Institutions, Property Rights, and Innovations in Agricultural Drainage: Insights from the Western Lake Erie Basin of Ohio

DISSERTATION

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By

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Abstract

Agricultural drainage is an important practice in the Western Lake Erie Basin of Ohio. Both scholars and practitioners recognize the importance of drainage, and acknowledge its implications beyond merely increasing agricultural productivity, but also as a vital instrument in adapting to climate change and achieving sustainable development. Paradoxically, drainage seems to have become a ‘forgotten factor’ in water discourse, with scholars arguing that institutions for managing agricultural drainage are lacking. The agricultural landscape in Ohio, however, presents over 150 years of drainage management institutions, providing a good opportunity to examine them in light of theory and practice.

My investigation of agricultural drainage draws upon two primary bodies of theory: collective action and diffusion of innovations. First, I employ a case study approach to examine drainage management institutions from the perspective of a public-goods dilemma, through the analytical lens of four variables important for collective action: group size, capability to choose to enter or exit from a group, heterogeneity in benefits and costs, and security of contributions. Analysis indicates that the theoretically expected effects of these variables on collective action are influenced by interactive effects both from the drainage management institution and from other factors.

Second, using a case study approach, I examine drainage management institutions from the perspective of resource asymmetry and property rights in collective action, through the analytical lens of property rights of access, withdrawal, management, exclusion and alienation. Document analysis and interviews with 16 government agents leads to the proposition of a
property-rights analytical scheme to suit the asymmetry of incentives in agricultural drainage systems. Analysis of interviews and landowner surveys indicates that property rights in the two different institutional mechanisms (mutual agreement and county petition) provide different incentives to cooperate, and that components of the property rights interact to encourage or discourage collective action.

Third, I employ a mixed methods research approach to examine change agents’ perceptions of the attributes of two-stage drainage ditches, an innovative agricultural drainage ditch design, and examine what affects their willingness to promote it. Analysis of interviews with change agents in 17 counties indicates that their perceptions of environmental benefits drives their willingness to promote two-stage ditches. Analysis of landowner surveys indicates that landowners’ perceptions of environmental benefits does not drive their willingness to adopt two-stage ditches.

Based on the findings in my dissertation, I believe that agricultural drainage institutions in Western Lake Erie Basin of Ohio provide a theoretically rich, but theoretically untested ground for scholars not only studying common-pool resource institutions, but more broadly in advancing understanding of social dilemmas, which are pervasive in our daily lives. Theoretically, this study suggests that a key government role may be to supply an alternative institution for stakeholders to generate collective action. Moreover, the finding that change agents’ perceptions of environmental benefits drives their willingness to promote a conservation practice is an encouraging sign, however, there is still a long way to go if we are to understand how to best encourage change agents to promote adoption of agricultural conservation practices.
Dedication

This dissertation is an offering at *Thy Lotus Feet*, for you are my guiding light. Dedicated to my parents, brother, and my sister-in-law, for your constant love and support.
Acknowledgments

I reflect back at the past four years, with a sense of accomplishment and humility. I believe I have become a better person, and the credit goes to the people around me.

At the very outset, I would like to thank my advisor – Dr. Tomas Koontz, for looking beyond GPAs and percentages, for your confidence in me which made me confident, for making research fun, for bringing out the best in me, for the record-breaking Skype calls, for the conferences and hikes, and last but not the least, for being a kind person. You are an inspiration. I would also like to thank my co-advisor – Dr. Jeremy Brooks, for your immensely helpful feedbacks, for being patient and understanding, for making me more reflective about my research, and for your kindness. Finally, I would like to thank my committee member – Dr. Jeremy Bruskotter, for your thought provoking questions and ideas, for accommodating impromptu meetings, and for your guidance. I would like to thank Dr. Jonathan Witter, for your belief in social science research and for your words of encouragement. The work presented in this dissertation was funded by U.S. Department of Agriculture-Natural Resources Conservation Service NIFA program under Award #2012-51130-20255. I would like to thank Dr. Joseph Bonnell for your guidance and help.

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Chapter 1: Introduction

Section 1. Agricultural drainage: Opportunities and Challenges

Drainage is an integral feature of the agricultural landscape in the Western Lake Erie Basin, which spreads across the states of Ohio, Indiana and Michigan. The basin covers an area of over 4.9 million acres, and is one of the most productive and intensively farmed regions of the world (USDA-NRCS, 2005). Since soils in the basin are poorly drained, an extensive network of drainage systems have been implemented to improve agricultural drainage (Rousseau & Lawrence, 2013). Approximately half of all cropland in Ohio, which covers 76% of the basin, has been altered by some type of artificial drainage in order to enhance agricultural productivity (D’Ambrosio, 2013). However, importance of agricultural drainage is not just limited to the Midwestern United States, but across the world. As per scientific estimates, 50% of the world’s irrigated land suffers from drainage issues (Abdeldayem et al., 2005). 250 million hectares of rain-fed cropland is in need of improved drainage (Abdeldayem et al., 2005). Moreover, due to neglect, need for improved drainage has developed for 10 to 15 million hectares of land in arid and semi-arid countries and the humid tropics (Tollefson, Atfy, Facon, & Kerc, 2014).

Drainage has implications beyond just enhancing agricultural productivity. Scholars have identified adequate provisioning of drainage infrastructure as being critical for climate change adaptation (Enete & Amusa, 2010). Climate change is also expected to increase the need for drainage (Tollefson, et al., 2014). In the US Midwest, due to
climate change, precipitation is expected to become more intense, leading to increased flood damage and strained drainage systems (USEPA, 2014). Others scholars believe that improvement in drainage could be a vital instrument in achieving sustainable development (Abdeldayem et al., 2005). Paradoxically, however, drainage has become a ‘forgotten factor’ in international water discourse as a theme and a concern (Abdeldayem et al., 2005; Scheumann & Freisem, 2002; Tollefson et al., 2014). Scholars argue that unlike irrigation management, for which institutional arrangements abound, institutions for managing agricultural drainage are lacking (Scheumann & Freisem, 2002; Schleyer, 2009).

The agricultural landscape in Ohio, however, presents a contrast, where the first agricultural drainage laws were passed in 1841 (Atherton, 1999). These laws granted local offices the authority to design and construct drainage projects and assess the costs to the benefitting landowners (ODNR, 2009). It is estimated that over 60% or approximately 7 million acres of Ohio’s cropland benefit from such drainage projects (ODNR, 2009). Thus, the Western Lake Erie Basin region of Ohio, the study context in my dissertation, presents a context in which drainage management institutions have been an integral component of the agricultural landscape. In fact, legally backed drainage management institutions have existed in Ohio for the past 150 years, thus providing a study context that is rich in institutions for managing agricultural drainage (County Advisory Bulletin - Ditch Maintenance Update, 2011). In addition to agricultural drainage being an important factor in Ohio, unlike the overall global context of it being a ‘forgotten factor’, more recently, scholars have begun to recognize the importance of effective management of
drainage systems in order to address nonpoint source pollution from agriculture (Needelman, Kleinman, Strock, & Allen, 2007; Strock, Kleinman, King, & Delgado, 2010). Other scholars have pointed out the need to mitigate the negative effect of agricultural drainage and balance its impact on agricultural production with that of other ecological and environmental functions (Abdeldayem et al., 2005).

Despite the recognition that there is a need to manage drainage systems for both agricultural and environmental objectives, in a recent study of government agents involved with functioning of drainage management institutions in Indiana, scholars found that water conveyance continues to remain the main focus (Dunn, Mullendore, de Jalon, & Prokopy, 2016). Their findings indicate the need for bringing a cultural shift in how drainage systems are managed.

The aforementioned description of agricultural drainage establishes its importance as a resource which merits study. It also establishes that the study context in my dissertation provides a unique opportunity to further our understanding of drainage management institutions, and examine whether the goal of agricultural drainage in Ohio is undergoing a transition from that of merely conveying water to one that provides a balance of agricultural and environmental objectives. With the goal of demystifying institutions for drainage management, the second and third chapters of my dissertation are grounded in the theory of collective action. My second chapter examines drainage management institutions from the perspective of a public-goods dilemma. My third chapter examines drainage management institutions from the perspective of resource asymmetry and property rights. The fourth chapter of my dissertation is grounded in the
diffusion of innovations theory, examining adoption of a drainage management “innovation” which promises a balance between agricultural and environmental objectives.

The remaining introduction chapter proceeds in the following order: Firstly, I provide a brief introduction of drainage management institutions in Ohio. Secondly, I provide a brief history of the agricultural landscape in Ohio. In the following sections, I introduce the second and third chapters of my dissertation, the rationale behind them and the research questions I am pursuing. This section is followed by providing methodological notes which are common to the second and third chapters of my dissertation. In the final section, I introduce the fourth chapter of my dissertation, the rationale behind it, my research questions and methods.

Section 2. A brief introduction to drainage management institutions in Ohio

Four institutional mechanisms have been provided for establishing and maintaining drainage systems involving more than one landowner, referred to as ‘group drainage improvement’, in Ohio (County Advisory Bulletin - Ditch Maintenance Update, 2011). These mechanisms are as follows: (1) Mutual Agreement, provided under County Ditch Law, (2) County Petition, also provided under County Ditch Law, (3) Conservation Works of Improvement or Senate Bill 160, provided under Soil & Water Conservation District law, and (4) Conservancy District Improvement, provided under Conservancy District Law. In my dissertation, I focus on the two most commonly used mechanisms: Mutual Agreement & County Petition. Mutual Agreement is used when landowners agree to voluntarily provide a group drainage improvement and are willing to pay the cost of
construction (“Drainage and Ditches,” 1994). County Petition is filed with the county commissioners, either by a benefitting landowner, or multiple benefitting landowners\(^1\), in order to have a group drainage improvement, which is then financed, constructed, and maintained via assessments on benefitting landowners in the watershed (County Advisory Bulletin - Ditch Maintenance Update, 2011). This mechanism is used when all benefitting landowners do not agree on the need or cost distribution of the proposed group drainage improvement (Atherton, Brown, Fausey, & Hitzhusen, 2004). Key similarities between the two mechanisms are that both involve more than one landowner and they are both provided under the County Ditch Law. There are several key distinctions between the two mechanisms. These distinctions are summarized in the table below.

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<tr>
<th>Key Distinctions</th>
<th>Mutual Agreement</th>
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<td>Level of govt. involvement</td>
<td>Minimal</td>
<td>Maximum</td>
</tr>
<tr>
<td>Scope</td>
<td>To construct a group drainage improvement</td>
<td>To construct and provide future maintenance for a group drainage improvement</td>
</tr>
<tr>
<td>Nature of involvement of landowners</td>
<td>Voluntary (disagreeing landowners in the watershed cannot be forced to contribute)</td>
<td>Non-voluntary (disagreeing landowners in the watershed(^a) can be forced to contribute)</td>
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Table 1.1. Key distinctions between mutual agreement & county petition

Notes:
* County petition projects define watershed as the land area or the drainage area benefitting from the group drainage improvement.

\(^1\) County petitions can also be filed by public bodies, however, such petitions are beyond the scope of my dissertation. I focus on petitions initiated by landowner/s.
The second chapter of my dissertation examines drainage management institutions from the perspective of a public-goods dilemma, whereas the third chapter examines these institutions from the perspective of resource asymmetry and property rights.

**Section 3. Agricultural drainage in Ohio: from channelization to conservation**

As mentioned earlier, Ohio’s first drainage laws were passed in 1841, which granted local offices the authority to design and construct drainage projects and assess the costs to the benefitting landowners (ODNR, 2009). Under the auspices of these laws, drainage projects allowed the development of marginal and poor lands into productive agricultural lands. Part of such a radical transformation of the agricultural landscape in Ohio has been attributed to the practice of channelization, also called “ditching” (D’Ambrosio, 2013). Channelization was typically carried out by creating a “trapezoidal drainage ditch design”, which successfully and efficiently drained the soil profile, but due to its deviations from a natural stream condition, often required “drainage improvements” in order to maintain the design, prevent sediment accumulation, and remove woody vegetation along the ditch banks (D’Ambrosio, 2013).

The traditional trapezoidal design was questioned by researchers in Ohio, leading to the development of the innovative two-stage ditch design (see Figure 1.1), as an alternative to traditional ditch maintenance for the purpose of increasing ditch stability,

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2 It is important to keep in mind that agricultural drainage consist of both surface (drainage ditches) and sub-surface (drainage tiles) drainage systems. A group drainage improvement, irrespective of whether constructed under mutual agreement or county petition, includes both types of drainage projects.
reducing bank erosion and flooding into adjacent fields (D’Ambrosio, 2013; Strock et al., 2010).

![Two-stage drainage ditch](image)

Figure 1.1. Two-stage drainage ditch. (*Source*: Dunn, et. al., 2016)

The first two-stage ditch was constructed in Wood County, Ohio, in 2002 (D’Ambrosio, 2013). The two-stage drainage ditch is a floodplain establishment design, which includes a low-flow channel, allowing for sediment transport during low-flow periods, and a floodplain area which allows for both handling large volumes of drainage water during high-flow periods and increasing surface contact between soil-water-vegetation to support nutrient removal (D’Ambrosio, 2013; Dunn et al., 2016). The underlying principle behind two-stage ditches is to incorporate key characteristics of a natural channel system into the drainage ditch design in order to mimic a natural stream environment (Dunn et al., 2016; Strock et al., 2010). A wide range of scholarly work supports the following non-exhaustive list of benefits associated with two-stage ditches: improves bank stability, increases sediment storage capacity, maintains or improves drainage capacity, reduces the need for ditch clean-outs, improves habitat for aquatic wildlife, and that the improved soil-water-vegetation interactions may have implications...
for water quality and ecological benefits (D’Ambrosio, 2013; Dunn et al., 2016; Strock et al., 2010). However, as described in the fourth chapter of my dissertation, there are also tradeoffs associated with their adoption. The fourth chapter examines government agents’ and landowners’ perceptions of the attributes of two-stage ditches and examines what factors encourage agents to promote them and landowners to adopt them.

**Section 4. A brief introduction to chapter 2: rationale and research questions**

One of the seminal works to further the theory of collective action was by Mancur Olson’s book *The Logic of Collective Action* (Olson, 1965). At the heart of Olson’s logic of collective action was the free-rider problem (Ostrom, 1990). However, Olson attempted at building a general theory of collective action based on only one characteristic of goods – that of exclusion, i.e. how easy or costly it is to exclude or limit potential users from consuming a resource (Ostrom, 2003). As scholars recognize, this is one type of collective action problem – a public good problem (Ostrom, 2003), also known as a public-good dilemma (Kollock, 1998). The second type of collective action problem is a common-pool resource problem (Ostrom, 2003), also known as a commons dilemma (Kollock, 1998), which exhibits the difficulty of exclusion, but also exhibits the second important characteristic of goods – that of subtractability, i.e. whether consumption of resource by one user subtracts from the availability of resource available to others. Ostrom (2003) argues that making such a fundamental distinction between the type of collective action problem is crucial in advancing the theory of collective action (Ostrom, 2003). In the second chapter of my dissertation, I make this theoretically
important distinction and conceptualize construction and maintenance of agricultural drainage systems from the perspective of a public-goods dilemma.

While making the aforementioned distinction between the types of collective action problem based on resource characteristics is critical, it is also important to further our understanding of how group characteristics, i.e. characteristics of the group of resource users, affect prospects for collective action. Scholarly debate over how group characteristics influence prospects of collective action, especially for the variables ‘group size’ and ‘heterogeneity’ is longstanding (Poteete & Ostrom, 2004). More recently, however, based on outcomes in multiple experimental social dilemmas, scholars have gained confidence in how a set of ten such variables, including group size and heterogeneity in benefits and costs, affects prospects of collective action (Poteete, Janssen, & Ostrom, 2010). In the second chapter of my dissertation, I select four such variables: group size (V1), capability to choose to enter or exit from a group (V2), heterogeneity in benefits and costs (V3), and security of contributions (V4), and I examine the public-goods dilemma in agricultural drainage systems. By selecting these four variables I am able to holistically examine how a group of landowners, under the auspices of drainage management institutions, obtains a group drainage improvement. The selection of variables is done purposively, as it allows for a closer examination of drainage management institutions.

There are several ways in which the second chapter of my dissertation theoretically builds upon the crucial contribution of Poteete et al., (2010). Firstly, I test these four variables (V1-V4) in a field-context, where previously they have been tested
by experiments. Secondly, I test these variables in a novel, previously untested collective action situation of obtaining group drainage improvements. Finally, I test these four variables specifically in the context of a public-goods dilemma, which has not been done before for variables V2, V3 & V4.

The overarching questions of the second chapter of my dissertation are –

1. How can we conceptualize public-goods dilemmas for agricultural drainage systems?

2. Whether and how drainage management institutions interact with variables (V1-V4) for solving public-goods dilemmas for agricultural drainage systems.

3. What factors encourage/discourage collective action in management of agricultural drainage systems?

Analysis indicates that two variables (V1 & V2), do not support theoretical expectations based on prior studies, V4 somewhat supports theoretical expectations based on prior studies, whereas, V3 supports theoretical expectations based on prior studies. The main theoretical contributions in this chapter are conceptual clarifications about extant scholarly understanding of group size (V1) and security of contributions (V4), and that the theoretically expected effects of key variables on collective action are influenced by interactive effects both from the drainage management institution and from other factors. Additionally, this study suggests that a key government role may be to supply an alternative institution for stakeholders to generate collective action.
Section 5. A brief introduction to chapter 3: rationale and research questions

Given that resource users often have diverse interests and incentives, natural resource management poses collective action dilemmas. Nobel laureate Elinor Ostrom's (1990) pioneering work on understanding collective action in a variety of natural resource management contexts, such as forests, irrigation systems, and fisheries, showed that local resource users can sometimes overcome such dilemmas by devising property rights and acting collectively to successfully manage a resource. Property rights are defined as “the capacity to call upon the collective to stand behind one’s claim to a benefit stream” (Bromley, 1991). Thus, property rights are only as strong and legitimate as the institutions behind them (Meinzen-Dick & Di Gregorio, 2004). Property rights are important as they can reinforce collective action by offering incentives and necessary authorization and control over the resource to the resource users in a collective action dilemma (Meinzen-Dick & Knox, 1999).

Scholarly work on examining how property rights affect incentives for collective action in common-pool resource management has benefitted immensely from the property-rights analytical scheme proposed by Schlager & Ostrom (1992). Following their work, property rights systems have been widely conceptualized and studied as containing cumulative bundles of five rights (access, withdrawal, management, exclusion, and alienation) rather than a single right, working together to affect individual behavior (Ostrom, 2010). However, these studies have usually focused on common-pool resources (CPRs) that are held by the community, i.e. under a common-property regime.
Less is known about common-pool resources\(^3\) which are held in a private property (land) ownership regime. Additionally, property rights literature typically examines resources without spatial asymmetries (Janssen & Rollins, 2012). In an asymmetric dilemma, the relative positions of resource users at the head and tail of the system generates asymmetric access to the resource (Ostrom & Gardner, 1993). Such physical arrangement of resource users affects their incentives for collective action. Recognizing the complex relationships among institutions, property rights and collective action, in the third chapter of my dissertation, I argue that the incentive of a right holder (landowner) to contribute in an agricultural drainage collective action dilemma is driven by their physical arrangement with respect to the resource, and the bundles of property rights which indicate the right holders’ claim to the resource.

Given the aforementioned knowledge gaps, in my third chapter, I apply Schlager & Ostrom’s (1992) property-rights analytical scheme to agricultural drainage systems, conceptualizing them as a common-pool resource held in a private property (land) ownership regime and exhibiting an asymmetric dilemma. Specifically, I examine property rights of access (P1), withdrawal (P2), management (P3), exclusion (P4), and alienation (P5) in agricultural drainage systems. In this chapter, I propose a revised property-rights analytical scheme to suit the asymmetry of incentives in drainage

\(^3\) I would like to remind the reader that in my second chapter I focus solely on the construction and maintenance aspects of agricultural drainage systems, which is referred as \textit{production of} a joint good in the social dilemmas literature. Hence, in my second chapter, agricultural drainage systems are examined from the perspective of a public-goods dilemma. However, in the third chapter, agricultural drainage systems are examined holistically to include \textit{production and use of} a joint good, which, as explained in chapter 3, exhibits common-pool resource characteristics. This distinction between public-good and common-pool resource follows Kollock (1998; pp. 191), who says, “public goods dilemmas concern the \textit{production of}, and commons dilemmas involve the \textit{use of}, a joint good from which it is difficult to exclude others”.

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systems, while examining how drainage management institutions allocate bundles of property rights and how property rights interact to affect incentives for collective action.

The overarching questions of the third chapter of my dissertation are –

1. How can we conceptualize property rights for agricultural drainage systems?
2. How do institutions interact with property rights for promoting collective action for agricultural drainage systems?

Analysis indicates that property rights in the two different institutional mechanisms (mutual agreement and county petition) provide different incentives to cooperate, and that components of the property rights interact to encourage or discourage collective action. The main theoretical contributions in this chapter are the proposition of a property-rights analytical scheme to suit the asymmetry of incentives in agricultural drainage systems, and the finding that different drainage management institutions allocated different “non-cumulative” bundles of property rights based on the lateral distribution of resource users (near & far-landowners), and the role of the local government agency. Additionally, this study suggests that a key government role may be to supply an alternative institution for stakeholders to generate collective action.

Section 6. Methodological notes on Chapters 2 & 3

Due to theoretical and methodological similarities between my second and third chapter, and also to provide conceptual clarity about collective action in agricultural drainage, I would like to provide the reader with methodological notes which apply to both the aforementioned chapters. I would also like to highlight that although there is
some redundancy of text between the two chapters, my goal is to formulate them as standalone journal articles.

The second and third chapters of my dissertation follow a comparative case-study design. Case studies are well suited for understanding complex phenomena in real-world settings, where many factors are potentially important (Yin, 2009). In addition, the comparative case-study design is appropriate for this study because I am concerned with examining the conditions under which collective action is likely to emerge (Yin, 2009). The benefits of using the case study methodology, especially applicable to both my chapters is that it allows me to explore drainage management institutions from the analytical lens of key variables (V1-V4 in chapter 2 & P1-P5 in chapter 3), using an open ended investigative approach, and thus fruitfully contribute to theory testing (Poteete, et al., 2010). Like any research methodology, there are tradeoffs such as lack of external validity and difficulty of replication (Poteete, et al., 2010). However, as explained later, I minimize these limitations by selecting cases based on clearly defined criteria and also by controlling for “contextual conditions”.

In the second and third chapter of my dissertation, my two cases are the two institutional mechanisms: Mutual Agreement (C1) and County Petition (C2). These two mechanisms are most commonly used for drainage improvements involving a group of landowners. Selection of these two cases allows comparison of a case with minimal involvement of government agencies and no dissenting landowners (C1) to a case with maximum involvement of government agencies and dissenting landowners (C2). Another important point to keep in mind when using the case study method is the “contextual
conditions” in relation to the selected cases. Landowners in every county in Ohio can choose to use either of the two institutional mechanisms, however, counties in Ohio may differ from each other with respect to the type of local government agency which assists landowners in carrying them out. Specifically, although county petitions (C2) fall under the jurisdiction of County Commissioners (CCs) and County Engineers’ Office (CEO), commissioners may choose to enter into agreement with the county Soil & Water Conservation District (SWCD) for carrying out group drainage improvements. In order to account for this contextual variation, and be able to compare the two cases, for my dissertation, I have collected data in three counties which do not have any such agreement. Thus county petitions (C2) are carried out by the same type of local government across the three counties.

Conceptualizing the unit of analysis, variables, and how these concepts are operationalized for data collection and analysis, are important to understand conditions for collective action (Poteete & Ostrom, 2004). Because of its dynamic nature, there is widespread scholarly recognition that collective action is difficult to measure and study (Meinzen-Dick, DiGregorio, & McCarthy, 2004). Collective action is complex as it can take many forms such as development of rules for resource management, resource mobilization, or coordination of activities among participants⁴ (Poteete & Ostrom, 2004). Cognizant of this difficulty, in the following paragraphs, I define my unit of analysis, my key variables of interest, and the meaning of collective action in my dissertation.

⁴ For a brief review of measures of collective action success, see Jones (2004).
In my second chapter, the two cases (Mutual Agreement & County Petition) are the unit of analysis, and the four variables V1-V4 are the key variables of interest. In my third chapter, the same two cases (Mutual Agreement & County Petition) are the unit of analysis, and the five property rights P1-P5 are the key variables of interest. In both the chapters I rely on multiple data sources, data from the local government agencies (interviewee data) and data from a landowner survey (survey respondent data). In addition, I analyze documents pertaining to drainage laws, drainage maintenance reports and manuals. Drawing on multiple data sources provides a way of triangulating, an important practice when conducting case study research (Yin, 2009).

Data from the interviewees describe factors which encourage landowners to cooperate regarding group drainage improvements, and also factors which facilitate and hinder implementation of these projects. Approval or implementation of group drainage improvement projects is a manifestation of collective action, since the project involves multiple actors coming together to invest resources for obtaining the collective good of improved drainage. Data from the survey respondents describe the factors affecting their willingness or non-willingness to participate in group drainage improvement mechanisms. Taken together, the interviewee and the survey data provide a rich understanding of the conditions under which one can expect successful collective action: manifested at the individual level in terms of conditions under which a landowner would be willing to participate in a group drainage improvement mechanism & manifested at the group level, or the project implementation level, in terms of conditions under which the collective good of a group drainage improvement is provided. By employing a dual
lens of examining conditions under which one can successful collective action, I believe, I am able to present a holistic insight into the meaning of successful collective action in agricultural drainage.

Section 7. A brief introduction to chapter 4: rationale, research questions and methods

Much has been written about adoption of agricultural best management practices, also known as conservation practices designed to alleviate problems associated with nonpoint source (NPS) pollution from agricultural runoff (Lubell & Fulton, 2007). Decades of scholarly work on adoption of conservation practices has examined characteristics of three primary sets of variables: the adopter (Baumgart-Getz, Prokopy, & Floress, 2012; Prokopy, Floress, Klotthor-Weinkauf, & Baumgart-Getz, 2008), the change agent (Hartwich, Halgin, & Monge, 2008; Rodriguez, Molnar, Fazio, Sydnor, & Lowe, 2009), and the conservation practice (Pannell et al., 2006; Reimer, Weinkauf, & Prokopy, 2012). Scholars examining innovations more broadly, of which conservation practices are an example, have distinguished between incremental and preventive innovations (Overstreet, Cegielski, & Hall, 2013). Incremental innovations provide immediate benefits or benefits in the near future, whereas preventive innovations provide benefits that are often delayed in time, are relatively intangible, and the unwanted consequence may not occur anyway (Rogers, 2002).

Although conservation practices are often preventive, since environmental benefits associated with them are intangible as well as delayed in time, the extant literature does not examine their “preventive” nature. One of the core difficulties to
promote a preventive innovation is the difficulty change agents have in demonstrating its relative advantage to potential adopters (Rogers, 2003). However, what we don’t know is what makes change agents want to promote a particular innovation. Additionally, since “being preventive” is an attribute of the innovation itself, in the fourth chapter of my dissertation, I argue that the five perceived attributes of the innovations (Rogers, 2003; pp. 222) may affect their decision to promote. Hence, in this chapter, I focus on the extant knowledge gap of examining change agents’ perception of the attributes of a preventive innovation and examine what makes them want to promote it. In addition, I also examine perceived relative advantage of a preventive innovation from the perspective of potential adopters. Specifically, I test whether the perceived advantages/disadvantages that affect change agents’ willingness to promote are the same as the advantages/disadvantages that affect potential adopters’ (landowners’) willingness to adopt an innovation.

The preventive innovation of focal interest in this chapter is the two-stage drainage ditch design. As explained earlier in this chapter, the agricultural drainage landscape of the Western Lake Erie Basin has a history of over 150 years of using the traditional trapezoidal drainage ditch design to drain the landscape. Two-stage drainage ditch design, a new, innovative design which is about 14 years old, instead promises a balance between drainage as well as environmental benefits. Given the relative newness of the two-stage ditch design (approx. 14 years), over the traditional trapezoidal drainage ditch design (over 150 years), a study about understanding their adoption is not only timely, but also needed.

The overarching questions of the fourth chapter of my dissertation are –
1. How can we conceptualize two-stage drainage ditches as a preventive innovation?

2. How do change agents perceive the attributes of two-stage drainage ditches?

3. What factors correlate with change agents’ willingness to promote two-stage drainage ditches?

4. How do the factors affecting change agents’ willingness to promote compare with the factors affecting landowners’ willingness to adopt two-stage drainage ditches?

5. How do change agents’ recommendations to promote compare with the factors affecting landowners’ willingness to adopt two-stage drainage ditches?

Diffusion of innovation theory provides the conceptual grounding as well as the theoretical motivation for this chapter. The data for this chapter come from a mixed method research approach using semi-structured interviews with change agents and a landowner survey. Analysis indicates that change agents’ perceptions of environmental benefits drives their willingness to promote two-stage ditches. The main theoretical contributions in this chapter is that change agents’ perceive two-stage ditches as low in relative advantage, with intangible and delayed benefits, and that their perception of relative advantage of two-stage ditch influences their perception to promote it.
Chapter 2: Role of ‘group size’ and ‘heterogeneity’ in agricultural drainage: implications for collective action

Section 1. Introduction & Rationale

Collective action is an action taken by a group to achieve common interests (R. Meinzen-Dick & DiGregorio, 2004). However, given that resource users often have diverse interests and incentives, natural resource management poses social dilemmas, a collective action situation in which there is a conflict between individual and collective interest (Kollock, 1998). A collective action dilemma, occurs when individuals in interdependent situations face incentives such that non-cooperation yields superior outcomes for the individual, yet if all individuals pursue such non-cooperation, all are made worse off (Van Lange et al., 2014). Garrett Hardin (1968), in The Tragedy of the Commons, provided the oft-cited example of a grazing pasture representing a collective action dilemma of herders pursuing a non-cooperative strategy. The herders kept as many cattle as possible on the pasture in order to maximize individual outcomes. Because each additional animal brought individual gains that exceeded individual costs from overgrazing, each herder rationally decided to add more cattle. However, if every herder pursued the same strategy, it led to degradation of the pasture for all –including the individual herders.

A dilemma concerning the production of a joint good, which exhibits the characteristics of non-excludability, i.e. all may benefit, regardless of whether they have
helped provide the good, is called a public goods dilemma (Kollock, 1998). On the other hand, a dilemma concerning the use of a joint good, which exhibits the characteristics of non-excludability and subtractability (of the benefits), is called a commons dilemma (Kollock, 1998). This theoretical distinction in collective action dilemmas is also reflected in Ostrom’s (2003) paper in which she identifies two types of collective action problems – public-good problem and common-pool resource problem. In fact, given the dramatically opposite behavior and outcomes in these two collective action situations, she argues that making such a fundamental distinction is crucial in advancing the theory of collective action (Ostrom, 2003). Being mindful of this theoretically important distinction, in this chapter, I conceptualize agricultural drainage systems as the joint good, whose construction and maintenance (production) poses the collective action dilemma of providing a public good, i.e. a public-goods dilemma.

Behavior in collective action dilemmas has been found to be affected by many structural variables (Ostrom, 1998; Poteete et al., 2010). In this chapter, I examine the public-goods dilemma in agricultural drainage systems from the analytical lens of four such variables: group size (V1), capability to choose to enter or exit from a group (V2), heterogeneity in benefits and costs\(^5\) (V3), and security of contributions (V4). The institutional mechanisms for constructing and maintaining agricultural drainage systems in the Western Lake Erie Basin (WLEB) region of Ohio provides the platform to examine the collective action dilemma of providing a public good. Specifically, I examine whether

\(^5\) For conceptual clarity, V3 has been conceptualized as heterogeneity in individual net benefit in this study. See section 4.4 for a detailed description.
and how the four variables (V1-V4) are defined for drainage management institutions and subsequently affect the public-goods dilemma. The study follows a comparative case-study design (Yin, 2009). The data for this study come from a mixed methods research approach using a landowner survey, interviews, and document analysis.

Section 2. Research Objective & Questions

The objective of this study is to examine the public-goods dilemma in agricultural drainage systems. Specifically, I examine whether and how the variables of group size (V1), capability to choose to enter or exit from a group (V2), heterogeneity in benefits and costs (V3), and security of contributions (V4), are defined for drainage management institutions and subsequently affect the collective action dilemma of providing a public good. I do so by examining the institutional mechanisms for constructing and maintaining agricultural drainage systems in the Western Lake Erie Basin region of Ohio. Thus, in the backdrop of drainage management institutions, I examine how variables pertinent to collective action dilemmas are shaped and their implication for solving the collective action dilemma of providing a public good. The overarching questions of this study are –

1. How can we conceptualize public-goods dilemmas for agricultural drainage systems?

2. Whether and how drainage management institutions interact with variables (V1-V4) for solving public-goods dilemmas for agricultural drainage systems.

3. What factors encourage/discourage collective action in management of agricultural drainage systems?

For clarity, I would like to remind the reader that drainage management institutions have a set of rules which shapes/determines the value of collective action variables (V1-V4).

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Section 3. Reviewing collective action variables in natural resource management

Although there is substantial evidence, both from extensive case-study and laboratory research, that collective action dilemmas can be overcome, debates have continued about whether and how particular factors, such as group size and heterogeneity, affect prospects of collective action (Poteete & Ostrom, 2004). Additionally, since heterogeneity is commonly expected to be greater in larger groups, these variables also interact with each other to affect prospects of collective action (Poteete, et al., 2010).

Although some scholarly evidence indicates smaller groups have a stronger ability to perform collectively (Baland & Platteau, 1999; Tang, 1992), there is also contradictory evidence in support for larger groups’ increased likelihood for solving collective action dilemmas (Kollock, 1998). Interestingly, other scholarly evidence points at a more complex relationship between group size and collective action. For example, a set of studies on forest management found a curvilinear relationship between group size and collective action for resource mobilization; the smallest groups were found to have less success than somewhat larger groups in mobilizing the resources required for forest protection, but similar success as the largest groups (Poteete & Ostrom, 2004). Additionally, there is no consensus on what is considered to be a small or a large group (Araral, 2009). The expected impact of group size on prospects of collective action has also been found to be affected by the type of collective action problem at hand – a public-goods problem or common-pool resource problem. For example, a large group is
expected to contain a critical mass of individuals whose interests are served by providing a highly non-subtractable public good, and thus solving a situation of a public-goods dilemma (Marwell & Oliver, 1993). Similarly, individuals facing a public goods problem have been found more likely to contribute in larger groups than in smaller groups, because cooperation by an individual increases the non-subtractive benefits to all without affecting individual costs (Poteete et al., 2010). In contrast, in a common pool resource (commons) dilemma, because each unit harvested by one individual is subtracted from those available to others, as the group gets larger, the fear of not harvesting while others harvest may increase, leading to less likelihood to cooperate in larger groups (Poteete et al., 2010). These divergent findings suggest that factors important for overcoming commons dilemmas may differ from those for overcoming public-goods dilemmas. In this chapter, I focus on public goods dilemmas in production of agricultural drainage systems.

Additional variables beyond group size account for collective action success. As mentioned earlier, heterogeneity is commonly expected to interact with group size to affect prospects of collective action (Poteete, et al., 2010). Scholars have identified heterogeneity as a factor that can both encourage and hinder collective action (Baland & Platteau, 1999; Gaspart & Platteau, 2007; Kurian & Dietz, 2004; Varughese & Ostrom, 2001). In addition to the uncertainty regarding how heterogeneity affects prospects of collective action, scholars have used the term ‘heterogeneity’ to refer to very different concepts, such as heterogeneity of values, knowledge, skills, location, economic inequality, preferences, or interest in maintaining the resource. This inconsistent use of
the concept makes it even more difficult to compare findings across studies and understand the relationship between heterogeneity and collective action (Poteete & Ostrom, 2004). Broadly, two forms of heterogeneity have been identified and studied in the literature: socio-cultural differences (heterogeneity) such as differences in ethnicity, case, class, etc. and economic inequalities (heterogeneity) in wealth, income, access to credit, etc. (Mudliar, 2016; Ruttan, 2008). Recent scholarly work, focusing specifically on heterogeneity of benefits and costs, found it usually to be associated with negative outcomes in collective action dilemmas (Poteete et al., 2010).

Examining the relevant form of heterogeneity in a collective action dilemma is important for understanding its relationship with collective action (Poteete & Ostrom, 2004). Heterogeneity in benefits and costs (V3) is very relevant for drainage management institutions, as they are often faced with the task of distributing the cost incurred in a drainage improvement among the benefitting landowners. However, making this distribution is not easy, as multiple factors such as potential increase in productivity, relative location of property in relation to the drainage system, quality of drainage, etc. affect the benefits accruing to each landowner in the drainage area. Thus, we need to examine how different drainage management institutions distribute costs among benefitting landowners, and most importantly, if that distribution is perceived to be fair by landowners. Perceived fairness of a given method for distributing costs and benefits between participants has been found to be an important factor influencing their willingness to contribute in a collective action situation (Biel & Thøgersen, 2007).
As described above, group size (V1) and heterogeneity in benefits and costs (V3) have been found to affect collective action. Their impact on collective action might depend on two more variables: capability to choose to enter or exit from a group (V2) and security of contributions (V4). First, capability to choose to enter or exit from a group (V2) has been found to have a positive impact on cooperation as it enables individuals to enter a collective action situation when others are cooperating and to leave when they are dissatisfied with outcomes (Poteete et al., 2010). It is connected to group size in that depending upon whether a landowner has the ability to choose if he wants to participate in a drainage improvement or not, the group size will change. Second, security of contributions (V4) usually has a positive impact on cooperation in a collective action dilemma as it reduces the risk of contributing resources and getting nothing in return. It does so by assuring an individual that his contributions will be returned if not enough others are contributing (Poteete et al., 2010).

There are three ways in which this study theoretically builds upon the crucial contribution of Poteete et al., (2010). Firstly, in this study, I test these variables in a field-context, where previously they have been tested by experiments. Secondly, this study tests for the key variables of interest (V1-V4) in a novel, previously untested collective action situation. Finally, I test these four variables specifically in the context of a public-goods dilemma, which has not been done before for V2-V4. A summary of the four variables (V1-V4) examined in this chapter, along with their expected impact on collective action, as identified by Poteete et al., (2010), is provided in Table 2.1.
### Table 2.1. Variables of interest and expected impact on collective action

(Adapted from Poteete et al., 2010)

<table>
<thead>
<tr>
<th>Variables of interest</th>
<th>Variable value and expected impact on collective action</th>
<th>Expected impact for the type of collective action problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Size (V1)</td>
<td>High (+) / Low (-)</td>
<td>Public-goods dilemma</td>
</tr>
<tr>
<td>Capability to choose to enter or exit from a group (V2)</td>
<td>High (+) / Low (-)</td>
<td>Not specified</td>
</tr>
<tr>
<td>Heterogeneity in benefits &amp; costs (V3)</td>
<td>High (-) / Low (+)</td>
<td>Not specified</td>
</tr>
<tr>
<td>Security of contributions (V4)</td>
<td>High (+) / Low (-)</td>
<td>Not specified</td>
</tr>
</tbody>
</table>

Section 4. Conceptual clarifications for agricultural drainage systems

Given the scholarly debate surrounding the issue of whether and how particular factors affect prospects of collective action, and given that these factors have been untested for agricultural drainage systems, it is important to provide conceptual clarifications upfront.

**4.1 Understanding public-goods dilemma in agricultural drainage systems**

My conceptualization of a public-goods dilemma concerns the *production*, i.e. construction and maintenance of agricultural drainage systems, a joint good, which exhibits the characteristics of non-excludability, i.e. all may benefit, regardless of whether they have helped provide the good (Kollock, 1998). The joint good, for agricultural drainage systems in Ohio, is commonly referred to as a ‘group drainage improvement’. By definition, the term “group” refers to the fact that such improvements concern more than one landowner. The drainage improvement provided, either in the
form of constructing new drainage ditches or laying down main drainage tiles, or in the form of maintaining the existing drainage system, is non-excludable. A landowner who has not contributed\(^7\) to a group drainage improvement, cannot be excluded from deriving drainage benefits from the drainage system because excess water will drain naturally or through main tiles into the ditch. Non-excludability may thus encourage individuals to free-ride on the efforts of other (Poteete & Ostrom, 2004). Also, in the course of land management, landowners might grade slopes and conduct other actions that could affect the flow of surface water onto adjacent lands. To deter this tendency to free-ride, institutions have been created to facilitate collective action (the two institutional mechanisms in this study). Hence the public-goods dilemma in agricultural drainage systems is how to avoid free-riding behavior in contributing to the production of a drainage system.

4.2 Conceptualizing group size (V1) in agricultural drainage systems

Group size in extant literature usually refers to the number of individuals in a group that could engage in collective action (Agrawal, 2001; Poteete & Ostrom, 2004). In agricultural drainage systems, group size (V1) becomes important at two different stages in the collective decision making process. In the first stage, it is a landowner or a group of landowners who identify the need for a group drainage improvement. In the second stage, depending upon the institutional mechanism in place, either the group of landowners or the local government agency makes a determination of group size by

\(^7\) An individual contribution is mainly in the form of incurring a share of the cost required for providing the group drainage improvement. However, an individual could also contribute by bearing some of the transaction costs associated with reaching an agreement to provide the improvement.
identifying the landowners who will benefit from the drainage improvement, and subsequently would be assessed the cost. Thus, group size varies from the first to the second stage, depending upon the drainage area that would benefit from the improvement. Unless everyone in the group had initially, in the first stage, agreed for the need of a drainage improvement, in the second stage, there could be landowners who oppose the improvement, and thus hinder prospects of collective action. Thus, unlike extant literature, in which group size is simply the number of individuals in a group who could engage in collective action, for drainage systems, we need to develop a nuanced understanding of group size and its impact on collective action.

4.3 Conceptualizing capability to choose to enter or exit from a group (V2) in agricultural drainage systems

The capability to choose to enter or exit from a group refers to whether a landowner can decide to exit from the group drainage improvement project, without having any obligation to pay for it. In the extant literature capability to choose to enter or exit from a group (V2) has been found to have a positive impact on cooperation as it enables individuals to enter a collective action situation when others are cooperating and to leave when they are dissatisfied with outcomes (Poteete et al., 2010). However, because group drainage improvements are non-excludable, i.e. a public-good, having the capability to enter/exit from a group may lead to a situation where a landowner is able to leave the group, but still receives the drainage benefits. Thus, whereas extant literature identifies V2 as a variable which has a positive impact on collective action, given the
public-good characteristic of drainage systems, V2 can have a negative impact on collective action. For simplicity, V2 will be referred as ability to enter/exit in this study.

4.4 Conceptualizing heterogeneity in benefits and costs (V3) in agricultural drainage systems

Production of a group drainage improvement involves distribution of cost across the benefitting landowners by means of the two most commonly used methods: (1) equal assessment method, also known as a flat-rate method, and (2) varied assessment method. In an equal assessment method the cost attribution is solely based on the number of acres owned by a landowner in the group. In this method, everyone pays a fixed rate per acre multiplied by the number of acres they own in that watershed. This method does not distribute costs equal to benefits received. For example, under this method, two landowners with the same landholding size will end up paying the same cost per acre irrespective of whether their land is close to a drainage ditch (hence benefits more) or further away from a drainage ditch (hence benefits less). Unlike the equal assessment method, in a varied assessment method the cost attribution is based on how much benefit a landowner is getting from a group drainage improvement. Making this calculation takes into account factors like how far away a given parcel of land is from the improvement, value of the parcel itself, length of the improvement being used, etc. This method distributes costs equal to the benefits received.

For simplicity and clarity, I conceptualize heterogeneity in benefits and costs, as heterogeneity in net benefit received by a landowner (benefit value minus cost incurred). Thus, for the equal assessment method, heterogeneity in individual net benefit (V3) will
be high, whereas it will be low for the varied assessment method. My conceptualization of V3, thus aligns well with Poteete et al (2010) conceptualization of heterogeneity in benefits and costs. However, unlike their focus on inequality of assets, my focus is specifically on inequality of individual net benefit. In addition, I also focus on perceived fairness of the net benefit received by an individual landowner. If heterogeneity in individual net benefit (V3) is perceived to be fair, it may have a positive impact on collective action. However, if heterogeneity in individual net benefit (V3) is perceived to be unfair, it may have a negative impact on collective action.

4.5 Conceptualizing security of contributions (V4) in agricultural drainage systems

The extant scholarly understanding of security of contributions is that contributions will be returned if not sufficient, thus safeguarding a contributor against being a “sucker” (Poteete, et al., 2010). Let us step back and understand “security of contribution” more conceptually. Feeling secure about one’s contribution is about a contributor incurring costs and subsequently either obtaining the collective good, or having his contributions returned if the collective good is not provided. This classic understanding of security of contribution in agricultural drainage systems would translate into whether the costs associated with initiating a group drainage improvement project is returned if the improvement is not provided. If security of contributions is provided, this reduces the risk of contributing because the contributions are only retained if the drainage improvement is provided; otherwise it is returned. However, one can also conceptualize reducing risks via means other than simply returning contributions if not sufficient. For
example, a contributing landowner may feel less at risk if there is a provision for a local government agency to absorb the costs incurred during the initial stages of the project, if the costs incurred upfront are low, and if there are locally devised arrangements to secure the initial contributions. These three circumstances can increase security of contributions by reducing the risk of an individual sinking substantial costs into a collective action that fails.

Thus, whereas extant literature identifies V4 as returning contributions if not sufficient, for agricultural drainage systems, we also need to account for the role of the local government agency in absorbing/imposing the costs incurred upfront, whether the costs incurred upfront are high or low, and presence/absence of locally devised arrangements to secure contributions. Having such a multitude of ways to secure contributions would reduce an individual’s risk associated with participating in a collective action situation, and hence may have a positive impact on collective action.

Section 5. Study Area

The Western Lake Erie Basin (WLEB) is one of the most productive and intensively farmed regions of the world (USDA-NRCS, 2005). The basin is located in the states of Indiana, Michigan, and Ohio, and covers an area of over 4.9 million acres (USDA-NRCS, 2005). In terms of area distribution, 76% of the basin is in Ohio, followed by 17% in Indiana, and 7% in Michigan. Poor agricultural practices have led to excessive sedimentation and nutrients input in the basin (Western Lake Erie basin - state of the basin, 2009). In fact, sedimentation due to agriculture is a leading environmental and economic issue in the basin. Due to extensive agriculture the basin is also being targeted
as a major contributor of nonpoint source (NPS) water pollution into Lake Erie (Rousseau & Lawrence, 2013). Historically, the Great Black Swamp covered approximately 1500 square miles (736,000 acres) of the basin. Soils in the basin are poorly drained and surface and subsurface drains have been implemented extensively to improve agriculture drainage (Rousseau & Lawrence, 2013).

The key government office/s responsible for drainage management in the U.S. varies from state to state. For example, in the state of Ohio, County Commissioners Offices (CCOs), County Engineer Offices (CEOs), Soil and Water Conservation Districts (SWCDs), and Conservancy Districts (CDs) are responsible for establishing and maintaining drainage systems. In contrast, in Indiana, County Surveyor’s Office and Drainage Boards, and in Michigan, drain commissioners are responsible for drainage systems. Thus, because states in the U.S. vary with respect to the institutional mechanisms in place for drainage management, in order to develop an in-depth understanding of collective action by testing the four variables (V1-V4), I focus specifically on the WLEB region of Ohio.

5.1 Drainage management institutions in Ohio

Ohio has a total population of approximately 11.6 million, with a population density of 108.3 per km². The state is characterized by fertile, flat soils and adequate rainfall. However, much of Ohio originally was swamp, too wet to farm (George, 1987). In fact, even today, approximately two-thirds of Ohio's cropland acres are naturally poorly drained and rely on man-made or artificial drainage systems to remove excess water (County Advisory Bulletin - Ditch Maintenance Update, 2011). Over 7.4 million
acres of cropland benefit from such drainage systems, making it an important agricultural practice (ODNR, 2008). Group or organized efforts are required for successful drainage of such large areas, which is true in the case of Ohio (George, 1987).

The proportion of drained land in Ohio served by drainage organizations is about 80-85 percent (George, 1987). Four institutional mechanisms have been provided for establishing and maintaining drainage systems involving more than one landowner, referred to as ‘group drainage improvement’ (County Advisory Bulletin - Ditch Maintenance Update, 2011). These mechanisms are as follows: (1) Mutual Agreement, provided under County Ditch Law, (2) County Petition, also provided under County Ditch Law, (3) Conservation Works of Improvement or Senate Bill 160, provided under Soil & Water Conservation District law, and (4) Conservancy District Improvement, provided under Conservancy District Law. In this study, I will focus on the two most commonly used mechanisms: Mutual Agreement & County Petition. Mutual Agreement is used when landowners agree to voluntarily provide a group drainage improvement and are willing to pay the cost of construction (“Drainage and Ditches,” 1994). County Petition is filed with the county commissioners, either by a benefitting landowner, or multiple benefitting landowners⁸, in order to have a group drainage improvement, which is then financed, constructed, and maintained via assessments on benefitting landowners in the watershed (County Advisory Bulletin - Ditch Maintenance Update, 2011). This mechanism is used when all benefitting landowners do not agree on the need or cost distribution of the proposed group drainage improvement (Atherton, Brown, Fausey, &

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⁸ County petitions can also be filed by public bodies, however, such petitions are beyond the scope of this study. The focus of this study is on petitions initiated by landowner/s.
Hitzhusen, 2004). Key similarities between the two mechanisms are that both involve more than one landowner and they are both provided under the County Ditch Law. There are several key distinctions between the two mechanisms. These distinctions are summarized in the table below.

<table>
<thead>
<tr>
<th>Key Distinctions</th>
<th>Mutual Agreement</th>
<th>County Petition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of govt. involvement</td>
<td>Minimal</td>
<td>Maximum</td>
</tr>
<tr>
<td>Scope</td>
<td>To construct a group drainage improvement</td>
<td>To construct and provide future maintenance for a group drainage improvement</td>
</tr>
<tr>
<td>Nature of involvement of landowners</td>
<td>Voluntary (disagreeing landowners in the watershed cannot be forced to contribute)</td>
<td>Non-voluntary (disagreeing landowners in the watershed can be forced to contribute)</td>
</tr>
</tbody>
</table>

Table 2.2. Key distinctions between mutual agreement & county petition

Notes:
* County petition projects define watershed as the land area or the drainage area benefitting from the group drainage improvement.

Section 6. Research Design & Method

The study follows a comparative case-study design (Yin, 2009). Comparative case studies are well suited for understanding complex phenomena in real-world settings, where many factors are potentially important (Yin, 2009). In this study, my two cases are the two institutional mechanisms: Mutual Agreement (C1) and County Petition (C2). These two mechanisms are most commonly used for drainage improvements involving a group of landowners. Selection of these two cases allows comparison of a case with
minimal involvement of government agencies and no dissenting landowners (C1) to a case with maximum involvement of government agencies and dissenting landowners (C2). Within each case, the four variables (V1-V4), form the key variables of interest. In addition, the comparative case-study design is appropriate for this study because I am concerned with examining the conditions under which collective action is likely to emerge (Yin, 2009).

Another important point to keep in mind when using the case study method is the “contextual conditions” in relation to the two cases. Every county in Ohio is permitted to use the different institutional mechanisms, however, counties differ from each other in who carries them out. Specifically, although county petitions (C2) fall under the jurisdiction of County Commissioners (CCs) and County Engineers (CEs), commissioners may choose to enter into agreement with the county SWCD for carrying out drainage improvements. In order to account for this contextual variation, and be able to compare the two cases, for this study, I have selected three counties which do not have any such agreement. Thus county petitions (C2) are carried out by the same type of local government across the three counties. These three counties are located in the Western Lake Erie Basin region of Ohio, and are characterized by somewhat poorly to very poorly drained soil. I will refer to these counties as county 1, 2, & 3.

6.1 Operationalization of Variables

Conceptualizing the unit of analysis, variables, and how these concepts are operationalized for data collection and analysis, are important to understand conditions for collective action (Poteete & Ostrom, 2004). In this study, the two cases (Mutual
Agreement & County Petition) are the unit of analysis, and the four variables V1-V4 are the key variables of interest. V1 (group size) is a function of the number of landowners contributing to a group drainage improvement (see Table 2.3).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Operationalization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group size (V1)</td>
<td>• Number of landowners contributing to a group drainage improvement project</td>
</tr>
<tr>
<td>Ability to enter/exit (V2)</td>
<td>• Can landowner/s decide whether to contribute to a group drainage improvement project</td>
</tr>
<tr>
<td>Heterogeneity in individual net benefit (V3)</td>
<td>• Perceived fairness of the distribution of costs and benefits</td>
</tr>
<tr>
<td>Security of contributions (V4)</td>
<td>• Availability of mechanisms to reduce the costs of initiating the project and/or to return contributions if the good is not provided</td>
</tr>
<tr>
<td>Effects on collective action</td>
<td>• Government agents describing factors which encourage landowners to cooperate for group drainage improvements(^a)</td>
</tr>
<tr>
<td></td>
<td>• Government agents describing factors which facilitate and hinder implementation of group drainage improvements(^b)</td>
</tr>
<tr>
<td></td>
<td>• Landowners describing factors for their willingness or non-willingness to participate in group drainage improvement mechanisms(^c)</td>
</tr>
</tbody>
</table>

Table 2.3. Operationalization of variables

Notes:
\(^a\) Response to the question: What do you think are factors that encourage landowners to cooperate regarding drainage improvement?
\(^b\) Response to the questions: Overall, what do you think are the constraints in implementing group drainage improvements in your region? & On the contrary, what factors facilitate implementation of group drainage improvements in your region?
\(^c\) Via an open ended question, landowners were asked to mention the biggest reason for their willingness or non-willingness to participate in Mutual Agreement or County Petition mechanisms.
Depending upon the drainage area, V1 can vary from 10-15 landowners for a small project, to 500-600 landowners for a big project. V2 (ability to enter/exit) is a function of whether or not a landowner can decide if he/she wants to be part of a drainage improvement project or not. V3 (heterogeneity in individual net benefit) is a function of how the costs are distributed among the landowners benefitting from the drainage improvement. V4 (security of contributions) is a function of whether or not there is a way the costs associated with initiating and obtaining a group drainage improvement can be reduced, and if contributions are returned if the good is not provided.

To understand how V1-V4 and other variables affect collective action, I rely on multiple data sources, data from the local government agencies (interviewee data) and data from a landowner survey (survey respondent data). Data from the interviewees describe factors which encourage landowners to cooperate regarding group drainage improvements, and also factors which facilitate and hinder implementation of these projects. Approval or implementation of group drainage improvement projects is a manifestation of collective action, since the project involves multiple actors coming together to invest resources for obtaining the collective good of improved drainage. Data from the survey respondents describe the factors affecting their willingness or non-willingness to participate in group drainage improvement mechanisms. Taken together, the interviewee and the survey data provide a rich understanding of the conditions under which one can expect successful collective action: manifested at the individual level in terms of conditions under which a landowner would be willing to participate in a group drainage improvement mechanism & manifested at the group level, or the project
implementation level, in terms of conditions under which the collective good of a group drainage improvement is provided.

6.2 Data Collection & Analysis

Data collection for this study included in-depth interviews with key informants. Key informants are people with firsthand knowledge of the events being studied who provide factual information about the organization from an insider perspective (Hardy & Koontz, 2009). In the study, key informants were those most closely involved with functioning of the drainage management institutions: county engineers, deputy engineers, drainage technicians, district technicians, etc. These individuals spend their careers interacting with landowners regarding drainage issues and are familiar with both the institutional mechanisms and farmers’ reactions to them. A snowball sampling technique was used to identify knowledgeable informants (Patton, 1990) in each county. Following each interview, respondents were asked to identify additional individuals with experience in all aspects of drainage management. I conducted interviews with 16 government agents involved in the two institutional mechanisms: Mutual Agreement & County Petition. 5 interviews were conducted in the first county, 6 interviews were conducted in the second county, and 5 interviews were conducted in the third county. I continued conducting interviews in a county until I reached a point of saturation, where additional interviews provided little or no new information. These interviews were conducted in-person during December, 2014 to January, 2015. 14 out of 16 interviews were recorded. All the interviews, including the 2 which were not recorded, were then transcribed. The interview duration ranged from 45-50 minutes to 150 minutes. Systematic qualitative
techniques such as coding, pattern matching, and synthesis were used to analyze the collected data. Quotes and short vignettes were instructive. This allowed for synthesis of interpretations and identification of themes that cut across cases (Miles & Huberman, 1994). Data analysis followed the approach of directed content analysis (Hsieh & Shannon, 2005). Analysis of key informant qualitative data led to a total of 846 manually coded segments in MAXQDA (a qualitative data analysis software; version 11).

In addition, I collected data from landowners to identify the effect of various factors on their willingness or non-willingness to participate in the two institutional mechanisms. These data were collected through a survey administered to 1500 landowners across the three counties. These surveys were mailed with multiple contacts, with a response rate of 34%. The primary criterion for selection of a landowner into the sample was that they have a drainage ditch on their land. The secondary criterion was that they owned 50 or more acres of land, although this was lowered in order to achieve a target of n=500 sampling frame in each county. Specifically, the survey data identifying factors for landowners’ willingness or non-willingness to participate in the two institutional mechanisms was provided by 244 survey respondents. Analysis of survey qualitative data led to a total of 318 manually coded segments in MAXQDA (a qualitative data analysis software; version 11).

Finally, document analysis provided additional data. Analysis of Ohio Revised Code (ORC) chapters 6131 and 6137 focused on understanding Mutual Agreement and County Petition mechanisms. Specifically, this analysis provided an understanding of the main provisions of the Ohio drainage laws. In addition, I analyzed county-specific
drainage system maintenance reports and manuals to better understand the nuances of drainage system construction and maintenance processes and historical trends.

**Section 7. Results**

In this section I describe the institutional mechanisms for drainage improvement, examine the role of variables V1-V4 in the emergence of collective action for drainage management, and identify which factors facilitate/hinder the implementation of group drainage improvement projects. I use a mix of key-informant insights, referred in the chapter as interviewees, landowner/farmer insights, referred in the chapter as survey respondents, and documentary evidence. Drawing on multiple data sources provides a way of triangulating, an important practice when conducting case study research (Yin, 2009).

A commonality across the two institutional mechanisms is that projects involve more than one landowner. Although a single landowner can initiate an institutional mechanism, the project should be addressing an issue which involves multiple landowners. Most of the times, it is either one landowner, or a group of landowners, who identify a drainage management issue, and approach either the county Soil and Water Conservation District (SWCD) or the County Engineers’ Office (CEO). After looking at the issue, the official can then make recommendation to the landowner, or the group of landowners, about which institutional mechanism to use. The final decision about which institutional mechanism to choose rests with the landowners.
7.1.1 A brief introduction to Mutual Agreement Projects

Mutual agreement (MA) projects, as the name suggests, are group drainage improvement projects that are mutually agreed upon. These projects are also known as group projects, or projects under ‘cooperative group procedure’. Mutual Agreement is used when landowners agree to voluntarily have a group drainage improvement and are willing to pay the cost of construction. MA projects are considered to be very landowner driven, wherein, landowners identify the issue, identify which other landowners are part of the project, make decisions about how they would want to distribute the cost among themselves, select a contractor of their choice, and eventually have the desired improvement. The role of the local government agency, either the SWCD or the CEO, is to provide watershed maps so that they can identify how many acres are going to benefit from the project, and thus which other landowners might be asked to be part of the project. Making this determination is important because it is the benefitting landowners who choose to participate who will eventually pay for the project. The final decision about whether the project goes ahead or not, rests with the landowner/s.

7.1.2 Key Variables in Mutual Agreement Projects

V1 – Group Size

Interviewees, in general, reported that MA projects are small projects. For example, an interviewee said, “Typically we are working with smaller projects…involving maybe a dozen landowners”. Another interviewee mentioned, “Typically MA projects are small in size” and “It would be a smaller project”. Interviewees perceiving group size with respect to the number of landowners, said, “It
comes down to numbers, and I don’t know what that magic number is. It could be 2 or it could be 10” and “There is no defined higher number, but I’d call it 25 if I had to put a number on it”. The findings thus suggest that group size (V1) in MA projects is typically small, and the actual group size can range from 2-3 to 10-25 landowners. Thus, V1 is low in MA (see Table 2.4).
<table>
<thead>
<tr>
<th>Variable</th>
<th>Variable value</th>
<th>Effect on collective action and frequencies</th>
<th>Overall Impact on Collective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mechanisms</td>
<td>Interviewee Frequency&lt;sup&gt;a,b&lt;/sup&gt;</td>
</tr>
<tr>
<td>V1 (Group size)</td>
<td>LOW</td>
<td>Lowers project cost (+)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gives greater landowner control (+)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Makes spearheading possible (+)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Correlates with small project size (+)</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Encourages the Olson effect (+)</td>
<td>6</td>
</tr>
<tr>
<td>V2 (Ability to enter/exit)</td>
<td>HIGH</td>
<td>Increases uncertainty about the fate of the project (-)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conflicts with private property rights (-)</td>
<td>2</td>
</tr>
<tr>
<td>V3 (Heterogeneity in individual net benefit)</td>
<td>HIGH</td>
<td>Leads to fair perception of V3 (+)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leads to unfair perception of V3 (-)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assessment method is easy to understand (+)</td>
<td>3</td>
</tr>
<tr>
<td>V4 (Security of contributions)</td>
<td>HIGH</td>
<td>Secures project costs upfront (+)</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 2.4. Variable values, effects, and overall impact on collective action in MA projects

**Notes:** Sign inside parenthesis indicates expected impact on collective action: (+) Helps; (-) Hinders.

<sup>a</sup> Although 16 interviews were conducted as part of this study, data about MA project was provided by 12 interviewees.

<sup>b</sup> Number of interviewees who mentioned this mechanism during the course of the interview.

<sup>c</sup> Number of survey respondents (landowners) who mentioned this mechanism in an open-ended question asking them to identify reasons for their willingness or non-willingness to participate in MA projects.

<sup>d</sup> The effect on collective action, based on interviewees’ and survey respondents’ responses.
The impact of V1 on success occurs through several mechanisms. For example, an interviewee said, “If it is a small number of landowners, then a mutual agreement is pretty enticing to everyone. It’s cheaper and the landowners have more control over it”. Another interviewee said, “Mutual agreement projects approximately involves 25 landowners on the higher side, after which things start getting difficult. That’s because somebody has got to spearhead the whole thing. Until this number you can think that mutual agreement is feasible, but once it crosses that number, you are getting into just too many people who are trying to get on the same page”. The crucial role of a landowner spearheading the MA project was captured very well by an interviewee, who said, “The landowner who is spearheading the project will get a contractor…who gives him an estimate [of the project]…[then comes to the County Engineers’ Office] we spread the cost using our formula [of distributing costs across benefitting landowners]. Then the landowner will go back to others in that drainage area, talk to them, and see if he can get them to agree or not”. Hence, low V1 helps collective action by providing drainage improvement at a lower cost, by allowing landowners to have greater control over the project, and by allowing somebody (a landowner) to spearhead the project. Further evidence for the effect of low V1 on collective action in MA was provided by survey respondents. One of the survey respondents wrote, “These work fine if only a few landowners are involved”. Another respondent indicating his willingness to participate in MA projects wrote, “Good only for two or three landowners”.

Small group size was described as correlating with small project size, which promotes collective action. One interviewee said, “If it is a small project I would
recommend mutual agreement, as it is definitely cost-efficient. There is no doubt about it”. Another interviewee said, “If you have a small area that a landowner wants to drain…maybe it is only benefitting him or other two people. So, they get together and do a group [MA] project, which was successful”. Another interviewee further added, “For smaller projects it seems like Mutual Agreement is the way to go”. Further evidence for the effect of small project size was provided by a survey respondent, he wrote, “If it is a small ditch [small project size] it is much cheaper to do it under a mutual agreement”. A small group size, in correlation with small project size, was found to allow communication within the group. An interviewee said, “When you are doing these [MA] projects, it is critical in the beginning to understand that if it is a large watershed it might be difficult to do the project. However, in a smaller watershed, in a smaller area, you can talk to your big farmers, your big landowners, and ask them to take a look at say a tile or a ditch and show them that this is the problem and what we can do to fix it”. Another interviewee, highlighting the crucial role of communication in MA projects said, “For the most part, for a small project, it’s like all the landowners are sitting around this table”. On the contrary, a large project size was found to be hindering collective action for MA projects. Evidence was provided by an interviewee who said, “We have had big [MA] projects which came to us but never went through just because money was the issue”.

Another effect of small group size, which helps collective action in MA, is what’s commonly identified in the public goods provisioning literature as the Olson effect. This is the condition where some individuals contribute enough to single-handedly provide a collective good because they receive a disproportionate share of benefits (Ruttan, 2008).
Olson identified this as a condition when privileged individuals may be motivated to unilaterally provide the collective good permitting others to free-ride on their efforts. Olson argued that this condition is more likely with a smaller group size, which is typical in MA projects. This is reflected very well in interviewee responses, such as, “It has happened before that they have paid for someone who doesn’t want to pay because they have still saved money by paying his bill too”, “The larger landowners would sometimes pay their [disagreeing landowners’] share just to have the project go through”, “There were probably half a dozen landowner involved, but just one landowner paid for the whole thing, on his own”, and “It does happen quite a bit where the landowner decides that it is just worth for him to pay for it [the project] on his own to put it in”. Further evidence in support for Olson effect was provided by a survey respondent, who wrote, “[MA project] works if people who benefit pay for those who won't or can't”.

**V2 – Ability to enter/exit**

In MA projects, landowners have the capability to choose whether they want to be part of the project or not. This was evident from interviewees’ responses such as, “A landowner can opt out of the project”, “A landowner can either chose to be, or chose not to be part of a group drainage improvement”, and “There is nothing binding him [a dissenting landowner]…There is nothing to hold them to it”. Thus, V2 is high in MA.

The impact of V2 on success occurs through several mechanisms. High V2 hinders collective action in MA by increasing uncertainty about the fate of the project. One interviewee said, “Under mutual agreement there is a lot of ifs and buts. Who knows, if in the end somebody does not want to pay, everyone else is going to have to pick up the
bill”. Additionally, given the non-excludable nature of the drainage improvement, landowner/s who choose to opt out are still able to free-ride on the effort of others. For example, an interviewee mentioned, “If you are in a drainage area, and the group decided to let you off the project and not pay for it, but that’s still where you are going to drain [i.e. in the same project]”. Interviewees noted that the ability to opt out can prevent a MA project from even being attempted: “A lot of time you know that right upfront…you know that they are not going to be in favor of the project”. If that is the case, an interviewee mentioned, “Early in that proposition, group can say that if we want this person to participate, then we will have to go through [a mechanism other than MA, which doesn’t allow opting out]”. Another interviewee added, “If someone is not willing to pay then the mutual group has to decide whether they are going to pick up that person’s share or the project doesn’t happen”. Another interviewee further added, “You only need couple of such people [landowners choosing to opt out] in a group project, because they probably have got large number of acres, and then don’t want to pay for the improvement”.

High V2 hinders collective action in MA as it comes in conflict with private property rights. This aspect was captured very well by an interviewee, who said, “If a landowner doesn’t want another landowner to come through his property the project is off a mutual agreement. Even if he says he is not going to pay, you cannot go across his property without his permission.”
He can stop the project, say by not allowing the tile\textsuperscript{9} to be cleaned”. Another interviewee further added, “There could also be a case where the drainage is on the property of the person who is not in agreement. At that point, they are pretty much stuck. So, even if everyone else in the mutual agreement agreed, and they wanted to pay for it, it doesn’t matter at that time because they are not in control of the property where the main drainage tile is located”.

**V3 – Heterogeneity in individual net benefit**

In MA projects, the decision of how the cost is going to be distributed across the benefitting landowner rests with the landowners who are part of the project. For example, an interviewee mentioned, “They [landowners] can do it however they want to do it, just making sure that everyone feels right about it”. Another interviewee mentioned, “It is up to them how they eventually decide to distribute the cost”. Thus, landowners can decide either to go with an equal assessment method or a varied assessment method. In practice, most often cost distribution is the heterogeneous one, equal assessment method. This method distributes costs as a function of acreage owned (same cost per acre), rather than as a function of benefits received from the improvement. Thus the net benefits (benefits minus costs) received vary greatly across landowners. As one interviewee described, “All the [MA] projects that I know have gone with flat rate [equal assessment]…the breakdown is easy, and there is no confusion”. Another reason why landowners may opt for equal assessment, as mentioned by an interviewee, was “If you want to do the target

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\textsuperscript{9} Drainage tiles are perforated pipes made up of clay, cement or plastic, which help remove excess water from soil subsurface. These tiles are installed below the surface of agricultural fields. Main drainage tiles run across multiple properties draining water eventually into a drainage ditch.
method [varied assessment], you would need to have the assistance of county engineers’ office with their computers. Thus, MA projects would most likely be a flat rate [equal assessment]”. Hence V3, i.e. heterogeneity in individual net benefit, is high.

High V3 effects collective action in MA depending on perceptions of fairness. While most interviewees thought landowners considered the equal assessment method to be fair, survey respondents indicated a more mixed picture. One interviewee said, “Yes, I think it is fair. If it wasn’t, they wouldn’t do it under mutual agreement.” Another interviewee said, “My impression is that they may not care if it is 100% equitable if they are making decisions…I wouldn’t say it is always according to the economic value, but it is always equitable to them because they agreed on it”. The same interviewee further added, “They [landowners] might say that you know my ability to pay is more than the neighbors, so I don’t mind picking up a percentage or two more. If I am a well-established farmer, and the guy next to me is probably just starting out, that well-established farmer is probably not going to squabble about paying a little extra because he is going to get the benefit that he wants. So, if that benefit [group drainage improvement] is going to cost him 3 dollars an acre more, he is still getting what he wanted. It was his idea, he got what he wanted, and he won’t mind paying a little higher share”. On the contrary, an interviewee who felt that landowners don’t perceive the distribution to be equitable, said, “I have talked to guys that have said that they don’t think of this method [equal assessment] as equitable”. Perceived fairness of the distribution of costs and benefits emerged as an important factor for survey respondents’ willingness or non-willingness to participate in MA projects. Six respondents perceived
that the distribution of costs and benefits in MA projects was fair. For example, a survey respondent wrote, “[MA project] spreads the costs fairly”. On the contrary, ten respondents felt that the distribution of costs and benefits in MA projects was unfair. For example, a survey respondent wrote, “You cannot get a group of people to agree to pay their fair share. There is always problems”.

Although V3 is high in MA projects, since the equal assessment method (same cost per acre), is easy for landowners to understand, it indirectly helps collective action. For example, an interviewee said, “If you [the group] decided to distribute the cost based on the more of the tile you use, the more money you pay, not a lot of projects were getting passed using this method [varied assessment]. Then they started paying the same amount per acre for everyone in the project [equal assessment], and the project was then getting passed. That’s because a lot of people didn’t realize why they were paying 22 dollars per acre whereas the other person was paying only 10 dollars”. Further evidence was provided by another interviewee, who said, “By going this way [equal assessment], there is no question about why is someone else paying less than me”.

Overall, the impact of heterogeneity in individual net benefit on collective action in MA depends on perceptions of fairness and the ease of understanding the method via which cost is distributed across benefitting landowners. Landowners who perceive this heterogeneity to be fair are more likely to participate in MA projects in the future, while those who perceive it as unfair are less likely to participate in MA projects in the future10.

10 Landowners who perceived V3 to be fair had a mean willingness score of 8.5 (n=6), while those who perceived V3 to be unfair had a mean willingness score of 6.4 (n=7). Willingness to
V4 – Security of contributions

In MA projects, security of contributions includes four components related to project costs: who absorbs the costs of initiating the project, the amount of these costs, locally devised arrangements to secure contributions, and whether contributions are returned if drainage improvement is not provided. First, most costs from initiating the project are absorbed by the local government agency. These initial costs, as identified by an interviewee, “may pertain to mailing, which is the biggest chunk of cost, then hourly wage of employees, supplies at the meeting, etc.” This was captured very well in interviewee responses, such as, “At this point, so far, the few [MA projects] that we have done lately, the SWCD [Soil & Water Conservation District] just absorbs the upfront cost”, SWCD can assist them with design of the practice, but the landowners won’t have to pay anything to them”, “For the initial costs that was incurred, in terms of our participation, that’s the tax dollars. It is a service that we offer”, and “They may have also come to us to get the watershed map, tile size, etc. but we don’t charge them for all that”. Absorption of upfront costs by the local government agency was identified as a positive factor for a survey respondent’s willingness to participate in MA projects.

The second component of security of contribution is with respect to the initial monetary costs associated with MA projects. Since the local government agency absorbs any such costs, landowners do not have to incur any monetary cost in reaching an agreement. This was reflected very well in an interviewee response, he said, “Until that time [completion of the initial stage of the project] they [landowners] probably don’t participate in MA projects in the future was measured via the survey on a scale of 1 to 10, with 1 being not at all willing and 10 being very willing.
have any cost that they have incurred”. Only after the group of landowners reach an agreement are monetary contributions made.

The third component of security of contribution is with respect to how landowners themselves take steps to ensure that everybody involved pays his decided share of the cost. These steps are setting up bank accounts, collecting checks in advance, and collecting at least 50% of the project cost upfront. For example, an interviewee said, “A lot of times in MA projects, they actually do put up the money [after the initial stage but before construction work begins]. Somebody in the group will set up an account at a bank. That way they would know that the project is going to be paid for”. In fact, depending upon the size of the project, landowners may either set up a bank account or collect checks from everyone involved. This aspect was captured very well by an interviewee, who said, “For MA project, if it is big, a lot of times the group will set up a bank account for dealing with money involved in the project. If it is a small project, then they just collect checks from everyone involved”. An interviewee also recommended, “It is up to them to decide how much money they would want to collect. That decision might be based on the size of the project. We recommend probably 50% of the money anyways. Without that, a person might say that he is in favor of the project, but once the project gets completed, there is nothing holding that guy to make his pay. This person could back out”.

The fourth component of security of contributions is with respect to returning a landowner’s contributions if the MA project is not provided. If for some reason the MA project does not get completed, landowners’ contributions are returned to them. However,
interviewees in this study, did not mention even a single instance when a group drainage improvement under MA project was not provided after contributions were made. Thus, although there is a provision for money to be returned, it happens rarely in MA projects.

Given the multitude of ways in which contributions can be secured, the landowners in the group are at a low risk of losing out on their contributions. Hence V4 is high in MA. The high V4 for MA projects has important positive effects on collective action. This aspect was captured very well by an interviewee, who said, “Usually what happens is that money is put upfront. They would already have their money in a pot before the work even starts. So, I would say a participating landowner would be hard-pressed to say give me my money back, I want to be out. That probably is not going to happen because you have already put the money upfront”. Securing contributions upfront, as mentioned by an interviewee, also seems to act as a proxy for an agreement. He said, “If the group wants to do it [MA project], then we suggest that the group put in money ahead of time so that there is some kind of agreement”.

7.1.3. Summary of Mutual Agreement Project Variables and their Impacts

Examining the public-goods dilemma in the case of Mutual Agreement projects, through the analytical lens of the four variables (V1-V4), led to several insights, which are summarized in Table 2.4. Group size (V1) was found to be typically small, involving 2-3 to 10-25 landowners. Hence V1 is low for MA projects. This low level of V1 helps collective action by lowering the project cost, and allowing landowners to both spearhead the project and have greater control over it. Low level of V1 helps collective action by the small project size and the Olson effect, i.e. unilateral provision of the drainage
improvement by landowners who expect greater drainage benefits. Landowners in MA projects have the capability to choose to enter or exit from the group. Hence V2 is high. This hinders collective action by increasing uncertainty about the fate of the project and indirectly by conflicting with private property rights. For V3, landowners in MA projects predominantly use an equal assessment method for distributing costs, which leads to heterogeneity in individual net benefit. This high level of V3 both helps and hinders collective action, depending on how it affects perceptions of fairness. Additionally, since heterogeneity in individual net benefit is easy to understand in an equal assessment method, it helps collective action. For V4, security of contributions was found to be high for MA projects, due to four components: initial costs absorbed by the local government agency, no monetary costs for landowners, securing project money by locally devised arrangements, and having a provision for returning project money to individual contributors if the drainage improvement is not provided. High security of contributions helps collective action by securing project costs upfront, which then acts as a barrier for a landowner to opt out of the project.
7.1.4 Additional factors important for collective action in Mutual Agreement projects

In addressing this study’s third research question, several factors were identified as facilitating and hindering implementation of MA projects, based on interviews and survey responses. These variables have been categorized under 6 broad categories that emerged from the data: (1) Resources, (2) Interpersonal dynamics, (3) Case specific variables (4) Contextual factors, (5) Individual level characteristics, & (6) Land-tenure systems (see Table 2.5).
### Table 2.5. Summary of additional variables with their impact on collective action for MA projects

<table>
<thead>
<tr>
<th>C1: MA Variable Category</th>
<th>List of Variables</th>
<th>Link to V1-V4</th>
<th>Interviewee Frequency&lt;sup&gt;b,c&lt;/sup&gt;</th>
<th>Survey Respondent Frequency&lt;sup&gt;d&lt;/sup&gt;</th>
<th>Impact on Collective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resources (73)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Financial – Low project cost</td>
<td></td>
<td>7</td>
<td>52</td>
<td>HELPS</td>
</tr>
<tr>
<td></td>
<td>Time efficient</td>
<td>3</td>
<td>3</td>
<td>HELPS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Human (govt. agents as facilitator)</td>
<td>V3: Increases perceived fairness</td>
<td>5</td>
<td>2</td>
<td>HELPS</td>
</tr>
<tr>
<td></td>
<td>Technological (Landowner/s having drainage equipment)</td>
<td>V1: Olson effect</td>
<td>1</td>
<td>0</td>
<td>HELPS</td>
</tr>
<tr>
<td>Interpersonal dynamics (54)</td>
<td>Willingness to cooperate</td>
<td></td>
<td>4</td>
<td>21</td>
<td>HELPS</td>
</tr>
<tr>
<td></td>
<td>Non-willingness to cooperate</td>
<td></td>
<td>2</td>
<td>14</td>
<td>HINDERS</td>
</tr>
<tr>
<td></td>
<td>Working relationship with neighbors</td>
<td></td>
<td>3</td>
<td>6</td>
<td>HELPS</td>
</tr>
<tr>
<td></td>
<td>Non-working relationship with neighbors</td>
<td></td>
<td>2</td>
<td>2</td>
<td>HINDERS</td>
</tr>
<tr>
<td>Case specific (34)</td>
<td>Greater landowner control</td>
<td>V1: Due to small project size</td>
<td>6</td>
<td>14</td>
<td>HELPS</td>
</tr>
<tr>
<td></td>
<td>Lack of future/permanent maintenance</td>
<td></td>
<td>6</td>
<td>2</td>
<td>HINDERS</td>
</tr>
<tr>
<td></td>
<td>Responsibility of maintenance on landowners</td>
<td>V2: Conflict with private property rights</td>
<td>0</td>
<td>6 (4+; 2-)</td>
<td>BOTH HELPS &amp; HINDERS</td>
</tr>
</tbody>
</table>

<sup>a</sup> Resources (73) includes 73 variables.

<sup>b</sup> Interviewee Frequency.

<sup>c</sup> Survey Respondent Frequency.

<sup>d</sup> Impact on Collective Action.

Continued
Table 2.5 Continued

<table>
<thead>
<tr>
<th>Contextual factors (14)</th>
<th>Perceived importance of drainage improvement</th>
<th>V3: Increases perceived fairness</th>
<th>2</th>
<th>12</th>
<th>HELPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual level characteristics (8)</td>
<td>House-lot owners; Absentee landowners</td>
<td>V3: Decreases perceived fairness</td>
<td>3</td>
<td>4</td>
<td>HINDERS</td>
</tr>
<tr>
<td>Farmers</td>
<td></td>
<td></td>
<td>1</td>
<td>0</td>
<td>HELPS</td>
</tr>
<tr>
<td>Land-tenure (2)</td>
<td>Sharecropping</td>
<td></td>
<td>1</td>
<td>0</td>
<td>HELPS</td>
</tr>
<tr>
<td>Cash-renting</td>
<td></td>
<td></td>
<td>1</td>
<td>0</td>
<td>HINDERS</td>
</tr>
</tbody>
</table>

Notes:

a The number inside parenthesis indicates the number of interviewees and survey respondents who mentioned a variable in that category.
b Although 16 interviews were conducted as part of this study, data about MA project was provided by 12 interviewees.
c Number of interviewees who mentioned this variable during the course of the interview.
d Number of survey respondent (landowner) who mentioned this variable in an open-ended question asking them to identify reasons for their willingness or non-willingness to participate in MA projects.
e Sign inside parenthesis indicates expected impact on collective action: (+) Helps; (-) Hinders.
Resources were most frequently identified as a factor important for collective action in MA projects. Both survey respondents and interviewees, reported that MA projects can be implemented at a lower cost than other institutions such as County Petitions. For example, indicating their willingness to participate in MA projects, survey respondents wrote, “Cheapest way to have drainage problems solved”, “If all can agree it is the cheapest way to accomplish goal”, and “Mutual agreement would be the cheapest method”. Reporting that MA projects costs less, an interviewee mentioned, “They [landowners] are going to save 2 or 3 times their money when going with mutual agreement”. Survey respondents and interviewees in this study also reported that MA projects are time efficient. For example, an interviewee mentioned, “If you want to do a drainage project, and you can get together with your neighbor and do it, it’s a whole lot simpler. You can expedite the whole process”. A survey respondent wrote, “The [MA] project gets done faster”. In addition to saving costs and time, interviewees and survey respondents also mentioned the crucial resource of the local government agency, acting as a facilitator of the MA project. For example, an interviewee mentioned, “He [the local government agent] is known around here to be the charmer. He normally makes personal calls to these individuals who are involved in the [MA] project, and tries to the best of his ability to get everybody to agree, and be on the same page”. A survey respondent, indicating his willingness to participate in MA projects wrote, “This [MA project] is done with cooperation of county engineers’ office”. Another survey respondent wrote, “SWCD [Soil & Water Conservation District] is a good group in our area”. Lastly, having farmers in the group who have their own equipment and machinery for making drainage
improvements allows them to work with other farmers in the group, and subsequently implement a MA project at a very low cost.

Interpersonal dynamics were identified as the next important factor for collective action in MA projects. Specifically, willingness/non-willingness to cooperate and having a working/non-working relationship with neighbors were frequently identified as factors which could help/hinder implementation of MA projects. Given that MA projects are issue driven and are carried out on a project to project basis, having a working relationship with neighbors and being willing to cooperate is critical for the success of these projects. For example, indicating their willingness to participate in MA projects, a few survey respondents wrote, “Agreeable landowners”, “Landowners are cooperating and getting along with each other”, “[MA] works good if all agree”, and “Everyone is easier to get along with and work with”. Emphasizing upon the importance of having a working relationship with neighbors, an interviewee mentioned, “I don’t see any constraints [in implementing MA projects] if you get along with your neighbors.” Another interviewee added, “If you can get along, and if you can come to a [mutual] agreement, then by all means go ahead and do it on your own”. On the contrary, having a non-working relationship with neighbors and non-willingness to cooperate hinders success of these projects. As one interviewee said, “Unlike 30 years ago when you knew your neighbors, now a days you don’t know who you are working with.” Another interviewee added, “I don’t think there is a sense of neighborhoods that there used to be”. This makes it harder to come to an agreement on the necessity of the project as well as cost sharing. Additionally, existing conflicts among neighbors can make it hard to initiate
and follow through with drainage projects. For example, indicating their non-willingness to participate in MA projects, a few survey respondents wrote, “Difficult to get everyone to agree”, “Can't always get all landowners to participate, “Problems with unwilling neighbors”, “Most times parties [landowners] can't agree on what or if anything needs to be done”, “Getting all parties to agree would be difficult”, and “No one is willing to cooperate”.

The next important factor for collective action is specific to the case, i.e. MA projects, which is that landowners have greater control over the project. For example, indicating their willingness to participate in MA projects, a few survey respondents wrote, “This process [MA] feels more locally driven”, “More control over the project setting the ditch I want and trust to do the project right!”, “Better control [over the project]”, and “Direct involvement of those involved”, and “Better understanding of why and how the project will be done”. The next important context specific factor is lack of future/permanent maintenance¹¹. This aspect was identified as a hindering factor for implementation of MA projects, and was well reflected in an interviewee’s response, who mentioned, “You can get something fixed and done under mutual agreement, but…what’s going to happen after the project has been done? Who is going to be in-charge? If I am a mile away from the ditch, am I going to go there and maintain that ditch”? A survey respondent reported this as well: “Not as willing because of the lack of longevity [of maintenance on MA project]”. However, evidence was also found in

¹¹ As explained in the section on CP project, whereas MA project fixes a drainage issue by providing a group drainage improvement, CP project not only fixes the issue, but also puts the drainage improvement on permanent maintenance.
support of survey respondents’ willingness to participate in MA projects because they could maintain the drainage improvement on their own, and thus save maintenance costs\textsuperscript{12}. For example, survey respondents wrote, “No maintenance fees paid”, “When a ditch needs cleaning call your neighbor and decide to do it”, “Everybody is responsible for maintaining his part of this ditch, so that is what we do” and “Much lower cost to maintain”. On the contrary, a survey respondent felt that landowners don’t maintain their section of the drainage improvement. Indicating his non-willingness to participate in MA projects, he wrote, “Neighbors tends to run the project to only benefit themselves. And then don't maintain it”.

A contextual factor pertaining to the perceived importance of drainage improvement was identified as the next important factor for collective action in MA projects. For example, landowners commented that their willingness to participate was affected by, “Drainage is very important for maximizing crop yield and reducing erosion”, “Would help to benefit drainage and erosion control”, “Preserve land and water quality”, and “Drainage is number one for optimum crop yields”. Emphasizing the perceived importance of drainage improvement, an interviewee mentioned, “Having a need facilitates implementation of a group project. If there is a group that has a serious problem, and they feel that they really need to do something about it. If the need is there then they are normally agreeable to get it done”.

Individual level characteristics were identified as the next important factor for collective action in MA projects. Specifically, having house-lot owners or having

\textsuperscript{12} Landowners benefitting from a CP drainage improvement are assessed an annual drainage improvement maintenance cost.
absentee landowners in the group were identified as factors which could hinder implementation of MA projects. For example, while talking about constraints in implementing MA projects, an interviewee mentioned, “Sometimes it is the house-lot people, who own a house out in the country, they don’t want to do anything about the issue. A lot of times they are the ones who object as they don’t want to pay”. This was also reflected by survey respondents, who, indicating their non-willingness to participate in MA projects, wrote “This [MA] works well as long as there are not too many non-agricultural holdings (houses) nearby”, and “Downside is getting everyone to agree if [MA project] in a residential area”. On the contrary, having a landowner in the group who is also a farmer, was identified as a factor which helps implementation of MA project. For example, while talking about what facilitates implementation of MA projects, an interviewee mentioned, “If a landowner is actually the farmer; their livelihood is tied to the ground”. A survey respondent, indicating his non-willingness to participate in MA projects, wrote “Too many non-farmers are not willing to participate”.

Land-tenure arrangements, e.g. sharecropping versus cash-renting, were identified as the next important factor affecting collective action in MA projects. Since drainage improvements are landowners’ responsibility, it matters whether the land is under sharecropping or under cash-rent. Specifically, the land-tenure arrangement of sharecropping helps collective action, and the land-tenure arrangement of cash-renting hinders collective action. If the land is under shared cropping, the landowner has a stake in fixing the drainage issue, as it effects his income. Thus, having land managed under shared cropping facilitates implementation of MA projects. On the contrary, a landowner
who is cash-renting his land may only be interested in receiving his agreed upon rent in the form of cash from his tenant, without caring much about the drainage issues on his land. Thus, having land managed under cash-rent tenure system hinders implementation of MA projects.

7.1.5. Summary of Mutual Agreement Project Additional Variables and their Impacts

In addressing this study’s third research question, six groups of additional factors were identified which had an impact on implementation of MA projects (see Table 2.5). Resources and interpersonal dynamics were most often mentioned.

Some of the additional factors link to the key variables of interest V1-V4. For example, having landowners in the group who have drainage equipment to obtain a drainage improvement, may encourage the Olson effect, one of the key effects of group size (V1; see Table 2.4). This aspect was captured very well by an interviewee, who mentioned, “Recently we have had several farmers who have actually purchased the equipment so that they can install their own tile mains, small ditches, etc. The way this helps even at a group level is that if you have someone in the watershed who has the equipment, then they may be able to do it [MA project] cheaper”. Another additional factor that indirectly links back to the key variable of fairness perception of V3 (Heterogeneity in individual net benefit), is the facilitating role played by the local government agency. Due to the facilitating role played by the local government agency, the perceived importance of drainage improvement for disagreeing landowners’ increases, which in turn increases their fairness perception of V3. For example, an interviewee
mentioned, “Everyone can come in and we can look at what they [group of landowners] are talking about, and we can give our insights on the project. Sometimes that helps the landowners who are disagreeing a little peace of mind, as they get to know that the project wasn’t something that was simply throwing money at something that wasn’t necessary. They get some reassurance”. Another additional factor that links back to the key variable of group size (V1), is greater landowner control. Since the number of landowners involved in MA projects is small, it allows landowners to have greater control over the project. For example, an interviewee mentioned, “It might be that there is one landowner who is more forward thinking than the rest, and he will get his neighbors involved. Then they will call a ditch or a tile contractor, and these contractors will then handle the [MA] project”. Another additional factor that links back to conflict with private property rights, one of the key effects of the ability to enter/exit (V2; see Table 2.4), is that individual landowners are responsible for maintaining the drainage improvement in MA projects. The resulting uncertainty about the maintenance of the drainage improvement was captured very well by an interviewee, who mentioned, “You can get something fixed and done under mutual agreement, but if say after 15 years go by…what’s going to happen? Who is going to be in-charge? If I am a mile away from the ditch, am I going to go there and maintain that ditch?” Perceived importance of drainage improvement project may directly link back to an increase in fairness perception of V3. For example, an interviewee mentioned, “Because it’s a major concern to them [landowners], the actual economics may not even bear into them. They got their way. They got their concern resolved. It might have cost them more than it should have, but
they got their way, and they are happy about it”. Another additional factor that may lead to a decrease in the fairness perception of V3 in MA projects is having absentee landowners in the group. This aspect was captured very well by an interviewee, who mentioned, “Sometimes it is the house-lot people, who own a house out in the country, they don’t want to do anything about the issue. A lot of times they are the ones who object as they don’t want to pay”.

7.2.1 A brief introduction to County Petition Projects

County Petition (CP) projects are group drainage improvement projects provided under the Ohio Revised Code (ORC) Chapter 6131. A CP procedure does not require that all landowners involved in the project agree upon the necessity of the drainage improvement, and allocation of costs and benefits. Just like MA projects, a single landowner, or a group of landowners can file a petition with the board of county commissioners (CCs). The CEO helps the landowner in not only filing the petition, but also coming up with the decision whether or not to file the petition. This decision making is facilitated by listing the pros and cons of filing a petition, and providing estimates of assessment rates. The goal behind doing so is to make sure that a petitioner has exhausted all other options before he decides to proceed with the petition. One of the main reasons why a county petition is filed is because people do not mutually agree. Petitions are also filed if the project is very big, and the petitioner/s do not want to go and talk about the project to a lot of landowners.

Once a petition has been filed, the CEO makes a determination of landowners who will benefit from the CP project. These landowners are then notified about their
involvement in the project, and are also invited to come to the viewing and hearings (first or preliminary hearing and second or final hearing) associated with the approval/disapproval of the project. During the viewing stage, the proposed improvement is viewed by CCs, CEO, and other stakeholders in the watershed. This is followed by first hearing during which the engineers’ office provides preliminary estimates about whether benefits from the improvement are likely to exceed the estimated costs. If the project is approved at the first hearing, the CEO makes all of the plans and does the survey work. This is followed by the final hearing during with CCs decide whether the project should get approved or not. Their decision is based on 3 criteria laid down in the ORC 6131. Firstly, benefits should exceed the cost. Secondly, the project should promote the public welfare. Thirdly, the project should be necessary. During both the hearings, which is presided over by the county commissioners, dissenting landowner/s can appeal for disapproval of the project. If the project is approved, bids are invited for the project from contractors. After the improvement has been constructed the CEO assigns a value to it, and then decides what percentage of that original value will be collected from the group of landowners in the project for its future maintenance. This value can be revised after every 6 years. A CP project puts the improvement on permanent maintenance, to be carried out by the local CEO in the future.

7.2.2 Key Variables in County Petition Projects

V1 – Group Size

Group size in a county petition (CP) project is important at two different stages. In the first stage, i.e. the stage at which a petition is filed, it could involve one or multiple
landowners. At this stage, the group size can be very small. For example, an interviewee mentioned, “Most of the times now it is an individual [who files the petition]”. Another interviewee mentioned, “Typically, a single petitioner initiates it [CP project]”. Thus, V1 at stage 1 is low. Once a petition has been filed, in the second (final) stage, the County Engineers’ Office (CEO) makes a determination of landowners in the watershed who will benefit from the project, and thus will be considered to be part of the group drainage improvement. The final group size of the project was found to be variable. For example, an interviewee mentioned, “The group size varies a lot. Last year we had a [county] petition project which covered an area of 10,000 acres. Whereas, year before that, we had a [county] petition project which just involved two landowners”. The findings thus suggest that the final stage group size (V1) is variable – sometimes high and sometimes low. However, in general, the group that initiates the petition, will be smaller when compared with the group that is finally considered to be part of the improvement. Overall, V1 in CP is low in the first stage, and variable in the final stage (see Table 2.6).
### Table 2.6. Variable values, effects, and overall impact on collective action in CP projects

<table>
<thead>
<tr>
<th>Variable</th>
<th>Variable value</th>
<th>Effect on collective action and frequencies</th>
<th>Overall Impact on Collective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>V1 (Group size)</strong></td>
<td>VARIABLE</td>
<td></td>
<td>UNCLEAR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Has low V1 at stage 1 (-)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Has low V1 at stage 2 (-)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Has high V1 at stage 2 (+)</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Correlates with large project size (+, -)</td>
<td>2 (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 (-)</td>
</tr>
<tr>
<td><strong>V2 (Ability to enter/exit)</strong></td>
<td>LOW</td>
<td>Increases certainty about the fate of the project (+)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>May lead to political pressure on county commissioners (+, -, no effect)</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 (-)</td>
</tr>
<tr>
<td><strong>V3 (Heterogeneity in individual net benefit)</strong></td>
<td>LOW</td>
<td>Leads to fair perception of V3 (+)</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leads to unfair perception of V3 (-)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>May be perceived as fair if local government agency explains assessment method (+)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td><strong>V4 (Security of contributions)</strong></td>
<td>LOW</td>
<td>Incurs upfront cost for filing a petition (-)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

**Notes:** Sign inside parenthesis indicates expected impact on collective action: (+) Helps; (-) Hinders.

*Although 16 interviews were conducted as part of this study, data about CP project was provided by 15 interviewees.

*b Number of interviewees who mentioned this mechanism during the course of the interview.

*c Number of survey respondents (landowners) who mentioned this effect in an open-ended question asking them to identify reasons for their willingness or non-willingness to participate in MA projects.

*d The effect on collective action, based on interviewees’ and survey respondents’ responses.
Low V1 in stage 1, i.e. filing of a county petition by a small number of landowners, hinders collective action in CP as it is indicative of disagreement with neighboring landowners on the perceived importance of a drainage improvement. For example, an interviewee mentioned, “When somebody is petitioning a project, there has already been some friction”. The interviewee further added, “There is not a group [of landowners] that comes in and says that we all really want to petition a project. That doesn’t happen”. Another interviewee added, “When we get into a petition, the landowners involved are not getting along”. A survey respondent indicated his non-willingness to participate in CP projects: “Don't like [CP] as much because it is more driven by smaller group of people [petitioning landowner/s]”. Another survey respondent added, “Absolutely no say by landowners other than petitioning party, for remedy and costs then passed to all landowners”. Disagreement within the group becomes a critical factor when county commissioners decide whether to approve/disapprove the project.

The impact of V1 on collective action is felt in the second (final) stage of CP projects as well. Low V1 hinders collective action in CP as it is indicative of the project not being conducive to public welfare, one of the clauses in the Ohio Revised Code (ORC 6131) for the project to get approved. Interviewees identified such petitions as “frivolous”. For example, an interviewee said, “There have been some real frivolous petitions. We had a [CP] project involving 3 landowners. That really should be solved between the landowners. It didn’t really fall within the spirit of what the petition process is”. Conversely, high V1 was identified as a positive factor for a survey respondent’s
willingness to participate in CP projects. He wrote, “If there are a lot of landowners it [CP project] seems to work well”.

Large group size (V1) in the second (final) stage of CP projects, was described as correlating with large project size, which might help or hinder collective action. One interviewee said, “In most cases when we get into a petition, either it is a huge project involving a lot of landowners, or the landowners involved don’t get along. Those are the ones which are doomed from the start. That’s what we have found”. On the other hand, large project size was identified as a positive factor for a survey respondent’s willingness to participate in CP projects. He wrote, “This [CP] works best on large projects”. An interviewee said, “If it is a small watershed [small project], and the costs are going to be very high, then we know that the petition won’t get approved”.

**V2 – Ability to enter/exit**

In CP projects, once the county engineers’ office makes a determination that a landowner is in the watershed and hence will benefit from a group drainage improvement project, he is considered to be part of the project. It is the watershed which dictates the boundary of the project. This insight is substantiated very well with interviewee responses such as, “Landowners are required to be part of the improvement once they are listed on the map”, “A landowner is considered part of the project if he in the watershed”, “In county petition, it is anybody in that watershed”, and “We have got drainage maps which show boundary lines to each particular channel. So, if you are in, you are in, and if you are out, you are out”. Once a CP project gets approved, landowners are assessed for the project, and the cost gets assigned to their property taxes. At this stage, as mentioned
by an interviewee, “It’s on their property taxes. Legally they cannot choose not to be part of the project”. Thus, V2 is low in CP.

Low V2 helps collective action in CP by increasing certainty about the fate of the project. Several survey respondents, indicating their willingness to participate in CP projects said, “Can accomplish projects without all landowners agreeing”, “Best way to get a project moving when all involved do not want to participate”, “More expensive – but [the project] will get done if a need exists”, and “It [CP] was the only way to get the ditch cleaned”. An interviewee further substantiated the effect of low V2 on CP projects: “If a petition is passed, it is going forward. A landowner can appeal, but the appeal is not for him to opt out of the project, but for the whole project to get stopped”. Another interviewee added, “Why I like the petition projects is because if the project goes through then it’s going to get paid”.

Although V2 is low in CP projects for an individual landowner, if enough individuals wish to exit the group they might prevail by appealing to the county commissioners for the project to get disapproved. As one interviewee said, “Since the commissioners are vote based [elected by people], there is a whole political factor involved as well”, “If there was a situation where 75% of the landowners involved in the petition did not agree, then the county commissioners might not approve the project”, and “If the commissioners want to get re-elected, they listen to the masses”. A survey respondent provided further insight on this aspect: “The county commissioners use most drainage petitions [CP] for political purposes. When benefits to the landowners exceed the costs, the commissioners will not move forward [disapprove the project] if municipal
areas with a lot of voters would have to share the costs”. On the contrary, an interviewee felt that, “If they [county commissioners] have been there that long, they have developed thick enough skin that they are not going to be swayed too much [in their decision]”.

Overall, while it is possible for a group of landowners to pressure county commissioners to disapprove a CP project altogether, the inability of landowners to exit individually has a positive effect on collective action in CP projects.

**V3 – Heterogeneity in individual net benefit**

Unlike MA projects, in which the decision of distributing cost across benefitting landowner rests with the landowners, for CP projects, this decision rests with the CEO. Every county calculates assessments differently. For example, in this study, county 1 uses a varied rate assessment per acre. It is based on a landowner’s proximity to the improvement, and how much of the improvement is the landowner using. This method is also called the “target method” of calculating assessments. In county 2, the method being used is called the “percent of benefit,” which is also a form of varied assessment method. In county 3, the engineer’s office looks at the number of acres of land a landowner has in the watershed as well as soil type, land use, and impervious area, to calculate a drainage coefficient. This helps in making an assessment of how much runoff a landowner is contributing to the improvement, based on which the assessment is calculated. Irrespective of the type of varied assessment method used, the goal is to distribute cost based on the benefit received by a landowner. Thus the net benefits (benefits minus costs) received is similar across landowners in CP projects. Hence V3, i.e. heterogeneity in individual net benefit, is low.
Low V3 affects collective action in CP depending on perceptions of fairness. Both survey respondents and interviewees indicated a mixed picture about perceptions of fairness. Perceived fairness of the distribution of costs and benefits emerged as an important factor for survey respondents’ willingness or non-willingness to participate in CP projects. 26 respondents perceived that the distribution of costs and benefits in CP projects was fair. For example, a survey respondent wrote, “This is the fairest way because everyone in the watershed will share the cost”. Another survey respondent wrote, “This is the best way and probably the fairest way of improving drainage”. On the contrary, 7 survey respondents felt that the distribution of costs and benefits in CP projects was unfair. For example, a survey respondent wrote, “County Commissioners made all the contributors pay…I get no help, no benefits. I am too far away”. An interviewee, supporting the argument that location within the watershed influences perceptions of fairness of V3, said, “I have heard landowners argue the assessment method in both ways. Whether they favor it, or are against it, often depends on where they are located in the watershed”. As per the varied assessment method, the closer a landowner is to the drainage improvement, the more benefits he derives and hence the more he pays. However, an interviewee contradicted this, he mentioned, “I believe what they [CEO] would tell you is that [landowner] closest to the ditch benefits the most. I do believe that’s how they figure out the cost. I know guys who are closest to the ditch, who will tell you that’s contrary to reality”. Overall, interviewees’ perception of landowners’ fair perception of the assessment method was supported by comments such as, “I cannot remember any situation where people have questioned the assessment”, “I think a
majority of landowners when they look at the target method they understand that it is the fair way to do it”, “I think probably most landowners would agree that varied rate assessment is most equitable”, and “I think the perception, and the feedback that we have got from talking to people about it [assessment method], I would say that they perceive the assessment method to be equitable”. Landowners who perceive this heterogeneity to be fair are more likely to participate in CP projects in the future, while those who perceive it as unfair are less likely to participate in CP projects in the future.

Although V3 is low in CP projects, since the varied assessment method is difficult to understand, it may hinder collective action. However, interviewees in this study recognized the importance of explaining this method to landowners, which in turn may then help collective action. Supporting the complexity of varied assessment method, an interviewee said, “I think it [varied assessment method] is very much similar to our tax evaluations. The equations may be complex in an attempt to be fair”. The importance of making landowners’ understand the cost distribution was reflected very well by an interviewee, who said, “They [landowners] will ask us how was our cost calculated, and we will explain it, and show it to them. After that they won’t dispute that. We have instances when he [Drainage Technician] actually explains to them how the cost was broken down”. Another interviewee, indicating that the ability to explain the varied assessment method to a landowner was important, mentioned, “I would hate to have somebody [a landowner] come in and say why I am being assessed, or how did you come

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13 Landowners who perceived V3 to be fair had a mean willingness score of 8.1 (n=18), while those who perceived V3 to be unfair had a mean willingness score of 5.1 (n=7). Willingness to participate in CP projects in the future was measured via the survey on a scale of 1 to 10, with 1 being not at all willing and 10 being very willing.
up with this assessment, and if I went errrrr……That’s going to get you into trouble…. It [varied assessment method] is something that I am comfortable with. I am comfortable discussing it. I am comfortable explaining where I am coming from. I think that’s what is important”.

Overall, the impact of heterogeneity in individual net benefits on collective action in CP depends on perceptions of fairness, which is related to the local government agency’s ability to explain the method via which cost is distributed across benefitting landowners. Most interviewees and survey respondents indicated a fair perception of V3.

**V4 – Security of contributions**

In CP projects, security of contributions includes two components related to project costs: the cost of initiating the petition and whether contributions are returned if drainage improvement is not provided. First, in a CP project, a petition is filed by the petitioning party, i.e. either a single or a group of landowners, by submitting a $500 bond, along with an additional $2 for each parcel of land in excess of 200 parcels listed in the petition as being benefitted. The bond money is used towards paper advertisement of the petition, mailing notices to all the landowners in the watershed, engineering costs, etc.

The second component of security of contributions is with respect to returning a landowner’s contributions if the CP project is not provided, which becomes important at two stages of the petition process – the preliminary and the final hearing. If the project gets disapproved at the preliminary hearing, the petitioners’ bond pays for the costs incurred up to then. As mentioned by an interviewee, “If the project is disapproved [at the first hearing], landowners get back whatever is left over [in the petitioners’ bond]. If there
was nothing returned to the landowners, the money got absorbed in the whole process”. Thus, if a petition gets disapproved at the first hearing, the petitioning landowners are at the risk of losing their bond money. If the project gets disapproved at the final hearing, then all the landowners within the watershed are assessed the costs incurred up to that point. As mentioned by an interviewee, “If the project gets passed after first hearing, after which we go out and do survey and all, everybody in the watershed pays if the project got disapproved [at the final hearing]”. Thus, if a petition gets disapproved at the final hearing, it is not only the petitioning landowners, but everyone in the watershed, including the petitioning landowners, must pay for the costs incurred up to that point.

Unlike MA projects, in which the local drainage management organization absorbs the upfront cost, there is no such avenue for CP projects. Instead, as explained earlier, petitioner/s incur costs in filing a petition. The presence of dissenting landowners in the group, both at the first and the final hearing, may only increase their level of insecurity about losing initial contributions without even obtaining the drainage improvement. Thus, the petitioning landowner/s may feel less secure about their contribution to the project. Hence V4 is low.

The low V4 for CP projects has important effects on collective action. Low V4, especially due to upfront costs associated with filing a petition, hinders collective action. For example, an interviewee mentioned, “The extra cost [petition bond] in petitioning the project is a constraint. We are looking at roughly twice the cost when compared with MA projects”. On the contrary, filing a bond by the petitioner/s was found to be indicative of their seriousness about the project. For example, an interviewee mentioned, “If you are
putting a 500 dollar bond, you are being serious about the project. You are not just doing it to get back to your neighbor”. Another interviewee added, “If you are serious about it [CP project], you are going to put a bond”. However, filing of a petition bond, by itself, was not found to be helpful for collective action. Overall, low V4, especially due to upfront costs associated with filing a petition bond, hinders collective action.

7.2.3. Summary of County Petition Project Variables and their Impacts

Examining the public-goods dilemma in the case of County Petition projects, through the analytical lens of the four variables (V1-V4), led to several insights, which are summarized in Table 2.6. Group size (V1) was found to be low in the first stage, and variable in the final stage of CP projects. This low level of V1 in the first stage hinders collective action by being indicative of disagreement with neighboring landowners on the perceived importance of a drainage improvement. Although V1 in the second stage is variable, low and high V1 were found to hinder and help collective action respectively. Whereas low V1 indicated that the project was not conducive to public welfare, high V1 was identified as a positive factor for a landowner’s willingness to participate in CP projects. High level of V1 in the second stage helps and hinders collective action also by correlating with large project size.

Landowners in CP projects do not have the capability to choose to enter or exit from the group. The boundary of the project is dictated by the watershed, and every landowner who is within this boundary, is considered to be part of the project and thus required to contribute. Hence V2 is low. This helps collective action by increasing certainty about the fate of the project and ensuring sufficient contributions to implement
the project is approved. Interestingly, low V2 may incentivize landowners to appeal to county commissioners to disapprove the whole project\textsuperscript{14}. But overall, the inability of landowners to choose to exit individually helps collective action.

For V3, the varied assessment method is used by CEOs for distributing cost, which leads to low heterogeneity in individual net benefits. This low level of V3 both helps and hinders collective action depending on how it affects perceptions of fairness. Most interviewees and landowners indicated it helps. Additionally, since varied assessment method is difficult to understand, a potential hindering effect on collective action is mitigated by the local government agency’s ability to explain the method.

For V4, security of contributions was found to be low for CP projects, due to two components: upfront costs associated with filing a petition, and lack of returning project money to individual contributors if the drainage improvement is not provided. The presence of dissenting landowners in the group, both at the first and the final hearing of CP projects, may increase petitioner/s level of insecurity about losing his initial contributions without even obtaining the drainage improvement. Low security of contributions hinders collective action by imposing financial risks on petitioning landowner/s.

\textsuperscript{14} County Commissioners’ decision to approve is based on the 3 criteria listed in the Ohio Revised Code: Firstly, benefits should exceed the cost. Secondly, the project should promote the public welfare. Thirdly, the project should be necessary. Any landowner who is opposed to the project can vocalize his opinion, which could matter, but not always.
7.2.4 Additional factors important for collective action in County Petition projects

In addressing this study’s third research question, several factors were identified as facilitating and hindering implementation of CP projects, based on interviews and survey responses. These variables have been categorized under 6 broad categories that emerged from the data: (1) Case specific variables, (2) Resources, (3) Contextual factors, (4) Interpersonal dynamics, (5) Individual level characteristics, & (6) Land-tenure systems (see Table 2.7).
<table>
<thead>
<tr>
<th>C2: CP Variable Category</th>
<th>List of Variables</th>
<th>Link to V1-V4</th>
<th>Interviewee Frequency&lt;sup&gt;b, c&lt;/sup&gt;</th>
<th>Survey Respondent Frequency&lt;sup&gt;d&lt;/sup&gt;</th>
<th>Impact on Collective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case specific (60)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Quality of maintenance on existing drainage improvements – Poor</td>
<td>V3: Decreases perceived fairness</td>
<td>1</td>
<td>26</td>
<td>HINDERS</td>
</tr>
<tr>
<td></td>
<td>Quality of maintenance on existing drainage improvements – Good</td>
<td>V3: Increases perceived fairness</td>
<td>0</td>
<td>10</td>
<td>HELPS</td>
</tr>
<tr>
<td></td>
<td>Future/permanent maintenance of drainage improvement</td>
<td></td>
<td>6</td>
<td>2</td>
<td>HELPS</td>
</tr>
<tr>
<td></td>
<td>Ohio Revised Code Structure for CP process</td>
<td>V2: Increases certainty about the fate of the project</td>
<td>3</td>
<td>5</td>
<td>HELPS</td>
</tr>
<tr>
<td></td>
<td>Lesser landowner control</td>
<td></td>
<td>0</td>
<td>7</td>
<td>HINDERS</td>
</tr>
<tr>
<td>Resources (53)</td>
<td>Financial – High overall project cost</td>
<td></td>
<td>7</td>
<td>29</td>
<td>HINDERS</td>
</tr>
<tr>
<td></td>
<td>Long project completion timeline</td>
<td></td>
<td>2</td>
<td>9</td>
<td>HINDERS</td>
</tr>
<tr>
<td></td>
<td>Timely project completion</td>
<td></td>
<td>0</td>
<td>1</td>
<td>HELPS</td>
</tr>
<tr>
<td></td>
<td>Information (govt. agents as provider of information)</td>
<td></td>
<td>3</td>
<td>0</td>
<td>HELPS</td>
</tr>
<tr>
<td></td>
<td>Technological (govt. agencies having drainage equipment)</td>
<td></td>
<td>0</td>
<td>2</td>
<td>HELPS</td>
</tr>
</tbody>
</table>

Table 2.7. Summary of additional variables with their impact on collective action for CP projects

Continued
Table 2.7 Continued

<table>
<thead>
<tr>
<th>Contextual factors (22)</th>
<th>Perceived importance of drainage improvement</th>
<th>V3: Increases perceived fairness</th>
<th>4</th>
<th>16</th>
<th>HELPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased federal control</td>
<td></td>
<td></td>
<td>2</td>
<td>0</td>
<td>HINDERS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interpersonal dynamics (8)</th>
<th>Peer pressure</th>
<th>V2: May lead to political pressure on county commissioners</th>
<th>1</th>
<th>2</th>
<th>HINDERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disagreement among landowners</td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>HINDERS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Individual level Characteristic (4)</th>
<th>House-lot owners</th>
<th></th>
<th>2</th>
<th>2</th>
<th>HINDERS</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Land-tenure (3)</th>
<th>Cash-renting</th>
<th></th>
<th>3</th>
<th>0</th>
<th>HINDERS</th>
</tr>
</thead>
</table>

Notes:

a The number inside parenthesis indicates the number of interviewees and survey respondents who mentioned a variable in that category.
b Although 16 interviews were conducted as part of this study, data about CP project was provided by 15 interviewees.
c Number of interviewees who mentioned this variable during the course of the interview.
d Number of survey respondent (landowner) who mentioned this variable in an open-ended question asking them to identify reasons for their willingness or non-willingness to participate in CP projects.
Factors specific to the case, i.e. CP projects, were most frequently identified as being important for collective action. The first factor hindering collective action in CP projects is the landowners’ perception that petitioned projects which are currently under permanent maintenance are not being maintained well by the County Engineers’ Office. This acts as a deterrent in wanting to participate in the petition process. As one interviewee said, “I guess, maybe that’s the reason why some people don’t like to go through the [CP] process because they don’t think that they are getting anything in return”. Further evidence in this regard was provided by some survey respondents, who wrote, “Maintenance is not very good”, “They [CEO] don't keep up with maintenance”, and “The county engineer ditch improvements are destructive resulting in channelization, deforestation, bank erosion and sedimentation”. On the contrary, other survey respondents felt that the project currently under permanent maintenance are being maintained well: “I think our county does an excellent job of maintenance”, and “Done correctly by county”. The next factor helping collective action in CP projects is that of the benefit of future/permanent maintenance. For example, an interviewee mentioned, “Landowners favor CP process as it puts their ditch on permanent maintenance”. Survey respondents, who also liked the benefit of future/permanent maintenance, wrote, “[Drainage improvement] will be maintained for future generations”, and “Willing because of longevity”.

The next case specific factor identified as a facilitator of CP projects was the fact that the Ohio Revised Code (ORC: chapters 6131 & 6137) provides a structure to the process of obtaining a drainage improvement. As one interviewee said, “There is an order
to the whole process, and it is something you can fall back on”. Another interviewee, who also felt that the ORC structure facilitates CP projects, said, “For CP projects there is a system to collect money, and they can be assessed directly on the taxes”. He further added, “If the [CP] project goes through then it’s going to get paid, and also it’s going to be on maintenance afterwards”. A structured process also allows for a project to get passed if it can be established that the benefits of the project exceed its costs. This is one of the clauses under the ORC Chapter 6131 for approval of petition projects. The next case specific factor which could hinder implementation of CP projects is that landowners have less control over the project. For example, indicating their non-willingness to participate in CP projects, a few survey respondents wrote, “Not much choice unless you can show good reason that [CP] project should or should not go”, “Less control on the project”, and “Don't always agree but don't really have much input”.

Resources were identified as the next factor important for collective action in CP projects. Both survey respondents and interviewees reported that CP projects have a higher project cost than MA projects. For example, indicating their non-willingness to participate in CP projects, a few survey respondents wrote, “With county petition the costs that all parties [landowners] would end up paying would double”, “Usually two to three times the actual cost than private contractors [under MA] could do the job”, “Way too expensive”, and “Cost sometimes are excessive”. Reporting that CP projects costs more, an interviewee mentioned, “[In CP] we are looking at roughly twice the cost when compared with mutual agreement”. Another interviewee further added, “If the construction was done under county petition the base price itself will be high, and
subsequently the percentage of assessment [for maintenance] which will be collected on a yearly basis will also be higher”. Survey respondents and interviewees in this study also reported that CP projects have a longer project completion timeline, i.e. the time required from the filing of a county petition to the construction of the drainage improvement. For example, an interviewee mentioned, “County petitions are time consuming because you have got to bid for the contractors, you have got to deal with government bureaucracy”. Another interviewee further added, “I don’t think landowners like to petition too many ditches because it is time consuming”. Citing both higher project cost and long timeline as reasons for landowners’ non-willingness to participate in CP projects, an interviewee mentioned, “It does happen quite a bit where the landowner is discouraged about going through the petition process because it does cost more money and takes more time”. Survey respondents provided further evidence for the long timeline associated with CP projects. Some of the survey respondents, indicating their non-willingness to participate in CP projects, wrote, “Takes too long to reach a decision”, “Takes a lot of time to get implemented”, and “This would involve a lot of time”. On the contrary, one survey respondent wrote: “It usually gets done on time”. Interviewees and survey respondents also reported the crucial roles of the local government agency, specifically the county engineers’ office, in providing pictorial evidence of the drainage problem to disagreeing landowners, establishing that benefits of the project exceed its costs, and also having the equipment and knowledge for providing the drainage improvement. For example, survey respondents wrote, “The County is maintaining areas for me and others that we don't
have the time and/or equipment to do the job and some areas may not be accessible”, and “They [the county engineers’ office] have equipment and knowledge”.

A contextual factor pertaining to the perceived importance of drainage improvement was identified as the next important factor for collective action in CP projects. Drainage was perceived to be important from several perspectives. For example, emphasizing the importance of drainage for farmers, and identifying that as a reason why farmers choose to cooperate for CP projects, an interviewee said, “Much of the drainage in our county is driven by farmers, whose motivation is to drain properly and make good money”. Another interviewee mentioned, “Because we are an agricultural county, even if landowners disagree, they go with the project”. Having mutual benefits from drainage improvement was also identified as another reason for landowners to cooperate in CP projects. For example, an interviewee said, “If two landowners understand what drainage will do for them…If they understand that there is an issue, and that both of them contribute to it”. Drainage was also perceived to be important in relation to geography. As one interviewee said, “A project from flat, marshy area gets approved because landowners there realize the benefits of improved drainage”. Perceived importance of drainage improvement was also identified as an important factor by survey respondents. For example, landowners commented that their willingness to participate in CP projects was affected by, “I am pro drainage, so I like the ditch to be in good working condition. I am very willing to pay dollars to have that”, “Our [drainage tile] outlets are old and need updated. Drainage is very important for maximizing crop yield and reducing erosion”, and “When necessary it’s in everyone’s best interest to go this way [CP]”. Another
contextual factor hindering implementation of CP projects is related to the increased federal control on CP projects in the form of stringent regulations, requirements of undertaking mitigation projects, etc. which in turn makes the project cost prohibitive. As one interviewee said, “Government, specifically EPA, is a constraint in implementing group drainage [CP] projects. Their regulations are pretty stringent. For some of our large drainage projects, we are required to go through Army Corps, which in turn slows down the project, as we are required to do multiple studies, get a lot of approvals. Sometimes you see a lot of cost associated with these approvals, but don’t see how they would be beneficial”. Citing this as a reason why CP projects get disapproved, he further added, “If cost of the project exceeds its benefits, the county commissioner disapproves the petition”.

Interpersonal dynamics were identified as the next important factor for collective action in CP projects. Specifically, peer pressure was identified as a factor which could hinder implementation of CP projects. As one interviewee said, “There is always some peer pressure. Some petitioners get harassed by others who do not want the project”. Another interviewee added, “In a petition process, you can make people pretty mad at you…it can get pretty heated in a small community”. The interviewee was referring to an instance when a ditch needed a lot of work, but the landowner decided not to petition it, as it would have his neighbors very unhappy with him. He further added, “It [peer pressure] does keep people from making petitions. It is a restriction…he will live with his temporary flooding rather than have all of his neighbors want to tar and feather him. This is the way society works. You choose your battles”. Another factor pertaining to
interpersonal dynamics which hindered implementation of CP projects was that of having disagreements among landowners. For example, a survey respondent wrote, “Neighbors get mad and don't like when they have to pay for something that they don't owe”.

Individual level characteristics were identified as the next important factor for collective action in CP projects. Specifically, having house-lot/homeowners were identified as factors which could hinder implementation of CP projects. As one interviewee said, “We also see an influx of, what I call, city people. They don’t have a clue about drainage… [They] don’t have that network of old timers, and it is hard for them to understand”. This also leads to disagreements within the group of landowners wanting to petition for a drainage improvement. For example, while talking about constraints in implementing CP projects, a survey respondent wrote, “Homeowners object to any cost”. Although another survey respondent wrote, “non-farmers cannot overrule it [CP project]”.

Land-tenure arrangement of cash-renting was identified as an important factors for collective action in CP projects. Specifically, being an absentee landowner and having a cash-renting land tenure agreement interact to hinder implementation of CP projects. Whereas the absentee landowner may not understand the value of drainage, and only wants his share of money, the renter who actually farms the ground may understand the importance of drainage, but does not have any incentive to invest in maintaining the drainage ditch. An interviewee described the absentee landowner and cash-renting farmer relationship, as follows, “He [renter] sends me [landowner] a check once a year. I don’t really even know what it [drainage issue] looks like, and what’s going on. I don’t care
what happens to it. I don’t care if it is causing you [reenter] a problem. I am getting that check once every year from you and I am fine”. Another interviewee further added, “We have a number of absentee landowners in this county. So, they rent out their farms. The cost of taking care of tile/ditch is not included in a renter’s rent”.

7.2.5. Summary of County Petition Project Additional Variables and their Impacts

In addressing this study’s third research question, six groups of additional factors were identified which had an impact on implementation of CP projects (see Table 2.7). Unlike MA projects, case specific variables were most often identified as an important factor for collective action in CP projects. Overall, for both CP & MA projects, resources were often identified as an important factor for collective action. Although, compared to MA projects, for which variables related to resources were found to help collective action, for CP, resources in the form of higher cost and longer timeline, hindered collective action. Additionally, compared to MA projects, interpersonal dynamics were found not to be as important for collective action in CP projects.

Some of the additional factors link to the key variables of interest, V1-V4. For example, a landowner who perceives that the quality of maintenance on existing drainage improvements is poor, may perceive that he is paying more cost in comparison with the benefits he is receiving, which in turn, decreases his fairness perception of V3 (Heterogeneity in individual net benefit). Citing this as a reason why landowners may not want to participate in the petition process, an interviewee mentioned, “I guess, maybe that’s the reason why some people don’t like to go through the [CP] process because they
don’t think that they are getting anything in return”. Survey respondents (landowners) provided further evidence in this regard. They wrote, “County does what they want and use the money for other things… [They] don't take care of ditch”, and “They want to put the ditch on permanent maintenance to ensure a regular source of income that never has to be voted on and has no end date”. On the contrary, a landowner who perceives that the quality of maintenance on existing drainage improvements is good, may perceive that he is paying his fair share of cost in comparison with the benefits he is receiving, which in turn, increases his fairness perception of V3. Another additional factor that directly links back to increased certainty about the fate of the project, one of the key effects of variable V2 (ability to enter/exit; see Table 2.6), is that the Ohio Revised Code provides a structure to the county petition process. For example, a survey respondent wrote, “In this case [CP] the landowner could object to the ditch maintenance but still will be required to pay if the petitioner gets the commissioner to agree to the petition”. Perceived importance of drainage improvement project may directly link back to an increase in fairness perception of V3. For example, an interviewee mentioned, “Because we are an agricultural county, even if landowners disagree, they go with the [CP] project”. Disagreement among landowners is the next factor that links back to the possibility of political pressure on county commissioners, one of the key effects of variable V2 (ability to enter/exit; see Table 2.6). Although V2 is low in CP projects for an individual landowner, if enough individuals wish to exit the group, i.e. disagree with the need of the project, they might prevail by appealing to the county commissioners for the project to get disapproved. However, as mentioned by an interviewee, “Normally, this [petition]
gets brought to light because one of the landowners has an issue with water…that landowner tries to get as many people that’s in that watershed on his side as possible. You may still have a few holdouts, but if you got the majority, you are going to get your petition pushed through”.

**Section 8. Discussion**

Extant scholarly work on understanding collective action dilemmas has often focused on examining structural variables that affect behavior in collective action dilemmas. Debates have continued about whether and how particular factors, such as group size and heterogeneity, affect prospects of collective action (Poteete & Ostrom, 2004). Synthesis of findings across decades of scholarship has led to identification of several such key variables of interest for collective action dilemmas (Poteete, et al., 2010). However, these variables have not been examined for the public-goods dilemma, a form of collective action dilemma, in agricultural drainage systems. Specifically, examining drainage management institutions and how each of these institutional mechanism affects the values of the four key variables of interest (V1-V4) leads to several new insights. In the following paragraphs, I compare both cases from the analytical lens of the 4 key variables of interest (V1-V4), specifically examining the variable values, their impact on collective action, and implications for theory.
<table>
<thead>
<tr>
<th>Case</th>
<th>V1 (Group size)</th>
<th>V2 (Ability to enter/exit)</th>
<th>V3 (Heterogeneity in individual net benefit)</th>
<th>V4 (Security of contributions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1: MA</td>
<td>Low HELPS ()</td>
<td>High HINDERS ()</td>
<td>High BOTH (**)</td>
<td>High HELPS (*)</td>
</tr>
<tr>
<td>Case 2: CP</td>
<td>Variable UNCLEAR</td>
<td>Low HELPS ()</td>
<td>Low MOSTLY HELPS (**)</td>
<td>Low HINDERS (*)</td>
</tr>
</tbody>
</table>

Table 2.8. Cross case comparisons

Notes:
() Does not support theoretical expectations based on prior studies
(*) Limited support for theoretical expectations based on prior studies
(**) Supports theoretical expectations based on prior studies

In mutual agreement (MA), the first case in this study, low value of group size (V1) was found to help collective action. This finding does not support prior studies on the effect of group size in public-goods dilemmas. Several mechanisms were identified through which group size affects collective action. Small group size was found to help collective action by providing drainage improvement at a lower cost, by allowing landowners to have greater control over the project, and by allowing a landowner to spearhead the project. In addition, small group size was found to help collective action due to small project size and the Olson effect. A small group size, in correlation with small project size, was found to allow communication within the group and thus help collective action. The Olson effect allowed unilateral provision of the drainage improvement by a subset of landowners who expect greater drainage benefits. The theoretical expectation of a small group size is that it will hinder successful provisioning of a public-good. Prior studies argue that a large group is expected to contain a critical
mass of individuals whose interests are served by providing a public-good (Marwell & Oliver, 1993), and that as the group gets larger cooperation by an individual increases the non-subtractive benefit to all without affecting individual costs (Poteete et al., 2010). Accounting for income effects, Poteete & Ostrom (2004) also argue that public goods provisioning increases with group size. Although most studies argue that high group size should help in a public-goods dilemma, my result does not support this for Mutual Agreement. As explained earlier, a small group size allowed provisioning of a group drainage improvement at a lower cost. Additionally, a small group size allowed for effective communication and coordination among landowners by allowing them to spearhead the project and have greater control over it. This contradictory finding is supported by other scholars who argue that a large group size may hinder collective action by making it harder to shape others’ behavior, by making it easier to defect, by making communication and coordination of actions difficult, by reducing the efficacy of one’s action and by making monitoring and sanctioning difficult (Kollock, 1998; Olson, 1965).

For mutual agreement, the ability to choose to enter or exit from a group (V2) was found to hinder collective action. This finding does not support prior studies. High V2 in this case hindered collective action by increasing uncertainty about the fate of the project and conflicting with private property rights. The theoretical expectation of V2 helping collective action comes from experimental social dilemmas where a high V2 enables individuals to enter a collective action situation when others are cooperating and to leave when they are dissatisfied with outcomes (Poteete et al., 2010). Additionally, the
literature does not specify the type of collective action situation, i.e. whether it is a public-goods dilemma or common-pool resource dilemma. As results in this study indicate, due to high V2 a landowner could choose not to contribute towards the provisioning of a drainage improvement and thus free-ride on the efforts of others. Doing so, as results indicate, increases the uncertainty about the fate of the project. Additionally, unlike in experimental dilemmas, the field context also becomes important, as indicated by how exercising rights to land hinders collective action. Hence, the extant theory is limited to experimental dilemmas, does not specify the type of collective action problem, and does not take into account the crucial role of context.

For mutual agreement, high value of heterogeneity in individual net benefit (V3) was found to both help and hinder collective action. This finding supports prior studies. High V3 was found to directly help as well as hinder collective action depending on perceptions of fairness. High V3 was also found to indirectly help collective action depending upon the ease of understanding the method by which cost is distributed across benefitting landowners. Although the effect of “heterogeneity” on collective action continues to remain contested, scholarly work focusing specifically on heterogeneity in benefits and costs emphasizes the importance of the perceived fairness of the method of distributing costs and benefits. For example, participants have been found to be more willing to contribute when they think that a proposal for sharing costs and benefits is fair (Biel & Thøgersen, 2007; Poteete, et al., 2010). As results in this study indicate, the perceptions of fairness/unfairness of heterogeneity in individual net benefit helps/hinders collective action. The findings in this study also align well with the finding that even
though heterogeneity may have a negative effect on collective action, with respect to the level of participation, the collective good of drainage improvement may still be provided due to the Olson effect (Ruttan, 2008).

For mutual agreement, high value of security of security of contributions (V4) was found to help collective action. This finding provides limited support for prior studies. High V4, especially by securing agreed upon shares of individual costs upfront, was found to help collective action. The theoretical expectation of V4 helping collective action comes from experimental social dilemmas where a high V4 is expected to reduce the risk of contributing resources and getting nothing in return (Poteete et al., 2010). However, as the results in this study indicate, MA projects reduce risk of a contributor based on four components related to project costs: who absorbs the costs of initiating the project, the amount of these costs, locally devised arrangements to secure contributions, and whether contributions are returned if drainage improvement is not provided. The component of reducing risk (or increasing security of contribution) which becomes most important in MA projects is that of securing agreed upon share of individual costs upfront. Hence, the extant theory is limited to experimental dilemmas and does not take into account the crucial role of context.

In county petition (CP), the second case in this study, group size (V1) was found to be dependent upon the stage of the project. Specifically, group size (V1) was found to be low in the first stage, and variable in the final stage of CP projects. This low level of V1 in the first stage was found to hinder collective action by being indicative of disagreement with neighboring landowners on the perceived importance of a drainage
improvement. Low and high V1 was found to hinder and help collective action respectively in the second stage of CP projects. While low V1 indicated that the project was not conducive to public welfare, high V1 was identified as a positive factor for a landowner’s willingness to participate in CP projects. High level of V1 in the second stage was found to both help and hinder collective action by correlating with large project size. To sum up, group size (V1) was found to be variable in CP projects, with an overall unclear effect on collective action. Although it is difficult to infer as to how these findings situate in the extant literature, the findings do lead to identification of several interacting variables, and highlight the importance of broadening our understanding of group size from merely the number of individuals in a group that could engage in collective action (Agrawal, 2001; Poteete & Ostrom, 2004), to paying careful attention to how group size varies at different stages of a public-goods provisioning situation and affects prospects of collective action. These findings also situate well in the extant scholarly debate about what is a small and large group and the role of context in mediating the effects of group size (Araral, 2009).

For county petition, low value of ability to choose to enter or exit from a group (V2) was found to help collective action. Low V2 helps collective action by increasing certainty about the fate of the project. Keeping benefiting landowners from free-riding increases the resource base available to pay the costs of the collective action. However, if enough landowners are upset about their inability to exit from the group, it is possible that they may put pressure on county commissioners to cancel the whole project, which might hinder collective action. The theoretical expectation of high V2 helping collective
action comes from experimental social dilemmas wherein, as it enables individuals to enter a collective action situation when others are cooperating and to leave when they are dissatisfied with outcomes (Poteete et al., 2010). As results in this study indicate, instead, due to low V2 a landowner cannot choose to opt out of contributing. This in turn increases the certainty about the fate of the project. Additionally, unlike in experimental dilemmas, the field context also becomes important, as indicated by the potential for pressure on elected county commissioners to disapprove the project. Hence, the extant theory is limited to experimental dilemmas and does not take into account the crucial role of context.

For county petition, low value of heterogeneity in individual net benefit (V3) was found to mostly help collective action. This finding supports prior studies. Just like in mutual agreement, the impact of V3 was found to depend on perceptions of fairness. Since V3 is calculated based on a complicated (varied assessment) method, a potential hindering effect on collective action, due to the difficulty in understanding the method, is mitigated by the local government agency’s ability to explain it and help a landowner understand how cost was distributed across benefitting landowners. Although the effect of “heterogeneity” on collective action continues to remain contested, scholarly work focusing specifically on heterogeneity in benefits and costs emphasizes the importance of the perceived fairness of the method of distributing costs and benefits. For example, participants have been found to be more willing to contribute when they think that a proposal for sharing costs and benefits is fair (Biel & Thøgersen, 2007; Poteete, et al.,
2010). As results indicate, the perceptions of fairness/unfairness of heterogeneity in individual net benefit helps/hinders collective action.

For county petition, the low value of security of contributions (V4) was found to hinder collective action. This finding provides limited support for prior studies. Low V4, especially due to upfront cost associated with filing a petition was found to hinder collective action. The theoretical expectation of V4 helping collective action comes from experimental social dilemmas where a high V4 is expected to reduce the risk of contributing resources and getting nothing in return (Poteete et al., 2010). However, as the results in this study indicate, MA projects reduce risk of a contributor based on two components: upfront costs associated with filing a petition, and having a provision for returning project money, if any money is left, to individual contributors if the drainage improvement is not provided. The component of increasing risk (or decreasing security of contribution) which is most important in CP projects is that of upfront cost associated with filing a petition. Hence, the extant theory is limited to experimental dilemmas and does not take into account the crucial role of context.

In addition to the examination of variable values of key interest (V1-V4), their impact on collective action, and implications for theory, examining drainage management institutions leads to further insights. The first insight pertains to how the theoretically expected effect of a variable on collective action is influenced by interactive effects both from the drainage management institution and from other factors. For example, the expected negative effect of heterogeneity in individual net benefits was mitigated since the institutional mechanism of mutual agreement allows landowners to agree upon the
heterogeneity (inequality) in individual net benefit. This insight is supported by extant scholarly work providing evidence that institutions mediate the effects of forms of heterogeneity (Poteete & Ostrom, 2004; Mudliar, 2016).

The second insight pertains to how variable values of key interest (V1-V4) are shaped by the drainage management institution, however, their effect on collective action occurs through several mechanisms, as summarized earlier in this section. As the analysis in this study indicates, two key variables (V1 & V2), do not support theoretical expectations based on prior studies, V4 somewhat supports theoretical expectations based on prior studies, whereas, V3 supports theoretical expectations based on prior studies.

The third insight pertains to the Olson effect exhibited in provisioning of agricultural drainage systems. This is the condition where some individuals provide collective goods because they receive a disproportionate share of benefits (Ruttan, 2008). The Olson effect has also been found to be empirically supported for studies of global commons (Ostrom, 2003), which may indicate the theoretical parallels that can be drawn with agricultural drainage systems. Just like the global commons, such as air pollution and climate change, drained water is a “collective bad”. However, the contrasting feature in agricultural drainage is that the unlike global commons, for which the group size is very large, group size in case of mutual agreement projects is small. A potential avenue for future research is to understand whether and how drainage systems provide a small scale to study and understand broader implications for climate change.

The fourth insight pertains to the theoretically important, as well as practically relevant scaling of the project size and issue with an underlying institutional mechanism.
Drainage management institutions in Ohio represent a suite of institutional options available for landowners to choose from. For example, whereas MA projects are suitable for small scale projects, CP projects fit a range of projects from small, to large, to even projects that cross county boundaries. In addition to having the choice of scale with respect to project size, landowners also have the choice of pursuing an institutional mechanism based on their preference for involvement of government agencies. Their choice ranges from minimal government involvement for MA projects to maximum government involvement for CP projects.

The fifth insight pertains to the theoretically important interactive nature exhibited by the two institutional mechanisms examined in this study. The presence of MA mechanism seems to be good as a first attempt to foster collective action, which landowners may prefer for smaller projects and CEOs/SWCDs direct landowners to first. The CP mechanism is more suited to larger areas and more landowners, or if landowners cannot come to a mutual agreement themselves. Rather than finding that one type of institution is always better than the other, it is evident that MA is sometimes more successful and CP is sometimes more successful, and in fact they are complementary. Whereas MA (Case 1) provides a landowner-driven institutional mechanism to give a first attempt at generating collective action, if that fails, CP (Case 2) acts as a government-driven institutional back-up to facilitate collective action. This resonates with Ostrom’s design principles encouraging users to develop their own rule making (including cost allocation for projects) but if this fails then there should be an outside government entity available. While Ostrom’s design principles see this outside entity as
important for conflict resolution (Ostrom, 1990, 2009), this case (CP) suggests another role for the outside entity: to provide an alternative institutional arrangement in case the MA is not successful. Thus, a theoretical argument can be made to consider the role for government beyond just existing as a conflict resolution venue. Rather, a key government role may be to supply an alternative institution for stakeholders to generate collective action. This insight is in line with studies of collaborative environmental management describing the complementarity of community-driven efforts and government resources (Koontz et al., 2004).

The sixth insight builds upon the previous insight about the interactive nature exhibited by the two institutional mechanisms examined in this study. As mentioned in the preceding paragraph, the presence of MA seems to be good as a first attempt to foster collective action between landowners voluntarily, however, if that fails, CP acts as a government-driven institutional back-up which can then force dissenting landowners to contribute towards the group drainage improvement. Presence of a government-driven institutional back-up which can force contributions by dissenting landowners, may thus incentivize landowners to voluntarily work together under the auspices of MA. Hence, this study finds that MA and CP are not just complementary. Since landowners have the choice of pursuing either of the two institutional mechanism, presence of CP as a back-up may thus incentivize collective action in MA.

Finally, this study also highlights the importance of understanding the impact of exurbanization, migration of urban residents to rural environments, on the two institutional mechanisms. Influx of urban residents into the agricultural landscape may
increase the level of heterogeneity of preference about the importance of drainage improvement, a factor important for collective action in both MA & CP. High level of heterogeneity of preference may especially hurt collective action in MA since interpersonal dynamics are very important for this institutional mechanism. Thus, exurbanization may lead to a high level of heterogeneity in preference about the drainage improvement, which may then lead to landowners opting for CP instead of MA for obtaining drainage improvements. Additionally, exurbanization may also lead to parcelization of land holdings in the agricultural landscape. Due to smaller divisions of formerly large holdings, the number of landowners in a given drainage basin will increase. As per the extant literature, large group size should help collective action for public goods provision, since cooperation by an individual increases the non-subtractive benefit to all without affecting individual costs. However, one also needs to be mindful of the impact of the contextual factor of land parcelization on not only increasing group size, but also increasing heterogeneity of preference about drainage improvement. A large group size, driven by land parcelization, may thus increase the transaction costs associated with reaching an agreement under MA projects, thus leading landowners to opt for CP instead of MA for obtaining drainage improvements. Theoretically, accounting for the factor of exurbanization will become important for understanding the role of group size in providing a public good.
Section 9. Implications for managers

A theoretically driven exploration of drainage management institutions led to several aforementioned insights. However, a practical question remains – what implications do these findings have for managers in the local government agencies?

A critical factor helping/hindering collective action for group drainage improvements, common to both the institutional mechanisms, is the fairness perception of how cost is distributed among benefitting landowners. As this study indicates, the willingness of landowners to contribute towards a group drainage improvement is driven by whether or not they perceive the cost-benefit distribution to be fair. In addition, a factor which becomes important, especially for CP projects, is whether and how the local government agency explains their assessment method. Thus, as much as managers should focus on evaluating the cost-benefit ratio of the project, they should also take steps at the local watershed level to explain their assessment method to the landowners.

Resources are indeed an important factor driving collective action under both the institutional mechanisms. The cost and time efficiency of MA projects helped them, while for CP projects, higher cost and longer timeline were identified as hindering factors for collective action. Yet another critical factor driving collective action in CP projects was landowners’ perception of the quality of maintenance on existing drainage improvements. Thus, devising ways to reduce project costs, shorten project timeline, and also address landowners’ perception of the quality of maintenance could help foster collective action for CP projects. Given the importance of interpersonal dynamics in MA projects, managers should also take steps to facilitate working relationships between
landowners, especially in agricultural landscapes experiencing influx of urban population. Additionally, managers could also serve the role of organizing a MA project and facilitating it proactively.

As described earlier, institutional mechanisms for obtaining group drainage improvements in Ohio represent a set of institutions which are conducive to scaling based on the scope of the project, as well as providing landowners the choice of selecting a landowner-driven approach or a government-driven institutional approach to achieve their drainage management goals. Given the importance of drainage in the Midwestern United States, this could be a critical point of learning for managers and policy makers in other states. However, as much as matching institutions to the scale and scope of problems is important, what is also critical is to make the institutions resource efficient. As was found in this study, government-driven institutional back-up to facilitate collective action is important, however, it is also critical that these institutions help landowners achieve drainage management goals timely and at a low cost.

A much broader, but very practical implication of this study is to contribute to the extant scholarly work espousing for changing the role of drainage from simply a means of conveying water to that of seeing them as an edge-of-the field opportunity to deal with non-point source pollution runoff (Needelman, et al., 2007; Strock, et al., 2010). However, as much as bringing this change is necessary, so is having an understanding of the compatibility of any new drainage practices with the existing drainage ditch laws (D’Ambrosio, 2013). With a rich understanding of the institutional fabric within which landowners make decisions about their drainage management practices, with this study,
my hope is that managers and policy makers will be able to help landowners make informed decision about their drainage practices.

Section 10. Conclusion

The goal of this study was to examine how collective action variables (V1-V4) are shaped by drainage management institutions, and subsequently impact collective action. In order to understand collective action in drainage management, this study conceptualizes drainage management from the theoretical lens of a public-goods dilemma. As was found in this study, construction and maintenance of agricultural drainage systems exhibit the characteristics of non-excludability, i.e. all may benefit, regardless of whether they have helped provide the good. Purposive selection of two contrasting cases (Mutual Agreement and County Petition) allowed investigation of a public-goods dilemma in provisioning agricultural drainage systems. Doing so also allowed close examination of variable interactions. Additionally, given the continuing scholarly debate and interest about whether and how particular factors affect prospects of collective action, and given that these factors have been untested for agricultural drainage systems, this study provided some critical theoretical clarifications. Specifically, theoretical contributions were made to our understanding of group size and security of contributions. Group size was found to become critical at different stages of county petition projects. The understanding of security of contributions was also broadened by including components of having provision for absorbing contributions incurred upfront, the amount of contributions itself, and whether there are locally devised arrangements to secure contributions.
Qualitative data analysis from 16 government agents and 244 landowners indicated that collective action variable values are indeed determined by the drainage management institution, however, their overall effect on collective action occurs through several interacting variables. Several such variables of theoretical importance were identified, including the Olson effect for group size (V1), uncertainty/certainty about the fate of project for ability to choose to enter/exit (V2), fairness perception and ease of understanding the method used for distributing costs and benefits for heterogeneity in benefits and costs (V3), and the critical role of securing contributions in mutual agreement and the contributions required upfront in county petition, for security of contributions (V4). As the analysis in this study indicates, two key variables (V1 & V2), do not support theoretical expectations based on prior studies, V4 somewhat supports theoretical expectations based on prior studies, whereas, V3 supports theoretical expectations based on prior studies.

This study also led to identification of several additional factors which effect collective action for the two institutional mechanisms. These additional factors were categorized under 6 broad categories that emerged from the data: (1) Case specific variables, (2) Resources, (3) Contextual factors, (4) Interpersonal dynamics, (5) Individual level characteristics, & (6) Land-tenure systems. Overall, for both CP & MA projects, resources were often identified as an important factor for collective action. Although, unlike MA projects, for which variables related to resources were found to help collective action, for CP, resources in the form of higher cost and longer timeline,
hindered collective action. Additionally, unlike MA projects, interpersonal dynamics were found not to be as important for collective action in CP projects.

Like all studies this one has limits. An important limitation is lack of data on group drainage improvements obtained under the two institutional mechanisms. Although CP projects are well recorded by respective county engineers’ office, unfortunately written records are not kept in a systematic manner for MA projects to determine the number of projects initiated or implemented. Despite the lack of this data, by following a case study approach, I was able to closely examine the conditions under which a landowner would be willing to participate in a group drainage improvement mechanism, as well as the conditions under which the collective good of a group drainage improvement is provided. Future endeavors to examine drainage management institutions in Ohio could select counties where records are maintained for both types of projects. Additionally, by following a survey methodology, scholars could test how key variables (V1-V4) interact with the mechanisms (interacting variables) identified in this study, to affect implementation of group drainage improvement projects.

As analyzing collective action variables indicates, drainage systems provide a rich foundation for advancing the theory of collective action. However, as much as this study provides conceptual clarifications and theoretical insights, it also leaves a number of questions unanswered. In particular, results raise several important questions and avenues for future research:

1. Can drainage be conceptualized as collective action for removing the “collective bad” of excess water, which helps get rid of polluted water from agricultural
fields? If yes, what parallels can be drawn with other “collective bads”, such as climate change, air pollution, water quality, etc., specifically with respect to Olson effect?

2. Methodologically, as scholars, do we limit the scale of our analytical lens if we narrow ourselves down to specific variables? As shown in this study, variable interactions are important to closely understand their effect on collective action.

3. The second key variable of interest in this study, V2 – the capability to choose to enter or exit from a group, poses a theoretically relevant question. Given that one of the institutions in this study limited V2 at an individual level, however, if enough individuals choose to be against the project, then they can exercise V2 collectively and possibly hinder approval of the project. The theoretically relevant questions is, as scholars do we need to give more attention to individual V2, or collective V2, when examining implications for collective action?
Chapter 3: Resource asymmetry and property-rights in agricultural drainage systems: implications for collective action

Section 1. Introduction & Rationale

Natural resource management, including water management, often requires resource users to work collectively. A classic example of such a resource management scenario is an irrigation system where a group of farmers act collectively to distribute water among themselves. This resource management scenario, although it sounds simple, is complex and grounded in the theory of “collective action”. Such an action requires the involvement of a group of people (e.g., farmers), a shared interest within the group (e.g., to enhance agricultural productivity), and coordinated behavior (e.g., coordinating water withdrawal rates/quantity) that works in pursuit of that shared interest (Meinzen-Dick, et al., 2004). Simply defined, collective action is an action taken by a group to achieve common interests (Meinzen-Dick & Di Gregorio, 2004).

However, given that resource users often have diverse interests and incentives, natural resource management poses collective action dilemmas. Garrett Hardin (1968), in *The Tragedy of the Commons*, provided the famous example of a grazing pasture representing a collective action dilemma of herders pursuing a non-cooperative strategy. The herders kept as many cattle as possible on the pasture in order to maximize individual outcomes. Because each additional animal brought individual gains that exceeded individual costs from overgrazing, each herder rationally decided to add more
cattle. However, if every herder pursued the same strategy, it led to degradation of the pasture for all—including the individual herders.

Nobel laureate Elinor Ostrom's (1990) pioneering work on understanding collective action in a variety of natural resource management contexts, such as forests, irrigation systems, and fisheries, showed that local resource users can sometimes overcome such dilemmas by devising property rights and acting collectively to successfully manage a resource. Property rights can be defined as “the capacity to call upon the collective to stand behind one’s claim to a benefit stream” (Bromley, 1991). These rights define who has access to the resource, how much can be harvested, who can manage, and how rights can be transferred (Schlager & Ostrom, 1992).

A plethora of collective action studies have investigated patterns of property rights and institutions of collective action for irrigation systems (Fujie, et al., 2005; Totin et al., 2014), fisheries (Kanchanaroek, et al., 2013; Schlager, 1994) and forests (Agrawal & Ostrom, 2001; Roy et al., 2012). Such institutional analysis has usually focused on common-pool resources (CPRs) that are held by the community, i.e. under a common-property regime. Less is known about common-pool resources which are held in a private property (land) ownership regime. Additionally, property rights literature

15 Goods/Resources have been identified in the extant literature based on the concepts of “exclusion”, i.e. how easy or costly it is to exclude or limit potential users from consuming a resource, and “subtractability”, i.e. whether consumption of a resource by one person subtracts from the availability of benefits to others (Ostrom, 2003). Common-pool resources are characterized by subtractability and high costs of exclusion (McGinnis, 2011).

16 A property right regime refers to the decision-making arrangements that define the conditions of access to and control over a range of benefits arising from a collectively used resource system (Edwards & Steins, 1998). Most commonly identified property rights regimes are open access, public/state property, common-property, and private/individual property (Bromley, 1992; Steins & Edwards, 1999). Under a common-property regime, use rights to a resource are attached to a specific user group.
typically examines resources without spatial asymmetries (Janssen & Rollins, 2012). In an asymmetric dilemma, the relative positions of resource users at the head and tail of the system generates asymmetric access to the resource (Ostrom & Gardner, 1993). Such physical arrangement of resource users affects their incentives for collective action. An agricultural drainage system is an example of a resource exhibiting an asymmetric dilemma, where multiple farmers own land parcels (a private property ownership regime) but not the drainage system, which is the common-pool resource\textsuperscript{17}.

Interestingly, water as a desired “good”, for irrigation, has long been studied by collective action scholars using institutional analysis (Fujiie, et al., 2005; Totin et al., 2014), yet water as a “bad” that is drained to allow crop production has not (Scheumann & Freisem, 2002; Schleyer, 2009). Like many other natural resources, management of agricultural drainage systems often involves more than one farmer, and thus requires cooperation and collective action among them. However, the coordinated management of drainage systems often proves to be difficult because of conflicting interests of farmers, leading to collective action dilemmas. Examining the rich interplay between property rights and institutions can help us understand the diverse incentives that participants face in a collective action dilemma, and thus understand the conditions for emergence of collective action (Ostrom, 2003).

\textsuperscript{17} Drainage systems have been identified as a resource exhibiting multiple resource characteristics (Thiel, et al., 2012), wherein these systems contribute to the common pool drainage in a given drainage basin (common-pool resource), as well as to features of a local landscape such as flood management, water quality management, etc. (public good), and localized drainage benefits in the form of improved farm drainage for a landowner, a private good. A multiple-resource conceptualization of drainage systems fits closely with Steins & Edward’s (1999) conceptualization of complex, multiple-use CPRs, where multiple use of the CPR generates separate incentive structure for different users (Edwards & Steins, 1998).
In this study, I examine institutional mechanisms for establishing and maintaining agricultural drainage systems in the Western Lake Erie Basin (WLEB) region of Ohio. Specifically, I examine whether and how property rights, i.e. rights of access (P1), withdrawal (P2), management (P3), exclusion (P4), and alienation (P5), are defined\textsuperscript{18} for drainage management institutions (Ostrom, 2009; Schlager & Ostrom, 1992). The study follows a comparative case-study design (Yin, 2009).

There are several practical implications of studying drainage systems. These systems carry non-point source pollution from agro-ecosystems to downstream water bodies (Needelman, et al., 2007), causing harmful effects including algal blooms (HABs). Policy interventions to address HABs are increasingly important since the need for drainage is expected to increase with climate change (Tollefson, et al., 2014). Understanding collective action for agricultural drainage is important as it is related to many important challenges we face today, such as air pollution and climate change, which, just like drained water, are “collective bads”.

\textbf{Section 2. Research Objective & Questions}

The objective of this study is to examine how property rights are shaped by institutions, and subsequently impact successful collective action. Specifically, I examine property rights of access, withdrawal, management, exclusion, and alienation in agricultural drainage systems. I do so by examining the institutional mechanisms for

\textsuperscript{18} For clarity, I would like to remind the reader that “rights” are the product of “rules” (Schlager & Ostrom, 1992). In the Ohio context, drainage management institutions have a set of rules which shapes/determines which users have certain property rights.
establishing and maintaining agricultural drainage systems in the Western Lake Erie Basin region of Ohio. The overarching questions of this study are –

1. How can we conceptualize property rights for agricultural drainage systems?

2. How do institutions interact with property rights for promoting collective action for agricultural drainage systems?

Section 3. A primer on property rights in common-pool resource management

A property right is the right to undertake a particular action or actions in relation to a specific domain, which in this case is a drainage system (Schlager & Ostrom, 1992). Commonly referred to as “bundles of rights,” these rights can be conceptualized as five categories: access, withdrawal, management, exclusion, and alienation (see Table 3.1).

<table>
<thead>
<tr>
<th>Property Right</th>
<th>Description</th>
<th>Bundles of Property Rights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access (P1)</td>
<td>The right to enter a defined physical property</td>
<td>Authorized User (P1+P2)</td>
</tr>
<tr>
<td>Withdrawal (P2)</td>
<td>The right to obtain the “products” of a resource</td>
<td></td>
</tr>
<tr>
<td>Management (P3)</td>
<td>The right to regulate internal use patterns and transform the resource</td>
<td>Claimant (P1+P2+P3)</td>
</tr>
<tr>
<td></td>
<td>by making improvements</td>
<td></td>
</tr>
<tr>
<td>Exclusion (P4)</td>
<td>The right to determine who will have an access right, and how that right</td>
<td>Proprietor (P1+P2+P3+P4)</td>
</tr>
<tr>
<td></td>
<td>may be transferred</td>
<td></td>
</tr>
<tr>
<td>Alienation (P5)</td>
<td>The right to sell or lease the right of management, exclusion, or both</td>
<td>Owner (P1+P2+P3+P4+P5)</td>
</tr>
</tbody>
</table>

Table 3.1. Bundles of Property Rights

Adapted from Schlager & Ostrom, 1992
Property rights are especially important in natural resource management as they offer incentives to the users, give them necessary authorizations and control, reinforce collective action, and help demonstrate to them the government’s commitment to delegation of power to local resource users (Meinzen-Dick & Knox, 1999). Property rights are often described as a bundle of rights, working together to affect individual behavior. For example, in a study of inshore fisheries Schlager (1994) found that having the rights of access, withdrawal, management and exclusion together allowed fishers to keep others from invading their inshore fisheries and encouraged investment. Similarly, in irrigation systems, Tang (1994) found that having the rights associated with access, withdrawal, management, and exclusion was crucial for long-term management of the resource.

Whereas Schlager and Ostrom (1992) classify bundles of rights as either use rights (access and withdrawal) or decision-making rights (management, exclusion, and alienation), such bundles of rights have also been grouped as *usus* rights to use the resource; *usufructus* rights to derive income from a resource; and *abusus* rights to change the resource (Meinzen-Dick, 2014). Similarly, Schlager and Ostrom (1992) identify rights originating among users as *de facto* rights (in practice), and rights granted and enforced by a government as *de jure* rights (in form). Property rights and collective action are interdependent, which is particularly clear in the case of common-pool resources, where holding rights in the resource reinforces collective action among members, and collective action is needed to manage the resource (Meinzen-Dick & Di Gregorio, 2004).
Recognizing the complex relationships among institutions, property rights and collective action, this study argues that the incentive of a right holder to contribute in an agricultural drainage collective action dilemma is driven by their physical arrangement with respect to the resource, and the bundles of property rights which indicate a users’ claim to the resource. In their seminal work Schlager & Ostrom (1992) focused specifically on fisheries, a common-pool resource held in a common-property regime, which does not exhibit an asymmetric resource dilemma. In this study, I expand its application to agricultural drainage systems, which exhibit an asymmetric resource dilemma and are held in a private property (land) ownership regime.

Section 4. Conceptualizing asymmetric resource dilemmas in agricultural drainage systems

To conceptualize resource dilemmas in agricultural drainage systems, a useful point of comparison is irrigation systems. An irrigation system brings water to land for human use, typically to grow crops. In irrigation systems, resource users face two kinds of related collective action problems: (1) joint investment in the resource system and (2) the allocation of water, i.e., the “resource units”, from the system (Tang, 1989). Allocation of resource units from an irrigation system poses an “asymmetric common-pool resource dilemma” (Janssen & Rollins, 2012). In such a dilemma, the relative positions of resource users at the head and tail of the system generate asymmetric access to the resource (Ostrom and Gardner, 1993). The resource users who are uphill and
physically nearer to the source of water are called the “head-enders” and those who are downhill and physically farther from it are called the “tail-enders (Ostrom & Gardner, 1993). In an irrigation system, use of water by a head-ender farmer reduces its availability for the farmers in the tail-end of the system. Thus, the shared interest within the group of farmers is that everyone gets water for their crop, for which they have to work collectively. But within the group of farmers, head-enders have little incentive to maintain the irrigation system, and their ability to access the water is less dependent on the actions of other farmers, compared to tail-enders.

In the schematic representation (Figure 3.1), landowner 1 (L1) to landowner 16 (L16) represent a group of users benefitting from an irrigation system, which is comprised of a main irrigation canal and multiple distributary canals. Once water crosses the property of a head-ender he has little incentive to contribute towards the maintenance of the irrigation system downhill. Within the group of head-end users, L4 & L8 are in a preferred position since they are not only uphill and physically close to the canal, but also get to withdraw water before any other user in the group. Hence, once water crosses their property, they have little incentive to contribute towards the maintenance of the irrigation system. My main argument is that in an asymmetric resource dilemma, the physical arrangement of resource users affects their incentives for collective action.

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19 In most commonly used representations of irrigation systems, head-enders are determined with respect to the source of water, say for example, a river or a lake. However, given the focus of this chapter on drainage systems, I conceptualize resource asymmetry with respect to the physical infrastructure, i.e. either an irrigation canal or a drainage ditch.
Excess water is bad for crops, making drainage systems also very critical for agricultural production. Similar to an irrigation system, a drainage system faces the collective action problem of joint investment, but instead of water allocation, the collective action problem here is to remove water from the cropland. The shared interest within the group of farmers in this case is that the cropland is optimally drained, for which they have to work collectively. Drainage systems also exhibit an asymmetric resource dilemma wherein the relative positions of resource users generate asymmetric incentives to provide the resource. This aspect can be better understood by visualizing the distribution of resource users deriving benefit from a ditch. In a given drainage area,
which drains into a drainage ditch, users who have the ditch running over their property\textsuperscript{20}, by virtue of being physically near the resource, can be considered to be “near-landowners”. The second group of resource users are those who do not have the ditch on their property, but being in the drainage area, are deriving drainage benefits from it. By virtue of being uphill of the near-landowners and physically distant from the resource, they can be considered to be “far-landowners”. These users can be visualized as being distributed laterally on both the sides of a drainage ditch (see Figure 3.2).

\textsuperscript{20} Under Ohio common law the owner of the land beside the ditch also owns the land beneath it. If the land on each side is owned by two different landowners (see figure 3.2), each owns the land to the center of the ditch (Black, n.d.).

![Diagram of drainage ditch and landowners](image-url)
A ‘group drainage improvement’ is an improvement involving more than one landowner. It can concern fixing a drainage issue, such as ditch bank erosion and stability problems, carrying out annual maintenance, or even constructing new drainage systems. However, given the physical distance from the resource itself, far-landowners may not perceive there being a need to pay towards a drainage improvement measure. Therefore, within the group of landowners, far-landowners have little incentive to maintain the drainage system, and their ability to access the resource unit is less dependent on the actions of other landowners, compared to near-landowners. On the contrary, a near-landowner faces flooding risks if the drainage system overflows, which makes his incentive high in contributing towards the maintenance of the drainage system.

In the schematic representation (Figure 3.2), landowner 1 (L1) to landowner 16 (L16) represent a group of users benefitting from a drainage system, which is comprised of a drainage ditch and multiple main drainage tiles. Once water drains from the property of a far-landowner he has little incentive to contribute towards the maintenance of the drainage system downhill. Within the group of far-landowners, L9 & L13 are in a preferred position since they are not only uphill and physically distant to the ditch, thus at low risk of flooding, but also water drains from their property before the property of any other user in the group due to slope of the land. Hence, once water drains from their property, they have little incentive to contribute towards the maintenance of the drainage system. Thus, just like irrigation systems, drainage systems exhibit an asymmetric

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21 Drainage tiles are perforated pipes made up of clay, cement or plastic, which help remove excess water from soil subsurface. These tiles are installed below the surface of agricultural fields. Main drainage tiles run across multiple properties draining water eventually into a ditch.
resource dilemma, as a result of which the physical arrangement of resource users affects their incentives for collective action.

Comparing irrigation versus drainage systems, thus, allows for emergence of some interesting similarities as well as contrasts (see Table 3.2).

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Irrigation</th>
<th>Drainage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Resource System (RS)</strong></td>
<td>Main Irrigation Canal + Distributary canals</td>
<td>Drainage ditch + Main drainage tiles</td>
</tr>
<tr>
<td><strong>Resource Unit (RU)</strong></td>
<td>Allocated water</td>
<td>Drained water</td>
</tr>
<tr>
<td><strong>Type of collective action problem</strong></td>
<td>Joint investment &amp; water allocation</td>
<td>Joint investment &amp; removal of excess water</td>
</tr>
<tr>
<td><strong>Asymmetric resource dilemma</strong></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Resource user distribution</strong></td>
<td>Head-enders &amp; Tail-enders</td>
<td>Near-landowner &amp; Far-landowner</td>
</tr>
<tr>
<td><strong>Incentive structure for maintaining RS</strong></td>
<td>Head-enders: little incentive, Tail-enders: high incentive</td>
<td>Near-landowners: high incentive, Far-landowners: little incentive</td>
</tr>
<tr>
<td><strong>Preferred position of resource user</strong></td>
<td>Uphill, Physically near, i.e. to be a head-ender</td>
<td>Uphill, Physically distant, i.e. to be a far-landowner</td>
</tr>
</tbody>
</table>

Table 3.2. Irrigation versus Drainage Systems

Section 5. Conceptualizing property rights in agricultural drainage systems

In their seminal work on property rights in common-pool resource management, Schlager & Ostrom (1992) identify five property rights – right of access, right of withdrawal, right of management, right of exclusion, and right of alienation. Their property-rights analytical scheme has been applied to many different common-pool resource management contexts, including irrigation systems, forests, and fisheries. A
recent application of this analytical scheme\textsuperscript{22} to irrigation systems also recognizes the importance of three types of property-rights: to the land, the infrastructure, and the water (Meinzen-Dick, 2014). In the section below, I apply Schlager and Ostrom’s property-rights analytical scheme to drainage systems.

The first property right is access, which is the right to enter a defined physical property (Schlager & Ostrom 1992). From the perspective of drainage, right of access would translate into whether or not a resource user has the right to enter a drainage ditch\textsuperscript{23}. Specifically for drainage systems, referring back to the lateral distribution of resource users along a drainage ditch, near-landowners, i.e., users who have the ditch running over their property, will have this right (see Figure 3.2). This is because drainage ditches are considered to be private property. Even among near-landowners, a resource user may physically access only the section of the drainage ditch which is on his property. Far-landowners, who derive benefit from the ditch, and may be paying towards its maintenance, do not have the right to physically access the ditch, however, they can physically access the section of the main drainage tile that runs through their property. A complex interplay between asymmetric distribution of resource users and right to the land (private property ownership), thus restricts physical access to the drainage infrastructure. This may act as a hindrance for landowners in perceiving the need for drainage improvement, and hence may act as a barrier for collective action.

\textsuperscript{22} In addition to the five property rights (P1-P5), the author also includes usufructus rights, which is the right to earn income from the resource (Meinzen-Dick, 2014). However, in drainage systems, the local government agency does not charge any water licensing fee, but uses tax assessments as a way of collecting money to offset costs of maintaining the drainage system.

\textsuperscript{23} Access right would also translate to the right to physically access the main drainage tile/distributary canal (see Figure 3.2).
The second property right is withdrawal. The classic understanding of ‘withdrawing’ is rooted in the idea that a resource user obtains the “products” of a resource. For example, a forest is the resource and a resource user obtains a tangible product in the form of timber. However, in drainage systems users do not “withdraw” anything tangible. They simply “use” the drainage system to obtain the benefit of improved drainage. This right would thus pertain to the water (Meinzen-Dick, 2014), not with the commonly studied goal of obtaining it and using it, but instead using the drainage system to drain land. Hence, drained water, which is the resource unit (see Table 3.2), is a product of using the drainage system, which is the resource system (see Table 3.2). Given that both near and far-landowners are part of the same drainage area, and they are deriving drainage benefit from the improvement, every user who has either contributed towards the construction of a drainage ditch and/or is contributing towards its current maintenance, has the right to reap the benefit of improved drainage. However, due to resource asymmetry and the natural (as well as tiled) flow of water downhill, a far-landowner has little or no incentive to contribute to maintenance once water drains from their property. This may act as a barrier for collective action.

The right of management refers to the right to regulate internal use patterns and transform the resource by making improvements. Regulating internal use patterns

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24 Meinzen-Dick (2014) identify withdrawal (P2) as a “consumptive use”. In drainage systems, consumptive use would translate into a group of resource users consuming the physical space for water to drain. This is similar to using atmosphere (physical space) as a sink for air pollutants.

25 A legal institution, the “Reasonable Use Doctrine” is often used by the courts in Ohio when dealing with conflicts related to drained water. As per this doctrine, ‘no landowner shall unreasonably increase or decrease the flow of surface water drainage onto adjoining lands, or unreasonably divert or alter the natural water course’.
pertains to determining how, when, and where “resource units” can be harvested from a resource. However, given the nature of the resource under consideration, where “resource unit” is often a function of the natural gradient of the land and flow patterns, it is very difficult to regulate use patterns among near and far-landowners. Whereas management is conducive to the idea of managing the internal use patterns of users when they are harvesting something, a more explicit inclusion of the right to maintain incorporates the need for recurring maintenance required for drainage systems. Hence, I argue that the right of management should be conceptualized as the decision making right of maintenance. Also, right of maintenance would pertain specifically to the infrastructure (Meinzen-Dick, 2014). However, exercising maintenance right is complicated by the right of access, since the lands on which drainage systems are located are privately owned. In other words, exercising the right of maintenance (right to the infrastructure) requires first exercising the right of access (right to the land), which in turn may act as a barrier for collective action.

Schlager & Ostrom (1992) define the right of exclusion as the right to determine who will have the right to access a resource, which in my case is physically accessing a drainage system, and how that right may be transferred. In a recent application of the property-rights analytical scheme by Schlager & Ostrom, Meinzen-Dick (2014) defined exclusion as the right to determine who can use the resource and how that right may be transferred. Drawing upon extant scholarly understanding of the right of exclusion, I would like to make three conceptual clarifications for drainage systems. Firstly, since using a drainage system does not require users to physically access it, Meinzen-Dick’s
(2014) conceptualization of excluding use is more conducive to drainage systems. Secondly, since using a drainage system does not require taking any action by a user at the time of use, I conceptualize the right of exclusion as excluding use without contributing. Thirdly, since transferring exclusion rights is already considered as part of the right of alienation in extant literature, in order to avoid redundancy and for conceptual clarity, I do not include it in my conceptualization of the right of exclusion for drainage systems. Following these conceptual clarifications, the right of exclusion of use without contributing in the Ohio context rests with local government agencies. The right to drain, which is the use right or the right of withdrawal in drainage systems, is a function of the drainage area in consideration. Very often, it is the local government agency\textsuperscript{26} which draws and has access to drainage maps, which help in determining who would qualify as a user of a given group drainage improvement. It is these government agencies which set the boundary, which then determines the total number of resource users who will pay towards the drainage improvement. By exercising this right, the government agency is able to exclude someone from potentially deriving drainage benefit without paying towards the improvement, which may promote collective action.

Schlager & Ostrom (1992) define the right of alienation as the right to sell or lease either or both of the rights, i.e., the right of management and the right to exclude. As explained earlier, in drainage systems, the right to maintain and the right to exclude, pertains to the infrastructure. Unlike commonly studied natural resource management contexts, in drainage systems, resource users do not “sell” or “lease” their rights in return.

\textsuperscript{26} County Engineer’s Office, County Commissioners, or Soil and Water Conservation District.
of money or any commodity, but simply “grant” their rights of maintenance and exclusion, either to other resource users or the local government agency. However, “granting” either or both of these rights comes in conflict with right to the land, i.e. private property ownership. The ability to grant both these rights, as explained later in the chapter, would depend upon the drainage management institutions, which establishes as well as allocates bundles of property rights.

My conceptualization of property rights in agricultural drainage systems is presented below. Note that text in italics indicates adaptation of Schlager and Ostrom’s conceptualization of property rights to suit the asymmetry of incentives and the private property (land) ownership of the common-pool resource of the agricultural drainage system.

<table>
<thead>
<tr>
<th>Property Right</th>
<th>Description</th>
<th>Property right pertains to…</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Access</strong> (P1)</td>
<td>The right to enter a defined physical property</td>
<td><strong>Infrastructure</strong> (conflicts with right to the land)</td>
</tr>
<tr>
<td><strong>Use</strong> (P2)</td>
<td>The right to obtain the “products” of a resource system</td>
<td><strong>Drained Water</strong> (a product of using the resource system)</td>
</tr>
<tr>
<td><strong>Maintenance</strong> (P3)</td>
<td>The right to maintain the resource system</td>
<td><strong>Infrastructure</strong></td>
</tr>
<tr>
<td><strong>Exclusion</strong> (P4)</td>
<td>The right to determine who will have a right to use the resource system without contributing</td>
<td>(use of) <strong>Infrastructure</strong></td>
</tr>
<tr>
<td><strong>Alienation</strong> (P5)</td>
<td>The right to grant the right of maintenance, exclusion, or both</td>
<td><strong>Infrastructure</strong> (conflicts with right to the land)</td>
</tr>
</tbody>
</table>

Table 3.3. Property rights in agricultural drainage systems
*Adapted from Schlager & Ostrom (1992) & drawing on insights from Meinzen-Dick (2014)*
Section 6. Drainage management institutions in Ohio

Ohio has a total population of approximately 11.6 million, with a population density of 108.3 per km². The state is characterized by fertile, flat soils and adequate rainfall. However, much of Ohio originally was swamp, too wet to farm (George, 1987). In fact, even today, approximately two-thirds of Ohio's cropland acres are naturally poorly drained and rely on man-made or artificial drainage systems to remove excess water (County Advisory Bulletin - Ditch Maintenance Update, 2011). Over 7.4 million acres of cropland benefit from such drainage systems, making it an important agricultural practice (ODNR, 2008). Group or organized efforts are required for successful drainage of such large areas, which is true in the case of Ohio (George, 1987).

The proportion of drained land in Ohio served by drainage organizations is about 80-85 percent (George, 1987). Four institutional mechanisms have been provided for establishing and maintaining drainage systems involving more than one landowner, referred to as ‘group drainage improvement’ (County Advisory Bulletin - Ditch Maintenance Update, 2011). These mechanisms are as follows: (1) Mutual Agreement, provided under County Ditch Law, (2) County Petition, also provided under County Ditch Law, (3) Conservation Works of Improvement or Senate Bill 160, provided under Soil & Water Conservation District law, and (4) Conservancy District Improvement, provided under Conservancy District Law. In this study, I will focus on the two most commonly used mechanisms: Mutual Agreement & County Petition. Mutual Agreement is used when landowners agree to voluntarily provide a group drainage improvement and are willing to pay the cost of construction (‘Drainage and Ditches,” 1994). County
Petition is filed with the county commissioners, either by a benefitting landowner, or multiple benefitting landowners, in order to have a group drainage improvement, which is then financed, constructed, and maintained via assessments on benefitting landowners in the watershed (County Advisory Bulletin - Ditch Maintenance Update, 2011). This mechanism is used when all benefitting landowners do not agree on the need or cost distribution of the proposed group drainage improvement (Atherton, Brown, Fausey, & Hitzhusen, 2004). Key similarities between the two mechanisms are that both involve more than one landowner and they are both provided under the County Ditch Law. There are several key distinctions between the two mechanisms. These distinctions are summarized in the table below.

<table>
<thead>
<tr>
<th>Key Distinctions</th>
<th>Mutual Agreement</th>
<th>County Petition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of govt. involvement</td>
<td>Minimal</td>
<td>Maximum</td>
</tr>
<tr>
<td>Scope</td>
<td>To construct a group drainage improvement</td>
<td>To construct and provide future maintenance for a group drainage improvement</td>
</tr>
<tr>
<td>Nature of involvement of landowners</td>
<td>Voluntary (disagreeing landowners in the watershed cannot be forced to contribute)</td>
<td>Non-voluntary (disagreeing landowners in the watershed can be forced to contribute)</td>
</tr>
</tbody>
</table>

Table 3.4. Key distinctions between mutual agreement & county petition

Notes:
a County petition projects define watershed as the land area or the drainage area benefitting from the group drainage improvement.

27 County petitions can also be filed by public bodies, however, such petitions are beyond the scope of this study. The focus of this study is on petitions initiated by landowner/s.
Section 7. Research Design & Method

The study follows a comparative case-study design (Yin, 2009). Comparative case studies are well suited for understanding complex phenomena in real-world settings, where many factors are potentially important (Yin, 2009). In this study, my two cases are the two institutional mechanisms: Mutual Agreement (C1) and County Petition (C2). These two mechanisms are most commonly used for drainage improvements involving a group of landowners. Selection of these two cases allows comparison of a case with minimal involvement of government agencies and no dissenting landowners (C1) to a case with maximum involvement of government agencies and dissenting landowners (C2). Within each case, the five property rights (P1-P5), form the key variables of interest (Yin, 2009).

Another important point to keep in mind when using the case study method is the “contextual conditions” in relation to the two cases. Every county in Ohio is permitted to use the different institutional mechanisms, however, counties differ from each other in who carries them out. Specifically, although county petitions (C2) fall under the jurisdiction of County Commissioners (CCs) and County Engineers (CEs), commissioners may choose to enter into agreement with the county SWCD for carrying out drainage improvements. In order to account for this contextual variation, and be able to compare the two cases, for this study, I have selected three counties which do not have any such agreement. Thus county petitions (C2) are carried out by the same type of local government across the three counties. These three counties are located in the Western
Lake Erie Basin region of Ohio, and are characterized by somewhat poorly to very poorly drained soil.

**7.1 Operationalization of Variables**

Conceptualizing the unit of analysis, variables, and how these concepts are operationalized for data collection and analysis, are important to understand conditions for collective action (Poteete & Ostrom, 2004). In this study, the two cases (Mutual Agreement & County Petition) are the unit of analysis, and the five property rights P1-P5 are the key variables of interest. The property rights (P1-P5) have been conceptualized based on the seminal work by Schlager & Ostrom (1992).

To understand how P1-P5 affect collective action, I rely on multiple data sources, data from the local government agencies (interviewee data) and data from a landowner survey (survey respondent data). Data from the interviewees describe factors which encourage landowners to cooperate regarding group drainage improvements, and also factors which facilitate and hinder implementation of these projects. Approval or implementation of group drainage improvement projects is a manifestation of collective action, since the project involves multiple actors coming together to invest resources for obtaining the collective good of improved drainage. Data from the survey respondents describe the factors affecting their willingness to participate in group drainage improvement mechanisms. Taken together, the interviewee and the survey data provide a rich understanding of the conditions under which one can expect successful collective action: manifested at the individual level in terms of conditions under which a landowner would be willing to participate in a group drainage improvement mechanism &
manifested at the group level, or the project implementation level, in terms of conditions under which the collective good of a group drainage improvement is provided.

**7.2 Data Collection & Analysis**

Data collection for this study included in-depth interviews with key informants. Key informants are people with firsthand knowledge of the events being studied who provide factual information about the organization from an insider perspective (Hardy & Koontz, 2009). In the study, key informants were those most closely involved with functioning of the drainage management institutions: county engineers, deputy engineers, drainage technicians, district technicians, etc. These individuals spend their careers interacting with landowners regarding drainage issues and are familiar with both the institutional mechanisms and farmers’ reactions to them. A snowball sampling technique was used to identify knowledgeable informants (Patton, 1990) in each county. Following each interview, respondents were asked to identify additional individuals with experience in all aspects of drainage management. I conducted interviews with 16 government agents involved in the two institutional mechanisms: Mutual Agreement & County Petition. 5 interviews were conducted in the first county, 6 interviews were conducted in the second county, and 5 interviews were conducted in the third county. I continued conducting interviews in a county until I reached a point of saturation, where additional interviews provided little or no new information. These interviews were conducted in-person during December, 2014 to January, 2015. 14 out of 16 interviews were recorded. All the interviews, including the 2 which were not recorded, were then transcribed. The interview duration ranged from 45-50 minutes to 150 minutes. Systematic qualitative
techniques such as coding, pattern matching, and synthesis were used to analyze the collected data. Quotes and short vignettes were instructive. This allowed for synthesis of interpretations and identification of themes that cut across cases (Miles & Huberman, 1994).

In addition, I collected data from landowners to identify the effect of various factors on their willingness or non-willingness to participate in the two institutional mechanisms. These data were collected through a survey administered to 1500 landowners across the three counties. These surveys were mailed with multiple contacts, with a response rate of 34%. The primary criterion for selection of a landowner into the sample was that they have a drainage ditch on their land. The secondary criterion was that they owned 50 or more acres of land, although this was lowered in order to achieve a target of n=500 sampling frame in each county.

Finally, document analysis provided additional data. Analysis of Ohio Revised Code (ORC) chapters 6131 and 6137 focused on understanding Mutual Agreement and County Petition mechanisms. Specifically, this analysis provided an understanding of the main provisions of the Ohio drainage laws. In addition, I analyzed county-specific drainage system maintenance reports and manuals to better understand the nuances of drainage system construction and maintenance processes and historical trends.

Section 8. Results

In this section I describe the institutional mechanisms for drainage improvement, how property rights are defined within each mechanism, and subsequently examine the role of variables P1-P5 in the emergence of collective action for drainage management. I
use a mix of key-informant insights, referred in the chapter as interviewees, landowner/farmer insights, referred in the chapter as survey respondents, and documentary evidence. Drawing on multiple data sources provides a way of triangulating, an important practice when conducting case study research (Yin, 2009).

A commonality across the two institutional mechanisms is that projects involve more than one landowner. Although a single landowner can initiate an institutional mechanism, the project should be addressing an issue which involves multiple landowners. Most of the times, it is either one landowner, or a group of landowners, who identify a drainage management issue, and approach either the county Soil and Water Conservation District (SWCD) or the County Engineers’ Office (CEO). After looking at the issue, the official can then make recommendation to the landowner, or the group of landowners, about which institutional mechanism to use. The final decision about which institutional mechanism to choose rests with the landowners.

8.1.1 A brief introduction to Mutual Agreement Projects

Mutual agreement (MA) projects, as the name suggests, are group drainage improvement projects that are mutually agreed upon. These projects are also known as group projects, or projects under ‘cooperative group procedure’. Mutual Agreement is used when landowners agree to voluntarily have a group drainage improvement and are willing to pay the cost of construction. MA projects are considered to be very landowner driven, wherein, landowners identify the issue, identify which other landowners are part of the project, make decisions about how they would want to distribute the cost among themselves, select a contractor of their choice, and eventually have the desired
improvement. The role of the local government agency, either the SWCD or the CEO, is to provide watershed maps so that they can identify how many acres are going to benefit from the project, and thus which other landowners might be asked to be part of the project. Making this determination is important because it is the benefitting landowners who choose to participate who will eventually pay for the project. The final decision about whether the project goes ahead or not, rests with the landowner/s.

8.1.2 Property rights in Mutual Agreement Projects

Referring to the description provided earlier, landowners who have the drainage system on their property have the right of physical access (P1), but only to the section of the drainage system on their property. For example, as mentioned by my interviewees, a far-landowner will still have to seek permission from a near-landowner owner to be able to physically access a drainage ditch. However, since these projects are usually small in size, and are usually carried out to fix a drainage issue, it is quite possible that all the resource users are able to get together, talk about the project, see for themselves what the issue is, and then work towards fixing that issue. As mentioned by one of the interviewees, “In a mutual agreement project, a group of landowners decides to work together and fix the problem”. This was also reflected by my survey respondents responding to an open-ended question about their biggest reason for willingness to participate in MA projects. The most frequently mentioned reasons were “Dealing with friends”, and “Working with neighbors”. From the perspective of the right of access, given that these projects are usually small, and involve a group of neighbors, it is possible that even far-landowners are able to physically access the ditch, see the issue for
themselves, and then work towards fixing that issue, as a de facto right (in practice) although not de jure right (in law). So, in case a drainage issue originates on someone’s property, and if the property owner disagrees with carrying out the improvement, others in the group do not have a right to access his property.

The right of use (P2), as mentioned earlier, translates into the right to use the benefit of improved drainage. So, everybody in the group, be it near or far-landowner, has the right to drain. However, what is interesting from a collective action point of view is that in MA projects, landowners have the capability to choose whether they want to contribute to the project or not. For instance, if a landowner says that he does not want to take part in the project, then the remaining landowners in the group have to decide whether they want to take up his cost, and still go ahead with the project. As mentioned by an interviewee, “That’s why it is good to make sure that everybody is onboard before things get started and that everybody understands the project. This person who disagrees will still be deriving the benefit”. Given the nature of the “resource system” i.e. a drainage ditch, and the “resource unit”, i.e. improved drainage, every landowner in the group has the right of use, but may decide not to contribute towards the improvement. For example, one of my interviewees recalled a group project where about six landowners were involved, but only one landowner decided to pay for the whole project. He added, “As far as how many times this happens, I am not sure. But it does happen quite a bit where the landowner is discouraged about going through the petition process [an alternative institutional arrangement, described below] because it costs more money and time. So, he decides that it is just worth for him to pay for the project on his own”. 
This mismatch between having the right to use the ditch but not having the obligation to contribute towards the improvement, may allow for free riders in the group and thus act as a barrier for collective action.

In mutual agreement projects, the right of maintenance (P3) rests with the individual landowner. Once a project has been done, i.e. an issue has been fixed, the individual landowner has the right to maintain his section of the drainage system. This individual level holding of the right of maintenance acts as a deterrent for promoting collective action. For example, one of my interviewees said, “In a county petition project, the maintenance is ongoing, irrespective of change in ownership of the land. But if ownership of land changes [in a mutual agreement project], it becomes difficult to keep maintaining the system”. This point was further supported by one of my survey respondents, who said, “The biggest problem is changing ownership”.

In Schlager & Ostrom’s (1992) property rights analytical scheme, an individual landowner holds the right of exclusion (P4) in determining who has the right to physically access his section of the drainage system. However, a near- or far-landowner who is in the same drainage area, but decides to not pay his share of the cost of the improvement, cannot be excluded from his right to use. Thus, although the group of landowners who decide to cooperate and work towards an improvement are able to

28 The mutual agreement procedure legally provisions for payment of maintenance costs for a year by the benefitting landowners, followed by an annual assessment for future maintenance (George, 1987; Nolte, n.d.). However, interviewees in this study consistently indicated absence of any such provision for future maintenance. I reconfirmed this by contacting one of my interviewees. The same interviewee called mutual agreement, a “handshake” agreement between landowners. At best, I can explain this difference as what property rights literature commonly recognizes as de jure rights (rights granted and enforced by a government) and de facto rights (rights originating among users). Thus, as per my analysis, in mutual agreement projects, the right of maintenance (P3) operates as a de facto right that rests with the individual landowner.
decide the size of the project, when it comes to drawing resource units, they are not able to exclude other potential beneficiaries, given the natural (as well as interconnected, tiled) flow of water downhill. Hence, excluding someone from using a resource without contribution becomes very difficult in mutual agreement. This problem was highlighted by survey responses such as, “You cannot get a group of people to agree to pay their fair share”, and “It is difficult to get everyone to agree”. Thus, the difficulty to exclude potential beneficiaries from obtaining the benefits of improved drainage may act as a deterrent for successful collective action.

The right of alienation (P5) refers to the right to sell or lease the right to exclude use without contributing (P4) and/or the right of maintenance (P3). As mentioned earlier, these rights pertain to the infrastructure, i.e. the drainage ditch and the main drainage tiles. Every landowner involved in a given MA drainage improvement project holds the right to maintain the section of the drainage system on his property, and hence “grant” this right to others. In contrast, landowners do not hold the right to exclude use (P4) of the resource, as uphill landowners will drain naturally or through main tiles into the ditch. As mentioned earlier, once the ownership of the land changes, the new owner is under no obligation to maintain his part of the drainage system, making it difficult to maintain the interconnected system. Changing land ownership was identified as a hindering factor for mutual agreement projects by both expert interviewees and survey respondents. Thus, when a landowner sells land, he alienates maintenance decisions to the new owner, who may choose not to maintain his section of the drainage system, which in turn may lead to spillover drainage issues in the area. This may act as a deterrent for other users in the area.
to act collectively for a drainage improvement in the future because it reduces certainty that the improvement will be maintained in the future.

### 8.2.1 A brief introduction to County Petition Projects

County Petition (CP) projects are group drainage improvement projects provided under the Ohio Revised Code (ORC) Chapter 6131. A CP procedure does not require that all landowners involved in the project agree upon the necessity of the drainage improvement, and allocation of costs and benefits. Just like MA projects, a single landowner, or a group of landowners can file a petition with the board of county commissioners (CCs). The CEO helps the landowner in not only filing the petition, but also coming up with the decision whether or not to file the petition. This decision making is facilitated by listing the pros and cons of filing a petition, and providing estimates of assessment rates. The goal behind doing so is to make sure that a petitioner has exhausted all other options before he decides to proceed with the petition. One of the main reasons why a county petition is filed is because people do not mutually agree. Petitions are also filed if the project is very big, and the petitioner/s do not want to go and talk about the project to a lot of landowners.

Once a petition has been filed, the CEO makes a determination of landowners who will benefit from the CP project. These landowners are then notified about their involvement in the project, and are also invited to come to the viewing and hearings (first or preliminary hearing and second or final hearing) associated with the approval/disapproval of the project. During the viewing stage, the proposed improvement is viewed by CCs, CEO, and other stakeholders in the watershed. This is followed by first
hearing during which the engineers’ office provides preliminary estimates about whether benefits from the improvement are likely to exceed the estimated costs. If the project is approved at the first hearing, the CEO makes all of the plans and does the survey work. This is followed by the final hearing during which CCs decide whether the project should get approved or not. Their decision is based on 3 criteria laid down in the ORC 6131. Firstly, benefits should exceed the cost. Secondly, the project should promote the public welfare. Thirdly, the project should be necessary. During both the hearings, which is presided over by the county commissioners, dissenting landowner/s can appeal for disapproval of the project. If the project is approved, bids are invited for the project from contractors. After the improvement has been constructed the CEO assigns a value to it, and then decides what percentage of that original value will be collected from the group of landowners in the project for its future maintenance. This value can be revised after every 6 years. A CP project puts the improvement on permanent maintenance, to be carried out by the local CEO in the future.

8.2.2 Property rights in County Petition Projects

As is the case in mutual agreement projects, in CP projects, landowners who have the drainage system on their property have the right of physical access (P1), but only to the section of the drainage system on their property. However, when the viewing of the project is held, the CCs, officials from the CEO, and anybody in the watershed have de jure rights to physically access the drainage system and take a look at the drainage issue. If the project is approved at the first hearing, officials from the CEO obtain the right to physically access the drainage system in order to do their survey work and assess the
problem. Subsequently, if the project gets approved, and the drainage improvement is provided, the improvement is put on permanent maintenance. Because the CEO is assigned the role to maintain the improvement, it has the right to access the drainage system in order to carry out maintenance activities such as spraying, bank repairs, etc.

Similar to the mutual agreement (MA) projects, everybody in the drainage area has the right to use (P2), i.e. drain into the improvement. However, unlike in MA projects, where a user can choose not to participate in the improvement, i.e. pay a share of the cost for improvement, once a CP project is approved, the CEO distributes the cost (both for construction and maintenance) across the benefitting landowners. This means that near-landowners as well as far-landowners must pay in the form of annual assessments. From the perspective of property rights, a county petition procedure helps tie the right to drain, with the obligation to pay annual assessments. Whether doing so facilitates collective action or impedes it, is a difficult question to answer. Some of my survey respondents, who indicated a willingness to participate in the CP projects in the future, wrote, “This is the fairest way because everyone in the watershed will share the cost”, “This way everyone pays their fair share”, and “This is the best way and probably the fairest way of improving drainage”. Other survey respondents, who were not willing to participate in CP projects in the future, felt that the cost was very high and the maintenance was not sufficient. For example, a survey respondent wrote, “This is the most expensive way to have problems solved. Maintenance is part of process paid for in taxes, but not received”.

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In CP projects, the right of maintenance (P3) rests with the CEO. Users do not have the right to make any changes in the drainage improvement. Once a petition is approved and an improvement is constructed, the CEO obtains a permanent easement for maintenance purposes. Thus, for CP projects, the right of maintenance rests with the CEO rather than with users. In fact, unlike a MA project, wherein change in land ownership makes it difficult to maintain an improvement, in a CP project, the maintenance is ongoing regardless of land ownership. Some of my survey respondents who indicated a willingness to cooperate on CP projects wrote, “The county is maintaining areas for me and others that we don't have the time and/or equipment to do the job; some areas may not be accessible”, “County Engineer can provide more expertise without cumbersome govt. regulations”, “They have equipment and knowledge”, and “With county maintenance neighbor cannot foul it up”. Conversely, some of my survey respondents who are not willing to cooperate on these projects in the future wrote, “They (CEO) don't keep up with maintenance”, “Been more than ten years of maintenance fees and no maintenance done since initial cleaning”, “When they want to clean the ditches they destroy crops without any reimbursement for the crop they destroyed”, and “There is lack of maintenance”.

In CP projects, landowners do not have the right to exclude anyone else in the watershed from their right to drain into the improvement without contributing (P4). This decision rests with the CEO. The physical boundary of a project is driven by the drainage area and determined by the CEO. Hence, the CEO has the right to exclude someone from deriving drainage benefits without paying towards the improvement (P4). By virtue of
having this right, the CEO is able to ensure that there are no free riders in the project. So, unlike MA, where a mismatch between the right to use without having the obligation to pay for the improvement may allow for free riders in the group, in CP projects, the CEO is able to ensure that there are no free riders. This in turn, may act as a factor which promotes collective action.

In CP projects, landowners in the group, by virtue of private land ownership, only have the right to exclude others in the group from physically accessing their section of the drainage system. However, neither do they have the right to exclude someone from obtaining drainage benefits, nor do they have the right of maintenance. Both of these rights are held by the CEO. A landowner can still sell his land, however, change in ownership does not impact maintenance of the drainage improvement. The new owner is obligated to pay for the improvement as part of an annual assessment, just like the previous owner. Thus, changing land ownership does not give the new owner a right to choose to not maintain the system, as the right of maintenance continues to rest with the CEO. This may encourage other users in the watershed to act collectively for drainage improvement in the future, since there is a security that the improvement will be maintained, and that there won’t be any free riders in the group.

8.3 Cross-Case Comparisons

Comparing independent and dependent variables across the two cases reveals patterns in the effects of the five key property rights of interest (P1-P5; see Tables 3.5 & 3.6).
Since both the cases have a legal backing in the county ditch law, they represent bundles of de jure rights (Schlager & Ostrom, 1992). However, as shown in table 3.5, these two cases vary with respect to property rights held by the local government agency. Whereas for MA projects, the local government agency does not hold any property rights, for CP projects, the local government agency not only has an advisory role, but also holds and enforces property rights. Specifically, the CP mechanism gives the local government agency the right to physically access the drainage system (P1), maintain the drainage system (P3), and exclude non-paying beneficiaries from using by forcing all beneficiaries to contribute through assessments (P4).

<table>
<thead>
<tr>
<th>CASE</th>
<th>Property Right Holder</th>
<th>Bundles of Property Rights</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1: Mutual Agreement</td>
<td>Near Landowner</td>
<td>P1\textsuperscript{a} + P2 + P3 + P5\textsuperscript{b}</td>
</tr>
<tr>
<td></td>
<td>Far Landowner</td>
<td>P1\textsuperscript{a} + P2 + P3 + P5\textsuperscript{b}</td>
</tr>
<tr>
<td></td>
<td>Local government</td>
<td>None</td>
</tr>
<tr>
<td>C2: County Petition</td>
<td>Near Landowner</td>
<td>P1\textsuperscript{a} + P2 + P5\textsuperscript{b}</td>
</tr>
<tr>
<td></td>
<td>Far Landowner</td>
<td>P1\textsuperscript{a} + P2 + P5\textsuperscript{b}</td>
</tr>
<tr>
<td></td>
<td>Local government</td>
<td>P1\textsuperscript{d} + P3 + P4</td>
</tr>
</tbody>
</table>

Table 3.5. Comparing agricultural drainage system property rights across the two cases

Notes: P1: Physical Access; P2: Right to use (drain); P3: Right to maintain; P4: Right to exclude use without paying; P5: Right to alienate
\textsuperscript{a}Physical access restricted to the section of drainage system on a landowner’s property.
\textsuperscript{b}Both near and far landowners continue to hold alienation rights pertaining to maintenance but not exclusion from use without contributing.
\textsuperscript{c}Both near and far landowners in the watershed can physically access the section of the drainage system with drainage issue during the viewing stage of the project.
\textsuperscript{d}A local government agent has the right to physically access the area with drainage issue in order to conduct surveys, assess the problem, and if the project is approved, to carry out maintenance activities.
In drainage systems, a resource user is able to exercise P2, i.e. obtain drainage benefits, without having the right to physically access (P1) the entire drainage system (see Figure 3.2). Due to private ownership of land, every user in a group drainage improvement project is only able to physically access the section of the drainage system on his property. Thus, a resource user in a group project is able to exercise use rights, i.e. P2, despite restricted physical access rights (i.e. P1). However, P1 allows a user to physically visit a drainage system, assess the problem, and make an informed decision about whether the improvement is needed or not. Whereas every user in the watershed has a right to do so during the viewing stage in CP projects (see Table 3.5), there is no such provision in MA projects. Even in CP projects, once an improvement has been provided, P1 rests with the individual landowner (for the section of the drainage system on his property) and the local government agency (for the entire drainage system). This conflict between land rights and rights to the infrastructure (P1 & P2), may act as a deterrent for collective action. A far-landowner’s frustration was represented well in my survey, wherein a respondent said about CP: “There is absolutely no say by landowners other than petitioning party, for remedy and costs then gets passed to all landowners”.

As is evident in Table 3.5, bundles of property rights are not the same across the two institutional mechanisms. For MA projects, landowners do not have the right of exclusion, because they cannot exclude a non-contributor from using the resource. However, they have physical access to the section of the drainage system on their property (P1), right to drain (P2), right to maintain the drainage system on their property (P3), and right to alienate their maintenance right (P5). Thus, unlike Schlager & Ostrom’s
(1992) conceptualization of progressive bundles of property rights (see Table 3.1), my analysis for mutual agreement project demonstrates that property rights may not always exhibit such progression (see Table 3.5).

For CP projects, landowners neither have the right to maintain (P3) or exclude (P4), both of which are “granted” to the local government agency by the petitioning landowners. Since landowners don’t have either P3 or P4, they cannot alienate these rights, as a result of which they don’t have P5, i.e. the right to alienate (P5). Thus, for CP projects, the agency becomes a property right holder, holding the rights of physical access (P1), maintenance (P3), and exclusion (P4). Since landowners have the right of physical access (P1) and use (P2), in a county petition project they can be described as “authorized users”, as defined by Schlager and Ostrom (1992) (see Table 3.1). Their property-rights analytical scheme conceptualizes property rights as progressive bundles of rights (see Table 3.1); my analysis corroborates their conceptualization for landowners in CP projects. However, such bundling of property rights does not hold true for the local government agency in CP projects (see Table 3.5).

As my results demonstrate, different drainage management institutions allocate different bundles of property rights to resource users as well as the local government agency, which in turn has implications for collective action. Specifically, for drainage institutions, property rights interact with each other to affect collective action.

As we already know from the two cases, the right to benefit from improved drainage (P2) rests with both near and far-landowners (see Table 3.5). However, whereas the voluntary nature of the arrangement allows for potential free riders to be present in a
MA project, in CP projects, the local government agency is able to make sure that there are no free riders in the group. They do so by enforcing P4: every user is required to pay their fair share based on the benefit they are drawing from the improvement. While this leads some resource users to question the cost-benefit distribution, it nevertheless may encourage users to work collectively, and thus promote collective action. In contrast, the absence of an enforcing agency in MA projects may deter users from working collectively towards drainage improvements, and hence discourage collective action. Thus, the interplay of P2 and P4 becomes a crucial factor in either encouraging or discouraging collective action (see Table 3.6).
### Table 3.6. Property right interactions in drainage systems

<table>
<thead>
<tr>
<th>CASE</th>
<th>PR interactions</th>
<th>Implications for Collective Action (+, -)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1: Mutual Agreement</td>
<td>Absence of P4 impacts P2</td>
<td>(-) Since it is difficult to exclude anyone in a given drainage basin to exercise his “right to drain”, in the absence of an authority to force everyone to contribute, all landowners(^a) in a drainage basin can exercise P2 regardless of their contributions. This increases the likelihood of free riding; decreases the likelihood of collective action.</td>
</tr>
<tr>
<td></td>
<td>Private land ownership impacts P3</td>
<td>(-) If a landowner sells his land, the new owner is under no obligation to maintain his part of the drainage system. This reduces certainty of future benefits and thus decreases the likelihood of collective action.</td>
</tr>
<tr>
<td>C2: County Petition</td>
<td>Presence of P4 impacts P2</td>
<td>(+) Local government agency draws the boundary of a group drainage improvement, which is usually driven by the drainage area; everybody who benefits from the improvement, pays for it. This decreases the likelihood of free riding; increases the likelihood of collective action.</td>
</tr>
<tr>
<td></td>
<td>Private land ownership does not impact P3</td>
<td>(+) Change in land ownership does not impact maintenance of the drainage system; local government agency maintains it through a permanent easement. This increases certainty of future benefits and thus increases the likelihood of collective action.</td>
</tr>
</tbody>
</table>

**Notes:** Sign inside parenthesis indicates expected impact on collective action: (+) Helps; (-) Hinders.  
PR: Property Right; CA: Collective Action; P1: Physical Access; P2: Right to use (drain); P3: Right of maintenance; P4: Right of exclude use without paying; P5: Right to alienate  
\(^a\)However, near-landowners will have an interest in regular maintenance of the system, given that they would want to avoid flooding risk.

A mutual agreement project adds a norm about how the group of landowners should maintain their respective sections of the drainage system. However, if a landowner
in the group sells his land, the new landowner is under no obligation to observe this norm. Unlike MA projects, for CP projects, the local government agency obtains a permanent easement for maintenance purposes, which allows the agency to maintain a drainage improvement irrespective of the change in ownership of the land. Thus, P3 is not impacted by the sale of private property. This reduces the insecurity that a drainage improvement will not be maintained with a change in ownership, thus encouraging collective action in CP projects.

Careful analysis of allocation of bundles of property rights across the two cases (Mutual Agreement & County Petition) leads to the conclusion that for a given case, near and far-landowners have the same bundles of property rights (see Table 3.5). Thus, my different expectations about incentives for resource users to participate in a given drainage improvement project are not because they hold different bundles of property rights, but because their spatial location with respect to the resource system generates different incentive structures. Additionally, as shown in table 3.6, the interplay among property rights is critical. Moreover, property rights interactions are more conducive to collective action in CP projects.

Section 9. Discussion

Extant scholarly work on collective action problems often focuses on common-pool resources (CPRs) that are held by the community under a common-property regime. However, agricultural drainage system is a common-pool resource which is held in a

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29 I would like to remind the reader to refer to my findings in chapter 2, which provides additional insights about conditions for emergence of collective action under the two institutional mechanisms.
private property (land) ownership regime. Additionally, property rights literature rarely examines resources which exhibit an asymmetric resource dilemma. Agricultural drainage systems are an example of one such resource. Due to resource asymmetry, resource users have different preferences over potential actions and outcomes in drainage management based on the spatial location of their private property, which may lead to a “free-rider problem”, the core problem in a collective action situation (Ostrom, 1990). Property rights can help individuals to overcome such free rider problems (Ostrom, 2004). Specifically, examining drainage management institutions and how each of these institutional mechanism allocates bundles of property rights leads to several new insights.

The first insight pertains to the theoretically important interactive nature exhibited by the two institutional mechanisms examined in this study. Rather than finding that one type of institution is always better than the other, it is evident that they are complementary. Whereas MA (Case 1) provides a landowner-driven institutional mechanism to give a first attempt at generating collective action, if that fails, CP (Case 2) acts as a government-driven institutional back-up to facilitate collective action. This resonates with Ostrom’s design principles encouraging users to develop their own rule making (including cost allocation for projects) but if this fails then there should be an outside government entity available. While Ostrom’s design principles see this outside entity as important for conflict resolution (Ostrom, 1990; Ostrom, 2009), this case suggests another role for the outside entity: to provide an alternative institutional arrangement in case the MA is not successful. Thus, a theoretical argument can be made to consider the role for government beyond just existing as a conflict resolution venue.
Rather, a key government role may be to supply an alternative institution for stakeholders to generate collective action. This insight is in line with studies of collaborative environmental management describing the complementarity of community-driven efforts and government resources (Koontz et al., 2004).

The second insight pertains to how we understand “bundles of property rights”. Following the seminal work by Schlager and Ostrom (1992), property rights systems have been widely conceptualized and studied as containing cumulative bundles of five rights rather than a single right (Ostrom, 2010). However, the five property rights are not necessarily held in a cumulative manner, i.e. as “progressive bundles of property rights”, as is often the case in fisheries, and other commonly studied CPRs such as self-organized irrigation systems and forests (Agrawal & Ostrom, 2001; Tang, 1994). For example, the extant literature emphasizes how having the rights associated with being a proprietor (P1+P2+P3+P4) is sufficient for encouraging users to contribute in a collective action dilemma (Tang, 1994; Agrawal & Ostrom, 2001; Schlager 1994; Schlager & Ostrom, 1992). However, such hierarchical and progressively stacked understanding of “bundles of property rights” does not apply to the drainage management institution of mutual agreement. As shown in table 3.5, property right bundles are not cumulative for mutual agreement projects. Instead, different institutional mechanisms (e.g., mutual agreement and county petition) allocate different bundles of property rights. Thus, a hierarchical understanding of property rights, as often is the case for CPRs, falls short of understanding property rights in resource systems exhibiting an asymmetric resource
dilemma combined with common-pool resource characteristics and private property ownership.

The third insight pertains to how individual property rights interact to affect collective action. Specifically, the right of exclusion (P4) interacted with the right to use (P2) and negatively affected collective action in mutual agreement, as it increased the likelihood of free-riding. Similarly, the interaction between the right to the land, i.e. private property, and the right of maintenance (P3) negatively affected collective action in mutual agreement, as it reduced the certainty that the group drainage improvement will be maintained in the future. The existing CPR literature recognizes that the five property rights are independent of one another, but are often cumulatively held for common-pool resources (Schlager & Ostrom, 1992; Ostrom, 2010). However, given the non-hierarchical, non-cumulative stacking of property rights for drainage systems, it is important to understand which property rights interact, how they interact, and what implications such an interaction has for collective action.

Like all studies, mine has limitations. The property rights theory guides me to the conclusion that my different expectations about incentives for resource users to participate in a given drainage improvement project are not because they hold different bundles of property rights, but because their spatial location with respect to the resource system generates different incentive structures. However, due to lack of data, I could not test this hypothesis. On that note, I would like to recommend that future scholarly work on this topic should collect data from both near- and far-landowners in order to further
examine the interplay between resource asymmetry and property rights in drainage management institutions.

Section 10. Conclusion

The goal of this study was to examine how property rights are shaped by drainage management institutions, and subsequently impact successful collective action. In their seminal work, Schlager & Ostrom (1992) provide a property-rights analytical scheme ranging from authorized user, to claimant, to proprietor, and to owner. Their work focused specifically on fisheries, which do not exhibit an asymmetric resource dilemma. In contrast, drainage systems in the Western Lake Erie basin of Ohio are characterized by asymmetries where users farther from the resource can use the resource (drain excess water) despite restricted physical access to the resource system, thus decoupling the direct link between use (P2) and physical access (P1). Such decoupling occurs due to the fact that unlike fisheries, which are common-pool resources and are held by the community, drainage systems are characterized by private property ownership alongside the common pool resource characteristics of drainage systems. Hence, landowners, by virtue of their land ownership, have physical access (P1) to the section of the drainage infrastructure on their property even as they are not able to exclude others from using the drainage infrastructure to drain their land.

By contrasting and comparing drainage and irrigation systems, this study demonstrates how physical arrangement of resource users with respect to the resource system affects their incentives to contribute in a collective action dilemma. As the property rights analysis indicates, drainage systems provide a rich foundation for
advancing the theory of collective action. However, as much as this study provides conceptual clarifications and theoretical insights, it also leaves a number of questions unanswered. In particular, results raise several important questions and avenues for future research:

1. Can drainage be conceptualized as collective action for removing the “collective bad” of excess water, which helps get rid of polluted water from agricultural fields? If yes, what parallels can be drawn with other “collective bads”, such as climate change, air pollution, water quality, etc., specifically with respect to property rights?

2. How can we curb free-riding behavior in collective action dilemmas where users can exercise use rights despite restricted physical access?

3. Which other resources don’t exhibit hierarchical and cumulative bundles of PRs?

4. Does lack of progressive bundles of property rights warrant special forms of institutional arrangements, including arrangements in which the government supplies an alternative institution for stakeholders to generate collective action?

Answering questions such as these will enable scholars and practitioners to better understand and manage resource systems that require users to work collectively. In particular, explaining institutional mechanisms is important for addressing collective action dilemmas involving common pool resources within a private property regime. Such mechanisms provide different incentives for overcoming asymmetrical resource dilemmas.
Chapter 4: Promoting adoption of two-stage ditches in the Western Lake Erie Basin: A change agent perspective

Section 1. Introduction & Rationale

An innovation is defined as “an idea, practice, or object that is perceived as new by an individual or other unit of adoption” (Rogers, 2003). Many of the modern conveniences in our daily lives, such as laptops, cell phones, etc. began as innovations, which were then incorporated into social or economic processes. Agricultural best management practices (Ag. BMPs), also known as conservation practices, are a classic, oft studied, example of one such “innovation” designed to alleviate problems associated with nonpoint source (NPS) pollution from agricultural runoff (Lubell & Fulton, 2007).

Decades of scholarly work on adoption of conservation practices, grounded in the diffusion of innovations literature, has examined characteristics of three primary sets of variables: the adopter, the change agent, and the innovation.

First, much scholarly work has focused on identifying factors that lead landowners to adopt conservation practices (Baumgart-Getz, Prokopy, & Floress, 2012; Prokopy, Floress, Klotthor-Weinkauf, & Baumgart-Getz, 2008). A review of twenty-five years of literature on adoption of conservation practices found that education levels, capital, income, farm size, access to information, positive environmental attitudes, environmental awareness, and utilization of social networks were more often positively associated with higher adoption rates (Prokopy et al., 2008). In a recent meta-analysis of
the adoption literature, access to and quality of information, financial capacity, and being connected to agency or local networks of farmers or watershed groups, were identified as variables having the largest impact on adoption (Baumgart-Getz et al., 2012). Some scholars, focusing specifically on environmental attitudes, found that farmers who are motivated by off-farm environmental benefits and those identifying responsibilities to others are most likely to adopt conservation practices (Reimer, Thompson, & Prokopy, 2012). Overall, although literature focusing on adopters of conservation practices has grown immensely over the past few decades, debates have also continued about the inconclusive nature of these findings (Knowler & Bradshaw, 2007; Reimer, Thompson, et al., 2012).

Second, some scholars have focused on the role of change agents in promoting and explaining adoption (Hartwich, Halgin, & Monge, 2008). A change agent is “an individual who influences clients’ innovation decision in a direction deemed desirable by a change agency” (Rogers, 2003; pp. 27). Studies of change agents, focusing on their individual attributes, have identified several factors important for promoting adoption of innovations, such as, change agents’ authority and technical expertise, perceived similarity to the potential adopters, residence within same community, communication skills, personal relationships with potential adopters, and empathy with the circumstances and problems of potential adopters (Pannell et al., 2006; Rogers, 2003). Other scholars have identified the persuasiveness of change agents being an important factor in explaining adoption of innovations by farmers (Hartwich et al., 2008).
Finally, some scholars have examined attributes of the conservation practice itself, which in turn may affect its adoption by farmers (Reimer, Weinkauf, & Prokopy, 2012). Diffusion of innovations literature identifies the following five perceived attributes of innovations: (1) Relative advantage, (2) Compatibility, (3) Complexity, (4) Trialability, & (5) Observability (Rogers, 2003; pp. 222). 49 to 87 percent of the variance in the rate of adoption of innovations is explained by these five perceived attributes, making them an important point of enquiry for scholars studying diffusion of innovations. Specifically, for conservation practices, perceived high levels of relative advantage, compatibility and observability have been identified as being most important in increasing adoption (Reimer, Weinkauf, et al., 2012). Other scholars, in addition to emphasizing the importance of perceived high relative advantage, have also identified trialability of conservation practices as being important in increasing adoption (Pannell et al., 2006).

In examining the innovation itself, some scholars have distinguished between incremental and preventive innovations (Overstreet, Cegielski, & Hall, 2013). Incremental innovations provide immediate benefits or benefits in the near future. A classic example of an incremental innovation is adoption of a hybrid corn seed, which assures a farmer of an increase in harvest. Conversely, preventive innovations provide benefits that may only be realized at some point in the distant future (Overstreet et al., 2013). These are innovations that require action at one point in time in order to avoid unwanted consequences at some future time (Rogers, 2002). Since rewards from adopting a preventive innovation are often delayed in time, are relatively intangible, and the
unwanted consequence may not occur anyway, such innovations have a slower rate of adoption (Rogers, 2002). For those interested in environmental benefits from agricultural conservation practices, preventive innovations are especially important, because many conservation practices that improve water quality have the characteristics of preventive innovations.

Unfortunately, the extant literature on adoption of preventive innovations is thin. At best, scholars recognize that conservation practices addressing on-farm issues are easy to adopt, whereas those dealing with longer time horizons between their adoption and their payoff are difficult to adopt (Meinzen-Dick & DiGregorio, 2004; Pannell et al., 2006). Other scholars have recognized that conservation practices often entail short-term economic costs for a producer, whereas the environmental benefits are often long-term, and uncertain due to the environmental benefit’s dependability on other adopters sharing a common-pool resource such as a watershed (Lubell & Fulton, 2007). However, the extant literature does not differentiate between preventive and non-preventive conservation practices, especially when the expected economic as well as environmental benefits are long-term and uncertain.

One of the core difficulties to promote a preventive innovation is the difficulty change agents have in demonstrating its relative advantage (Rogers, 2003). As we already know from the theory of diffusion of innovations, change agents play a crucial role by acting as a facilitator of the flow of innovations to potential adopters (Rogers, 2003). However, what we don’t know is what makes change agents want to promote a particular innovation. Additionally, since “being preventive” is an attribute of the innovation itself,
in this study, I argue that the five perceived attributes of the innovations (Rogers, 2003; pp. 222) may affect their decision to promote. Hence, I focus on the extant knowledge gap of examining change agents’ perception of the attributes of a preventive innovation and examine what makes them want to promote it.

The study also provides additional insights about the perceived attribute of relative advantage of a preventive innovation from the perspective of potential adopters. Specifically, I test whether the perceived advantages/disadvantages that affect change agents’ willingness to promote are same as advantages/disadvantages that affect potential adopters’ (landowners’) willingness to adopt. Diffusion of innovation theory provides the conceptual grounding as well as the theoretical motivation for this study. The data for this study come from a mixed methods research approach using semi-structured interviews with change agents and a landowner survey. Interviews and surveys provide data on the adoption of two-stage drainage ditches, a preventive innovation in the Western Lake Erie Basin (WLEB) region in Ohio.

There are several merits to this study, both theoretical and practical. From a theoretical standpoint, by identifying variables influencing adoption of two-stage ditches, I am uniquely poised to not only contribute to the conservation practice adoption literature, but also examine the role of change agents in promoting adoption of these practices. From a practical standpoint, the study has important implications for dealing with issue of Harmful Algal Blooms (HABs) in Lake Erie. Drainage ditches act as conduits for agricultural runoff from agro-ecosystems to downstream water bodies (Needelman, et al., 2007). Understanding adoption of a conservation practice, specifically
for drainage ditches, thus provides an opportunity to reduce HABs, especially since adoption of these practices have been identified as an important mechanism by which NPS pollution in Lake Erie can be reduced (Bosch, Allan, Selegean, & Scavia, 2013; Makarewicz et al., 2009).

**Section 2. Research Objective & Questions**

The objective of this study is to identify the barriers and bridges for both promoting and adopting two-stage drainage ditches in the Western Lake Erie Basin region of Ohio.

The overarching questions of this study are –

1. How can we conceptualize two-stage drainage ditches as a preventive innovation?
2. How do change agents perceive the attributes of two-stage drainage ditches?
3. What factors correlate with change agents’ willingness to promote two-stage drainage ditches?
4. How do the factors affecting change agents’ willingness to promote compare with the factors affecting landowners’ willingness to adopt two-stage drainage ditches?
5. How do change agents’ recommendations to promote compare with the factors affecting landowners’ willingness to adopt two-stage drainage ditches?
Section 3.1. A primer on theoretical approaches to understand adoption of innovations

Diffusion of an innovation is a social process of members of a social system talking about the innovation, evaluating its costs and benefits and then adopting it if benefits outweigh costs (Lubell & Fulton, 2007; Rogers, 2003). A social system has been defined as a set of interrelated units, which could be individuals, informal groups, organizations, etc., engaging in joint problem solving to accomplish a common goal (Rogers, 2003; pp. 23). The diffusion of innovation theory examines questions such as how, when, and by whom an innovation is adopted (Overstreet et al., 2013). This happens to be one of the most-studied and documented phenomenon in a wide range of academic disciplines (Hartwich et al., 2008). Adoption of an innovation, being a social process, lends itself to a myriad of other theoretical approaches. For example, as per the theory of cultural evolution, individuals make decisions based on the behavior of other members in the group, a process known as social learning (Lubell & Fulton, 2007). Hence, as per this theory, adoption of an innovation would be a result of the process of social learning. Another theoretical approach to understand adoption is from the perspective of social capital theory, as per which, individuals invest in building social capital (i.e., social cohesion, shared norms and values, and trust among members), which affects adoption of innovations (Hartwich et al., 2008). Building social capital is considered to be important since the costs and benefits of adoption are influenced by multiple other actors in the social system (Lubell & Fulton, 2007). Yet another theoretical approach of understanding adoption behavior is the Reasoned Action Approach, which is a recent extension of the
Theory of Planned Behavior (Reimer, Weinkauf, et al., 2012). As per this approach, an individual’s decision to adopt is a function of his intent to adopt, which in turn is influenced by attitude towards the behaviors, subjective and descriptive norms, and perceived behavioral control (Reimer, Weinkauf, et al., 2012).

As explained above, a wide range of theoretical approaches help us understand how, when, and by whom an innovation is adopted. While acknowledging the applicability of these theoretical approaches, the diffusion of innovation theory provides the conceptual grounding as well as the theoretical motivation for this study. This approach is well suited because it (1) focuses on the characteristics of two-stage drainage ditches, the focal innovation in this study, and hence allows for advancing our understanding of preventive innovations, and (2) lends itself to examining the role of change agents in promoting two-stage drainage ditches.

**Section 3.2. Preventive innovations and their perceived attributes**

Preventive innovations, as explained earlier, are innovations that require action at one point in time in order to avoid unwanted consequences at some future time (Rogers, 2002). Given that rewards from adopting these innovations are often delayed in time, are relatively intangible, and the unwanted consequence that the innovation is trying to prevent may not occur anyways, they have a slower rate of adoption (Rogers, 2002). A few scholars have examined the difficulty in promoting preventive innovations pertaining to agricultural practices. For example, educational programs intended to promote integrated weed management have been found to be ineffective due to the short-term complexity and learning costs associated with this practice (Wilson, Hooker, Tucker,
Another example comes from the dryland salinity prevention program in Australia (Pannell et al., 2006). Success of the program was expected to depend upon cooperation from neighbors. However, after more than a decade, the program was deemed a learning failure since farmers could not observe the connection between their actions to prevent dryland salinity and the actual response in the form of desalinization, which occurs underground with long lags between cause and effect (Pannell et al., 2006).

Several strategies have been recommended to foster adoption of preventive innovations. Rogers (2002) recommends emphasizing their relative advantage, utilizing champions, changing norms of the system through peer support, using educational programs, and activating peer networks. A recent meta-analysis found attitude, subjective norms, perceived behavioral control, and self-efficacy to be positively related to the adoption of preventive innovations (Overstreet et al., 2013). Observability, the degree to which the results of an innovation are visible to others and trialability, the degree to which an innovation may be experimented with on a limited basis, were also identified as the best avenues for influencing potential adopter’s beliefs regarding the performance of the actions required by the preventive innovation (Overstreet et al., 2013; Pannell et al., 2006).

The extant scholarly work on understanding preventive innovations, although limited, makes a strong case for the crucial role change agents can play in promoting them. Since perceived innovations have low “relative advantage”, anything that change agents can do to increase the perceived relative advantage of such innovations is expected
to increase their rate of adoption (Rogers, 2002). Additionally, as described in the previous paragraph, the extant scholarly work also identifies factors which could encourage adoption of preventive innovations. However, referring to the central argument in this study, what we do not know is what makes change agents want to promote preventive innovations? Given the scholarly emphasis on perceived low “relative advantage” of preventive innovations, this specific attribute provided the starting point of enquiry in this study. However, the emerging themes from the data obtained in this study were situated more broadly within the five perceived attributes of innovations (Rogers, 2003; pp. 222).

**Section 3.3. The role of change agents in diffusion of innovations**

One of the key variables determining the rate of adoption of innovations in the classic diffusion literature is the extent of change agents’ promotional efforts (Rogers, 2003; pp. 222). Change agents may refer to a wide variety of actors who promote adoption of innovations by providing farmers with, or giving them access to information and inputs which help them adopt an innovation (Hartwich et al., 2008). Change agents have been broadly conceptualized as advisors, agents of state, purveyors of expert knowledge, etc. (Ingram, 2008). Specifically, in the context of agricultural watershed management, change agents are considered to be part of the policy networks which helps spread information about conservation practices (Lubell & Fulton, 2007). In the Western Lake Erie Basin (WLEB) region of Ohio, these individuals are government agents involved closely with advising farmers/landowners about their drainage management practices. Given their involvement in decisions related to drainage management, they
play a crucial role in promoting two-stage ditches, which is an innovative drainage ditch design.

There is a widespread scholarly recognition of the crucial role played by change agents in promoting adoption of innovations. For example, knowledge exchange between agronomist (a type of change agent) and farmers, underpinned by trust, credibility, empathy, and consultation, promotes adoption of conservation practices (Ingram, 2008). In another study, the persuasiveness of change agents was found to be an important factor in adoption of innovations by farmers (Hartwich et al., 2008). The crucial role of change agents in establishing the relative advantage of a preventive innovation is also recognized in literature (Rogers, 2003). In a recent-meta study, their role in fostering a favorable evaluation of preventive innovations by a potential adopter has also been emphasized (Overstreet et al., 2013). However, the extant scholarly work lacks an explicit understanding of factors which make change agents want to promote preventive innovations, and their perception of what factors would help/hinder their adoption. Additionally, recognizing the need to examine both the supplier-side (change agent) and adopter side (farmer/landowner) perspectives (Hartwich et al., 2008) in order to further our understanding of adoption of preventive conservation practices, this study also tests whether the perceived advantages/disadvantages that affect change agents’ willingness to promote are the same as the advantages/disadvantages that affect potential adopters’ (landowners’) willingness to adopt.
Section 4. Research Method & Data Collection

The data for this study come from a mixed methods research approach using semi-structured phone interviews with government agents and a landowner survey. The study was conducted in the Western Lake Erie Basin region of Ohio. The phone interview data was obtained from one government agent each in 17 counties across the Western Lake Erie Basin. The criteria for selection of an interviewee was based on their involvement in drainage improvement and maintenance in a county. Since advising landowners\textsuperscript{30} about drainage ditch management is one of the main responsibilities of these interviewees, it is important to understand their perception about two-stage ditches. All the interviewees in this study were asked if they were aware of two-stage drainage ditches, and would be willing to be interviewed on this topic. 10 out of 17 interviewees were from Soil & Water Conservation District offices. The remaining 7 interviewees were from County Engineers’ Offices. Some of the most common interviewee designations were: district technicians, drainage engineer, ditch maintenance supervisor, and county engineer. These interviews were conducted during September, 2013 to December, 2013, 15 of which were telephone interviews and 2 of which sent their responses via email. The interview duration ranged from 60 minutes to 75 minutes. All the interviews were then transcribed.

Interviews in this study included questions about what interviewees thought about two-stage ditches as a management practice, their perception about whether or not they

\textsuperscript{30} In the survey administered in 3 counties in this study, landowners were asked to identify organizations from where they sought advice on drainage ditches. 46% of landowners provided response to this question. Out of these respondents, 57% sought advice either from the Soil & Water Conservation District office or the County Engineers’ office.
are beneficial and why, what promotes and hinders adoption of two-stage ditches, and whether and why they thought farmers would be willing or not willing to adopt two-stage ditches. Although the focus of the interview was on identifying perceived relative advantage of adopting two-stage ditches, the emerging themes from the interviewee data were situated more broadly within the five perceived attributes of innovations (relative advantage, compatibility, complexity, trialability, and observability) (Rogers, 2003; pp. 222). The underlying goal of this analysis was to understand the preventive nature of two-stage drainage ditches, identify barriers for their adoption, and also identify opportunities for promoting their adoption. Systematic qualitative techniques such as coding, pattern matching, and synthesis were used to analyze the collected data. Quotes and short vignettes were instructive. This allowed for synthesis of interpretations and identification of themes that cut across cases (Miles & Huberman, 1994). Analysis of interviewees’ qualitative data led to a total of 335 manually coded segments in MAXQDA (a qualitative data analysis software; version 11).

In addition, I collected data from landowners to identify their perception of two-stage ditches’ relative advantage. These data were collected through a survey administered to 1500 landowners across three counties in the Western Lake Erie Basin region of Ohio. These counties are characterized by somewhat poorly to very poorly drained soil, and are predominantly agricultural, typical of the Western Lake Erie Basin region of Ohio. Surveys were mailed with multiple contacts, with a response rate of 34%. The primary criterion for selection of a landowner into the sample was that they have a drainage ditch on their land. The secondary criterion was that they owned 50 or more
acres of land, although this was lowered in order to achieve a target of n=500 sampling frame in each county. In the survey, landowners were asked to indicate whether they had ever heard of a two-stage ditch design. In my sample, 20% of survey respondents indicated that they had heard about two-stage ditch design, and have been considered for analysis in this study.

Section 5. Study Context

Ohio’s first drainage laws were passed in 1841 (Atherton, 1999). These laws granted local offices the authority to design and construct drainage projects and assess the costs to the benefitting landowners (ODNR, 2009). The Great Black Swamp, which stretched across 11 counties in Ohio, and extended into Indiana along the Maumee River, covered approximately 1500 square miles (736,000 acres) of the Western Lake Erie Basin. Under the auspices of these laws, drainage projects allowed the development of marginal and poor lands intro productive agricultural lands. By the end of the 19th century, the Great Black Swamp was reclaimed and drainage on existing agricultural land was also improved (D’Ambrosio, 2013). Part of such a radical transformation of the agricultural landscape has been attributed to the practice of channelization, also called “ditching” (D’Ambrosio, 2013). Channelization was typically carried out by creating a “trapezoidal drainage ditch design”, which successfully and efficiently drained the soil profile, but due to its deviations from a natural stream condition, often required “drainage improvements” in order to maintain the design, prevent sediment accumulation, and remove woody vegetation along the ditch banks (D’Ambrosio, 2013). By the year 1930, more than 80,000 miles of drainage ditches had been constructed legal mechanisms in
Ohio, Michigan, Indiana and Minnesota (D’Ambrosio, 2013). Prior to the year 1947, in Ohio, maintenance of drainage ditches was the responsibility of benefitting landowners, wherein sections of a drainage ditch were assigned by the county ditch supervisor to benefitting landowners to maintain (Atherton, 1999). However, due to poor maintenance of existing drainage ditches, some of these drainage projects ended up getting constructed multiple times (ODNR, 2009). As a result of this, an optional maintenance fund was created after 1947, which was later mandated by law in 1957, by virtue of which, a majority of benefitting landowners could petition for a drainage ditch to be put on county maintenance, a term now commonly known as “group drainage improvement”31 (Atherton, 1999; ODNR, 2009). Approximately 4,000 miles of drainage ditches are maintained for agricultural drainage in Ohio, and an estimated $450/mile was spent annually for their maintenance (D’Ambrosio, 2013). It is also estimated that over 60% or approximately 7 million acres of Ohio’s cropland has drainage improvement (ODNR, 2009).

The two-stage drainage ditch is an innovative drainage ditch design which contrasts with the traditional trapezoidal structure of drainage ditches (see Figure 4.1).

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31 It is important to keep in mind that drainage consist of both surface (drainage ditches) and sub-surface (drainage tiles) drainage systems. A petitioned group drainage improvement includes both types of drainage projects. The focus of this chapter is on drainage ditches.
The traditional trapezoidal design was questioned by researchers in Ohio, leading to the development of the innovative two-stage ditch design, as an alternative to traditional ditch maintenance for the purpose of increasing ditch stability, reducing bank erosion and flooding into adjacent fields (D’Ambrosio, 2013; Strock, Kleinman, King, & Delgado, 2010). The first two-stage ditch was constructed in Wood County, Ohio, in 2002 (D’Ambrosio, 2013). The two-stage drainage ditch is a floodplain establishment design, which includes a low-flow channel, allowing for sediment transport during low-flow periods, and a floodplain area which allows for both, handling large volumes of drainage water during high-flow periods and increasing surface contact between soil-water-vegetation to support nutrient removal (D’Ambrosio, 2013; Dunn, Mullendore, de Jalon, & Prokopy, 2016). The underlying principle behind two-stage ditches is to incorporate key characteristics of a natural channel system into the drainage ditch design in order to mimic a natural stream environment (Dunn et al., 2016; Strock et al., 2010). A wide range of scholarly work supports the following non-exhaustive list of benefits associated with two-stage ditches: improves bank stability, increases sediment storage.
capacity, maintains or improves drainage capacity, reduces the need for ditch clean-outs, improves habitat for aquatic wildlife, and that the improved soil-water-vegetation interactions may have implications for water quality and ecological benefits (D’Ambrosio, 2013; Dunn et al., 2016; Strock et al., 2010). However, there are also tradeoffs associated with their adoption. For example, since two-stage ditches are generally 10 to 20 ft. wider than trapezoidal drainage ditches, there is a loss of 1 to 3 acres of land per linear mile of two-stage ditch (Strock et al., 2010). In addition to the loss of land, the initial excavation and construction costs of two-stage ditches are also greater than excavation costs of trapezoidal drainage ditches (Strock et al., 2010). There are also concerns of potential downstream flooding since two-stage drainage ditches increase flow-handling capacity by 25% to 100% (Strock et al., 2010), in addition to a potential impact on existing federal cost-share practices such as grass buffers, and the actual water quality benefits gained from adoption of two-stage ditches (D’Ambrosio, 2013).

Preventive innovations, as described earlier, are innovations that require an action at one point in time in order to avoid an unwanted future condition. In the context of this study, the desired action is that of adopting a two-stage drainage ditch in order to avoid unwanted future conditions such as bank instability, escalating and recurring drainage ditch maintenance costs, flooding of fields, and the goal which is common to all the conservation practices, that of alleviating problems associated with nonpoint source pollution. As we already know from the literature, the rewards from adopting a preventive innovation are often delayed in time, are relatively intangible, and the
unwanted consequence may not occur (Rogers, 2003). Thus, preventive innovations have low “relative advantage”, i.e. the degree to which an innovation is perceived as better than the innovation it supersedes. As per Rogers, (2003), this reduces the likelihood of adoption. Given the relative newness of the two-stage ditch design (approx. 14 years), over the traditional trapezoidal drainage ditch design (over 150 years), a study about understanding their adoption is not only timely, but also needed.

Section 6. Results

The results section in this study is split into two halves. The first half focuses on “change agents”, referred in the study as interviewees, and the second half focuses on “adopters”, referred in this study as landowners.

In the first half of this study, I analyze change agents’ perception of the relative advantage of two-stage drainage ditches and their willingness to promote them. Given the scholarly emphasis on perceived low “relative advantage” of preventive innovations, this specific attribute provided the starting point of enquiry in this study. The first two sections focus on establishing the “preventive” conceptualization of two-stage drainage ditches, from the perspective of perceived relative advantage, tangibility and immediacy of benefits. The next two sections focus on perceived attributes of “compatibility” and “complexity” of innovations. Although diffusion of innovations literature identifies 5 perceived attributes of innovations, trialability and observability did not emerge as recurring themes in this study. The following section synthesizes across multiple perceived attributes of two-stage ditches, and examines their effect on change agents’
willingness to promote them. This is followed by a section on change agents’ recommendations about promoting adoption of two-stage ditches.

In the second half of the study, I analyze adopters’ perception of the relative advantage of two-stage drainage ditches, and subsequently understand their willingness to adopt two-stage ditches. This analysis has 3 distinct goals. In the first section my goal is to compare the benefits/advantages and non-benefits/disadvantages of two-stage ditches across change agents and landowners. In the second section my goal is to test whether the perceived advantages/disadvantages that affect change agents’ willingness to promote are same as perceived advantages/disadvantages that affect landowners’ willingness to adopt two-stage ditches. In the third section my goal is to test whether the factors that change agents believe encourage landowners to adopt two-stage ditches are the same as factors which landowners report affect their willingness to adopt two-stage ditches.

6.1 Change agents’ perceptions of relative advantages/disadvantages associated with two-stage ditches

Relative advantage indicates the costs and benefits resulting from adoption of an innovation (Rogers, 2003). Interviewees in this study identified a range of benefits/advantages associated with the adoption of two-stage ditches (see Table 4.1).
<table>
<thead>
<tr>
<th>Benefit/Advantage</th>
<th>Frequency&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Percentage&lt;sup&gt;b&lt;/sup&gt; (n=17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water quality benefits</td>
<td>8</td>
<td>7 (41%)</td>
</tr>
<tr>
<td>Less/No future maintenance cost; Self cleaning</td>
<td>10</td>
<td>7 (41%)</td>
</tr>
<tr>
<td>Flood relief/control; act as retention/detention pond</td>
<td>8</td>
<td>6 (35%)</td>
</tr>
<tr>
<td>Less sediment runoff/reduces sedimentation</td>
<td>3</td>
<td>3 (18%)</td>
</tr>
<tr>
<td>Stable ditch banks</td>
<td>3</td>
<td>3 (18%)</td>
</tr>
<tr>
<td>Easy to maintain</td>
<td>1</td>
<td>1 (&lt;1%)</td>
</tr>
<tr>
<td>Increases ditches’ longevity</td>
<td>1</td>
<td>1 (&lt;1%)</td>
</tr>
</tbody>
</table>

Table 4.1. Advantages associated with two-stage drainage ditch

Notes:

<sup>a</sup> Includes all mentions across all interviewees (e.g., if an interviewee mentioned an advantage twice, it was counted as 2 times in the frequency column).

<sup>b</sup> Number of all interviewees who mentioned an advantage at least once.

The greatest number of interviewees, 7 out of 17, identified water quality benefits and the benefit of less to no future maintenance costs associated with two-stage drainage ditches. This was followed by several interviewees, 6 out of 17, identifying the benefit of flood control associated with two-stage drainage ditches. This was followed by an equal number of interviewees, 3 out of 17, identifying the benefits of less sedimentation runoff and stable ditch banks. This was followed by an interviewee identifying the benefit that two-stage ditches are easy to maintain. Another interviewee identified the benefit that two-stage ditches increase the longevity of drainage ditches. An important point to keep in mind is that 4 out of 17 interviewees did not identify any benefits associated with two-stage ditches. Instead, they identified disadvantages associated with them. Although a fewer number of disadvantages (5 disadvantages vs 7 advantages) associated with two-stage ditches were identified, the number of interviewees who identified these
disadvantages, as well as the frequency with which they were identified, was much higher when compared with advantages associated with them (see Table 4.2).

<table>
<thead>
<tr>
<th>Non-Benefit/Disadvantage</th>
<th>Frequencya</th>
<th>Percentageb (n=17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent loss of farming land</td>
<td>30</td>
<td>16 (94%)</td>
</tr>
<tr>
<td>Increased cost of construction</td>
<td>13</td>
<td>10 (59%)</td>
</tr>
<tr>
<td>Future maintenance difficult</td>
<td>5</td>
<td>5 (29%)</td>
</tr>
<tr>
<td>Issue of dealing with excavated soil</td>
<td>4</td>
<td>2 (12%)</td>
</tr>
<tr>
<td>Context specific – Trees cut for construction; against environment</td>
<td>1</td>
<td>1 (&lt;1%)</td>
</tr>
</tbody>
</table>

Table 4.2. Disadvantages associated with two-stage drainage ditch

Notes:
a Includes all mentions across all interviewees (e.g., if an interviewee mentioned a disadvantage twice, it was counted as 2 times in the frequency column).
b Number of all interviewees who mentioned a disadvantage at least once.

The greatest number of interviewees, 16 out of 17, identified that adoption of two-stage ditch would require permanent loss of farming land. This was followed by the disadvantage of increase in the cost of construction of two-stage drainage ditches, especially in comparison with the cost associated with construction of traditional drainage ditches. For example, an interviewee mentioned, “Two-stage ditches are more expensive than conventional drainage ditch designs”. Another interviewee who emailed his response, wrote, “I believe it would be safe to estimate that a two-stage channel could cost double that of a standard design for an annual storm”. This was followed by the disadvantage of difficulty with future maintenance of two-stage ditches. Highlighting this disadvantage, one of the interviewees mentioned, “The two-stage ditches are so wide that
typical [maintenance] equipment couldn't reach the center [of the ditch] making maintenance a nightmare”. Another interviewee added, “An issue with two-stage ditch is when you have to remove the sediments [carry out a form of ditch maintenance]. Since the top has been widened it becomes tougher to clean it”. This was followed by, in decreasing order, dealing with the soil that’s excavated in order to construct them two-stage ditch, and the context specific factor that sometimes trees are cut in order to construct these ditches, which goes against the environmental benefits associated with them.

As the above analysis indicates, adoption of two-stage drainage ditches involves incurring immediate costs in the form of losing land and incurring high initial costs, whereas the benefits are distant in the form of water quality benefits, reduction in future ditch maintenance costs, and flood relief. Talking about these tradeoffs, an interviewee mentioned, “With two-stage ditches, the economic offset is not enough for me to be able to go and promote it”. He further added, “We have had meetings about two-stage ditches, more than anything, it is the cost that kills it”. Overall, given the balance of evidence, it can be argued that the “relative advantage” associated with two-stage drainage ditches is low.

Thus, the two-stage drainage ditch fits the preventive innovations’ definition that they are low in relative advantage. As per Rogers (2002), the low perceived relative advantage of a preventive innovation is also due to the fact that rewards from adopting them are relatively intangible and often delayed in time. The next section focuses on
change agents’ perception of tangibility and immediacy of benefits associated with adoption of two-stage drainage ditches.

6.1.1 Intangibility & immediacy of benefits associated with two-stage ditches

One of the key features of preventive innovations is that benefits from adopting them are relatively intangible and often delayed in time (Rogers, 2002). Interviewees in this study identified several dimensions of intangibility of benefits associated with the adoption of two-stage ditches. These dimensions of intangibility of benefits are: temporal, economic, spatial, functional, and uncertainty (see Table 4.3).

<table>
<thead>
<tr>
<th>Dimension of intangibility</th>
<th>Frequencya</th>
<th>Percentageb (n=17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporal</td>
<td>10</td>
<td>9 (53%)</td>
</tr>
<tr>
<td>Economic</td>
<td>3</td>
<td>3 (18%)</td>
</tr>
<tr>
<td>Spatial</td>
<td>2</td>
<td>2 (12%)</td>
</tr>
<tr>
<td>Functional</td>
<td>2</td>
<td>1 (&lt;1%)</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>1</td>
<td>1 (&lt;1%)</td>
</tr>
</tbody>
</table>

Table 4.3. Dimensions of intangibility of benefits associated with two-stage drainage ditch

Notes:
a Includes all mentions across all interviewees (e.g., if an interviewee mentioned a dimension twice, it was counted as 2 times in the frequency column).
b Number of all interviewees who mentioned a dimension of intangibility at least once.

The greatest number of interviewees, 9 out of 17, identified the temporal dimension of intangibility of benefits associated with adoption of two-stage ditches. This was followed by, in decreasing order, economic intangibility (3 out of 17), spatial intangibility (2 out of 17), functional intangibility (1 out of 17), and intangibility due to uncertainty of benefits (1 out of 17). Although the frequency of any single dimension of
intangibility of benefits associated with two-stage ditches is low, it is important to note that 11 out of 17 (65%) interviewees in this study reported one or several of the intangibility dimensions.

Temporal intangibility of benefits was identified by interviewees from the perspective that although costs associated with adoption of two-stage ditches are immediate, the benefits are delayed in time. For example, an interviewee emphasizing the aspect of immediate costs, mentioned, “Up here in our county, a landowner won’t see any benefit associated with a two-stage ditch as he is losing land”. Another interviewee mentioned, “They [landowners] do not see the benefits for the extra costs in building huge two-stage channels [two-stage drainage ditches].” The aspect of intangibility of long term benefits was captured very well by an interviewee, who mentioned, “Landowners do not see the long term benefits associated with two-stage ditches”. Another interviewee added, “As of now, landowners in my county are not willing to adopt two-stage ditches. They don’t see its benefit yet”.

Economic intangibility of benefits was identified by interviewees from the perspective that attributing an economic value to the benefits associated with two-stage ditches is difficult. For example, an interviewee mentioned, “They [landowners] are not willing [to adopt two-stage ditch] because they don’t see any tangible economic benefit”. Another interviewee mentioned, “Farmers are mainly interested in and more willing for BMPs that benefits/pays them. If the BMP [referring to two-stage ditch] lacks a tangible benefit then they are not willing to go for it. Economics comes into play”. Another
interviewee further added, “How do we put a dollar value on the benefits of two-stage ditches?”

Spatial intangibility was identified by interviewees from the perspective of the location of benefitting landowners in the watershed with respect to the two-stage ditch (see section 4 of Chapter 3; conceptualizing asymmetric resource dilemma in agricultural drainage systems). This aspect was captured very well by an interviewee, who mentioned, “Who is going to receive the benefits due to construction of a two-stage ditch? How far is a farmer from the ditch and how is he being assessed the cost”. Another interviewee, also referring to the aspect of spatial intangibility of benefits of adopting two-stage ditch, mentioned, “Most of the people [landowners] are not right next to a drainage ditch; only 10% are next to a drainage ditch”. The interviewee was indicating that since majority of landowners in the watershed are spatially away from the drainage ditch, they will not perceive that two-stage ditches are beneficial.

The intangibility dimension of uncertainty of benefits was identified by an interviewee from the perspective that benefits associated with adoption of two-stage ditches are uncertain. Highlighting the dimension of uncertainty of benefits, an interviewee mentioned, “As of now, I am at 50-50 level in terms of whether they [two-stage ditches] are beneficial or not. I know that they are projected not to have any maintenance requirement…but are these benefits going to last?”

Functional intangibility dimension pertains to the notion that adoption of two-stage ditches does not lead to any perceptible change in the flow of drained water. This dimension relates closely with Roger’s (2003) finding that the rate of adoption of a new
innovation is affected by the old innovation that it supersedes. The yardstick against which an innovation is compared is the practice that it supersedes. As mentioned earlier, the goal with the traditional trapezoidal ditch design was to successfully and efficiently drain the soil profile. However, with the adoption of the two-stage drainage ditch design, as reported by an interviewee in this study, farmers do not see any perceptible change in the flow of drained water. He mentioned, “Farmers don’t see any tangible benefit [from adoption of two-stage ditches] as they don’t see any increase in water flow”.

In addition to the aforementioned specific dimensions of intangibility of benefits, 6 out of 17 (35%) interviewees in this study identified three general dimensions of intangibility. The first is the notion that benefits associated with two-stage ditches are difficult to perceive. For example, an interviewee mentioned, “Many landowners do not see the benefits associated with two-stage ditches”. Another interviewee mentioned, “They don’t see overall benefits associated with two-stage ditches”. The second is the notion that benefits of two-stage ditches are difficult to demonstrate. For example, an interviewee mentioned, “Farmers do not see tangible benefits associated with adopting two-stage ditch...It is hard to demonstrate benefits of a two-stage ditch”. Another interviewee added, “You have to show farmers/landowners that if this BMP takes so much land it also provides that much benefit”. The third is the notion that the environmental benefits associated with two-stage ditches are imperceptible. For example, an interviewee mentioned, “People [landowners] don’t see any environmental benefit [associated with adoption of two-stage ditches]”.

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Overall, 13 out of 17 (76%) interviewees in this study either reported one or several of the specific intangibility dimensions, or reported general intangibility of benefits associated with adoption of two-stage ditches. As the above analysis indicates, the benefits associated with adoption of two-stage ditches are indeed intangible, often delayed in time, and are sometimes tentative. Thus, the findings further support the “preventive” conceptualization of two-stage drainage ditches.

6.1.2 Compatibility of the Innovation

In addition to the perceived relative advantage of two-stage ditches, the next important theme that emerged from interviewee data was that of “compatibility”. Compatibility of an innovation refers to the degree to which an innovation is perceived as being consistent with existing values, past experiences, and needs of potential adopters (Rogers, 2003; pp. 240). An innovation can be compatible or incompatible with respect to need, previously introduced ideas, or sociocultural values and beliefs (Rogers, 2003). Interviewees in this study identified several dimensions pertaining specifically to incompatibility of two-stage drainage ditches with needs of potential adopters. These dimensions of incompatibility with need are: perceived lack of need for the increased drainage capacity benefit provided by two-stage ditches, perception that there are no issues with existing drainage ditches and hence there isn’t a need to change it, perception that two-stage ditches won’t fix drainage issues in areas with flat-terrain and excessive sedimentation, and that the existing design already mimics natural stream conditions and provides self-cleaning and water quality benefits, which is respectively the underlying
principle and the two main benefits associated with two-stage drainage ditches (see Table 4.4).

<table>
<thead>
<tr>
<th>Dimensions of incompatibility with needs</th>
<th>Frequency^a</th>
<th>Percentage^b (n=17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perception of there not being a need for the benefit provided by two-stage ditch</td>
<td>6</td>
<td>4 (24%)</td>
</tr>
<tr>
<td>No current issues with drainage ditches</td>
<td>2</td>
<td>2 (12%)</td>
</tr>
<tr>
<td>Perception that two-stage ditch won’t fix the existing issues</td>
<td>2</td>
<td>2 (12%)</td>
</tr>
<tr>
<td>Old design does what two-stage ditch design promises</td>
<td>2</td>
<td>2 (12%)</td>
</tr>
</tbody>
</table>

Table 4.4. Dimensions of incompatibility with needs

Notes:
^a Includes all mentions across all interviewees (e.g., if an interviewee mentioned a dimension of incompatibility with needs twice, it was counted as 2 times in the frequency column).
^b Number of all interviewees who mentioned a dimension of incompatibility with needs at least once.

Several interviewees, 4 out of 17, perceived that there was a lack of need for an increased drainage capacity provided by two-stage drainage ditches. For example, an interviewee mentioned, “Our ditches are already functioning with the [drainage] capacity as a two-stage [ditch] would make it function. We already have a similar process going on which is as good as two-stage ditches”. Another interviewee added, “Currently they [landowners] do not see a need to make a ditch bigger in size [to obtain an increased drainage capacity] than what they already have”. Further insights about the perception that there are no issues with existing drainage ditches and hence there isn’t a need to change it, was provided by two interviewees. One of them mentioned, “If they [landowners] don’t have a problem with integrity/stability of bank, then why should they
Another interviewee added, “The ditches that we have in our county are very old and they have been working very well. So, the notion is why to change something that has been working fairly well”.

Evidence about the perception that two-stage ditches won’t fix drainage issues in areas with flat-terrain and excessive sedimentation, was provided by two different interviewees. One of them mentioned, “The downfall that I can see in my county [with respect to the benefit of adoption of two-stage ditch] is that we are very flat up here. Our main priority here is to have our tile outlet”. The second interviewee mentioned, “In our county, long-term ditch maintenance benefit does not come into picture because of loads of sedimentation. Irrespective of the drainage design [whether two-stage ditch or trapezoidal ditch], sedimentation becomes the main issue, as it blocks the outlet [of drainage] tiles”. Both the interviewees implied that the benefits provided by two-stage ditches are not compatible with the local drainage ditch maintenance needs.

Evidence that existing ditch designs already mimic the conditions and provides water quality benefits was provided by an interviewee, who mentioned, “In our county we have more naturally forming ditches. We have canary grasses here which have a tendency to filter the water anyways. Thus, I don’t see any benefit of promoting a two-stage ditch”. Another interviewee felt that the existing design is already self-cleaning, and thus provides the benefits which two-stage ditches promise. He mentioned, “I have channels [drainage ditches] under maintenance for over 25 years that have never had to

Drainage tiles are perforated pipes made up of clay, cement or plastic, which help remove excess water from soil subsurface. These tiles are installed below the surface of agricultural fields. Main drainage tiles run across multiple properties draining water eventually into a drainage ditch.
have the bottoms excavated [a form of ditch maintenance] because they were designed at the optimum width for the annual storm, and keep themselves clean”.

Although the frequency of any single dimension of incompatibility with needs associated with two-stage ditches is low, it is important to note that 7 out of 17 (41%) interviewees in this study reported one or several of the ‘incompatibility with needs’ dimensions. Moreover, evidence was found in support of incompatibility of two-stage ditches with previously introduced ideas, and sociocultural values and beliefs, two additional forms of incompatibility identified in the diffusion of innovations literature (Rogers, 2003). As per Rogers (2003), previous practice provides a familiar standard against which an innovation is compared and interpreted. Evidence in support of incompatibility of two-stage ditches with previously introduced idea was provided by three interviewees. The first interviewee mentioned, “A lot of ditches in my county are pretty small, wherein the bottom is at the most two feet wide. So, a two-stage ditch won’t fit there”. The second interviewee mentioned, “We have low gradient ditches, so two-stage ditches won’t be a practical solution in our county”. The third interviewee mentioned, “We pretty much have a standard ditch design here. There is not much here that we can change”.

Evidence in support of incompatibility of two-stage ditches with existing sociocultural values and beliefs about drainage ditches was provided by two interviewees. The first interviewee mentioned, “A lot of ditches have been built years ago, farmers want them to be built back to the original [trapezoidal] design”. Highlighting the predominant notion of draining water, he further added, “Landowners care more about
their water. They want their water to go away [get drained]”. The second interviewee mentioned, “I think mind-set acts as a hindering factor. There is this mind-set of doing things in the traditional way. It goes back to the old generation thinking, if it worked then why change”. In this study, reluctance to change is due in part to the two-stage ditches’ incompatibility with the sociocultural beliefs of potential adopters.

Overall, 8 out of 17 (47%) interviewees in this study either reported one or several of the incompatibility with need dimensions, or reported incompatibility of two stage ditches with existing drainage ditch design or with the prevalent sociocultural beliefs about drainage ditch management goals.

6.1.3 Complexity of the Innovation

In addition to the perceived relative advantage and compatibility of two-stage ditches, the next important theme that emerged from interviewee data was that of “complexity”. Complexity of an innovation refers to the degree to which an innovation is perceived as relatively difficult to understand and use (Rogers, 2003; pp. 257). In this study, complexity of two-stage ditches has been conceptualized from the dimension of their “conditional suitability”, which implies that the many elements of local conditions have to be right for two-stage ditches to be applicable and useful. Rather than being equally applicable everywhere, two stage-ditch suitability depends on a number of interacting contextual factors. Understanding the conditional suitability of two-stage ditches is important for their promotion, highlighted by an interviewee, who mentioned, “If we found a place where a two-stage ditch was feasible and practical, then we [change agents] can promote it”. While some of the interviewees did not identify the specific
conditions in which two-stage ditches’ would be suitable, others felt that their suitability was driven by topographical features such as floodplain, type of soil, land gradation, and the level of urbanization in an area. Another interviewee felt that they are suitable if only there is a need for greater drainage capacity (see Table 4.5).

<table>
<thead>
<tr>
<th>Dimensions of Complexity as a function of conditional suitability</th>
<th>Frequencya</th>
<th>Percentageb (n=17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General conditional suitability</td>
<td>5</td>
<td>5 (29%)</td>
</tr>
<tr>
<td>Suitability driven by topography</td>
<td>5</td>
<td>4 (24%)</td>
</tr>
<tr>
<td>Suitability driven by need</td>
<td>3</td>
<td>1 (&lt;1%)</td>
</tr>
</tbody>
</table>

Table 4.5. Dimensions of complexity associated with two-stage drainage ditch

Notes:
a Includes all mentions across all interviewees (e.g., if an interviewee mentioned a dimension of complexity twice, it was counted as 2 times in the frequency column).
b Number of all interviewees who mentioned a dimension of complexity at least once.

The general conditional suitability of two-stage ditches was highlighted by an interviewee, who mentioned, “The location, and condition has to be right. Two-stage ditches cannot be incorporated into every project. I am not an expert, but from my experience, the conditions have to be good for two-stage ditches to be beneficial”. Another interviewee added, “I think in certain areas two-stage ditches would be more adoptable compared with other ditch designs. Whereas, there are places where a conventional ditch does the job. There is a fine line when it comes to where a two-stage ditch can work, and where it can’t”. Although these interviewees did not identify specific
conditions, their response highlights the fact that two-stage drainage ditches are complex in terms of the conditions under which they can be applicable and useful.

Another important dimension of complexity associated with two-stage drainage ditches is that their suitability is driven by topographical features, which implies that topographical conditions have to be right for two-stage ditches to be applicable and useful. An interviewee who felt that two-stage ditches are suitable in a floodplain area, mentioned, “When you are almost into a floodplain, this could be the area where you could construct a two-stage ditch”. He further added, “A two-stage ditch would work well if you are in a region which is more of a natural creek, and you need better flow in order to avoid flooding issues”. Another interviewee highlighting the importance of soil type in determining two-stage ditches’ suitability, mentioned, “Soil type is an important driving force when it comes to deciding about a ditch design. If the soil type is sandy, then a two-stage design would work better as it helps in widening the ditch and providing bank stability”. An interviewee who felt that land gradation was an important topographical feature in determining suitability of two-stage ditches, mentioned, “I don’t think two-stage ditches are the answer on a flat [land] grade. I think they would be beneficial if there is enough [land] gradation [slope]”. Another interviewee who felt that two-stage ditches will not be feasible in urbanized areas, mentioned, “There are residential areas where it is not possible to do a two-stage ditch...due to zoning/building regulations”.

In addition to the aforementioned general and topographical conditional suitability, the suitability of a two-stage ditch design was also found to be driven by the
situational need for a greater drainage capacity. Emphasizing this dimension of conditional suitability of two-stage ditches, an interviewee mentioned, “They [two-stage ditches] should be promoted and used only when a channel [drainage ditch] needs to be modified to have the capacity for a 5, 10, 25 year storm\textsuperscript{33}”. He further added, “I believe two-stage ditches are ideal when you are creating a channel [drainage ditch] with the capacity for a very large storm”.

Although the frequency of any single dimension of complexity associated with two-stage ditches is low, it is important to note that 8 out of 17 (47%) interviewees in this study reported one or several of the ‘conditional suitability’ dimensions. Hence, the above analysis provides evidence for complexity of two-stage ditches as a function of its conditional suitability, which means that many elements of local conditions have to be right for two-stage ditches to be a viable innovation.

6.2 Change agents’ willingness to promote “preventive” two-stage ditches

The analysis in the preceding sections, focusing specifically on the perceived attributes of two-stage drainage ditches, provides ample support for their “preventive” nature. Drawing upon insights from change agents’ perspective, the study finds support for low “relative advantage” of two-stage ditches, one of the key features of preventive innovations. Evidence is also found in support of intangible benefits associated with two-stage ditches, that these benefits are often delayed in time and that they may sometimes be tentative. Several dimensions pertaining specifically to incompatibility of two-stage drainage ditches with needs of potential adopters were also identified. Evidence was also

\textsuperscript{33} One of the main drainage ditch design criteria is the frequency of major storm events.
found in support of their incompatibility with existing drainage ditch design and prevalent sociocultural beliefs about drainage ditch management goals. In addition, evidence was found in support of the “complex” nature of two stage drainage ditches. From the focus on perceived attributes of two-stage ditches, I now turn my attention to change agents’ willingness to promote them.

While describing the variety of perceived attributes of two-stage drainage ditches and establishing their preventive nature is instructive, an important question remains: how do change agents’ perceived attributes of two-stage ditches affect their willingness to promote them? To synthesize across multiple perceived attributes of two-stage ditches, and examine their effect on willingness to promote, I arranged the interviewees in decreasing order of their willingness to promote two-stage ditches (see Table 4.6).

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34 The mean willingness to promote two-stage drainage ditches was 4.56 (SD=2.40, n=16). Willingness to promote was measured on a scale of 1 to 10, with 1 being not at all willing and 10 being very willing.
<table>
<thead>
<tr>
<th>Code^a</th>
<th>Type of Benefits</th>
<th>Type of Disadvantages</th>
<th>Incomp-atible(^{b,c})</th>
<th>Complex(^{e})</th>
<th>Willingness to promote(^d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>B2</td>
<td>B3</td>
<td>B4</td>
<td>B5</td>
<td>B6</td>
</tr>
<tr>
<td>A6</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✘</td>
<td>✘</td>
</tr>
<tr>
<td>A7</td>
<td>✓</td>
<td>✘</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>A1</td>
<td>✘</td>
<td>✓</td>
<td>✘</td>
<td>✘</td>
<td>✘</td>
</tr>
<tr>
<td>A13</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✘</td>
<td>✘</td>
</tr>
<tr>
<td>A11</td>
<td>✘</td>
<td>✓</td>
<td>✓</td>
<td>✘</td>
<td>✘</td>
</tr>
<tr>
<td>A16</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
</tr>
<tr>
<td>A12</td>
<td>✓</td>
<td>✘</td>
<td>✘</td>
<td>✘</td>
<td>✘</td>
</tr>
<tr>
<td>A8</td>
<td>✘</td>
<td>✘</td>
<td>✓</td>
<td>✘</td>
<td>✘</td>
</tr>
<tr>
<td>A9</td>
<td>✘</td>
<td>✘</td>
<td>✘</td>
<td>✘</td>
<td>✘</td>
</tr>
<tr>
<td>A3</td>
<td>✘</td>
<td>✘</td>
<td>✘</td>
<td>✘</td>
<td>✘</td>
</tr>
<tr>
<td>A5</td>
<td>✘</td>
<td>✘</td>
<td>✓</td>
<td>✘</td>
<td>✘</td>
</tr>
<tr>
<td>A17</td>
<td>✘</td>
<td>✓</td>
<td>✓</td>
<td>✘</td>
<td>✘</td>
</tr>
<tr>
<td>A4</td>
<td>✓</td>
<td>✓</td>
<td>✘</td>
<td>✘</td>
<td>✘</td>
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<td>A2</td>
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<td>✘</td>
<td>✘</td>
<td>✘</td>
<td>✘</td>
</tr>
<tr>
<td>A14</td>
<td>✘</td>
<td>✘</td>
<td>✘</td>
<td>✘</td>
<td>✘</td>
</tr>
<tr>
<td>A15</td>
<td>✘</td>
<td>✘</td>
<td>✘</td>
<td>✘</td>
<td>✘</td>
</tr>
</tbody>
</table>

Table 4.6. Perceived attributes & change agents’ willingness to promote two-stage ditches

**Notes:** A ‘✓’ mark indicates that a particular benefit/advantage was mentioned by an interviewee. A ‘✘’ mark indicates that a particular benefit/disadvantage was not mentioned by an interviewee.

**BENEFITS** – B1: Water quality benefits; B2: Less/no future maintenance cost; B3: Flood relief/control; B4: Reduces sedimentation; B5: Stabilizes ditch bank; B6: Easy to maintain; B7: Increases ditches’ longevity

**DISADVANTAGES** – D1: Loss of land; D2: Increased cost of construction; D3: Future maintenance difficult; D4: Dealing with excavated soil; D5: Environmental costs (trees cut for construction).
Table 4.6 Notes continued

a Refers to the code assigned to an interviewee in this study. Although 17 interviews were conducted as part of this study, one interviewee did not provide data on his willingness to promote two-stage ditch, and has been excluded from this analysis.

b Incompatibility measure includes incompatibility with needs dimensions, as well as incompatibility with existing drainage ditch design and incompatibility with sociocultural beliefs about drainage ditch management goals.

c Blank cells in this column indicate that this theme was not identified by an interviewee.

d Willingness to promote two-stage drainage ditches was measured on a scale of 1 to 10, with 1 being not at all willing and 10 being very willing.
Analysis reveals several patterns suggesting which variables might be influential in determining outcomes. The set of 12 benefits and disadvantages listed in the table represent the “perceived relative advantage” of two-stage ditches. Incompatibility and complexity are two additional themes listed in the table. Together, these variables represent the perceived attributes of two-stage ditches, while willingness to promote is the outcome variable. I will first focus on the benefits and disadvantages to identify patterns, which will then be followed by comparing across the attributes of compatibility and complexity.

Let us first broadly look across the highlighted and non-highlighted sections of the table. A count of check marks under ‘types of benefits’ reveal that benefits were identified 19 times by the 7 interviewees in the highlighted section of the table. On the contrary, in the non-highlighted section, benefits are identified only 8 times by 9 interviewees. In fact, 4 out of these 9 interviewees (A9; A3; A14 & A15) did not identify any benefit associated with two-stage ditches. A similar count of check marks under ‘types of disadvantages’ reveals that disadvantages were identified 12 times by the 7 interviewees in the highlighted section of the table. On the contrary, in the non-highlighted section, disadvantages were identified 19 times by 9 interviewees. Specifically, 19 benefits versus 12 disadvantages (high perceived relative advantage) for interviewees in the highlighted section of the table, correlates with higher mean willingness to promote ($M= 6.86; n=7$). Similarly, 8 benefits versus 19 disadvantages (low perceived relative advantage) for interviewees in the non-highlighted section of the
table, correlates with lower mean willingness to promote ($M = 2.78; n=9$). Broadly, this analysis reveals that perceived relative advantage correlates with willingness to promote.

Let us now take a look at specific benefits, one at a time, while comparing across interviewees in the highlighted (with high willingness scores) and non-highlighted (with low willingness) sections of table 4.6. 7 out of 16 interviewees identified water quality benefits (B1), 5 in the highlighted section of the table and 2 in the non-highlighted section. An interviewee identifying water quality benefits reflects his recognition that two-stage ditches have environmental benefits, a critical selling point for conservation practices. The 5 interviewees in the highlighted section of the table also had high willingness to promote two-stage ditch, which indicates that perceptions of environmental benefits is important for change agents to be willing. We would have expected the 2 interviewees (A4 & A2) in the non-highlighted section to also have high willingness. For interviewee A4, who also listed three other benefits (B2, B5 & B6), his willingness to promote was affected by his perception of low acceptability of two-stage ditches by landowners in his county. Interviewee A2, who identified water quality benefits as the only advantage, felt that the economic offset, given the loss of land (D1) and increased cost of construction (D2), was not enough for him to promote two-stage ditches. Despite these two outliers, it can be concluded that perceptions of environmental benefits is important for change agents to be willing to promote two-stage ditches.

Let us now consider the benefit of less or no future maintenance cost (B2). 7 out of 16 interviewees identified this benefit, 5 in the highlighted section of the table and 2 in the non-highlighted section. Given that recurring, annual maintenance cost is an
important aspect of ditch maintenance, identification of this benefit by an interviewee is indicative of his recognition that adoption of two-stage ditches can reduce/remove this cost in the future, a critical selling point for “preventive” innovations. The 5 interviewees in the highlighted section of the table also had a high willingness to promote two-stage ditch, which indicates that perceptions of less or no future maintenance cost is important for change agents to be willing. We would have expected the 2 interviewees (A17 & A4) in the non-highlighted section to also have high willingness. For A4, as explained earlier, his willingness to promote was affected by his perception of low acceptability of two-stage ditches by landowners in his county. Interviewee A17 felt that his organizations’ lack of knowledge would necessitate seeking outside help to implement two-stage ditches. Despite these two outliers, it can be concluded that perception of less or no future maintenance cost is important for change agents to be willing to promote two-stage ditches.

Let us now consider the benefit of flood relief/control (B3). 5 out of 16 interviewees identified this benefit, 3 in the highlighted section of the table and 2 in the non-highlighted section. Although almost equal number of interviewees (3 vs 2) identified this benefit, it is important to note that the highlighted section has a total of 7 interviewees, resulting in 43% of interviewees reporting this benefit. On the contrary, only 22% (2 out of 9) interviewees in the non-highlighted section identified this benefit. The 3 interviewees in the highlighted section of the table also had a high willingness to promote two-stage ditch, which indicates that perceptions of the benefit of flood relief/control is important for change agents to be willing. We would have expected the 2
interviewees (A8 & A5) in the non-highlighted section to also have high willingness. Interviewee A8 felt that he did not know enough about two-stage ditches. Interviewee A5 felt that although two-stage ditch provides flood relief, it was not worth the additional cost associated with its adoption. It is important to also note that he identified 3 disadvantages (D1, D2, & D3) associated with two-stage ditches. Despite these two outliers, it can be concluded that perception of flood relief/control benefit is important for change agents to be willing to promote two-stage ditches.

Let us now consider the benefit that two-stage ditch reduces sedimentation (B4). 3 out of 16 interviewees, all of them in the highlighted section of the table, identified this benefit. These interviewees also had a high willingness to promote two-stage ditch, which indicates that perceptions of reduction in sedimentation is important for change agents to be willing to promote two-stage ditches. Let us now consider the benefit that two-stage ditch design stabilizes ditch bank (B5). This benefit was identified by 3 out of 16 interviewees, 2 in the highlighted section of the table and 1 in the non-highlighted section. Since almost equal number of interviewees (2 vs 1) identified this benefit on both sides of the willingness to promote spectrum, this factor is not a driver in affecting change agents’ willingness to promote two-stage ditch. Let us now consider the remaining 2 benefits (B6 & B7). Given that these benefits were identified only once, they are not considered as drivers in affecting change agents’ willingness to promote two-stage ditch.

Let us now take a look at specific disadvantages, one at a time, while comparing across interviewees in the highlighted (with high willingness scores) and non-highlighted
(with low willingness) sections of table 4.6. 15 out of 16 interviewees identified the disadvantage of loss of land (D1), 6 in the highlighted section of the table and 9 in the non-highlighted section. Except for interviewee A11, every interviewee identified the disadvantage of loss of land associated. Hence, although this is an important disadvantage, it is not driving change agents’ willingness to promote two-stage ditch. Let us now consider the disadvantage of increased cost of construction (D2). 9 out of 16 interviewees identified this disadvantage, 4 in the highlighted section of the table and 5 in the non-highlighted section. Since almost equal number of interviewees (4 vs 5) identified this benefit on both sides of the willingness to promote spectrum, this factor is not a driver in affecting change agents’ willingness to promote two-stage ditch.

Let us now consider the disadvantage that future maintenance may become difficult with a two-stage ditch design (D3). 4 out of 16 interviewees identified this disadvantage, 1 in the highlighted section of the table and 3 in the non-highlighted section. An interviewee identifying this disadvantage reflects his apprehension of not only the difficulty in maintaining two-stage ditches in the future, but also his disagreement with the underlying principle that the two-stage ditches are self-cleaning. The 3 interviewees in the non-highlighted section of the table also had a low willingness to promote two-stage ditch, which indicates that perceptions of difficulty with future maintenance is a driver in affecting change agents’ non-willingness to promote two-stage ditch. We would have expected interviewee A1 in the highlighted section to also have low willingness. However, it is important to note that unlike other interviewees (A3, A5, & A15) who did not identify the benefit of less to no future maintenance cost (B2),
interviewee A recognizes this benefit, which, as identified earlier is an important driver in affecting change agents’ willingness to promote two-stage ditch. Despite an outlier, it can be concluded that perception of difficulty with future maintenance is important in affecting change agents’ non-willingness to promote two-stage ditch.

Let us now consider the disadvantage that adoption of two-stage ditch will involve dealing with soil excavated for its construction (D4). 2 out of 16 interviewees identified this disadvantage, 1 in the highlighted section of the table and 1 in the non-highlighted section. Since equal number of interviewees identified this disadvantage on both sides of the willingness to promote spectrum, this factor is not a driver in affecting change agents’ willingness to promote two-stage ditch. Let us now consider the disadvantage of environmental costs of adoption of two-stage ditch (D5). Since this disadvantage was identified only once, it is not considered as a driver in affecting change agents’ willingness to promote two-stage ditch.

From our focus on the variable of perceived relative advantage, let us now turn our attention to the remaining two perceived attributes: incompatibility and complexity. Let us first focus on incompatibility. The theme of incompatibility was identified by 8 out of 16 interviewees, 4 in the highlighted section of the table and 4 in the non-highlighted section. Since equal number of interviewees identified this theme on both sides of the willingness to promote spectrum, it is not a driver in affecting change agents’ willingness to promote two-stage ditch. Let us now focus on complexity. As a reminder, in this study, complexity of two-stage ditches was conceptualized from the dimension of their “conditional suitability”, which implies that the many elements of local conditions have
to be right for two-stage ditches to be viable. The theme of complexity was identified by 7 out of 16 interviewees, 4 in the highlighted section of the table and 3 in the non-highlighted section. Although almost equal number of interviewees (4 vs 3) identified the theme of complexity, it is important to note that the highlighted section has a total of 7 interviewees, resulting in 57% of interviewees reporting the theme of complexity. On the contrary, only 33% (3 out of 9) interviewees in the non-highlighted section identified this theme. The findings thus suggest that complexity is a driving factor in affecting change agents’ willingness to promote two-stage ditch.

To sum up the findings in this section, the following four benefits were identified as important for change agents to be willing to promote two-stage ditches: Water quality benefits (B1), Less to no future maintenance cost (B2), Flood relief/control (B3), and Sedimentation reduction benefit (B4). The following disadvantage was identified as important in affecting change agents’ non-willingness to promote two-stage ditch: Difficulty of future maintenance (D4). It was also found that the overall perceived relative advantage correlates with willingness to promote two-stage ditch. Evidence was also found in support of landowners’ unacceptability of two-stage ditches affecting change agents’ willingness to promote them. Additionally, one interviewee said that lack of knowledge about two-stage ditches was affecting his willingness to promote them.

35 However, it is important to note that the relationship between complexity and willingness to promote is in an opposite direction of what the literature predicts; greater complexity perception seems to have a positive effect on change agents’ willingness to promote. I believe this contradictory finding is due a confounding variable, change agents’ knowledge about two-stage ditches. This could be an avenue for future research.
Evidence is also found in support for incompatibility not being an important factor in having an effect on change agents’ willingness to promote two-stage ditches.

6.3 Change agents’ recommendations for promoting landowner adoption of two-stage ditches

On asking an interviewee about what he thought would promote adoption of two-stage ditches, he replied, “You will have to be a really good salesman to be able to sell two-stage ditches in my county”! With the goal of identifying opportunities for promoting adoption of two-stage ditches, interviewees were asked to identify factors which would help promote their adoption. The following factors were identified: providing financial incentives, providing education and information, showing/demonstrating examples of two-stage drainage ditches in the field, targeting conservation-minded landowners, promoting them as an option based on conditional suitability, and promoting them through the Soil & Water Conservation District & the Natural Resources Conservation Service (see Table 4.7).
### Table 4.7. Recommendations about promoting adoption of two-stage ditches

<table>
<thead>
<tr>
<th>Change agents’ recommendation for promotion of two-stage ditches</th>
<th>Frequency&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Percentage&lt;sup&gt;b&lt;/sup&gt; (n=17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide financial incentives (Cost-share, compensate landowners losing land)</td>
<td>12</td>
<td>8 (47%)</td>
</tr>
<tr>
<td>Provide education &amp; information (facts and figures, educate about long-term benefits)</td>
<td>3</td>
<td>3 (18%)</td>
</tr>
<tr>
<td>Show/demonstrate field examples</td>
<td>2</td>
<td>2 (12%)</td>
</tr>
<tr>
<td>Target conservation minded landowners</td>
<td>2</td>
<td>2 (12%)</td>
</tr>
<tr>
<td>Promote as an option based on conditional suitability</td>
<td>1</td>
<td>1 (&lt;1%)</td>
</tr>
<tr>
<td>Promote through SWCD &amp; NRCS</td>
<td>1</td>
<td>1 (&lt;1%)</td>
</tr>
</tbody>
</table>

Notes: SWCD: Soils & Water Conservation District; NRCS: Natural Resources Conservation Service

<sup>a</sup> Includes all mentions across all interviewees (e.g., if an interviewee mentioned a recommendation twice, it was counted as 2 times in the frequency column).

<sup>b</sup> Number of all interviewees who mentioned a recommendation at least once.

The greatest number of interviewees, 8 out of 17, recommended that providing financial incentives, either in the form of having cost-share programs or compensating landowners who lose land as a result of adoption of two-stage ditch, will help promote their adoption. For example, an interviewee mentioned, “If we put some incentives out there to compensate farmers who go for [adopt] two-stage ditches that would promote its adoption”. This was followed by 3 out of 17 interviewees’ recommendation that providing education and information about two-stage ditches would help promote their adoption. Interviewees emphasized the importance of providing information about facts and figures about two-stage ditches, as well as educating farmers about their long term benefits. For example, an interviewee mentioned, “I think with education and more information there will be more interest for adoption of two-stage ditches”. Another interviewee mentioned, “If we make farmers understand that the long term maintenance
cost associated with a two-stage ditch is low, then they would be willing to adopt them”. This was followed by interviewees’, 2 out of 17, recommendation that farmers should be shown field examples of two-stage drainage ditches. For example, an interviewee mentioned, “Once you have a few projects in place and you can demonstrate that two-stage ditches are good, then farmers would be willing to go for them. We have to show that 2-stage ditches have benefits”. An equal number of landowners, 2 out of 17, also felt that conservation-minded landowners should be targeted for promoting adoption of two-stage drainage ditches. One interviewee recommended that two-stage ditches should be promoted as an option for landowners if it is suitable. Highlighting the conditional suitability of two-stage ditches, he mentioned, “The only way to promote two-stage ditch is to put them there as an option if it would fit the area”. One interviewee recommended that two-stage drainage ditches should be promoted through the Soil & Water Conservation District & the Natural Resources Conservation Service offices in the county.

6.4 Comparing landowners to change agents

From the focus on change agents in the previous sections, I now turn my attention to potential adopters of the innovation. A landowner survey about drainage ditch management was administered across three counties in the Western Lake Erie Basin region of Ohio. In the survey, landowners were asked to indicate whether they had ever heard of a two-stage ditch design. In my sample, 20% of survey respondents indicated that they had heard about two-stage ditch design. These 20% survey respondents were asked to indicate their willingness to install a two-stage ditch on one or more of their
drainage ditches. The mean willingness to adopt\textsuperscript{36} a two-stage ditch was 4.61 (SD=2.90; n=90). In addition to reporting their willingness to adopt, others measures were developed in order to identify the reasons why landowners may or may not be willing to adopt two-stage ditches. Landowners also reported their familiarity with two-stage drainage ditches. The selection of measures for this analysis is driven by the findings from change agents in the previous section of this study.

\textbf{6.4.1 Landowner versus change agent perceived relative advantage of two-stage ditches}

In order to fulfil the first goal of this analysis, the top three benefits/advantages identified by change agents were listed in decreasing order of their reported percentage (see Table 4.8).

\textsuperscript{36} Willingness to adopt was measured on a scale of 1 to 10, with 1 being not at all willing and 10 being very willing.
<table>
<thead>
<tr>
<th>Benefit/Advantage&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Interviewee Percentage&lt;sup&gt;b&lt;/sup&gt; (n=17)</th>
<th>Matching Survey Item/s&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Landowner Percentage&lt;sup&gt;d&lt;/sup&gt; (n=70)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water quality benefits</td>
<td>7 (41%)</td>
<td>2 separate items:</td>
<td>47 (67%)&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1. They are good for the environment; &amp; 2. They help in reducing nutrient runoff, thus reduce occurrence of algal blooms in Lake Erie</td>
<td></td>
</tr>
<tr>
<td>Less/No future maintenance cost; Self cleaning</td>
<td>7 (41%)</td>
<td>Long-term ditch maintenance cost is low</td>
<td>34 (49%)</td>
</tr>
<tr>
<td>Flood relief/control; act as retention/detention pond</td>
<td>6 (35%)</td>
<td>They reduce flooding risks</td>
<td>38 (54%)</td>
</tr>
</tbody>
</table>

Table 4.8. A comparison of benefits/advantages across change agents & landowners

Notes:
<sup>a</sup> Lists the top three benefits/advantages reported by interviewees.
<sup>b</sup> Number of interviewees who mentioned a benefit/advantage.
<sup>c</sup> The matching survey item provided to landowners. Survey items measured as a dummy variable (1=checked box; 0= unchecked box)
<sup>d</sup> Number of landowners who checked the box identifying a benefit/advantage.
<sup>e</sup> Reports average number and percentage, since there were two survey items.

The benefits reported by landowners were then matched with the benefit reported by change agents. Water quality benefits were matched with two survey items, (Good for environment (70%) & help in reducing nutrient runoff (63.8%)), resulting in an average of 67% landowners identifying environmental benefits associated with adoption of two-stage ditches. In addition, 49% landowners reported the benefit of long-term reduction in ditch maintenance cost and 54% reported the benefit of reduction in flooding risks. It is important to note that a higher percentage of landowners reported environmental benefits (67% vs 41%). Unlike change agents, reduction in flooding risk was identified as the next important benefit by landowners (54% vs 35%). Overall, it can be concluded that several
key benefits of two-stage ditches important for change agents are also important for landowners.

Similar to the above analysis, the top three disadvantages identified by change agents were listed in decreasing order of their reported percentage (see Table 4.9).

<table>
<thead>
<tr>
<th>Non-Benefit/Disadvantagea</th>
<th>Interviewee Percentageb (n=17)</th>
<th>Matching Survey Item/séc</th>
<th>Landowner Percentaged (n=86)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent loss of farming land</td>
<td>16 (94%)</td>
<td>A two-stage ditch takes away land from production</td>
<td>39 (45%)</td>
</tr>
<tr>
<td>Increased cost of construction</td>
<td>10 (59%)</td>
<td>NONE</td>
<td>N/A</td>
</tr>
<tr>
<td>Future maintenance difficult</td>
<td>5 (29%)</td>
<td>Future maintenance is difficult with a two-stage ditch design</td>
<td>16 (19%)</td>
</tr>
</tbody>
</table>

Table 4.9. A comparison of non-benefits/disadvantages across change agents & landowners

Notes: N/A: Not applicable
a Lists the top three non-benefits/disadvantages reported by interviewees.
b Number of interviewees who mentioned a non-benefit/disadvantage.
c The matching survey item provided to landowners. Survey items measured as a dummy variable (1=checked box; 0= unchecked box)
d Number of landowners who checked the box identifying a non-benefit/disadvantage.

The disadvantages reported by landowners were then matched with the disadvantage reported by change agents. Loss of farming land (45%) and future maintenance becoming difficult (19%) were also identified by landowners as disadvantages associated with two-stage ditches. An important point of contrast

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37 In addition to the two matched disadvantages, landowners also identified the following two disadvantages that were not mentioned by change agents: (1) Negative impact on existing cost-share agreements (12.8%; n=86) & (2) Require too much paperwork and permits (11.6%; n=86).
between change agents and landowners is the difference in reported percentage for the disadvantage of loss of farming land (94% vs 45%). It is important to note that although there was no matched survey item for the disadvantage of increased cost of construction, in a different question 26.7% (n=86) landowners checked the box in agreement with this statement, “financial costs outweigh the benefits”. Difficulty with future maintenance was reported as a disadvantage by both change agents and landowners (29% vs 19%).

6.4.2 Landowner willingness to adopt versus change agent willingness to promote

In order to fulfil the second goal of this analysis, the perceived benefits and disadvantages that affect change agents’ willingness to promote two-stage ditches were listed, and correlations were run between landowners’ matched benefits and disadvantages and willingness to adopt two-stage ditches (see Table 4.10).
The correlation analysis allows testing of whether the perceived advantages/disadvantages that affect change agents’ willingness to promote are the same as the perceived advantages/disadvantages that affect landowners’ willingness to adopt two-stage ditches. As the analysis indicates, an important difference is in environmental benefits. Perceptions of environmental benefits is important for change agents to be willing to promote two-stage ditches, but not for landowners to be willing to adopt two-
stage ditches. No significant correlations were found between the two survey items assessing perceived environmental benefits and willingness to adopt two-stage ditch. A similarity was found in the significant positive correlation between landowners’ perception that long-term ditch maintenance cost is low and their willingness to adopt two-stage ditches ($r=0.475$, $p<0.001$). A significant positive correlation was also found between landowners’ perception that two-stage ditches reduce flooding risks and their willingness to adopt it ($r=0.367$, $p=0.002$). Since the survey did not have a matched measure for the benefit of sedimentation reduction, a benefit positively affecting change agents’ willingness to promote two-stage ditch, it could not be tested for landowners. Although difficulty of future maintenance was identified as a perceived disadvantage negatively affecting change agents’ willingness to promote two-stage ditch, no significant correlation was found between landowners’ perception of this disadvantage and their willingness to adopt two-stage ditch. Overall, results are mixed: what makes change agents more or less willing to promote an innovation, may or may not be similar to what makes landowners more or less willing to adopt an innovation. Perceived water quality benefits and difficulty of future maintenance were important for change agents’ willingness to promote but not for landowners’ willingness to adopt. On the other hand, less future maintenance costs and more flood control were important factors affecting both change agents’ willingness to promote and landowners’ willingness to adopt.
6.4.3 Landowners’ willingness to adopt versus change agent’s recommendations to promote

In order to fulfil the third goal of this analysis, change agents’ recommended factors for promoting two-stage ditch were listed, and correlations were run between landowners’ matched factors and their willingness to adopt two-stage ditches (see Table 4.11).

<table>
<thead>
<tr>
<th>Change agents’ recommendation for promotion of two-stage ditches&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Matching Survey Item/s</th>
<th>Survey Item/s Correlation Coefficient&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide financial incentives (Cost-share, compensate landowners losing land)</td>
<td>Cost-share programs are available</td>
<td>.131 (n=68)</td>
</tr>
<tr>
<td>Provide education &amp; information (facts and figures, educate about long-term benefits)</td>
<td>Overall, how familiar are you with 2-stage ditches?</td>
<td>.214* (n=90)</td>
</tr>
<tr>
<td>Show/demonstrate field examples</td>
<td>I have been to field day or workshop</td>
<td>.249* (n=88)</td>
</tr>
<tr>
<td></td>
<td>I have seen two-stage ditches in the field</td>
<td>.237* (n=87)</td>
</tr>
</tbody>
</table>

Table 4.11. A comparison of recommendations to promote and willingness to adopt two-stage ditch across change agents & landowners

Notes:
<sup>a</sup> Recommendation identified based on findings in section 6.3.
<sup>b</sup> Numbers in the column indicate Pearson correlation coefficient. Reported coefficients are a result of correlations between the matching survey item and landowners’ willingness to install a two-stage ditch on one or more of their ditch(es).
<sup>*</sup> Correlation is significant at the 0.05 level (2-tailed).
The goal behind running the correlation analysis was to test whether the factors that change agents perceive are important for promoting two-stage ditch are the same as factors that affect landowners’ willingness to adopt it. As the analysis indicates, although providing financial incentives is recommended by almost 50% of the change agents interviewed in this study, it is not a factor that affects landowners’ willingness to adopt two-stage ditch. No significant correlation was found between the survey item that cost-share programs are available and landowners’ willingness to adopt two-stage ditch. In contrast, another change agent recommendation, providing education and information about two-stage ditches (recommended by 3 interviewees (18%)), was supported by landowner survey data. Familiarity with two-stage ditches was found to be significantly and positively correlated with landowners’ willingness to adopt two-stage ditch ($r=0.214$, $p=0.043$). Another recommendation by change agents’ was to show/demonstrate field examples of two-stage ditches. Significant positive correlations were found between the two matched survey items assessing landowners’ field experience of two-stage ditch and willingness to adopt it. A significant positive correlation was found between landowners’ having been to a field day or workshop and their willingness to adopt two-stage ditches ($r=0.249$, $p=0.019$). A significant positive correlation was also found between landowners’ having seen two-stage ditches in the field and their willingness to adopt them ($r=0.237$, $p=0.027$). Overall, it can be concluded that most of the factors change agents perceive are important for promoting two-stage ditches are similar to factors that make landowners more willing to adopt an innovation. Surprisingly, availability of cost share programs was not significantly correlated with landowner willingness to adopt, even though providing
financial incentives was identified most frequently by change agents as a way to promote landowner adoption.

**Section 7. Discussion**

Extant scholarly work on adoption of conservation practices has often examined the characteristics of three sets of variables: the adopter, the change agent, and the innovation. Some scholars examining the innovation itself have distinguished between incremental innovations, those which provide immediate benefits, and preventive innovations, those which provide intangible benefits often delayed in time. The diffusion of innovations literature clearly establishes the crucial role of change agents in demonstrating the relative advantage of preventive innovation to potential adopters. However, the extant literature is thin on explaining what makes change agents want to promote a particular innovation. Taking the example of an innovative two-stage drainage ditch design, and examining change agents’ perception of its attributes, leads to several theoretical as well as practical insights.

Firstly, matching change agents’ perceptions of the attributes of two-stage ditches helps establish that they are indeed preventive. Interviewee data establish that change agents perceive two-stage ditches as low in relative advantage, that benefits from adopting them are intangible and often delayed in time. Several nuanced dimensions of perceived attributes were also identified by change agents. Extant scholarly work highlights the difficulty change agents have in promoting preventive innovations since it is difficult for them to demonstrate their relative advantage (Rogers, 2003; Rogers, 2002). However, this study also highlights the importance of demonstrating relative advantage
of adopting preventive innovations to change agents themselves. The perceived relative advantage of two-stage ditches correlates with change agents’ willingness to promote them. Thus, perceived relative advantage not only influences the willingness to adopt an innovation, but also the willingness to promote it. Hence, one of the crucial roles of those wishing to encourage preventive innovations should be to influence the change agents’ perception about the relative advantage of adopting an innovation.

Secondly, a comparison of willingness to promote and willingness to adopt two-stage ditches across change agents & landowners led to the critical finding that factors which make change agents more or less willing to promote an innovation can be similar and different from what makes landowners more or less willing to adopt it. A critical point of difference between change agents and landowners was that although perceptions of environmental benefits are important for change agents to be willing to promote two-stage ditch but they are not for landowners to be willing to adopt it. From a theoretical standpoint, this highlights the challenge of promoting conservation practices, which are usually preventive due to long term environmental benefits which are often intangible.

Extant literature on preventive innovations emphasizes the role of change agents in fostering their favorable evaluation by a potential adopter (Overstreet et al., 2013). While doing so is important, this study also highlights the importance of being mindful that a factor which influences change agents’ willingness to promote an innovation may be different from a factor which influences an adopter’s willingness to adopt it. From a practical standpoint, this finding is also important for extension educators, who should

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38 In Ohio this includes some university extension educators and The Nature Conservancy.
continue to inform change agents about the environmental benefits of a conservation practice, even though landowners may not be as receptive to it.

Thirdly, the study found that willingness to promote a two-stage ditch design is driven not just by benefits/disadvantages specific to drainage, such as reduced maintenance cost, flood relief, reduced sedimentation, and difficulty of future maintenance, but also by benefits pertaining to the environment. This finding corroborates extant scholarly work arguing that the role of agricultural drainage is shifting from that of water conveyance, to a more holistic approach which also takes into account environmental benefits (Needelman, et al., 2007; Strock et al., 2010).

Fourthly, several findings in this study are supported by extant scholarly work. For example, the study found evidence in support of incompatibility of two-stage ditches with existing sociocultural values and beliefs about drainage ditches, in part due to landowners’ reluctance to change. In a study of change agents in southern United States, reluctance to change by farmers was identified as the most frequently mentioned barrier to adoption of sustainable agricultural practices (Rodriguez, Molnar, Fazio, Sydnor, & Lowe, 2009). This study also found evidence in support for incompatibility not being an important factor in having an effect on change agents’ willingness to promote two-stage ditches. This finding is in line with extant literature, which, although focuses on adopters’ perception of compatibility unlike this study’s focus on change agents’ perception of compatibility, finds that compatibility is somewhat less important in predicting rate of adoption than is perceived relative advantage (Rogers, 2003).
Finally, a practical implication of this study is the finding that although financial incentives are recommended most often by change agents’, it may not be a factor affecting landowners’ willingness to adopt two-stage ditches. Rather, change agents should focus more on increasing landowners’ familiarity with two-stage ditches, by providing education and information about the practice. This is critical, given that only 20% of survey respondents in the study sample had even heard about the two-stage ditch design. Additionally, change agents’ should also show/demonstrate field examples of two-stage ditches to promote their adoption.

Section 8. Conclusion

Although research about the importance of change agents in promoting innovations is abundant, we lack an understanding about their perception of attributes of an innovation and how that affects their willingness to promote it. Recognizing this gap, the goal of this study was to examine change agents’ perceptions of the attributes of two-stage ditches. Although perceived “relative advantage”, one of the oft-studied attributes of innovations, provided the starting point of inquiry, the emerging themes from the data were situated more broadly within the five perceived attributes of innovations (relative advantage, compatibility, complexity, trialability, and observability).

Qualitative data analysis from one government agent in each of 17 counties across the Western Lake Erie Basin established that two-stage ditches have features of a preventive innovation, due to their low perceived relative advantage, intangibility of benefits and that benefits from adopting them are delayed in time. Interviewee insights also helped identify several dimensions of intangibility of benefits: temporal, economic,
spatial, functional, and uncertainty. Evidence was found in support of two-stage ditches’ incompatibility with needs, incompatibility with existing drainage ditch design, and incompatibility with sociocultural beliefs about drainage ditch management goals. Evidence supporting complexity of two-stage ditches was also found. Although diffusion of innovations literature identifies 5 perceived attributes of innovations, trialability and observability did not emerge as recurring themes in this study. Analysis of perceived relative advantage led to identification of five factors (4 positive and 1 negative) affecting change agents’ willingness to promote two-stage ditches.

Quantitative data obtained from 97 landowners led to the finding that although environmental benefits are important for change agents to be willing to promote two-stage ditches, they are not as important for landowners’ willingness to adopt two-stage ditches. Instead, landowner’s willingness to adopt matched with change agent’s willingness to promote two-stage ditches on the measures of reduced long-term ditch maintenance cost and reduced flooding risks. It was also found that change agents’ recommendation of providing financial incentives was not a driver for landowners’ willingness to adopt two-stage ditches. Instead, increased landowners’ familiarity and field experience with two-stage ditches were found to be significantly and positively correlated with their willingness to adopt them.

Like all studies this one has limits. Due to limited resources the landowner survey could be administered only in 3 out of the 17 counties where change agents were interviewed. In order to minimize this limitation, counties were selected such that they would be typical of the Western Lake Erie Basin region of Ohio. The lack of landowners’
awareness of two-stage ditches was also a limitation in this study. However, semi-structured phone interviews with government agents allowed an in-depth understanding of the innovation.

Situating this study in the diffusion of innovations literature provided a theoretically rich, as well as conceptually sound foundation for understanding change agents’ perceptions of the attributes of two-stage ditches. However, as much as this study provides theoretical and practical insights, it also leaves a number of questions unanswered. In particular, results raise several important questions and avenues for future research:

1. Adoption of two-stage ditches could lend itself to a situation of a group of landowners in a watershed making joint decision about adopting/rejecting them. Thus, as much as it fits the “optional” type of innovation-decision identified in the diffusion of innovations literature, it could also fit the “collective” type of innovation-decision. With this in mind, future scholars could also test the applicability of the theory of collective action in understanding adoption of two-stage ditches.

2. Future scholars should consider testing the perceived attributes of observability and trialability in affecting the adoption of two-stage ditches.

3. Given the preventive nature of two-stage ditches, a critical dimension scholars should keep in mind is that of certainty/applicability of benefits to the local context. Since one of the important dimensions of preventive innovations is
delayed benefits, whether and how important are the dimensions of certainty/applicability of benefits to the local context?
Chapter 5: Conclusion

Section 1. A quick overview

Agricultural drainage is an important practice in the Western Lake Erie Basin. In the state of Ohio alone, which covers 76% of the basin, approximately half of all cropland is benefitting from drainage in order to enhance agricultural productivity. Both scholars and practitioners recognize the importance of drainage, and acknowledge its implications beyond merely increasing agricultural productivity, but also as a vital instrument in adapting to climate change and achieving sustainable development. Paradoxically, however, drainage seems to have become a ‘forgotten factor’ in international water discourse, with scholars arguing that institutions for managing agricultural drainage are lacking (Abdeldayem et al., 2005; Scheumann & Freisem, 2002; Tollefson et al., 2014). The agricultural landscape in Ohio, however, presents over 150 years of drainage management institutions, providing a good opportunity to examine them in light of theory and practice. Moreover, scholars have more recently begun to recognize the need to broaden the meaning of drainage from merely conveying water to one that provides a balance of agricultural and environmental objectives. Thus drainage management institutions in Ohio are at a crossroads, with a rich history of institutions and a more recent scholarly emphasis on balancing the agricultural and environmental objectives of drainage.
My investigation of agricultural drainage drew on two primary bodies of theory. Chapters 2 and 3 were grounded in the theory of collective action, while Chapter 4 was grounded in the diffusion of innovations theory. In the second chapter, I examined drainage management institutions from the perspective of a public-goods dilemma. Specifically, I examined the public-goods dilemma in agricultural drainage systems from the analytical lens of four variables: group size (V1), capability to choose to enter or exit from a group (V2), heterogeneity in benefits and costs (V3), and security of contributions (V4). In the third chapter, I examined drainage management institutions from the perspective of resource asymmetry and property rights. I applied Schlager & Ostrom’s (1992) property-rights analytical scheme to agricultural drainage systems, conceptualizing them as a common-pool resource held in a private property (land) ownership regime and exhibiting an asymmetric dilemma. Specifically, I examined property rights of access (P1), withdrawal (P2), management (P3), exclusion (P4), and alienation (P5) in agricultural drainage systems. Both Chapter 2 and 3 explored the conditions for emergence of collective action.

In Chapter 4, I focused on examining change agents’ perception of the attributes of a preventive innovation (two-stage drainage ditches) and examined what makes them want to promote it. In addition, I also examined perceived relative advantage of a preventive innovation from the perspective of potential adopters. Specifically, I tested whether the perceived advantages/disadvantages that affect change agents’ willingness to promote are the same as the advantages/disadvantages that affect potential adopters’ (landowners’) willingness to adopt an innovation.
The remaining conclusion chapter proceeds in the following order: Firstly, I write about the theoretical contributions from each of the three main chapters of my dissertation. Secondly, I write about crosscutting theoretical contributions of my dissertation, providing a brief overview of themes which are applicable to multiple chapters. Thirdly, I write about the practical contributions of my dissertation. In the fourth and final section, I conclude with ideas for future research and concluding thoughts.

**Section 2. Theoretical contributions**

**Chapter 2**

Examining drainage management institutions and how the institutional mechanisms affect the values of the four key variables of interest (V1-V4) led to several theoretical insights. Firstly, theoretical contributions were made to how scholars understand group size (V1) and security of contributions (V4). For the institutional mechanism of county petition, group size was found to become important at different stages of the process. Unlike the extant scholarly understanding of group size as simply the number of individuals in a group that could engage in collective action (Agrawal, 2001; Poteete & Ostrom, 2004), findings in this chapter indicate that the variable of group size merits a more dynamic understanding. In this chapter, I also theoretically broadened the understanding of security of contributions. Whereas, the extant scholarly understanding of contributions getting returned if not sufficient provides a good starting point, in this chapter, I broadened this understanding to include the components of having
provision for absorbing contributions incurred upfront, the amount of contributions required, and whether there are locally devised arrangements to secure contributions.

Secondly, it was found that although the values of key variables of interest were determined by the drainage management institutions, their overall effect on collective action occurred through several interacting variables. Several such variables of theoretical importance were identified, including the Olson effect for group size (V1), uncertainty/certainty about the fate of project for ability to choose to enter/exit (V2), fairness perception and ease of understanding the method used for distributing costs and benefits for heterogeneity in benefits and costs (V3), and the critical role of securing contributions in mutual agreement and the contributions required upfront in county petition, for security of contributions (V4). As my analysis in this chapter indicates, two key variables (V1 & V2), do not support theoretical expectations based on prior studies, V4 somewhat supports theoretical expectations based on prior studies, and V3 supports theoretical expectations based on prior studies.

Thirdly, although extant theory on collective action guided me to my four (V1-V4) key variables, analysis in this chapter also led to identification of several additional factors which affect collective action for the two institutional mechanisms. These additional factors were categorized under 6 broad categories that emerged from the data. Overall, it was found that for both County Petition (CP) & Mutual Agreement (MA) projects, resources were an important factor for collective action. Although, unlike MA projects, for which variables related to resources were found to help collective action, for CP projects, resources in the form of higher cost and longer timeline, hindered collective
action. Additionally, unlike MA projects, interpersonal dynamics were found not to be as important for collective action in CP projects.

Finally, it was found that the theoretically expected effect of a variable on collective action was influenced by interactive effects both from the drainage management institution and from other factors. For example, the expected negative effect of heterogeneity in individual net benefits was mitigated since the institutional mechanism of mutual agreement allowed landowners to agree upon the heterogeneity (inequality) in individual net benefit. This insight is supported by extant scholarly work providing evidence that institutions mediate the effects of forms of heterogeneity (Poteete & Ostrom, 2004; Mudliar, 2016).

Chapter 3

Examining drainage management institutions from the perspective of resource asymmetry and property rights (P1-P5) led to several theoretical insights. Firstly, I adapted Schlager & Ostrom’s (1992) property-rights analytical scheme to suit the private property (land) context of the common-pool resource of the agricultural drainage system. In the revised property-rights analytical scheme, I was able to highlight the importance of understanding whether property rights pertain to the drainage infrastructure, or use of the infrastructure. The revised property-rights analytical scheme also highlighted the importance of how rights to the infrastructure can come in conflict with land rights and subsequently affect the management of the resource.

Secondly, it was found that drainage management institutions did not always allocate cumulative bundles of property rights. Following the seminal work by Schlager
and Ostrom (1992), property rights systems have been widely conceptualized and studied as containing cumulative bundles of five rights rather than a single right (Ostrom, 2010). However, as I found in this chapter, the five property rights are not necessarily held in a cumulative manner, i.e. as “progressive bundles of property rights”, as is often the case in fisheries, and other commonly studied CPRs such as self-organized irrigation systems and forests (Agrawal & Ostrom, 2001; Tang, 1994). Instead, different drainage management institutions (mutual agreement and county petition), allocated different “non-cumulative” bundles of property rights based on the lateral distribution of resource users (near & far-landowners), and the role of the local government agency. Thus, a hierarchical understanding of property rights, as often is used for common-pool resources, falls short of understanding property rights in resource systems exhibiting an asymmetric resource dilemma combined with common-pool resource characteristics and private property ownership.

Thirdly, it was found that property rights interact to affect prospects of collective action. Specifically, the right of exclusion (P4) interacted with the right to use (P2) and negatively affected collective action in mutual agreement, as it increased the likelihood of free-riding. Similarly, the interaction between the right to the land, i.e. private property and the right of maintenance (P3) negatively affected collective action in mutual agreement, as it reduced the certainty that the group drainage improvement will be maintained in the future. The extant literature recognizes that the five property rights are independent of one another, but are often cumulatively held for common-pool resources (Schlager & Ostrom, 1992; Ostrom, 2010). However, given the non-hierarchical, non-
cumulative stacking of property rights for drainage systems, it is important to understand which property rights interact, how they interact, and what implications such interactions have for collective action.

Chapter 4

Examining change agents’ perceptions of attributes of two-stage drainage ditches led to several theoretical insights. Firstly, a “preventive” analytical approach to conservation practices facilitated a closer analysis of the perceived attributes of two-stage drainage ditches. Additionally, this approach helped in the identification of several dimensions of perceived attributes of two-stage ditches. Thus future scholarly endeavors into understanding adoption of conservation practices, should consider applying the “preventive” perspective.

Secondly, my findings in this chapter highlighted the theoretical importance of demonstrating relative advantage of adopting preventive innovations to change agents themselves. Extant scholarly work highlights the difficulty change agents have in promoting preventive innovations since it is difficult for them to demonstrate their relative advantage (Rogers, 2002, 2003). However, as I found in this chapter, the perceived relative advantage of two-stage ditches correlated with change agents’ willingness to promote them. Thus, perceived relative advantage not only influences the willingness to adopt an innovation, but also the willingness to promote it.

Thirdly, on comparing willingness to promote and willingness to adopt two-stage ditches across change agents & landowners, results suggest that factors which make change agents more or less willing to promote an innovation may be different from what
makes landowners more or less willing to adopt it. From a theoretical standpoint, this finding highlights the challenge of promoting conservation practices, which are usually preventive due to long term intangible, environmental benefits. Extant literature on preventive innovations emphasizes the role of change agents in fostering their favorable evaluation by a potential adopter (Overstreet, Cegielski, & Hall, 2013). While doing so is important, the findings in this chapter also highlights the importance of being mindful that a factor which influences an adopter’s willingness to adopt an innovation may be different from a factor which influences a change agent’s willingness to promote it.

Section 3. Crosscutting theoretical contributions

Looking across all three parts of my study suggests several crosscutting theoretical contributions of this research. These are theoretically relevant themes that are simultaneously applicable to multiple chapters of my dissertation.

Firstly, it was found that the two drainage management institutions in this study exhibit an interactive nature. The mutual agreement mechanism seemed good as a first attempt to foster collective action, which landowners preferred for smaller projects. The local government agency also directed landowners to this mechanism first. In contrast, the county petition mechanism was found to be more suited to larger areas and more landowners, or if landowners could not come to a mutual agreement themselves. Rather than finding that one type of institution is always better than the other, it was evident that MA was sometimes more successful and CP was sometimes more successful, and in fact they were complementary. Whereas MA provided a landowner-driven institutional mechanism to give a first attempt at generating collective action, if that failed, CP acted
as a government-driven institutional back-up to facilitate collective action. This crosscutting theoretical theme resonates with Ostrom’s design principles encouraging users to develop their own rule making (including cost allocation for projects) but if this fails then there should be an outside government entity available. While Ostrom’s design principles see this outside entity as important for conflict resolution (Ostrom, 1990, 2009), the county petition mechanism suggests another role for the outside entity: to provide an alternative institutional arrangement in case the MA is not successful. Based on this finding, a theoretical argument can be made to consider the role for government beyond just existing as a conflict resolution venue. Rather, a key government role may be to supply an alternative institution for stakeholders to generate collective action. This insight is in line with studies of collaborative environmental management describing the complementarity of community-driven efforts and government resources (Koontz et al., 2004).

Secondly, to add to the theoretical contribution of complementarity of institutions, these two institutions were also found to complement each other from the perspective of collective action dilemmas. Whereas, MA provided an institutional platform that allowed free-riding, it was backed up with providing landowners with a choice of CP institutional platform which curbs free-riding. Such an institutional complementarity can be of relevance for scholars studying collective action dilemmas.

Thirdly, it was found in the second chapter that private property rights, a form of right to land, interacts with a landowners’ ability to enter/exit (V2) to affect collective action (see Table 2.4). As explained in the third chapter, unlike extant scholarly work
which has focused on common-pool resources (CPRs) that are held by the community, i.e. under a common-property regime, drainage systems represent a common-pool resource held in a private property (land) ownership regime. As a result of the interaction between private property rights and a landowners’ ability to enter/exit (V2) in a mutual agreement project, it could hurt prospects of collective action.

Fourthly, it was found that the spatial location of a landowner with respect to the drainage system, a concept referred in the third chapter of my dissertation as resource asymmetry, does interact with the dimension of spatial intangibility of benefits, a concept identified in the fourth chapter of my dissertation. As explained in the third chapter, the physical arrangement of resource users with respect to the drainage system (referred to as near & far-landowners) may affect their incentive to contribute for obtaining a group drainage improvement. In the fourth chapter, it was found that landowners who are spatially away from the drainage ditch may not perceive that two-stage drainage ditches are beneficial, and thus may not contribute for its adoption.

Finally, comparing theoretical conceptualization of agricultural drainage systems in the second and third chapters of my dissertation may raise a critical question of how scholars understand a public-goods dilemma versus a common-pool resource (commons) dilemma. Here are some initial thoughts on this topic. Goods/resources have been identified in the extant literature based on the concepts of “exclusion” and “subtractability” (McGinnis, 2011). Both, public-goods and common-pool resources (CPRs) share the characteristic of difficulty of exclusion. Hence, production of a joint good, irrespective of whether it is a public-good or a CPR, can fit within the domain of
public-goods dilemma literature. If we consider *use* of a joint good, and if the usage is non-subtractive, then this resource management situation also fits within the domain of public-goods dilemma literature. However, if the *use* is subtractive, then the resource management situation fits within the domain of commons dilemma. As highlighted in the introduction chapter, this distinction between public-goods and commons dilemma follows Kollok (1998; pp.191), who says, “public goods dilemmas concern the *production of*, and commons dilemmas involve the *use of*, a joint good from which it is difficult to exclude others”.

**Section 4. Practical contributions for managers and policy makers**

Examining institutional arrangements for collective action in agricultural drainage provides not only theoretical insights, but practical advice as well. Several practical contributions from the three chapters of my dissertation are described below.

Firstly, a critical finding about drainage management institutions in Ohio is that they represent a suite of institutional options available for landowners to choose from. For example, whereas MA projects are suitable for small scale projects, CP projects fit a range of projects from small, to large, to even projects that cross county boundaries. In addition to having the choice of scale with respect to project size, landowners also have the choice of pursuing an institutional mechanism based on their preference for involvement of government agencies. Their choice ranges from minimal government involvement for MA projects to maximum government involvement for CP projects. This can be critical for policy makers in other states in the Midwestern United States who are considering providing multiple institutional avenues for effective drainage management.
Secondly, it was found that perceptions of environmental benefits are important for change agents to be willing to promote two-stage ditches. From a practical standpoint, this finding is also important for extension educators, who should continue to inform change agents about the environmental benefits of a conservation practice, even though landowners may not be as receptive to it.

Thirdly, it was found that the willingness to promote two-stage ditches was driven not just by benefits/disadvantages specific to drainage, but also by benefits pertaining to the environment. This finding corroborates extant scholarly work arguing that the role of agricultural drainage is shifting from that of water conveyance, to a more holistic approach which also takes into account environmental benefits (Needelman, Strock, & Allen, 2007; Strock, Kleinman, King, & Delgado, 2010). However, advice for policy makers and managers would be to keep in mind that as much as bringing this change is necessary, so is having an understanding of the compatibility of any new drainage practices with the existing drainage ditch laws (D’Ambrosio, 2013). With a rich understanding of the institutional fabric within which landowners make decisions about their drainage management practices, managers and policy makers will be better able to help landowners make informed decision about their drainage practices.

Finally, it was found that although financial incentives are recommended most often by change agents, it may not be a factor affecting landowners’ willingness to adopt two-stage ditches. Change agents might be more successful by focusing more on increasing landowners’ familiarity with two-stage ditches, by providing education and information about the practice. Additionally, change agents should also
show/demonstrate field examples of two-stage ditches to promote their adoption. This could also translate into policy makers directing more funding towards education and awareness programs.

**Section 5. Future research & concluding thoughts**

I began this research endeavor situating drainage as a ‘forgotten factor’ in the international water discourse. However, as demonstrated in my dissertation, Ohio presents an agricultural landscape with over 150 years of drainage management institutions. Moreover, there is an ever increasing emphasis on balancing agricultural and environmental objectives of drainage. Thus, a study on drainage management institutions and adoption of an innovative drainage ditch design was not only timely, but also needed.

Like every research endeavor this one also has limits. An important limitation is lack of data on group drainage improvements obtained under the two institutional mechanisms. Although CP projects are well recorded by respective county engineers’ office, unfortunately written records are not kept in a systematic manner for MA projects to determine the number of projects initiated or implemented. In my future endeavors to understand drainage management institutions, I would like to select counties which have recorded data for both the mechanisms, which will subsequently provide a good measure for successful collective action. In my dissertation, particularly in the first two chapters, due to lack of this data, I was not able to carry out county level comparisons. Despite the lack of this data, by following a case study approach, I was able to closely examine the conditions under which a landowner would be willing to participate in a group drainage improvement mechanism, as well as the conditions under which the collective good of a
group drainage improvement is provided. A specific mechanism I would like to test in the future is the fairness perception of heterogeneity in individual net benefit. I would also like to assess how easy or difficult landowners in a given county perceive the cost-benefit distribution method to be.

More broadly, a fruitful avenue of inquiry would be to test the key variables V1-V4 in a different socio-economic and cultural context. I have made some progress in this regard by collecting data from 12 Water and Soil Associations (WaSA) in the Elbe River Basin region of Brandenburg, Germany. Preliminary insights indicate that although every benefitting landowner is forced to pay for drainage improvement, more recently, landowners who have forests on their property have started questioning the assessment (Holger Lettow, Personal Communication). Forest owners have started suing the WaSA, taking them to court and petitioning to be taken off the assessments on their property for drainage improvements. This finding closely parallels the key variable ability to enter/exit (V2) in my second chapter. Future research endeavors would also include examining what drainage management institutions can teach us about institutions for irrigation.

Based on the findings in my dissertation, I believe that agricultural drainage institutions in Ohio, as well as institutions around the Midwestern United States, provide a theoretically rich, but theoretically untested ground for scholars not only studying common-pool resource institutions, but more broadly in advancing understanding of social dilemmas, which are pervasive in our daily lives. Theoretically, this study suggests that a key government role may be to supply an alternative institution for stakeholders to
generate collective action. Moreover, the finding that change agents’ perception of environmental benefits drives their willingness to promote a conservation practice is an encouraging sign, however, there is still a long way to go if we are to understand how to best encourage change agents to promote adoption of agricultural conservation practices.
References


Drainage and Ditches. (1994) (pp. 1–16). Columbus: County Commissioners Association of Ohio.


Appendix A: Semi-structured key-informant interview questions for chapters 2 & 3

1. What are your organization’s goals? Which ones are specifically related to drainage management?

2. What types of drainage restoration and maintenance programs are currently underway in the region (Specify name of the county/conservancy district)?

3. What are the major drainage management issues in the region (Specify name of the county/conservancy district)?

4. Very often, drainage improvement requires cooperation among landowners. How does the decision making process work, specifically for making drainage improvements involving a group of landowners?

5. In situations where a group of landowners are unable to reach an agreement for making a drainage improvement, what role does your organization play in resolving the issue?

6. What do you think are factors that encourage landowners to cooperate regarding drainage improvement?

7. The number of landowners involved in drainage improvement may vary based on who all are deriving benefit as a result of the improvement. Who pays for such group drainage improvements? If landowners pay for it, how is the cost distributed across them?

8. Do you think the distribution of cost and benefit among the landowners is equitable? If yes, then how? If no, then why not?

   8a. Do you think landowners perceive the distribution of cost and benefit to be equitable?

9. Who has the power to decide the number of landowners who can be part a group drainage improvement?

10. Can a landowner either chose to be, or chose not to be part of a group drainage improvement? If a landowner is currently taking part in a group drainage improvement, can he choose to exit the group? Who makes such decisions?

11. Who decides whether the group drainage improvement project gets approved or not? If a project gets disapproved who bears the initial costs incurred? If landowners incur it, is the money returned to them?

12. Overall, what do you think are the constraints in implementing group drainage improvements in your region (Specify name of the county/conservancy district)?

13. On the contrary, what factors facilitate implementation of group drainage improvements in your region (Specify name of the county/conservancy district)?
14. Over the last ten years, how many group drainage improvement projects have been implemented in your region (Specify name of the county/conservancy district)?

14a. Of these projects, how many have been implemented under: CP, MA, SB 160, & CD improvement?
14b. Under each of the 4 institutional process, how many group projects were originally initiated?
14c. If a group project was initiated, but did not finish, what was the reason behind it?

15. Do you think implementation of group drainage improvements projects have led to improved/better drainage in the area? If yes, then how? If no, then why not?

16. Have you heard of two-stage ditches? If yes, how familiar are you with them?

17. What do you think of two-stage ditches as a management practice? Is it beneficial and if yes, then how? If no, then why do you think it is not beneficial?

18. On a scale from 1 to 10, with 1 being not at all willing and 10 being very willing, how willing are you to promote 2-stage ditches as a management practice?

19. Have 2-stage ditches been adopted in your area using the institutional process of MA/CP/SB160/CD improvement? If yes, then how many? If no, have landowners approached your organization in order to discuss about two-stage ditches?

20. What additional organizations address drainage management issues in this area?

21. What is your annual budget? What sources of funding do you get this budget from?

22. Are there any other comments you would like to make about drainage management in your area?

23. Can you recommend any other key informants that I should talk with?
Appendix B: Semi-structured key-informant interview questions for chapter 4

1. How long have you been working in the capacity of advising about agricultural drainage practices and other BMPs in this county? What is your main role in this?
2. How familiar are you with an alternative drainage ditch designs like the two-stage ditch?
3. How often do you interact with landowners/farmers? Is there any specific group of landowners you frequently engage with? If yes, which group it is and what is responsible for this frequent engagement?
4. What factors do you think are important in landowners deciding to do agricultural best management practices?
5. Out of the factors mentioned above, identify one factor which you think is the most important in landowners deciding to do agricultural best management practices.
6. What promotes adoption of two-stage ditches as an agriculture best management practice?
7. What hinders adoption of two-stage ditches as an agriculture best management practice?
8. Do you think farmers/landowners in your county are willing to adopt two-stage ditches? If yes, what do you think promotes its adoption? If no, what do you think is/are the hindering factor/s?
9. Do you think farmers are more or less willing to adopt two-stage ditches compared with other agriculture BMP’s? Why?
10. What do you think of two-stage ditches as a management practice? Is it beneficial and if yes, then how? If no, then why do you think it is not beneficial?
11. There are many drainage designs, how do you decide on which drainage design to promote?
12. On a scale from1 to 10, with 1 being not at all willing and 10 being very willing, how willing are you to promote 2-stage ditches as a management practice?
13. What factors affect your recommendations about drainage improvements and maintenance?
14. Do you think there is an impact of urbanization on farmer’s/landowner’s decision of going for a specific BMP? If yes, are two-stage ditches one of them?
15. Can you tell us which landowners/farmers have ditches in need of repair/maintenance? How might I obtain a list of these?
16. In your role as a (specify designation/position), who are you friends with?
17. In your role as a (specify designation/position), who do you take advice from?
18. In your role as a (specify designation/position), who do you discuss important matters with?
19. In particular with respect to two-stage ditches, who do you take advice from?
20. In particular with respect to two-stage ditches, who do you discuss important matters with?
Appendix C: Landowner Survey for chapters 2, 3 & 4
SECTION A – LOCATION, FARMING & LAND MANAGEMENT

Q1. In what county do you currently live? (Fill in the blank)
   (county)

Q2. How many acres do you farm... (Fill in the blanks. If you do not farm please skip to Section B – go to page 2.)
   that you currently own? _________ acres
   that you currently rent? _________ acres
   Total acres farmed _________ acres

Q3. What is your typical crop rotation? 

Q4. Do you raise livestock? (Circle one answer)
   1. Yes (if yes, which types?) 
   2. No

Q5. Is your primary source of income on-farm or off-farm? (Circle one answer)
   1. On-farm
   2. Off-farm

Q6. How important are the following goals in your land management decisions? (Circle one number for each row)

<table>
<thead>
<tr>
<th>Land management decision goal</th>
<th>Not at All Important</th>
<th>A Little Important</th>
<th>Moderately Important</th>
<th>Very Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Achieving production efficiency......</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>b) Controlling erosion.................</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>c) Protecting water quality...........</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>d) Providing wildlife habitat.........</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>e) Improving scenic quality..........</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>f) Reducing land management costs......</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>g) Other (please specify):______________</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
SECTION B – DRAINAGE MANAGEMENT

Q7. Before you began taking this survey, had you ever heard of a 2-stage ditch design? (Circle one answer)
   1. Yes
   2. No  (If no, please skip to Q13 — go to page 3)

Q8. Because you have indicated ‘yes’ in the previous question, we would like to learn more about your awareness of 2-stage ditches. Please answer the questions below (Circle one answer for each row)

<table>
<thead>
<tr>
<th>I have a 2-stage ditch on my land</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am aware that they have been constructed in my region</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>I have been to field days or workshops about 2-stage ditches</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>I have seen 2-stage ditches in the field</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>I have heard about 2-stage ditches from other sources</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Q9. Overall, how familiar are you with 2-stage ditches? (Circle one answer)
   1. A little familiar
   2. Somewhat familiar
   3. Very familiar

Q10. There are many potential reasons why people may not be willing to install 2-stage ditches. Which, if any, of the reasons below apply to you? (Check all that apply)
   - Not applicable — I do not have drainage ditches on my land (skip to Q13 on page 3)
   - I don’t know enough about them
   - My ditch is working fine; there is no need to change the existing ditch design
   - A 2-stage ditch takes away land from production
   - I don’t find them beneficial
   - The financial costs outweigh the benefits
   - Future maintenance is difficult with a 2-stage ditch design
   - They require too much paperwork and permits
   - They negatively impact existing cost-share agreements on my land
   - Other (please specify): __________

Q11. There are many potential reasons why people may be willing to install 2-stage ditches. Which, if any, of the reasons below apply to you? (Check all that apply)
Q14. Do any drainage ditches run through or immediately next to land that you own? (Circle one answer)

1. Yes
2. No – (If no, please skip to Q20 – go to page 5)

Q15. About how long are these ditches on or next to your land? (If you have more than one drainage ditch on or next to your land, please add up the total length)

_________ Feet OR __________ Miles

Q16. Do you currently have any problems with the drainage ditches on or immediately next to your land? (Circle one answer)

1. Yes
2. No – (If no, please skip to Q18 below)

Q17. Which, if any, of the following problems do you have with drainage ditch(es) on or immediately next to your land? (Check all that apply)

- Inadequate outlet
- Bank instability
- Siltation in the ditch bottom
- Ageing of the drainage ditch
- Reduced drainage capacity
- Other (please specify):

Q18. How long ago was the last time a ditch maintenance activity was done on any of these ditches?

_________ years ago

Q19. Do you think any of these drainage ditches are currently in need of repair/maintenance? (Circle one answer)

1. Yes
2. No
Q20. There are many conservation practices. In the table below, first, please indicate if you currently do these conservation practices. Second, on a scale of 1 to 10, please indicate how willing you are to do these conservation practices in the future.

<table>
<thead>
<tr>
<th>Conservation practice</th>
<th>Do you currently do this conservation practice? (Circle 'Y' or 'N')</th>
<th>Your willingness to do this conservation practice in the future (Circle one number for each row)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Y  N  1  2  3  4  5  6  7  8  9  10</td>
<td></td>
</tr>
<tr>
<td>Grass waterways</td>
<td>Y  N  1  2  3  4  5  6  7  8  9  10</td>
<td></td>
</tr>
<tr>
<td>Control drainage</td>
<td>Y  N  1  2  3  4  5  6  7  8  9  10</td>
<td></td>
</tr>
<tr>
<td>No-tillage</td>
<td>Y  N  1  2  3  4  5  6  7  8  9  10</td>
<td></td>
</tr>
<tr>
<td>Nutrient management</td>
<td>Y  N  1  2  3  4  5  6  7  8  9  10</td>
<td></td>
</tr>
<tr>
<td>Vegetated barriers</td>
<td>Y  N  1  2  3  4  5  6  7  8  9  10</td>
<td></td>
</tr>
<tr>
<td>Cover crops</td>
<td>Y  N  1  2  3  4  5  6  7  8  9  10</td>
<td></td>
</tr>
<tr>
<td>Constructed wetlands</td>
<td>Y  N  1  2  3  4  5  6  7  8  9  10</td>
<td></td>
</tr>
</tbody>
</table>

Q21. Are you currently being levied an annual ditch maintenance assessment? (Circle one answer)

1. Yes
2. No – (If no, please skip to section C – go to page 6)
3. Don’t know (If don’t know, please skip to section C – go to page 6)

Q22. What was the annual ditch maintenance assessment for you in the year 2013? (Indicate the amount below, if you paid in monthly/quarterly installments, please indicate the total amount for the year 2013).  
Dollar:

Q23. If an improved drainage ditch design were to be installed in your drainage area, how much more would you be willing to pay for your annual ditch maintenance assessment? (Circle one answer)

1. 0%
2. 5%
3. 10%
4. 25%
5. 50% or more
### SECTION C – DRAINAGE DITCHES & SOCIAL NETWORKS

Q24. How often do you seek advice on drainage ditches from the following? (Circle one number for each row)

<table>
<thead>
<tr>
<th>Entity</th>
<th>Never (0 times/year)</th>
<th>Rarely (1-3 times/year)</th>
<th>Sometimes (4-12 times/year)</th>
<th>Often (More than 12 times/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil and Water Conservation District (SWCD)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>County Engineers' Office</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>County Commissioners' Office</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>University/Federal personnel</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>The Nature Conservancy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>USDA NRCS</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Others (please specify):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q25. Name up to 5 people, whom you turn to, for advice on drainage ditches. (For example, if you seek advice from a farmer who is a friend of your's, then mention 'farmer' under the heading 'Title' and 'friend' under the heading 'Relationship to you'. If you seek advice from an engineer from SWCD, then mention 'engineer' under the heading 'Title' and 'government agent' under the heading 'Relationship to you'.)

<table>
<thead>
<tr>
<th>Name</th>
<th>Title (if any)</th>
<th>Relationship to you (if any)</th>
<th>Office/Organization (if any)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Q26. Use this space to write the names of other people you turn to for advice on drainage ditches.
(Please mention their name, title, relationship to you and which office/organization they are from)

Q27. How often do you take advice on 2-stage ditches from the following: (Circle one number for each row: If you are not aware of 2-stage ditches, please skip to section D — go to page 9)

<table>
<thead>
<tr>
<th></th>
<th>Never (1-6 times/year)</th>
<th>Rarely (7-12 times/year)</th>
<th>Sometimes (More than 12 times/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil and Water Conservation District (SWCD)</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>County Engineers' Office</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>County Commissioners' Office</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>University / Extension personnel</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>The Nature Conservancy</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>USDA NRCS</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Others (please specify):</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
Q28. Name up to 5 people, whom you turn to, for advice on 2-stage ditches. (For example, if you seek advice from a farmer who is a friend of yours, then mention farmer under the heading 'Title' and friend under the heading 'Relationship to you'; if you seek advice from an engineer from SWCD, then mention engineer under the heading 'Title' and government agent under the heading 'Relationship to you'.)

<table>
<thead>
<tr>
<th>Name</th>
<th>Title (if any)</th>
<th>Relationship to you (if any)</th>
<th>Office/Organization (if any)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q29. Use this space to write the names of other people you turn to for advice on 2-stage ditches. (Please mention their name, title, relationship to you and which office/organization they are from.)
SECTION D - DRAINAGE GOVERNANCE

NOTE: If you do not have a drainage ditch on or immediately next to your land, please skip to section E – go to page 12.

Q30. How do you maintain your drainage ditch(es)? (Circle one answer)

1. On my own
2. Under a county ditch maintenance program
3. Both; Some ditches are maintained on my own and others are under county ditch maintenance program

NOTE: Improving and maintaining drainage ditches is very often a group activity and requires cooperation from a group of landowners from a drainage district. There are three different ways in which a group drainage improvement and maintenance can be done:

(a) **Mutual Agreement** – These projects are done under the supervision of the local Soil and Water Conservation District (SWCD). SWCD provides survey, design, and construction inspection at no cost to the landowners. However, landowners are assessed costs for the construction and maintenance. A Mutual Agreement requires that 100% of interested landowners agree on the necessity of the project, and on how to allocate costs among the benefiting landowners.

(b) **County Petition** – These projects are done through the County Commissioners and the County Engineer’s Office. A landowner in the drainage area submits a petition to the County Engineer’s Office to request a project. If the petition is approved, all landowners in the drainage area are assessed for all costs of survey, design, and construction inspection. In addition, landowners are assessed costs for the construction and maintenance. A county petition can be filed by one or more landowners and does not require a 100% agreement by all the landowners.

(c) **Senate Bill 169** – These projects are done through the County Commissioners and the local Soil and Water Conservation District. Landowners are not assessed costs for the survey, design, or construction inspection. However, they are assessed costs for the construction and maintenance. This process is often used if there are landowners who object the project.
Q31. On page 9, we have described the three group drainage ditch improvement processes. In the table below, first, please indicate if you have ditch(es) currently maintained under any of the processes. Second, on a scale of 1 to 10, please indicate how willing you are to participate in these processes in the future.

<table>
<thead>
<tr>
<th>Group drainage ditch improvement process</th>
<th>Do you have ditch(es) currently maintained under this process? (Circle 'Y' or 'N')</th>
<th>Not at all willing</th>
<th>Very willing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mutual Agreement</td>
<td>Y N</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>County Petition</td>
<td>Y N</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Senate Bill 166</td>
<td>Y N</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

Q32. Based on your response to Q31, we would like to know the biggest reasons for your willingness or non-willingness for these group drainage ditch improvement processes. (Please use the space provide below to write your answer)

Mutual Agreement:
________________________________________________________
________________________________________________________
________________________________________________________

County Petition:
________________________________________________________
________________________________________________________
________________________________________________________

Senate Bill 166:
________________________________________________________
________________________________________________________
________________________________________________________
Q33. If you have a 2-stage ditch, how is it maintained? (Circle one answer. If you do not have a 2-stage ditch, please skip to Q34 below)

1. Maintained on my own
2. Maintained under Mutual Agreement
3. Maintained under County Permit
4. Maintained under Senate Bill 160

Q34. How willing are you to participate in the following group drainage ditch improvement processes in the future, for installation of 2-stage ditch(es).

<table>
<thead>
<tr>
<th>Group drainage ditch improvement process</th>
<th>Not at all willing</th>
<th>Very willing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mutual Agreement</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>County Permit</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>Senate Bill 160</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>
SECTION E – BACKGROUND QUESTIONS

Finally, we need to ask a few questions about your background. This information, as with all information in this survey, will be used for statistical analysis only and will remain strictly confidential.

Q35. What is your age (as of your last birthday)? _______ years

Q36. What is your gender? (Circle one answer)

1. Female
2. Male

Q37. What is the level of your formal education? (Circle one answer)

1. Less than 9th grade
2. 9th to 12th grade, no diploma
3. High school graduate (includes equivalency/GED)
4. Associate’s degree, completed a technical school program, or some college
5. Bachelor’s degree
6. Graduate or professional degree

Q38. What is your present employment status? (Circle one answer)

1. Employed or self-employed on a full-time basis
2. Employed or self-employed on a part-time basis
3. Retired
4. Full-time homemaker
5. Student
6. Unemployed

Q39. In the year 2013, what was your total farm operation’s annual gross income? (Circle one answer)

1. Less than $10,000
2. $10,000 - $19,999
3. $20,000 - $29,999
4. $30,000 - $39,999
5. $40,000 - $49,999
6. $50,000 or greater
Q40. How willing would you be to participate in a workshop or field day about 2-stage ditches if you receive payment for your time? (Circle one answer)

1. Not at all willing
2. A little willing
3. Somewhat willing
4. Very willing

Q41. If you are willing, what is the best way to contact you? (Check all that apply)

__ Phone: ____________________________

__ Email: ____________________________

__ Address: ____________________________________________

________________________________________

Thank you for your help! If you have additional comments, please provide them here:

______________________________
## Appendix D: Additional landowner survey analysis for chapter 4

<table>
<thead>
<tr>
<th>Matched survey items</th>
<th>Type and scales</th>
<th>Frequency</th>
<th>Percentage</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost-share programs are available</td>
<td>Dummy (1=checked box; 0=unchecked box)</td>
<td>22</td>
<td>31.4%</td>
<td>70</td>
</tr>
<tr>
<td>Familiarity with two-stage ditches:</td>
<td>Ordinal (1= A little familiar; 2=Somewhat familiar; 3=Very familiar)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A little familiar</td>
<td></td>
<td>43</td>
<td>44.3%</td>
<td></td>
</tr>
<tr>
<td>Somewhat familiar</td>
<td></td>
<td>37</td>
<td>38.1%</td>
<td></td>
</tr>
<tr>
<td>Very familiar</td>
<td></td>
<td>17</td>
<td>17.5%</td>
<td></td>
</tr>
<tr>
<td>Have seen 2-stage ditches in the field</td>
<td>Dummy (1=yes; 0=no)</td>
<td>20</td>
<td>21.1%</td>
<td>95</td>
</tr>
<tr>
<td>Have been to field days or workshops about 2-stage ditches</td>
<td>Dummy (1=yes; 0=no)</td>
<td>44</td>
<td>45.4%</td>
<td>94</td>
</tr>
</tbody>
</table>
### Appendix E: Codebook for qualitative data analysis

#### Key variable values and mechanism for MA projects

<table>
<thead>
<tr>
<th>Code</th>
<th>Brief description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Size (V1)</td>
<td>Qualitative data segments establishing the variable value of group size</td>
<td>“Typically MA projects are small in size”</td>
</tr>
<tr>
<td>V1 – Mechanism: Low project cost</td>
<td>Reduced project cost due to group size</td>
<td>“If it is a small number of landowners, then a mutual agreement is pretty enticing to everyone. It’s cheaper”</td>
</tr>
<tr>
<td>V1 – Mechanism: Greater landowner control</td>
<td>Greater landowner control due to group size</td>
<td>“If it is a small number of landowners, then a mutual agreement is pretty enticing to everyone. Landowners have more control over it”</td>
</tr>
<tr>
<td>V1 – Mechanism: Spearheading possible</td>
<td>Project spearheading possible due to group size</td>
<td>“Mutual agreement projects approximately involves 25 landowners on the higher side, after which things start getting difficult. That’s because somebody has got to spearhead the whole thing”</td>
</tr>
<tr>
<td>V1 – Mechanism: Small project size</td>
<td>Small project size in terms of scope/scale due to group size</td>
<td>“If it is a small project I would recommend mutual agreement, as it is definitely cost-efficient. There is no doubt about it”.</td>
</tr>
<tr>
<td>V1 – Mechanism: Olson effect</td>
<td>Some landowners contributing enough to single-handedly provide a group drainage improvement due to group size</td>
<td>“The larger landowners would sometimes pay their [disagreeing landowners’] share just to have the project go through”</td>
</tr>
<tr>
<td>Ability to enter/exit (V2)</td>
<td>Qualitative data segments establishing the variable value of ability to enter/exit</td>
<td>“A landowner can opt out of the project”</td>
</tr>
<tr>
<td>V2 – Mechanism: Uncertain project fate</td>
<td>Increased uncertainty about the fate of the project due to ability to enter/exit</td>
<td>“If someone is not willing to pay then the mutual group has to decide whether they are going to pick up that person’s share or the project doesn’t happen”</td>
</tr>
<tr>
<td>V2 – Mechanism: Private property rights conflict</td>
<td>Conflict with private property rights due to ability to enter/exit</td>
<td>“If a landowner doesn’t want another landowner to come through his property the project is off a mutual agreement”</td>
</tr>
<tr>
<td>Heterogeneity in individual net benefit (V3)</td>
<td>Qualitative data segments establishing the variable value of heterogeneity in individual net benefit</td>
<td>“All the [MA] projects that I know have gone with flat rate [equal assessment]…the breakdown is easy, and there is no confusion”</td>
</tr>
</tbody>
</table>

257
| V3 – Mechanism: Fair perception of V3 | Indicates fair perception of distribution of costs and benefits | “Yes, I think it is fair. If it wasn’t, they wouldn’t do it under mutual agreement” |
| V3 – Mechanism: Unfair perception of V3 | Indicates unfair perception of distribution of costs and benefits | “I have talked to guys that have said that they don’t think of this method [equal assessment] as equitable” |
| V3 – Mechanism: Assessment method easy to understand | Indicates ease of understanding distribution of costs and benefits | “By going this way [equal assessment], there is no question about why is someone else paying less than me” |
| Security of contributions (V4) | Qualitative data segments establishing the variable value of security of contributions | “They may have also come to us to get the watershed map, tile size, etc. but we don’t charge them for all that” |
| V4 – Mechanism: Project costs secured upfront | Securing upfront project costs due to security of contributions | “Usually what happens is that money is put upfront. They would already have their money in a pot before the work even starts” |

### Additional variables for MA projects

<table>
<thead>
<tr>
<th>Code</th>
<th>Brief description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low cost</td>
<td>Project implementation at a lower cost</td>
<td>“Cheapest way to have drainage problems solved”</td>
</tr>
<tr>
<td>Time efficient</td>
<td>Time efficient project implementation</td>
<td>“The [MA] project gets done faster”</td>
</tr>
<tr>
<td>Human resources</td>
<td>Facilitating role of the local government agent</td>
<td>“He [the local government agent] is known around here to be the charmer. He normally makes personal calls to these individuals who are involved in the [MA] project, and tries to the best of his ability to get everybody to agree, and be on the same page”</td>
</tr>
<tr>
<td>Technological resources</td>
<td>Having farmers in the group who have their own equipment and machinery</td>
<td>“Recently we have had several farmers who have actually purchased the equipment so that they can install their own tile mains, small ditches, etc.”</td>
</tr>
<tr>
<td>Willingness to cooperate</td>
<td>Interpersonal dynamics of having landowners in the group who are willing to cooperate for drainage improvement</td>
<td>“Landowners are cooperating and getting along with each other”</td>
</tr>
<tr>
<td>Non-willingness to cooperate</td>
<td>Interpersonal dynamics of having landowners in the group who are not willing to cooperate for drainage improvement</td>
<td>“No one is willing to cooperate”</td>
</tr>
<tr>
<td>Category</td>
<td>Description</td>
<td>Quote</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>Working relationship</td>
<td>Interpersonal dynamics of having working relationship with neighbors</td>
<td>“I don’t see any constraints [in implementing MA projects] if you get along with your neighbors”</td>
</tr>
<tr>
<td>Non-working relationship</td>
<td>Interpersonal dynamics of having non-working relationship with neighbors</td>
<td>“Unlike 30 years ago when you knew your neighbors, now a days you don’t know who you are working with”</td>
</tr>
<tr>
<td>Greater landowner control</td>
<td>Landowners having greater control over the project</td>
<td>“More control over the project setting the ditch I want and trust to do the project right!”</td>
</tr>
<tr>
<td>Future/permanent maintenance</td>
<td>Lack of future/permanent maintenance of drainage improvements</td>
<td>“Not as willing because of the lack of longevity [of maintenance on MA project]”</td>
</tr>
<tr>
<td>Maintenance responsibility</td>
<td>Responsibility of maintenance of drainage improvement resting with landowners</td>
<td>“Neighbors tends to run the project to only benefit themselves. And then don't maintain it”</td>
</tr>
<tr>
<td>Importance of drainage improvement</td>
<td>Perceived importance of drainage improvement</td>
<td>“Having a need facilitates implementation of a group project. If there is a group that has a serious problem, and they feel that they really need to do something about it”</td>
</tr>
<tr>
<td>House-lot owners; Absentee landowners</td>
<td>Individual level characteristic of having house-lot owners or absentee landowners in the group</td>
<td>“Sometimes it is the house-lot people, who own a house out in the country, they don’t want to do anything about the issue”</td>
</tr>
<tr>
<td>Farmers</td>
<td>Individual level characteristic of having farmers in the group</td>
<td>“If a landowner is actually the farmer; their livelihood is tied to the ground”</td>
</tr>
<tr>
<td>Sharecropping</td>
<td>Land-tenure arrangement of having land farmed under sharecropping</td>
<td>“If it was shared crop or something, where the landowner was paying for the inputs and he was getting part of the harvest, then they are more opt to getting things fixed because it is effecting my cheque book”</td>
</tr>
<tr>
<td>Cash-renting</td>
<td>Land-tenure arrangement of having land farmed under cash-renting</td>
<td>“If you are treating the ground as an asset or you are getting a trust payment or you are getting a cash rent that somebody is paying you every year, then you don’t care much”</td>
</tr>
<tr>
<td>Code</td>
<td>Brief description</td>
<td>Example</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Group Size (V1)</td>
<td>Qualitative data segments establishing the variable value of group size</td>
<td>“The group size varies a lot. Last year we had a [county] petition project which covered an area of 10,000 acres. Whereas, year before that, we had a [county] petition project which just involved two landowners”</td>
</tr>
<tr>
<td>V1 – Mechanism: Low V1 at stage 1</td>
<td>Low group size at stage 1 of CP</td>
<td>“There is not a group [of landowners] that comes in and says that we all really want to petition a project. That doesn’t happen”</td>
</tr>
<tr>
<td>V1 – Mechanism: Low V1 at stage 2</td>
<td>Low group size at stage 2 of CP</td>
<td>“There have been some real frivolous petitions. We had a [CP] project involving 3 landowners. That really should be solved between the landowners. It didn’t really fall within the spirit of what the petition process is”</td>
</tr>
<tr>
<td>V1 – Mechanism: High V1 at stage 2</td>
<td>High group size at stage 2 of CP</td>
<td>“If there are a lot of landowners it [CP project] seems to work well”</td>
</tr>
<tr>
<td>V1 – Mechanism: Large project size</td>
<td>Large project size in terms of scope/scale due to group size</td>
<td>“This [CP] works best on large projects”</td>
</tr>
<tr>
<td>Ability to enter/exit (V2)</td>
<td>Qualitative data segments establishing the variable value of ability to enter/exit</td>
<td>“Landowners are required to be part of the improvement once they are listed on the map”</td>
</tr>
<tr>
<td>V2 – Mechanism: Certainty project fate</td>
<td>Increased certainty about the fate of the project due to ability to enter/exit</td>
<td>“Can accomplish projects without all landowners agreeing”</td>
</tr>
<tr>
<td>V2 – Mechanism: Political pressure on county commissioners</td>
<td>Indicates political pressure on county commissioners due to ability to enter/exit</td>
<td>“If the commissioners want to get re-elected, they listen to the masses”</td>
</tr>
<tr>
<td>Heterogeneity in individual net benefit (V3)</td>
<td>Qualitative data segments establishing the variable value of heterogeneity in individual net benefit</td>
<td>“We use something called as varied rate assessment per acre. It is based on a landowner’s proximity to the improvement, and how much of the improvement is the landowner using”</td>
</tr>
<tr>
<td>V3 – Mechanism: Leads to fair perception of V3</td>
<td>Indicates fair perception of distribution of costs and benefits</td>
<td>“This is the fairest way because everyone in the watershed will share the cost”</td>
</tr>
<tr>
<td>V3 – Mechanism: Leads to unfair perception of V3</td>
<td>Indicates unfair perception of distribution of costs and benefits</td>
<td>“County Commissioners made all the contributors pay…I get no help, no benefits. I am too far away”</td>
</tr>
<tr>
<td>V3 – Mechanism: Fair perception if local government agency explains assessment</td>
<td>Indicates the effect of government agency explaining cost and benefit distribution on landowners’ fairness perception</td>
<td>“They [landowners] will ask us how was our cost calculated, and we will explain it, and show it to them. After that they won’t”</td>
</tr>
<tr>
<td>method</td>
<td>Qualitative data segments establishing the variable value of security of contributions</td>
<td>“If the project gets passed after first hearing, after which we go out and do survey and all, everybody in the watershed pays if the project got disapproved [at the final hearing]”</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Security of contributions (V4)</td>
<td>Indicate high upfront cost associated with filing a petition</td>
<td>“The extra cost [petition bond] in petitioning the project is a constraint. We are looking at roughly twice the cost when compared with MA projects”</td>
</tr>
</tbody>
</table>

### Additional variables for CP projects

<table>
<thead>
<tr>
<th>Code</th>
<th>Brief description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor maintenance</td>
<td>Poor quality of maintenance on existing drainage improvements</td>
<td>“They [CEO] don't keep up with maintenance”</td>
</tr>
<tr>
<td>Good maintenance</td>
<td>Good quality of maintenance on existing drainage improvements</td>
<td>“I think our county does an excellent job of maintenance”</td>
</tr>
<tr>
<td>Future/permanent maintenance</td>
<td>Future/permanent maintenance of drainage improvements</td>
<td>“Landowners favor CP process as it puts their ditch on permanent maintenance”</td>
</tr>
<tr>
<td>Structured process</td>
<td>Ohio Revised Code Structure for the county petition process</td>
<td>“There is an order to the whole process, and it is something you can fall back on”</td>
</tr>
<tr>
<td>Less landowner control</td>
<td>Landowners having less control over the project</td>
<td>“Less control on the project”</td>
</tr>
<tr>
<td>High cost</td>
<td>Project implementation at a higher cost</td>
<td>“With county petition the costs that all parties [landowners] would end up paying would double”</td>
</tr>
<tr>
<td>Time inefficient</td>
<td>Longer timeline for project implementation</td>
<td>“I don’t think landowners like to petition too many ditches because it is time consuming”</td>
</tr>
<tr>
<td>Human resources</td>
<td>Information providing role of the local government agent</td>
<td>“They [the county engineers’ office] have equipment and knowledge”</td>
</tr>
<tr>
<td>Technological resources</td>
<td>Local government agency having drainage equipment and machinery</td>
<td>“Once a petition has been filed, we go out in the field and take pictures of the problems mentioned in the petition. Sometimes, conflicting landowners are simply not aware that there is indeed a problem”</td>
</tr>
<tr>
<td>Importance of drainage improvement</td>
<td>Perceived importance of drainage improvement</td>
<td>“Much of the drainage in our county is driven by farmers, whose motivation is to drain properly and make good money”</td>
</tr>
<tr>
<td>-----------------------------------</td>
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</tr>
<tr>
<td>Federal control</td>
<td>Increased federal control over county petition drainage improvement projects</td>
<td>“Government, specifically EPA, is a constraint in implementing group drainage [CP] projects”</td>
</tr>
<tr>
<td>Peer pressure</td>
<td>Interpersonal dynamics of pressure from neighboring landowners to drop the project</td>
<td>“There is always some peer pressure. Some petitioners get harassed by others who do not want the project”</td>
</tr>
<tr>
<td>Landowner disagreement</td>
<td>Interpersonal dynamics of having disagreement among landowners in the group</td>
<td>“Neighbors get mad and don't like when they have to pay for something that they don't owe”</td>
</tr>
<tr>
<td>House-lot owners</td>
<td>Individual level characteristic of having house-lot owners in the group</td>
<td>“Homeowners object to any cost”</td>
</tr>
<tr>
<td>Cash-renting</td>
<td>Land-tenure arrangement of having land farmed under cash-renting</td>
<td>“He [renter] sends me [landowner] a check once a year. I don't really even know what it [drainage issue] looks like, and what’s going on. I don't care what happens to it”</td>
</tr>
</tbody>
</table>