, in much of the western part of the region, rainfall is such that land can be farmed only every other year. Thus, size of farm operations is more accurately interpreted as an indicator of geographical zone than socio-economic status of the farm operation. So, to measure size, we utilized a variable that measured the percentage of farmers that obtained three-quarters or more of the farm's income from agriculture (52.7 percent). While this is not as direct a measure of size as receipts would be, we do note that for those farmers who reported their receipts, percentage of income from agriculture and receipts were highly correlated (Chi-square of 117.07, $P < 0.001$).

For measures of social networks, we used variables that asked respondents how important it was for them to a) attend *Farm Bureau meetings*, and b) *meet with neighbors* in order to obtain information to help with on-farm decision-making. For each of these variables, farmers were separated into one of three categories: not important, slight importance, mostly (or extreme) important. We also utilized a social capital variable that measured farmer *attendance at field days* run by the land grant university to serve wheat producers. Respondents were asked how many field days they had participated in over the previous five years. The variable is coded from one to six or more, with the mean number of attendances being 2.4. For all three of these variables, it is important to recognize that we are measuring the extent of social network interaction.

One research objective was to compare the influence of human capital and social networks influences on the dependent variables with respondent behaviors and attitudes about farm management and structural issues in agriculture. For this reason, we incorporated five additional independent variables into the analysis. One variable measured whether the respondent believed that *high yields are*

the most important factor in determining farm success, an attitude we assume is linked to a modernist orientation towards agriculture. We also asked farmers whether they did actually *save any of their seed* for future planting, as well as whether the felt the *development of perennial wheat should be a breeding priority*. We assume that these two variables reflect a farmer inclination towards controlling genetics and using such genetics to develop a more environmentally sustainable form of farming. Finally, we measured farmer concern about structural issues facing agriculture by asking respondents whether they felt that *local decline in farm numbers and community had an effect* on their farm operations, and whether the *current commodity system for wheat should be maintained.*

Table 2. Ordered Logistic Regressions of Interest in Conservation and Genetic Diversity.

	Model 1		Model 2	
	C	SE	C	SE
Age of Respondent	0.132	0.150		
Educational Level	0.129	0.147		
Income from Agriculture	0.077	0.183		
Importance Farm Bureau Meetings	0.170	0.131		
Importance of Neighbors	0.283*	0.117	0.281**	0.106
Field Days Attended	0.070	0.041		
High Yields are Most Important Factor	0.515**	0.185	0.395*	0.166
Saves Own Seed	0.076	0.187		
Priority of Perennial Wheat	-0.259*	0.122	-0.257*	0.111
Affect of Local Decline	0.570**	0.186	0.591**	0.171
Maintain Current Commodity System	-0.003	0.141		
N	448		521	
LR Chi-square	35.52***		33.38***	

* $p < 0.05$; ** $p < 0.01$; *** < 0.001
C = Coefficient estimate
SE = Standard Error

All of these variables were utilized in ordinal logistic regressions on each of our two dependent variables (Tables 2 and 3). All of the models computed had significant R^2 values, but readers are cautioned to remember that in logistic regression, unlike in OLS regression, the R^2 statistic is a measure of goodness of fit, not proportion of variance explained in the dependent variable [37,38]. Also of interest is that in all of the models, age of respondent, formal educational level and percentage of income derived from Agriculture are *not* significant independent predictors. In other words, factors that traditionally were thought to be important in understanding which types of farmers would be most likely to adopt new, modern technologies in agriculture are *not* useful in understanding which wheat farmers in our study have an interest in conservation, genetic diversity and saving seed for future use.

In the models presented in Table 2, farmers who valued information from their neighbors (P <0.01), who believe that high yields are an important factor for success (P <0.05), who place a high priority on the development of perennial wheat (P <0.05), and who believe that a decline in farm numbers and community has an affect on farm operations, were significantly more likely to be interested in Conservation and Genetic Diversity. This was true even after controlling for age, educational level and the size of the farm operation. This finding corroborates the work of Coughenour [22] and others that suggests that social networks (in this case neighbors) and sensitivity to community dynamics are positively associated with interest in incorporating environmental and genetic diversity considerations in making farm decisions. However, the fact that emphasis on high yields was also significant suggests that, in the minds of farmers at least, there is no contradiction between interest in maximizing production and in conservation and genetic diversity.

Table 3. Ordered Logistic Regression of Value Placed on Saving Seed.

	Model 1		Model 2	
	C	SE	C	SE
Age of Respondent	-0.222	0.153		
Educational Level	0.025	0.154		
Income from Agriculture	0.264	0.188		
Importance Farm Bureau Meetings	-0.110	0.135		
Importance of Neighbors	0.089	0.119		
Field Days Attended	0.033	0.043		
High Yields are Most Important Factor	0.124	0.188		
Saves Own Seed	2.089***	0.212	2.113***	0.199
Priority of Perennial Wheat	-0.282*	0.125	-0.286*	0.114
Affect of Local Decline	0.139	0.192		
Maintain Current Commodity System	0.025	0.142		
N	448		509	
LR Chi-square	125.56***		132.46***	

* p < 0.05; ** p < 0.01; *** < 0.001
C = Coefficient estimate
SE = Standard Error

In the case of interest in saving seed, two variables were significantly associated with the dependent variable. These were whether the farmers saved their own seed (P <0.001) and placing a high priority on the development of perennial wheat (P <0.05). These findings demonstrate a consistency between attitude and behavior in terms of seed saving, as well as interest in developing traits in wheat that might help wheat producers farm more sustainably. Indeed, it is most intriguing that the one independent variable that was significant in both sets of models was the variable that asked whether

farmers placed a high or low priority on the development of perennial wheat. Scientists involved in developing perennial wheat describe their efforts as challenging the trends in conventional agriculture [36]. More research is needed to explore the degree to which farmers' perspectives on perennial wheat parallel those of the scientists.

5. Discussion and Conclusions

The overall goals of our analysis were to investigate the degree to which wheat farmers in Washington State are moving towards acceptance of some agricultural production practices that are believed to enhance sustainability. We sought to determine if young, highly educated, larger scale farmers are more likely to be the kind of "modern" farmer envisioned in much of the traditional innovation of diffusions research, or if these young, highly educated farmers are becoming more "progressive." Furthermore, we sought to determine if indicators of human capital and size are more or less important than indicators of social networks and farmer attitudes in predicting which farmers are most likely to be interested in practices associated with a more sustainable agriculture.

The evidence we have presented suggests that there is interest amongst some farmers in management schemes that blend alternative, more ecologically sustainable farming practices into mainstream practices, and that this interest is related to activity in social networks and concern about the effects of community decline on agriculture. These findings provide support to studies indicating that the spread of new knowledge regimes in support of more sustainable agricultural practices is supported by social networks that connect farmers to one another. Clearly, more in depth research is needed to investigate the processes by which farmers in these networks share information about sustainable agricultural practices. Nonetheless, our analysis has demonstrated that individuals active in networks are not only more likely to be interested in conservation practices, genetic diversity and saving their own seed, but also appear to be interested in blending this management style with more conventional goals of increasing yield and maximizing profits.

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