

Understanding Environmental Behaviors:

A modification of value-belief-norm theory applied to farmer
nutrient management decisions in the Maumee Watershed

Project: People, Climate Change, and Lake Erie

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CHAPTER 1: Presentation of the problem and literature review

Presentation Of The Problem

As the shallowest, warmest, and most productive of the Great Lakes, Lake Erie is particularly susceptible to the effects of environmental stressors (Michalak et al, 2013). As the Lake Erie greater watershed region has given way to urban, residential, and particularly agricultural development, runoff into the lake has wreaked havoc on the lake's ecosystems. Increased application of fertilizer for agriculture, and increasing rainfall as the world's climate warms and its weather patterns grow more erratic, create conditions for an influx of phosphorus, a key nutrient in fertilizers and the limiting factor for algal growth in the lake (EPA, 2010). In recent years, with an abundance of phosphorus readily available, Lake Erie has suffered repeated algal blooms with serious consequences for human and non-human life. In 2011 Lake Erie experienced the "largest harmful algal bloom in its recorded history," and, if agricultural practices, land use, and environmental conditions continue to trend in their current directions, this may be "a harbinger of future blooms" on the lake (Michalak et al, 2013 pg 6448).

The Maumee River Basin, one of many tributaries flowing into the lake, is considered by experts to be the primary contributor of phosphorus into Lake Erie (EPA, 2010). Land use within the river basin consists largely of corn and soybean fields, which routinely receive applications of industrial fertilizers that, after severe rain events, flow into adjacent tributaries and then the lake itself, triggering rampant algae growth. While a degree of fertilizer-supplied nutrient runoff from farm fields is nearly unavoidable, there are fertilizer application and management practices that can be used to minimize excessive nutrient loss. In 2010 the EPA's Ohio Lake Erie Phosphorus Task Force released a report detailing a number of best management practices (BMPs, Table 4), which, if implemented by farmers, are expected to significantly reduce the amount of runoff into Lake Erie. Given the scale of their collective contribution to Lake Erie's algae problem, farmers' decisions about whether or not to

implement BMPs has major implications for the health of the lake. The goal of this research is to better understand farmers' decision-making in regards to BMP adoption in the Maumee River Basin. This will be accomplished by testing a theoretical model to predict farmer behavior, which may aid further research, policy, and communication aimed at reducing nutrient loss across the watershed.

Several studies have examined understand farmers' decision-making in regards to adopting best management practices on their farms. Gareth Edwards-Jones' survey of the existing research on farmer adoption of BMPs breaks the factors affecting farmer decision-making into five categories: farm type and size, the farmer's social influences, the characteristics of the farm's household, and the specifics of the practice under consideration (Edward-Jones, 2006). Another survey of the literature on farmer adoption of precision agricultural technologies (PATs) found an even larger list of influential factors, consisting of seven primary categories, such as socio-economic factors, agro-ecological factors, and institutional factors, as well as 34 subcategories. These subcategories include, but are not limited to, years of farming experience and farm production value, both of which were found to correlate positively with the adoption of PATs, and debt-to-asset ratios, which correlated negatively with PAT adoption (Tey & Brindal, 2012). A third study by Prokopy et al (2008), a synthesis of fifty-five studies published since 1982, focuses specifically on adoption of BMPs in the United States. The study identifies dozens of subcategories (e.g., environmental awareness, willingness to take risks, availability of labor, etc.), and concludes that higher education levels, income, and access to information, among other factors, lead to increased adoption of BMPs on farms. While these surveys provide a sense of the more immediate causes of farmers' willingness, or lack thereof, to adopt BMPs, the absence of a larger theoretical framework to understand farmers' attitudes and behaviors limits the predictive power of these studies' conclusions.

Although many of the studies briefly reviewed above focus on socio-economic and institutional factors, some farmer-specific studies have examined the relationship between psychological variables such as values, attitudes, and beliefs, and their relative effect on farmer decision-making. Petzelka and Korsching (1996) used survey data to test the correlative strength between farmers' attitudes and behaviors regarding sustainable practices on their farm, with a survey population limited to farmers who were already members of a sustainable agriculture organization. They found that attitudes towards sustainable farming and community are positively associated with lower chemical use, though all the significant correlations were moderate (Petzelka and Korsching 1996). Wilcock et al (1999) drew from a more general population of farmers to determine if farmers' behaviors could be predicted by their attitudes towards innovative farming practices, the status associated with farming, and other variables. This study used attitudes to predict a composite of behaviors (e.g., information gathering and off-farm employment), as attitudes are often more predictive of suites of behaviors than individual behaviors. They found moderate positive relationships between environmental attitudes and behaviors. Artikov et al (2006) take a slightly different approach, providing weather and climate information to farmers to test how attitudes, social norms, and behavior are related. They found that attitudes and social norms both have a significant positive influence on the use of weather information and forecasts in farmers' decision behavior. These studies build on a robust body of behavioral research suggesting that behaviors are influenced by a number of variables, including values, attitudes, and beliefs. Below I briefly describe some of the more influential behavioral literature on these topics most of which has been completed outside the context of farmer decisions, to provide a more robust understanding of the factors that influence decision-making generally as a way to improve our understanding of farmer behavior in the context of nutrient loss on Lake Erie.

A Brief History Of Behavioral Research

Social psychology and the study of attitudes have always gone hand in hand. In fact, the field of social psychology was originally defined as the scientific study of attitudes (Thomas & Znaniecki, 1918; Watson, 1925; Ajzen & Fishbein, 2005). Today, we understand an attitude to be a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor (Eagly & Chaiken, 1993). There was a general assumption by early social psychologists, bolstered by empirical evidence from numerous studies, that attitudes were the key to understanding human behavior (Ajzen & Fishbein, 2005). Attitudes and behaviors were viewed and treated as though one necessarily followed the other; one's attitude was assumed to be a strong predictor of one's behavior (e.g., If I think that recycling is good, I will be likely to recycle).

The veracity of this relationship was challenged by a landmark study done by Richard LaPiere (1934), in which he concluded that social attitudes are “seldom more than a verbal response to a symbolic situation”. In this study, LaPiere followed a Chinese couple as they traveled around the country, and recorded whether they received service at hotels and restaurants along the way. Afterwards, he mailed a letter to the establishments the couple had visited asking if, in general, they would accommodate members of the Chinese race, and, while the couple had only been refused service once, all but one of the establishments that responded to the letter said they would not serve a Chinese man (LaPiere, 1934; Heberlein, 2012; Ajzen & Fishbein, 2005). LaPiere's study illustrated that people do not always act in accordance with their attitudes and that behavior is often in direct contradiction to stated attitudes (LaPiere, 1934; Heberlein, 2012; Ajzen & Fishbein, 2005). Stephen Corey, who tried to use college students' attitudes towards cheating to predict cheating behavior in the classroom, followed LaPiere's work in 1937. His results corroborated LaPiere's – attitudes had very little predictive power for behavior (Corey, 1937; Ajzen & Fishbein, 2005). Though these studies sat idle for over 30 years,

social psychologists such as Irwin Deutscher and Allan Wicker rediscovered this modest body of work in the mid- to late-1960s and published papers of their own, building on LaPiere and Corey's findings (Deutscher, 1966; Wicker, 1969; Ajzen, 1991). The result was the birth of a new field of scholarship that revolved around reconciling this divide between attitudes and behavior (Heberlein, 2012), and by the late 1960s there were over 45 separate studies on the nature of this relationship (Ajzen & Fishbein, 2005). The current understanding of the attitude-behavior relationship shows a positive correlation under certain conditions. Given that behavior is specific and that multiple attitudes often influence a particular behavior, attitudes can have little to do with specific behaviors (Heberlein, 2012 pg. 5-6). For example, attempting to predict recycling behavior by asking the attitudinal question "do you care about the environment?", will not be very effective, as the question is much broader than the behavior of interest. (Heberlein, 2012 pg. 5-6). It is clear that understanding specific environmental behaviors requires more than simply understanding one's general attitude toward the environment. Rather, measuring attitudes at the same level of specificity as behaviors (e.g., measuring attitudes toward recycling to predict recycling behavior), and measuring behaviors across time (e.g., using attitudes towards recycling to predict recycling behavior over the course of a year, rather than on a particular day) yield a much stronger relationship between the two, and make attitudes much stronger predictors of behavior (Heberlein, 2012).

In the 1970s, as societal awareness and legislation around environmental issues grew, the study of environmental attitudes and behaviors fell under the purview of social psychology (Schultz, 2001). Initially, environmental behavior was studied as a single class of behavior (Stern, 2000), not distinguishing, for example, between the motivational differences for a willingness to pay higher taxes to support an environmental initiative and marching in the street to protest the construction of an environmentally destructive hydroelectric dam. However, the study of environmental attitudes and

behavior was taking place concurrently with other major developments in the larger field of social psychology that complicated this uniform approach. Specifically, behavior was increasingly understood to be the result of a number of influences and constraints, including social norms and values. These additional influences provide new insight into why attitudes may not always perfectly predict behavior, even why attitudes may not always align with behavior at all, and how more comprehensive models aimed at predicting behavior are needed to fully understand why individuals act in certain ways.

Social norms are the expectations a group has for its members regarding acceptable and appropriate attitudes and behaviors (Gerrig and Zimbardo, 2002). Psychologists such as Solomon Asch, Stanley Milgram, and Muzafer Sherif concluded that social norms have a convergent effect on behavior, meaning that while peoples' values, attitudes, and beliefs may differ, social norms can result in their displaying the same behavior in order to conform to what is perceived as the socially correct or acceptable behavior (Asch, 1951; Milgram, 1963; Sherif, 1935). Norm-activation theory, first articulated by Shalom Schwartz in 1973, was a distillation of earlier studies on social norms, suggesting that norms have a causal effect on behavior through the mechanism of anticipated sanctions when they are circumstantially applicable, or activated (Schwartz, 1973). To explain this by way of example: when standing next to a recycling bin there is a perceived increase in social pressure to toss your empty bottle into the bin instead of on the ground. In this case the sight of the recycling bin has activated the social norm of "not littering," with the "anticipated sanctions" being possibly nasty stares or comments from passersby, or a loss of respect of members in the community.

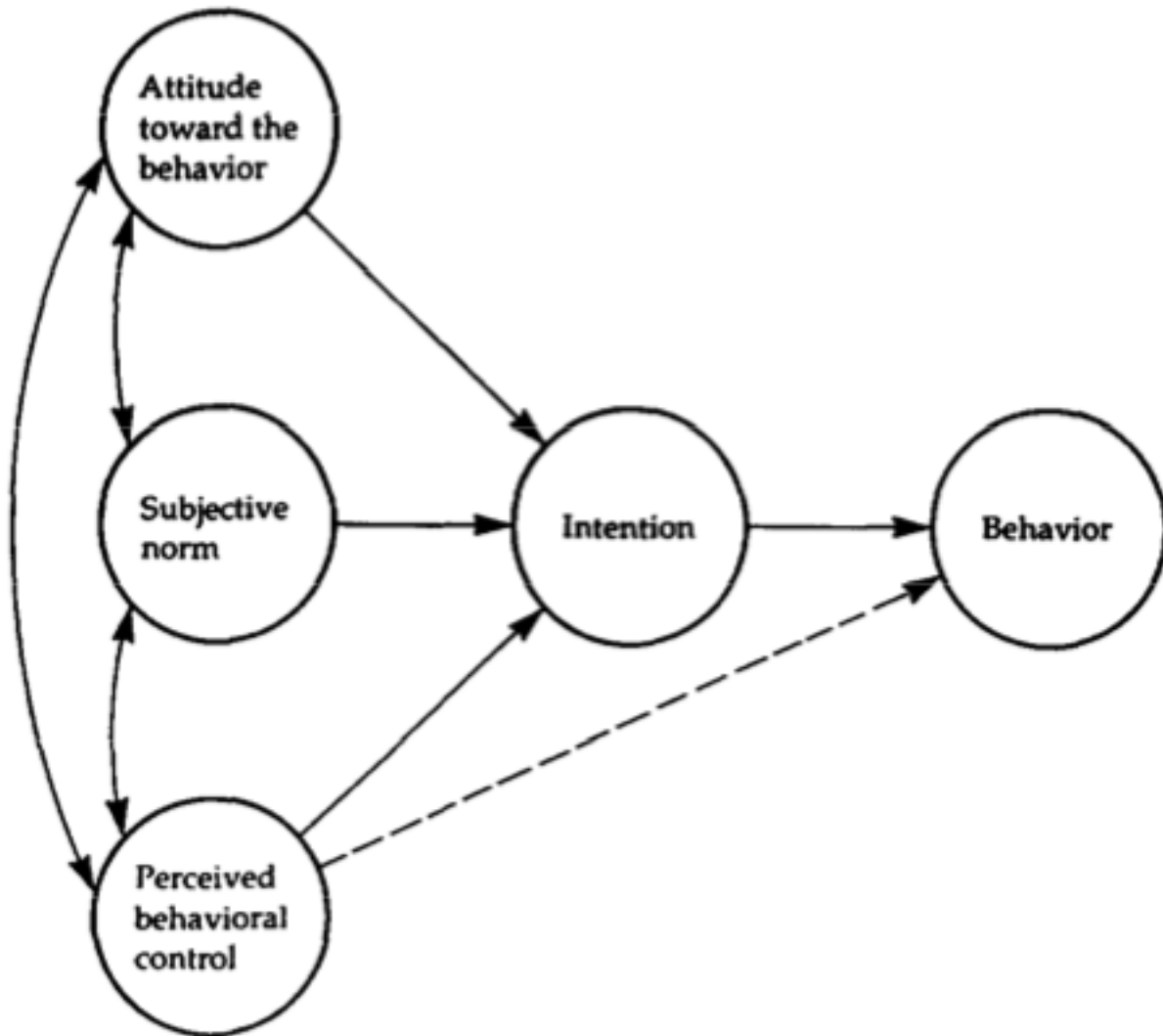
Values were also identified as playing a crucial role in the development of attitudes and behaviors (Rokeach, 1968, 1971; Schwartz, 1973, 1977). Milton Rokeach defined values as "standard[s] or yard-stick[s] to guide actions, attitudes, comparisons, evaluations and justifications of self and others" (Rokeach, 1971, 1968). An early advocate for the role of values in behavior, Rokeach

asserted that while attitudes and values are both important predictors of behavior, values predicted both attitudes and behaviors, and thus deserved to be at the center of attention in social psychology (Rokeach, 1968). Building on Rokeach's conclusions, Schwartz organized values into ten domains, which he clustered into two paired categories: self-enhancement vs. self-transcendence (i.e., a focus on improving one's self, or on improving the world and people around one's self), and openness to change vs. traditionalism (i.e., willingness to accept and adopt new technologies and ideas, or believing in the precedent of established institutions) (Schwartz, 1994). Schwartz concluded that with his ten value domains he had shown how universal and basic values were to the human condition, claiming they transcended nationality and could thus be studied across societies (Schwartz, 1994).

These preliminary studies on behavioral influences and constraints led to the creation of many methods and models for predicting behavior, two of which stand out as prominent frameworks for the contemporary study of environmental attitudes and behavior: the theory of planned behavior and the value-belief-norm theory. Icek Ajzen published the theory of planned behavior (TPB) in 1991, as a modification of his earlier theory of reasoned action (TRA) (modified by including perceived behavioral control defined as people's perception of their ability to perform the behavior of interest) (Figure 1).

Figure 1: Ajzen's Theory of Planned Behavior (1991)

The theory proposes that the major predictors of behavioral intention are attitudes, norms, and perceived control, and that intentions serve as a proximate predictor of behavior.

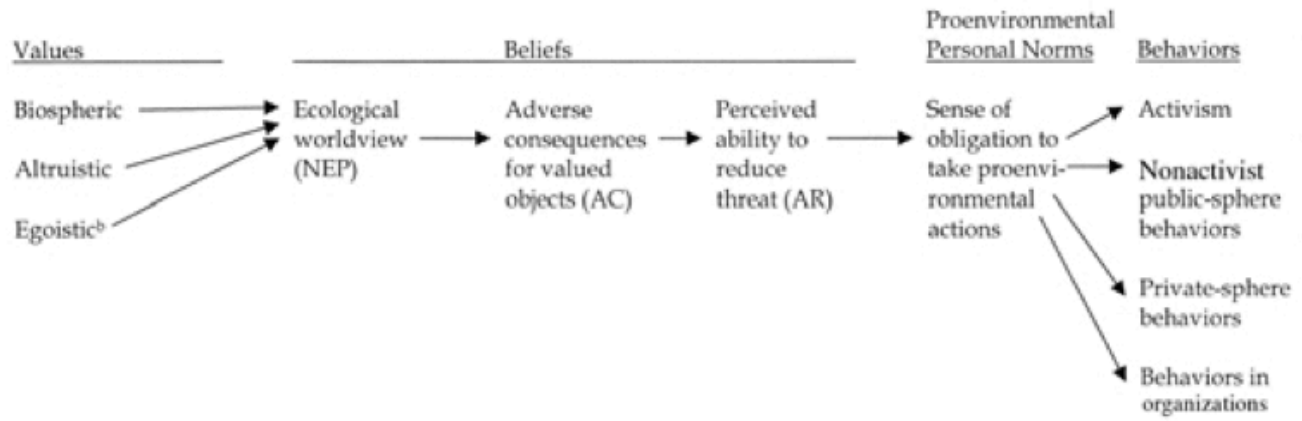


The TPB accounts for situational influences on behavior, as well as the gap between behavioral intention and actual behavior (Kaiser, Bogner, & Hübner, 2005). Ajzen's model has proven to be quite effective at

explaining intentions and behaviors using its three component parts (i.e., attitudes, norms, and perceived control) (Connor & Armitage, 1998), and has been applied to a wide range of behaviors, including environmental behaviors such as predicting adoption of green energy and increased bus use, intentions to recycle, and buying organic foods (Hinds & Sparks, 2007). However, the model has its limitations, and has been subjected to no small degree of criticism and modification. One major criticism is that the TPB describes only the proximate causes of behavior, and ignores the various distal factors that affect attitudes, norms, and perceived control. Another criticism is that the TPB suggests a causal relationship between its predictors, intention, and behavior, but in application most experiments that employ the model are not organized to test for causal relationships (Conner & Armitage, 1998). A third criticism is that the theory is incompletely identified, meaning that it does not specify a direction, or order of influence, for the relationship between its component parts (does attitude influence perceived control, or the other way around?) (Kaiser, Bogner, & Hübner, 2005).

An alternative theory that attempts to address these issues is the value-belief-norm theory (VBN), developed by Paul Stern and colleagues and considered “the best explanatory account to date of a variety of behavioral indicators of non-activist environmentalism” (Stern, 2000). The theory attempts to understand the factors that influence environmentally significant behavior, which Stern defines as behavior that is implemented to change – normally to benefit – the environment (Stern, 2000). The theory uses previous research on values, attitudes, beliefs and norms to create a causal chain of five variables leading to behavior that moves from relatively stable, central elements of personality and belief structure to more focused beliefs about human-environment relations, their consequences, and the individual’s responsibility for taking corrective action (Stern, 2000)

Figure 2: Stern's Value Belief Norm Theory (2000)



The VBN theory addresses some of the criticisms directed at the TPB. The relationship between each of the five component parts – namely values, ecological worldview, adverse consequences, perceived ability to reduce threat, and personal norms – to their antecedent is predictive, with each variable having an effect on those that follow it (Stern, 2000) and thus the model is fully identified (Kaiser, Bogner, & Hübner, 2005). Also, the VBN theory incorporates Schwartz's values-first sensibility into its model. Stern uses a modified version of Schwartz's ten value domains, lumping them into three larger categories, which he includes as the first step in his chain of behavioral causality: biospheric values (concern for the planet), altruistic values (concern for other people), and egoistic values (concern for one's self). Yet Stern's model is not free from criticism either. Several researchers have pointed to the tripartite breakdown of values that Stern employs, charging that there is a lack of evidence to suggest three distinct value structures (Schultz, 2001; Stern et al, 1995; Eagly & Chaiken, 1993). Others have called attention to the New Environmental Paradigm (NEP) belief index of the VBN model, saying, "its influence on self-ascribed responsibility, personal norms, and conservation behavior is insufficiently covered" (Kaiser, Bogner, & Hübner, 2005). My objective in this thesis is to test a

modified version of the VBN model, both to assess its applicability to nutrient loss management behaviors in the Maumee watershed, and to determine whether Stern's model might have applicability in the realm of stewardship behaviors and in the broader field of conservation. Previous studies of Value Belief Norm theory have found the theory to be a strong predictor of pro-environmental behavior. Kaiser et al used VBN theory to predict conservation behaviors in undergraduate students at a German university, such as recycling behavior, home heating reduction in the wintertime, and purchase of products in refillable packaging (Kaiser, Bogner, & Hübner, 2005). They found that VBN theory predicted 64 percent of behavioral variance in their population. Riper and Kyle tested VBN theory on conservation behaviors by park visitors in Channel Island National Park in California, with behaviors including volunteering in the park to remove non-native species, encouraging other visitors not to disturb archeological artifacts in the park, and properly disposing of waste (such as apple cores) that could trigger the spread of non-native plant life. In their study they found that the theory accounted for 22 percent of behavioral variance (Riper and Kyle, 2014). A third study, by Steg et al, tested the VBN theory's applicability to predicting the acceptability of energy policies in a random sample in the city of Groningen in the Netherlands and found that, in accordance with VBN theory, the model explained 32 percent of the total variance in participant responses. These studies suggest that VBN theory has applicability to predicting conservation behavior, but reveal a largely unexplored area of study in the literature; the application of VBN theory to land stewardship behaviors. Given the strength of the model in predicting pro-environmental, non-consumer behavior, its use in a study predicting nutrient management behaviors on Lake Erie may suggest a new line of scholarship (Steg et al, 2005).

CHAPTER 2: A modification of Value-Belief-Norm Theory applied to farmer behavior in the Maumee Watershed

Introduction

Recent harmful algal blooms on Lake Erie have resulted in negative environmental and social impacts, and are attributed to the misuse of fertilizer in agricultural landscapes in combination with increasing spring storm events in the region. The result has been an increasing loss of nutrients from farms to the lake since the mid-1990s, leading to increased oxygen depletion rates, hypoxia extent, and algal biomass (Michalak et al., 2013). Given the scale of their collective contribution to Lake Erie's algae problem, farmers' decisions about whether or not to implement nutrient loss reduction practices have major implications for the health of the lake. Past research identifies a range of factors that may explain why certain farmers adopt recommended BMPs. These studies examine the proximate causes of farmers' willingness, or lack thereof, to adopt BMPs (Edward-Jones, 2006; Tey & Brindal, 2012; Prokopy et al, 2008); however the specificity of the results and their heavy dependence on socioeconomic factors limit their applicability to a more general understanding of the forces explaining the adoption of BMPs. In contrast, other studies of environmental behavior attempt to link behaviors to a source of ultimate causation, namely attitudes and values (Petrzelka and Korsching 1996; Wilcock et al, 1999; Artikov et al, 2006).

The goal of this research is to better understand farmers' decision-making in regards to specific nutrient loss reduction practices in the Maumee River Basin using Paul Stern's Value-Belief-Norm model (VBN) as a framework for understanding farmer nutrient management behavior. VBN theory was developed to analyze and interpret the adoption of pro-environmental behavior, and will allow me to test the relationships between specific nutrient management behaviors and farmers' values. In order to

address the lack of specificity exhibited in many behavior studies, this study focuses on management practices similar to the 4Rs of Nutrient Stewardship (i.e., right fertilizer source, at the right rate, right time, and right place) (The Fertilizer Institute, 2014) that are widely promoted throughout the Great Lakes farming region (Burnett, 2014).

The objectives of this research are twofold. The first objective is to measure five psychological variables in a population of farmers in the Maumee River Basin and evaluate how these variables affect farmers' willingness to implement nutrient loss reduction practices. The variables this project will consider are the following:

1. Farmer identity, divided generally into an identity based on Conservationist ideals and an identity based on Productionist ideals
2. Awareness of the 4Rs of Nutrient Stewardship
3. Perception of the degree of risk of nutrient loss
4. Individual sense of responsibility of the need to take action to reduce nutrient loss
5. Efficacy, or the ability to mitigate nutrient loss through individual actions

The second objective is to propose a model for farmer decision-making using these five variables that will improve upon previous models and demonstrate stronger predictive power for farmer behavior than existing behavioral models. This model will address a crucial gap in the existing knowledge on environmental decision-making by focusing on land stewardship behaviors, specifically behaviors related to runoff prevention, rather than on the more commonly studied environmental behaviors of consumers (Stern, 2011). The model proposed in this project will hopefully help bridge this gap in our theoretical understanding of the resistance by some farmers to adopt more environmentally friendly management practices on their farms. This model may also inform efforts by researchers, policy makers,

and communicators to increase adoption of BMPs among farmers both in the Maumee River Basin and in the broader Midwest farming community.

Methods

Population and Survey Administration

A mail-back survey was developed and administered to corn and soybean farmers living in the Maumee watershed. Due to concerns about response rate and survey fatigue among this highly studied population, a virtual census was taken of the target population. Of an estimated 11,500 farmers in the watershed, surveys were mailed to 10,000 farmers pulled from a list purchased from Farm Market ID. A randomly selected group of 1500 farmers with less than 50 acres were excluded from the purchased list. There were four versions of the survey sent out, three of which contained the variables used in this study, for a total initial sample of 8,270 farmers. Survey administration followed Dillman's Tailored Design method, with 5 mailings including an initial announcement letter, a packet with cover letter and the survey instrument, a follow-up reminder postcard, a replacement packet for non-responders, and a final reminder letter (Dillman, 2000). To increase the response rate of the study, a \$1 incentive was included with the first survey mailing.

Theoretical Model and Hypotheses

The objective of this study was to assess a modified version of Stern's VBN model (Stern, 2000), in the context of farmer nutrient management decisions (figure 3). First, rather than using Stern's value component, my model uses social identity as a substitute by assessing the values that respondents associate with being a good farmer (Burton, 2004; McGuire et al., 2013). Many researchers have found that identity is an important predictor of behavior (Whitmarsh & O'Neill, 2010; Turner, 2010; Hinds & Sparks, 2007; Conner & Armitage, 1998; Petrzela & Korsching 1996), as it captures the influence of

the social context on individuals and can thus serve as a proximate measure of one's politics, ideology, and values, thereby indirectly influencing behavior (Charng et al., 1988). This element of my model will be specifically based on the Good Farmer Identity Theory, which suggests that farmers' sense of identity plays a crucial role in determining their willingness to adopt conservation practices (Burton, 2004; McGuire et al., 2013). For the beliefs component of the model, I measured risk perception and efficacy, corresponding with Stern's measures of awareness of consequences (AC) and ascription of responsibility to self (AR). Based on ongoing debate about its effectiveness, I replaced the problematic NEP index with awareness of 4R Nutrient Stewardship practices. Stern's measure of social norms is defined as a "sense of obligation to take pro-environmental actions" (2000), which I replaced with a measure of responsibility. The relationship between this suite of variables and behavior will be tested. The specific correlational relationships being hypothesized are listed below (table 1). Overall, I hypothesize that a Conservationist identity (a block 1 variable) will have a positive predictive influence on block two variables (i.e., awareness, perceived risk, responsibility, and efficacy), while a Productionist identity will have a negative predictive influence on block two variables. The block two variables will in turn have a positive predictive influence on the main dependent variable of interest, behaviors related to the 4R's of nutrient management.

Figure 3: Proposed Model

The model suggests correlational relationships between each of the connected variables, and a left-to-right predictive relationship between the blocks.

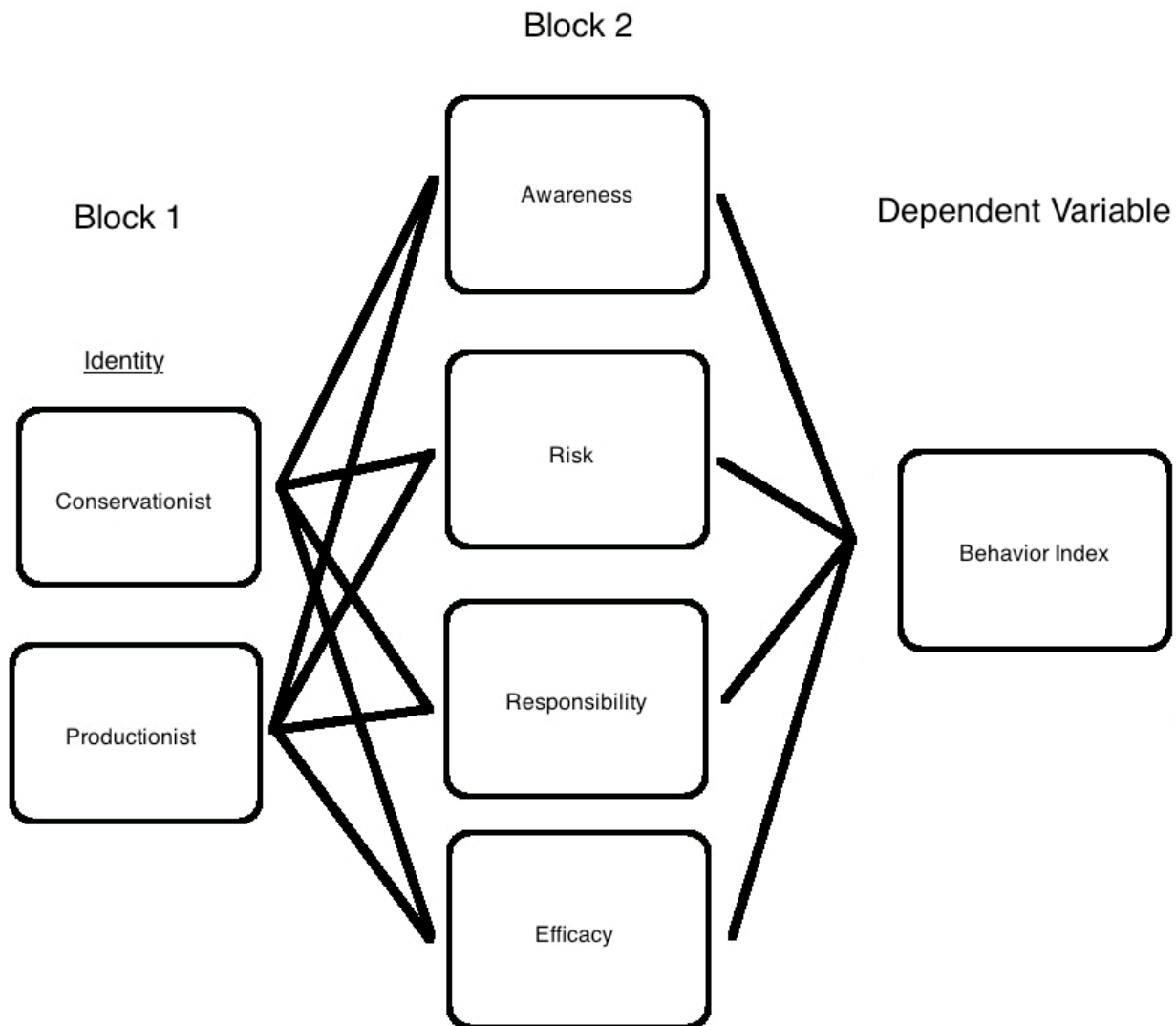


Table 1: Hypotheses

Hypothesized relationships between independent variables

<p>Hypothesis 1: Conservationist identity will be positively correlated with block two variables</p>	<p>H1a: Conservationist identity will be positively correlated with awareness of 4R Nutrient Stewardship practices</p> <p>H1b: Conservationist identity will be positively correlated with perception of risk associated with nutrient loss</p> <p>H1c: Conservationist identity will be positively correlated with a sense of responsibility to do something about nutrient loss</p> <p>H1d: Conservationist identity will be positively correlated with a sense of efficacy relating to mitigating nutrient loss</p>
<p>Hypothesis 2: Productionist identity will be negatively correlated with block two variables</p>	<p>H2a: Productionist identity will be negatively correlated with awareness of 4R Nutrient Stewardship practices</p> <p>H2b: Productionist identity will be negatively correlated with perception of risk associated with nutrient loss</p> <p>H2c: Productionist identity will be negatively correlated with a sense of responsibility to do something about nutrient loss</p> <p>H2d: Productionist identity will be negatively correlated with a sense of efficacy relating to mitigating nutrient loss</p>
<p>Hypothesis 3: Block two variables will be positively correlated with the behavioral index</p>	<p>H3a: Awareness of 4R Nutrient Stewardship practices will be positively correlated with a behavioral index</p> <p>H3b: Perception of risk associated with nutrient loss will be positively correlated with a behavioral index</p> <p>H3c: Sense of responsibility to take mitigating action against nutrient loss will be positively correlated with a behavioral index</p> <p>H3d: Sense of efficacy relating to mitigating nutrient loss will be positively correlated with a behavioral index</p>

Measurement of the Latent Constructs

Two dependent variables were measured: farmer intention to adopt BMPs on their farm, and current farmer adoption of BMPs (Table 4). To control for circumstantial variability among different farms and farmers, ten management practices were chosen from the larger list recommended in a report by the Phosphorous Task Force of Ohio, shown in the table below (Ohio EPA, 2010). Respondents were asked how willing they would be to adopt each practice, with responses including 0 (will never adopt), 1 (unlikely to adopt), 2 (likely to adopt), and 3 (will definitely adopt). If they have already adopted these practices, they were asked to check “already doing it” and also indicate on what percent of their total planted acreage this practice was implemented during the past year. Based on their responses participants were given a score representing the strength of their intentions, with the actual adoption of the behavior being the highest score on the scale.

The independent variables of interest in this study (i.e., identity, awareness, risk perception, responsibility, and efficacy) were assessed using multiple items as well, in order to increase the reliability of the intended measure. Farmer identity (Table 2) was measured using twelve items. The items ask participants to assess the characteristics of a “good farmer” as a way to approximate their identity, based on the Good Farmer Identity Theory (Burton, 2004; McGuire et al., 2013). In measuring for identity, there were five questions assessing a Productionist identity (e.g., is a good farmer one who uses the latest seed and chemical technology?), and seven questions assessing a Conservationist identity (e.g., is a good farmer one who minimizes nutrient runoff into waterways?). Participants circled the number they believed best represented how important each of the aspects in the table were to being a good farmer, with responses including 0 (not important at all), 1 (slightly important), 2 (somewhat important), 3 (important), and 4 (very important). Following the framework of Good Farmer Identity Theory, based on their responses participants were given a score representing the strength of their

Productionist and Conservationist identity. The responses from the questions measuring Conservationist identity were averaged, and the same was done for the Productionist identity measures to create two final combined identity measures.

Awareness of 4R Nutrient Stewardship practices was measured using two questions (Table 3). The first question asked how familiar farmers were with 4R Nutrient Stewardship, with possible responses being 0 (not at all), 1 (slightly), 2 (moderately), 3 (very), and 4 (extremely). The second question asked how often farmers had received information or participated in programming about 4R Nutrient Stewardship, with possible responses being 0 (never), 1 (rarely), 2 (sometimes), 3 (often), and 4 (frequently). To gauge awareness of nutrient stewardship practices, responses to the two items were averaged together to form one score per respondent on a scale of 0 to 4.

Risk perception was measured using two questions to assess risk likelihood (e.g., how likely or unlikely is it that nutrient loss on your farm will result in decreased crop yield?) and risk seriousness (e.g., how serious do you feel the negative consequences of nutrient loss in western Lake Erie are to you and your family?) regarding nutrient loss and its potential consequences (Table 3). This resulted in measures of perception of risk likelihood and risk severity, respectively. Risk likelihood was measured with possible responses 0 (not at all likely), 1 (somewhat likely), 2 (very likely), and 3 (extremely likely), and risk seriousness was measured with possible responses 0 (not at all serious), 1 (slightly serious), 2 (serious), 3 (moderately serious), and 4 (extremely serious). Responses for risk likelihood were averaged, as were responses for risk severity, and these final scores were multiplied to create an overall measure of risk perception on a scale from 0 to 12.

Perceived responsibility to do something about nutrient loss on their farms and local water quality were measured by three items (e.g., it is my responsibility to adopt best management practices that limit nutrient loss) (Table 4). Respondents were asked to indicate their level of agreement with these

three questions, with possible responses being 0, (strongly disagree), 1 (disagree), 2 (neither agree nor disagree), 3 (agree), and 4 (strongly agree). The responses to all three questions were averaged to produce an overall responsibility score ranging from 0 to 4.

Lastly, farmers' sense of efficacy related to nutrient management behaviors was measured with three items as well (e.g., taking additional steps to reduce nutrient loss on my farm would be easy) (Table 4). These responses were measured on the same scale as the responsibility questions, with possible responses being 0 (strongly disagree), 1 (disagree), 2 (neither agree nor disagree), 3 (agree), and 4 (strongly agree). Again, the responses to all three questions were averaged to produce an overall responsibility score ranging from 0 to 4.

Analysis

All analyses were conducted using the Statistical Package for the Social Sciences (SPSS), a statistical software program. Descriptive statistics were obtained through frequency analyses, which quantified responses. Frequency analysis was also used to analyze a behavioral index (table 4). Reliability analyses were run on each of the dependent and independent variable scales, providing a Cronbach's alpha value to measure the reliability of the scales used in the study (Table 2). Bivariate analyses were used to establish correlational strength between variables (i.e., identity, awareness, risk perception, responsibility, efficacy, and behaviors). Finally, hierarchical regression analysis was run to assess the predictive quality of the order of variables in the proposed model.

Results

Descriptive Statistics

The survey respondents were overwhelmingly male (97.8%). The mean age was 59 years, with a range of 17 to 96 years. More than half the farmers had high school degrees (50.6%), while only about 2% had no diploma, 18.8% had some college, 10.9% had an associate's degree, 12.3% had a bachelor's degree, and 5.4% had a graduate or professional degree. The distribution of farm income was fairly even across the board, with 16.6% making \$50,000 or less; 20.4% between \$50,000 and \$99,000; 27.9% between \$100,000 and \$249,000; 16% between \$250,000 and \$499,999; and 19.1% making over \$500,000. The survey population had been farming for an average of 38 years. The average acreage of corn grown on each respondent's farm was 209 acres, with a range of 0 to 7,010 and a median of 100, while the average acreage of soybeans grown was 236, with a range of 0 to 5,000 and a median of 120.

To assess its representativeness, data from this sample were compared with data from the 2012 agricultural census (United States Department of Agriculture, 2012). According to the census, 28% of farm operators in Ohio were female, while our sample contained 2% female farmers. This indicates that female farmers were underrepresented in our survey. Average annual gross income in Ohio's farming population was \$34,700, while the average annual gross income of our survey was between \$100,000 and \$250,000. This indicates that larger farms may have been overrepresented in our survey. The differences in our survey and the 2012 census may be due to surveying of exclusively corn and soybean farmers, whose farming operations tend to be larger and more lucrative than smaller specialty operations. Furthermore, the census included only farmers in Ohio, while the survey sample included farmers throughout the Maumee watershed (including parts of Indiana and Michigan).

Reliability Analyses

The variables I used in my analysis were Conservationist identity, Productionist identity, awareness of 4R Nutrient Stewardship practices, risk perception (likelihood of nutrient loss), risk perception (seriousness of nutrient loss), responsibility to take action regarding nutrient loss, sense of efficacy related to personal actions to reduce nutrient loss, and a behavioral index (Tables 4 and 5). The scales intended to represent each construct were assessed for reliability using Cronbach's alpha, and a scale with an alpha of .70 or greater was accepted as reliable enough to be included in further analyses (Field, 2009). For Conservationist identity (Table 2, $\alpha = .907$), the mean score was 2.99 on a scale of 0 to 4, while the mean score for Productionist identity (Table 2, $\alpha = .779$) was 1.73 on a scale of 0 to 4. These results indicate that farmers in our sample held fairly strong Conservationist identities relative to Productionist identities, which were moderate. Awareness of 4R Nutrient Stewardship was measured on a four-point scale as well (Table 2, $\alpha = .890$), with a mean response of 1.28 on a scale from 0 to 4. This indicates that farmer awareness of BMPs was low to moderate. Risk perception was subdivided into two smaller variables, risk likelihood and risk seriousness, with mean response values of 1.50 and 2.02, respectively on a scale of 0 to 3 for risk likelihood and 0 to 4 for risk seriousness (Table 2, $\alpha = .894$ and $.915$, respectively). These responses suggest farmers' sense of risk related to nutrient loss was roughly indifferent. These variables were then combined to create a final risk perception variable ($\alpha = .890$). The mean score of this final risk perception variable was 3.31, on a scale of 0 to 12. Responsibility had a mean response of .953 on a scale from -2 to 2 (table 2, α of $.823$). This is the alpha value for responsibility after one item was removed, asking for respondents to agree or disagree with the sentence, "farmers in northwest Ohio should be doing more to reduce nutrient runoff into waterways." With this question included in the measure, the alpha value was $.670$ (Table 3), below Fields' threshold

of acceptability (Fields, 2009). Lastly, efficacy (table 2, α of .587) had a mean response of .496 on a scale from -2 to 2. While this alpha value is below the minimum threshold of acceptability according to Fields (2009), it was used in my analysis anyway, with its relative weakness as a measure taken into consideration in the final analysis of my results. These numbers revealed that farmers' sense of responsibility to do something about nutrient loss on their farms and sense of efficacy related to personal behaviors were both moderately high. The responses for awareness, risk perception, responsibility, and efficacy were all positively skewed, indicating that overall farmers scored low on all of these scales.

The behavioral index was created by combining the behavioral intention scale with the actual behavior variable for each behavior and then averaging them. While behavioral intentions and behaviors were originally going to be analyzed separately, in order to simplify the analysis the two were combined to give a single measure of behavior. Four behaviors were used in the behavioral index (Table 5, α = .821): delaying broadcasting when the forecast predicts a 50 percent or more chance of at least one inch of total rainfall in the next 12 hours, avoiding winter or frozen ground surface application of phosphorus, avoiding fall application of phosphorus, and placement of fertilizer at least two to three inches below the soil surface (Table 4). These behaviors are most closely related to nutrient loss prevention and the 4R management practices (The Fertilizer Institute, 2014), and therefore more closely measure the same type of conservation behavior (Burnett, 2014). A fairly similar response pattern emerged across the behavioral index (Table 4), with adoption rates ranging from 31 to 45 percent.

Table 2 Reliability Analysis of Identity Items

Latent Variable Item	Reliability Analysis	
	Cronbach's Alpha	Alpha if deleted
Productionist Identity¹	0.779	
<i>A good farmer is one who...</i>		
has the highest yields per acre		0.722
gets their crops planted first		0.739
has the highest profit per acre		0.749
has the most up-to-date equipment		0.724
uses the latest seed and chemical technology		0.759
Conservationist Identity¹	0.907	
<i>A good farmer is one who...</i>		
considers the health of waterways that run through or along their land to be their responsibility		0.896
minimizes soil erosion		0.893
minimizes nutrient runoff into waterways		0.889
thinks beyond their own farm to the social and ecological health of their watershed		0.89
maintains or increases soil organic matter		0.896
manages for both profitability and minimization of environmental impact		0.892
puts long-term conservation of farm resources before short-term profits		0.898

¹ Identity variables measured on a scale between 0 and 4 (0: not important at all, 1: slightly important, 2: somewhat important, 3: important, 4: very important)

Table 3: Reliability Analysis of Block Two Variables

Latent Variable	Item	Reliability Analysis	
		Cronbach's Alpha	Alpha if deleted
Awareness ²		0.89	
	Please circle the number that best represents how familiar you are with 4R Nutrient Stewardship		
	Please circle the number that best represents how often you have directly received information or directly participated in programming about 4R Nutrient Stewardship		
Risk Perception (likelihood) ³		0.894	
	<i>Please circle the number that indicates how likely or unlikely it is that nutrient loss on your farm will result in...</i>		
	decreased crop yield		0.857
	decreased water quality		0.878
	decreased soil health		0.842
	decreased production costs		0.874
Risk Perception (seriousness) ⁴		0.915	
	<i>Please circle the number that indicates how serious you feel the negative consequences of nutrient loss in western Lake Erie are to...</i>		
	you and your family		0.897
	your local community		0.895
	communities on and around Lake Erie		0.899
	plants and animals in local streams		0.893
	plants and animals in Lake Erie		0.897
Responsibility ⁵		0.670	
	Farmers in northwest Ohio should be doing more to reduce nutrient runoff into waterways		0.823
	It is my responsibility to adopt best management practices that limit nutrient loss		0.453
	it is my responsibility to help protect local water quality		0.458
Efficacy ⁵		0.587	
	Taking additional steps to reduce nutrient loss on my farm would be easy		0.504
	I can engage in practices that limit nutrient loss on my farm		0.539
	I have the ability to change my practices to further limit nutrient loss on my farm		0.396

² For the first question measuring awareness, the scale was between 0 and 4 (0: not at all, 1: slightly, 2: moderately, 3: very, 4: extremely); for the second question, the scale was between 0 and 4 (0: never, 1: rarely, 2: sometimes, 3: often, 4: frequently)

³ Risk perception (likelihood) was measured on a scale from 0 to 3 (0: not at all likely, 1: somewhat likely, 2: very likely, 3: extremely likely)

⁴ Risk perception (seriousness) was measured on a scale from 0 to 4 (0: not at all serious, 1: somewhat serious, 2: serious, 3: moderately serious, 4: extremely serious)

⁵ Responsibility and efficacy were measured on a 4 point scale (0: strongly disagree, 1: disagree, 2: neither agree nor disagree, 3: agree, 4: strongly agree)

Table 4: The Frequency of response for each option on the behavior scale included in the survey

	Will never adopt	Unlikely to adopt	Likely to adopt	Will definitely adopt	Have already adopted
Nutrient Management Practices	Valid Percentages				
Delaying broadcasting when the forecast predicts a 50% or more chance of at least 1 inch of total rainfall in the next 12 hours	13.6	11.0	32.1	11.7	31.6
Avoiding winter or frozen ground surface application of phosphorus	14.6	6.0	17.3	16.5	45.5
Avoiding fall application of phosphorus	16.8	22.9	22.7	10.8	26.7
Placement of fertilizer at least 2-3 inches below the soil surface	15.2	17.7	26.6	9.1	31.4

Table 5: Reliability analysis for the four behaviors intended for the behavioral index

Behavior	Reliability Analysis	
	Cronbach's Alpha	Alpha if deleted
<i>Behavioral Index</i>	0.821	
Delaying broadcasting		0.774
Avoiding winter application		0.725
Avoiding fall application		0.791
Placing fertilizer underground		0.804

Hypotheses

Bivariate correlations

As a preliminary assessment of the predictive strength of the proposed path model, correlation analyses were performed (Table 4). Pearson's r values from 0 to $\pm.30$ were considered weak, values from $\pm.30$ to $.49$ were considered moderate, and values from $\pm.50$ to 1 were considered strong (Cohen, 1988). The first set of hypotheses (Table 1, 1a – 2d) relate to the relationship between farmer identity and the other independent variables of interest. Overall, these hypotheses were supported by correlation analyses. Specifically, Conservationist identity positively correlated with awareness of 4R Nutrient Stewardship behaviors ($r = .167, p = .0005$), perception of risk associated with nutrient loss ($r = .407, p = .0005$), a sense of responsibility to take action to mitigate nutrient loss ($r = .450, p = .0005$), and a sense of personal efficacy related to nutrient loss management behaviors ($r = .254, p = .0005$), (Table 1, 1a – 1d). Additionally I found support for my hypotheses regarding the Productionist identity. I hypothesized that farmers with a stronger Productionist identity would be less aware, perceive less risk and feel less responsibility (Table 1, 2a-2d), exhibiting a negative relationship with the independent variables measured, and when considered in my model Productionist identity related negatively to adoption of BMPs, with weak relationships with Block 2 variables awareness ($r = .074, p = .0005$), risk perception ($r = .152, p = .0005$), responsibility ($r = .090, p = .0005$), and efficacy ($r = .033, p = .0005$). The positive correlations between the Conservationist identity and the other constructs of interest were much stronger than between the Productionist identity and the same constructs, and warrant further discussion and study into the nature of the relationship between identity and the implementation of nutrient management behaviors.

For the third set of hypotheses (Table 1, 3a – 3d), we predicted that there would be a positive correlation between our independent variables of interest and adoption of conservation behaviors. The results supported these hypotheses, indicating that farmers with higher levels of awareness of 4R Nutrient Stewardship behaviors, higher perception of risk associated with nutrient loss, higher responsibility to take action to mitigate nutrient loss, and higher personal efficacy related to nutrient management behaviors were more likely to implement or consider implementing nutrient management practices on their farms. Though it was outside the scope of our hypotheses, bivariate correlation results also showed significant positive relationships between our independent variables within blocks, indicating that farmers with, for example, a degree of awareness of 4R Nutrient Stewardship behaviors were more likely to perceive nutrient runoff as risky, etc.

Table 6: Correlations between independent and dependent variables

Pearson's Correlation Coefficients	Conservationist Identity	Productionist Identity	Awareness	Risk Perception	Responsibility	Efficacy
Productionist Identity	0.255*	1*				
Awareness	0.167*	0.074*	1*			
Risk Perception	0.407*	0.152*	0.125*	1*		
Responsibility	0.450*	0.090*	0.161*	0.315*	1*	
Efficacy	0.281*	0.089*	0.141*	0.279*	0.324*	1*
Behavioral Index	0.254*	0.033*	0.175*	0.159*	0.161*	0.160*

* $p < .01$

Hierarchical Multiple Regression

Given that I found significant relationships between the variables in the proposed model, I carried out a hierarchical regression analysis to assess the predictive strength of sets, or blocks, of independent variables. The first block, which contained Conservationist and Productionist identities, explained 6.7% of the variance in nutrient management adoption behavior. Conservationist identity made the greatest overall contribution to my model ($B=.263$, $p=.0005$), as well as a greater contribution than Productionist identity, which, when considered in the regression model without the block 2 variables, was not statistically significant ($B=-.052$, $p=.078$). After adding the block two variables (i.e., awareness of 4R Nutrient Stewardship behaviors, perception of risk associated with nutrient loss, a sense of responsibility to take action to mitigate nutrient loss, and a sense of personal efficacy related to nutrient loss management behaviors), the total variance explained by the model was 9.3%. Of the six independent variables, Conservationist identity still made the largest contribution ($B=.198$, $p=.0005$), followed by awareness ($B=.126$, $p=.0005$), then efficacy ($B=.072$, $p=.0005$), risk perception ($B=.043$, $p=.035$), and Productionist identity ($B=-.041$, $p=.030$). Responsibility made the smallest contribution to my regression model, a contribution that was not significant ($B=.018$, $p=.402$).

Table 7: The hierarchical regression analysis results explaining adoption of a suite of 4R nutrient management behaviors

<u>Variable</u>	<u>Unstandardized B</u>	<u>SE</u>	<u>Standardized Beta</u>
Model 1	1.017*	0.105	—
Conservationist Identity	0.474*	0.035	0.263*
Productionist Identity	-0.052**	0.029	-0.034**
Model 2	1.049*	0.106	—
Conservationist Identity	0.356*	0.040	0.198*
Productionist Identity	-0.063 ⁺	0.029	-0.041 ⁺
Awareness	0.127*	0.019	0.126*
Risk Perception	0.020 ⁺	0.009	0.043 ⁺
Responsibility	0.036**	0.043	0.018**
Efficacy	0.143*	0.039	0.072*

* p = < .01

+ p = < .05

** p = > .05

Discussion, Conclusion, and Limitations

This project was conducted to examine the factors influencing farmer' decision-making regarding nutrient management in the Maumee watershed of Lake Erie. Following the theoretical framework of Paul Stern's Value Belief Norm model (Stern, 2000), which posits that values, beliefs, and norms play predictive roles in determining pro-environmental behaviors, the model proposed in this project hypothesized that farmers' sense of identity, their awareness of 4R Nutrient Stewardship behaviors, their sense of responsibility to take action regarding nutrient loss, and their sense of efficacy related to personal stewardship choices worked together in a predictive manner to influence farmers' stewardship behaviors. The application of Stern's VBN model to farmer stewardship behavior found theoretical justification in previous research on farmers' behaviors, which has shown that a wide variety of influences, including values, identity, beliefs, and attitudes play crucial predictive roles in farmer land management and stewardship behaviors (Petzelka and Korsching 1996; Wilcock et al, 1999; Artikov et al, 2006), as well as prior examinations revealing role predictive strength of VBN theory on conservation behaviors (Kaiser, Bogner, & Hübner, 2005; Riper and Kyle, 2014; Steg et al, 2005).

My research indicates that farmers who associate conservation practices with being a good farmer are significantly more likely to have an increased awareness of BMPs regarding nutrient management behaviors and heightened perception of risk of algal blooms on Lake Erie, feel a greater sense of responsibility to take personal action, and expect those actions to be more effective. This is consistent with Burton's Good Farmer Theory (Burton, 2004), which suggests that famers with a stronger sense of Productionist identity will place a greater emphasis on the productivity and appearance of their farm, while Conservationist farmers will prioritize pro-environment symbols of successful farming such as nutrient management and group and community collaboration (Burton, 2004; McGuire et al, 2013). Additionally, in accordance with the Burton (2004) and McGuire's (2013) findings, farmers

who associated higher levels of production with being a good farmer were less likely to have an increased awareness and perception of risk of algal blooms on Lake Erie, as well as a weaker sense of responsibility to and efficacy in taking personal action in implementing conservation behaviors on their farms; however the relationships between Productionist identity and Block 2 variables were less significant.

Overall, hierarchical regression analysis revealed that farmers who felt a stronger sense of efficacy regarding their personal choices and actions' benefits for water quality, in addition to those who had a high risk perception of nutrient loss, were also more likely to implement nutrient management behaviors. Farmers' sense of responsibility to take action regarding nutrient loss on their farms did not make a significant contribution to behavior implementation. Of the block 2 independent variables (i.e., awareness, risk perception, responsibility, and efficacy), awareness of 4R nutrient management practices was the strongest predictor of conservation behaviors. While the nature of this relationship fell as predicted, its strength in relation to the other variables is somewhat contrary to the literature on awareness and the adoption of BMPs, which finds that awareness is often the most insignificant predictor of behavior adoption (Prokopy et al, 2008). The high level of awareness I recorded may be a result of the specificity of awareness measured in my study, given that it is measuring awareness of 4R nutrient management decisions, or in other words measuring awareness of the behaviors themselves. In contrast, the questions assessing risk perception, responsibility, and efficacy were worded more generally around the concept of nutrient loss. This level of specificity in the questions measuring awareness may explain its unanticipated strength as a predictor of behavior. However, my analysis does not distinguish between correlation and causation, and so it is also possible that the relationship between awareness and behaviors was high because farmers who are implementing BMPs are therefore aware of their existence. This relationship would need to be tested further to shed light on its nature. One possible

way to do this would be to divide a sample of farmers who had never heard of the 4Rs of Nutrient Stewardship into two groups, provide one of the groups with information regarding the practices, and over time measure the differences in the implementation of 4R BMPs.

The relationship between Conservation identity and conservation behavior was stronger than the relationship between Productionist identity and conservation behavior (table 6). This supports my initial hypothesis that identity would have a positive relationship with a behavioral index, though the strength of the relationships suggests that further study is needed to confirm my results. The overall variance explained by a hierarchical regression analysis of my model (9.3 percent), while significant, was somewhat low. This could be for a number of reasons. First, two of the psychological variables studied in this report were somewhat problematic. The measure of efficacy did not meet Field's minimum standard for internal consistency, (2009), and the measure of responsibility did not make a significant contribution to the overall strength of the model. Second, hierarchical regression analysis may not be the most applicable statistical analysis for this sample population. One alternative for future study is latent class analysis. Farmers are a heterogeneous group, however this heterogeneity cannot always be observed through demographics or survey responses alone. Latent class analysis tests for these differences within a population without assuming them, and, based on prior research, explains more of the variance in a survey of farmers than hierarchical regression (Wilson et al, 2014). Another statistical tool that may have gone further to account for response variance is the use of logistic regression, rather than linear regression, in categorizing responses. It is possible that by grouping responses to questions into categories, rather than letting them stand alone, would have reflected the population better and resulted in more variance explained. Both of these analyses were outside the scope of this report, but provide opportunity for further study. Efficacy's low Cronbach's alpha value could be due to the slightly different aspects of efficacy measured in the three questions assessing the psychological variable (Table

3). The second question of the three, “I can engage in practices that limit nutrient loss on my farm,” assesses the efficacy of current practices, while the first, “taking additional steps to reduce nutrient loss on my farm would be easy,” and the third, “I have the ability to change my practices to further limit nutrient loss on my farm,” assess opinions on future actions. In the context of my study, the second question is the most applicable, as the study is interested in the current implementation of BMPs by farmers on their farms. Further study on this topic should take this divergence in the nature of efficacy questions into consideration.

On the whole, the findings of this study support previous research on the nature of these relationships, indicating that farmers’ values have positive relationships with their beliefs, and that farmers’ beliefs have positive relationships with conservation behavior. When considered in a model that places values before beliefs and beliefs before behaviors, the results of my study suggested that these variables are predictive when ordered in this way, and that the overall model was more predictive of behavior than the independent variables considered alone. Given the significance and directionality of my results, this project supports VBN theory as a worthwhile model for understanding nutrient stewardship behaviors, with applicability to the population of farmers surveyed in the Maumee watershed. However, given the moderate strength of the results, further study would be required to determine the extent of the applicability of VBN theory, both to my population of interest and to land stewardship behaviors in general.

Research has shown that Conservationist identity needs to be activated and socially supported in order to endure, and that identity and social perception of the good farmer role is influenced by feedback loops, which can shift farmers’ identities within a larger community (McGuire et al, 2013). These shifts in social identity can redefine group and personal norms, and other important forces that influence the adoption of best management practices (Riper and Kyle, 2014). In light of these findings, it will be

important for agricultural extension programs, government environmental organizations, and other groups promoting the adoption of nutrient loss management behaviors to understand the role that identity and identity activation play in farmer decision-making, and incorporate this understanding into efforts to promote specific behaviors. The establishment of sustainable farming organizations might allow for the normalization of conservation behavior, and activate conservation farming identities in the broader farming community. Additionally, my research suggests that awareness of nutrient management behaviors, perception of risk regarding nutrient loss, and a sense of efficacy regarding nutrient loss management behaviors help predict the adoption of BMPs; therefore increasing each of these variables in the populations of farmers in the Maumee watershed, through targeted communication, nutrient management workshops, and other forms of outreach can be expected to lead to higher rates of BMP adoption.

My analysis revealed that farmers who identified as Conservationists farmers compared to Productionist farmers owned smaller farms, and had fewer years of farming experience. Farmers who were more likely to implement best management practices on their farms tended to be younger and have fewer years of farming experience, yet had bigger farms and higher incomes. This indicates that these demographics could be very generally assumed by organizations interested in outreach as more likely to have already adopted BMPs or to be more receptive to information regarding the practices. In targeting farmers who identify as Conservationists, communications tailored towards activating conservation identity, increasing awareness, risk perception, and sense of efficacy, framed in a way that emphasizes the detrimental effects of nutrient loss on the larger ecosystem and farming community could, in light of prior research and my own findings, be expected to increase rates of BMP adoption in this subgroup (McGuire, 2013). Based on Good Farmer Identity theory Productionist identity correlated negatively with the adoption of best management practices, suggesting that when communicating with farmers that

identify this way agriculture extension programs working to promote BMPs could reframe their information and outreach to emphasize the pro-production aspects of nutrient loss management behaviors, such as the long-term yield increases that, for example, planting cover crops could provide.

As climate conditions continue to change, the alteration of farmer nutrient management practices is becoming increasingly urgent. Further understanding of the forces and influences that shape farmer decision-making will be essential to the implementation of BMPs on farms across the Maumee watershed, and must be used to inform policy, communication, and outreach efforts going forward.

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