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FACTORS INFLUENCING FARMERS’ ADOPTION AND INTENTIONS TO ADOPT POLLINATOR CONSERVATION PROGRAMS AND PRACTICES IN ILLINOIS, U.S.A.

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by

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Due to the growing recognition of the social and ecological consequences of the global decline in pollinator species, the need for more effective policies for the conservation of pollinator habitat is now more than ever. These trends call for research that provides a deeper understanding of farmers' decision-making processes. In this regard, this study tested a modified version of the Theory of Planned Behavior as a conceptual model for explaining farmers' perceptions and behavior regarding the adoption of pollinator conservation programs and practices. Specifically, the study tested how farmers' perceived behavioral control, attitudes, subjective norms, concern about herbicide resistance issues, and sociodemographic variables influence their intentions and actual adoption of pollinator conservation programs and practices. Quantitative survey data were gathered from 41 principal farm operators in the state of Illinois through the administration of a web-based survey. The resulting data were first explored using descriptive statistics and correlation analysis, following which multiple regression analysis was used to test four hypotheses on the predictors of farmers' intentions to adopt, as well as their adoption of pollinator conservation practices and programs. The results from the regression analysis showed that farmers' attitudes and their subjective norms had statistically significant positive effects on their adoption of pollinator conservation practices on their farms, as well as their intentions to adopt those practices in the near future. Perceived behavioral control also had a statistically significant positive effect on farmers' adoption of federal pollinator conservation

programs, as well as their intentions to enroll in these programs in the future. Overall, these findings call for comprehensive pollinator conservation policies that facilitate the provision of information and incentives for farmers to voluntarily adopt pollinator conservation practices on their farms, as well as the provision of appropriate resources and opportunities for farmers to enroll in pollinator conservation programs over which they have minimal control.

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TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

The United States and the world have experienced rapid intensification of agricultural production over the past century (Burkle, Marlin, & Knight, 2013; Foley et al., 2005; Gaines-Day & Gratton, 2017). A drastic shift from naturally diverse levels of biological variation into single-species croplands, intentionally depauperate in weeds and pest insects, has resulted in the widespread loss of suitable pollinator habitat (Winfree, Bartomeus & Cariveau, 2011; Gaines-Day & Gratton, 2017). Coinciding with this loss of suitable habitat, ecologists have concluded that the US, and the world, is experiencing extensive pollinator declines (Potts et al., 2010). Global declines in pollinator species may be one of the most important environmental issues facing agricultural production today. This phenomenon may have significant implications for the future of agricultural production (Pereira et al., 2010; Potts, 2010). Further declines threaten food security, human health, and economic and ecological sustainability (Pereira et al., 2010).

In the US state of Illinois for instance, the conversion of land to agricultural production has created a deficit in available habitat for pollinators (Burkle, Marlin, & Knight, 2013; Gaines-Day & Gratton, 2017). Since the 1850's, Illinois has converted more than 99% of its natural prairies, 90% of its wetland habitats and 80% of its forests (Iverson & Oliver, 1989). Loss of habitat limits abundant native plant species and floral provisions for pollinators, straining pollinator-host interactions (Klein et al., 2007; Winfree & Kremen, 2008). A study in Carlinville, Illinois which compared recent pollinator networks to those recorded 120 years before, found widespread degradation in the interaction network structure and function (Burkle, Marlin, & Knight, 2013). Half of all bee species were extirpated from the study area, many connections were lost or missing, and few new connections were established (Burkle, Marlin, & Knight, 2013). Similar declines in both species richness and abundance are pervasive at both national and global levels (Goulson et al., 2015).

Therefore, mitigation of further losses by increasing suitable habitat on a global scale requires expedient, yet effective action by land managers and/or governmental policy-makers to establish highly successful strategies using sound scientific information (Kennedy et al., 2013; Williams & Kremen, 2007). As 44.4% of all US land is agricultural land (FAO, 2015) much of which is readily convertible to pollinator habitat development (Vaughan & Skinner, 2015), conservation strategies with the goal of expanding suitable habitat are, therefore, imperative to limit further losses (Kennedy et al., 2013; Williams & Kremen, 2007). Several organizations, including the United States Department of Agriculture (USDA), and the Natural Resources Conservation Service (NRCS), are currently promoting farm-based conservation programs to confront this issue. These programs offer financial incentives and technical support to farms that enroll in conservation programs that help farmers to create pollinator habitat on their farms (Vaughan & Skinner, 2015).

Although some areas of the country have high levels of support from the agriculture community (USDA FSA, 2019), other areas are still facing significant hurdles to implementation. Adoption of these programs is often limited by lack of resources, including time, financial resources, and knowledge, as well as the attitudes and background of the farm's making decision-maker (McCann & Claassen, 2016; Thompson, Reimer & Prokopy, 2015). However, as these programs are still in their infancy, coherent conceptual frameworks for understanding the factors that influence farmers' adoption behaviors are still lacking in the literature.

The purpose of this study was to identify and explain the factors influencing farmers' adoption of programs and practices that support pollinator communities. A proposed conceptual framework based on the Theory of Planned Behavior (TPB) was used as the theoretical foundation of the study. To address the specific research questions and hypotheses, quantitative data were gathered through the administration of a web-based survey among farmers in the state of Illinois. The data were analyzed using various descriptive statistics, as well as correlation analysis and multiple regression analysis. Results of this research will serve to inform policies aimed at conserving pollinator habitat for the future security of pollinators and pollination services.

This thesis contains five chapters, including this introductory chapter. Chapter two provides a detailed review, synthesis, and critique of the extensive literature relevant to this study. Specifically, the chapter highlights research on the current status of pollinators worldwide, the importance of pollinators to agroecosystems, as well as conceptual framings of farmers' patterns of adoption of pollinator conservation programs. This chapter also presents a proposed conceptual framework based on TPB, as well as the research questions and hypotheses to be addressed in the study. Chapter three describes the methodological choices that were made in the design and execution of the study. Here, the research paradigm, approach and methodology of the study are presented. The process of questionnaire development, including a detailed description of the measurement of constructs and variables is explained. Also, a detailed summary of the procedures used in sampling, as well as data collection and analysis is given. Chapter four presents the results of the analysis of the survey data. The final segment of the thesis, chapter five, offers a discussion of the results based on the existing literature. Limitations of the study, directions for future research, and the policy implications of the findings are also presented in this concluding chapter.

CHAPTER 2

LITERATURE REVIEW

Intensification of agricultural production in the United States has foreshadowed the widespread reduction of suitable pollinator habitat. Global pollinator declines, primarily the result of habitat degradation (Burkle et al., 2013; Jones Ritten et al., 2017; Kearns et al., 1998; Koh et al., 2016), has significant implications for the future of agricultural production. A further loss to pollinators threatens food security (Aizen & Harder, 2009), human health (Eilers et al., 2011), and economic (Hellerstein et al., 2017; Klein et. al., 2007) and ecological sustainability (Ollerton, Winfree & Tarrant, 201; Kremen et al., 2007). As farmland accounts for the majority of the convertible land in the US for pollinator habitat development (FAO, 2015; Vaughan & Skinner, 2015), it is essential that conservation policies target farmers' adoption of pollinator-beneficial practices (Kennedy et al., 2013; Williams & Kremen 2007). Although existing pollinator conservation programs received some initial support (USDA FSA, 2019), they may currently be facing significant implementation hurdles (Gaines-day & Gratton, 2017; Jones Ritten et al., 2017; McCann & Claassen, 2016; Thompson, Reimer & Prokopy, 2015). In 2017, several cases of conservation seed mixes contaminated with Palmer Amaranth, an economically important, herbicide-resistant weed, were reported (Oseland et al., 2017). Concurrent increase in the use of new herbicide-resistant soybean varieties associated with off-target herbicide movement (USEPA, 2018) may have also complicated farmers' attitudes towards adopting pollinator conservation practices.

In this chapter, I present a narrative review of the literature to reveal current themes surrounding the adoption of farm-based pollinator conservation practices in the U.S. Among the themes highlighted in the review are: the global decline of pollinator species, as well as the causes and consequences associated with it; policy responses aimed at pollinator conservation in the U.S.; and barriers in farmers' adoption of pollinator conservation initiatives. Following this review, the chapter presents a conceptual framework based on the Theory of Planned Behavior (TPB) represent the factors influencing farmers' decision-making regarding the adoption of pollinator conservation programs and practices. Specific research questions and hypotheses based on this framework are subsequently presented in the latter part of the chapter, following which concluding remarks are provided.

2.1 Synthesis of Pollinator Conservation Research

Pollinator Declines

Pollinators play a major role in sustaining biological diversity and plant reproductive success essential for healthy ecosystems, economies and people (Aizen & Harder, 2009; Klein et al., 2007; Kluser & Peduzzi, 2007). More than a third of all food crop species depend on pollination services (Hellerstein et al., 2017; Klein et. al., 2007). In 2005, it was estimated that insects contributed approximately $215 billion globally through free pollination services (Vanbergen, 2013). In fact, the impact of pollination services on soybeans (*Glycine max* L.), one of the most commonly planted pollinator-benefiting crops in the Midwest (U.S.A.) and elsewhere, is an estimated $200 per acre (Lautenbach et al., 2012). Most fruit, vegetable and nut crops, and to some degree animal products, rely on these ecosystem amenities. As 35% of all food consumed by humans is directly dependent on animal pollination (Hellerstein et al., 2017; Klein et al., 2007), floral visitors also provide services essential to human health and wellbeing. Many nutrients essential for human development are found almost exclusively in animal-pollinated plants, including 98% of the available water-soluble vitamin C produced worldwide (Eilers et al., 2011). The services provided by bees, butterflies and other pollinators are vital to the health and well-being of humans and ecosystems. However, the stability of pollinator communities has become threatened as a number of factors have increased their vulnerability.

Numerous, well-substantiated reports have exposed ongoing, widespread degradation within pollinator invertebrate communities over the past 50 years (Burkle, Marlin, & Knight, 2013; Kearns, Inouye, & Waser, 1998; Koh et al., 2016). Moreover, pollinator declines, both in number and species, coincide with considerable changes to habitat structure due to agricultural intensification (Burkle, Marlin, & Knight, 2013; Kearns, Inouye, & Waser, 1998; Giribaldi et al., 2011). The twentieth century shift towards extensive monocultural production has transformed landscapes, limiting the necessary natural floral variation for sustaining the array of pollinating insects (Blüthgen & Klein, 2011; Kearns et al., 2011). Erosion of ecological networks resulting from the diminution of biological diversity has been identified amongst many, as a significant driver (Koh et al., 2016). Correspondingly, this threatens the integrity of ecosystems, eroding global food webs (Koh et al., 2016), and ultimately endangering human well-being globally (Kluser & Peduzzi, 2007). As nearly one-third (35%) of the global food supply relies on ecosystem services provided by animal pollinators (Klein et al., 2007), and 84% of the world's plant species are animal-pollinated angiosperms (Ollerton, Winfree & Tarrant, 2011), pollinators are integral to reproduction for many plant taxa (Allen-Wardell et al., 1998). Economic drivers in agriculture however have constrained pre-industrial levels of biological variation. Focus towards high efficiency, single-cropping systems (Bowman & Zilberman, 2013) has led to fields depauperate in insects and weeds (Klein et al., 2007).

Throughout the U.S., declines in pollinator species are prevalent. Managed honeybee colonies, for example, have decreased in the U.S. from 5 million to an estimated 2.6 million since the 1940's (Jones Ritten, et al., 2017). For many years, honeybees have been, and continue to be, an important part of agriculture. However, native bees provide insurance against ongoing honey bee losses (Winfree, 2007). *Bombus affinis* is the most recent invertebrate species to be listed for protection under the US Endangered Species Act (USFWS, 2017) as have several native *Bombus* (Cameron et al., 2011), and *Hylaeus* (Magnacca, 2007) species. Out of the hundreds of species of bees native to the Eastern US (Burkle, Marlin, & Knight, 2013), 74 of them have not been observed or collected in over 20 years (Marlin & LaBerge, 2001). Declines and extinctions have been described in several non-bee invertebrate orders, as well. The monarch butterfly (*Danaus plexippus* L.), once common throughout the United States, has experienced a significant depression in abundance. Loss of breeding habitat and exclusion of its larval host plant, *Asclepias syriaca*, through conventional agronomic practices and increasing extremes in weather conditions have contributed to this (Brower et al., 2012). Loss of habitat, as well as habitat fragmentation have preceded the decline of many bee, butterfly and other pollinating species.

Conservation for Pollinators

A number of organizations have responded with conservation measures that seek to create and maintain high-quality, accessible habitat for pollinators in the U.S. Several of these programs promote farmland retirement and conversion, offering both financial incentives and technical support. In 2012, more than 40% of all land in the United States was cultivated through production crop systems (USDA-NASS, 2012). By targeting marginally productive lands, conservation organizations can encourage implementation of the series of practices that benefit both pollinators and agroecosystems on 914 million acres of the most convertible land type in the U.S. Many of these strategies focus on developing partnerships with private landowners with incentive-based approaches that offer technical and financial support. Because the majority of land in the United States (60.2%) and in Illinois (95.9%) is privately owned (USDA-NASS, 2012), incentives that target landowners are crucial.

Numerous conservation programs offer financial support to U.S. farmers for converting productive farmland into wildlife habitat or for maintaining current natural areas for the preservation of its existing ecological diversity. The USDA Conservation Reserve Program (CRP), Conservation Stewardship Program (CSP) and the Environmental Quality Incentives Program (EQIP) help to support farmers in making these conversions. Recently, initiatives that foster the growth of new pollinator habitat have come to the forefront of conservation efforts. One of the more effective initiatives for this is the CRP, which has successfully funded the conversion of hundreds-of-thousands of farm acres to effective pollinator habitat. Landowners can now receive payment and technical support for converting or enhancing cropland to benefit pollinator communities. Several land management agencies have developed partnerships with farmers with the goal of making management decisions that consider pollinator health needs by both establishing both pollinator habitat and incentivizing the use of pollinator food plots. More defined strategies and goals were established in 2014 to set forth guidelines which organize pollinator conservation on the national level. In June 2014, a Presidential Memorandum "Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators," was signed, laying out a set of directives emphasizing research, outreach, conservation, and partnership development to strengthen and protect the vitality of pollinator populations nationwide. From this, the Pollinator Partnership Action Plan (Pollinator Health Task Force, 2016) was developed to institute effective policy promoting honey bee health, monarch butterfly conservation, and pollinator habitat enhancement, restoration and land conservation. These national level interventions have contributed to outlining gaps in current knowledge of pollinators and pollinator declines and identifying priority research efforts needed to close these gaps (Obama, 2014). The Pollinator Health Task Force and its associated Pollinator Research Action Plan, the United States Fish and Wildlife Service (USFWS), and United States Forest Service (USFS), with technical support from the Natural Resources Conservation Service (NRCS), have collaborated with other research institutions to develop strategies for conserving pollinator habitats throughout the country.

An integral piece of legislation for this, the 2014 USDA Farm Bill, developed multiple incentives-based initiatives with far-reaching, comprehensive approaches towards pollinator conservation. The 2014 Farm Bill updated several USDA conservation programs to give U.S. farm managers a variety of incentivized options for implementing pollinator conservation practices. In this regard, NRCS field agents were made available to provide technical expertise and support to farmers needing guidance. NRCS agents offer direction for establishing structural improvements and conservation management practices that benefit both agricultural production and support surrounding environments (Vaughan & Skinner, 2015). The 2014 Farm Bill expanded USDA conservation programs to include strategies that support pollinators. The Conservation Stewardship Program (CSP), the most extensive conservation subsidies program in the nation, was one of several programs that underwent changes from the new legislation. Under the updated CSP, farmers were given the ability to enroll in conservation-based enhancements, which could be implemented into existing conservation installations. Another program that saw changes was the Environmental Quality Incentives Program (EQIP), one of several programs that funds the installation and implementation of environmental management practices and land retirement from agricultural production. EQIP prioritized pollinator conservation in the CRP; the Conservation Reserve Enhancement Program (CREP), which encourages partnerships in the land retirement initiative; and the Conservation Stewardship Program (CSP), which encourages further improvements to current conservation activities (Vaughan & Skinner, 2015).

Also legislated into the 2014 Farm Bill, was the Pollinator Habitat Initiative, or Conservation Practice 42 (CP-42) with oversight by the USDA Farm Service Agency (FSA) through its CREP program. In 2008, CP-42 was developed with the specific goal of expanding and connecting pollinator habitat (Jones Ritten et al., 2017). The program offers financial benefits to farmers to convert production farmland into pollinator habitat. CP-42 incentivizes farmers to retire unused or marginal land for pollinator and soil conservation. This program is especially beneficial for farmers when crop prices drop and production costs are increasing. Farmers may also profit from a multitude of ancillary factors including increased hunting acreage, increased yield to flowering crops, aesthetic appeal and more. As the value to farmers is significant, CP-42 is likely one of the most promising programs for enhancing and expanding pollinator habitat.

Potential CP-42 land must have been under cultivation for at least four of the previous six years to be eligible for this program, with plantings of whole fields, block plantings and strips at a minimum size of one-half acre and at least 20 feet wide. Each contract is signed for a ten-year period. Farmers receive a one-time sign-up incentive payment of up to $150 per acre, and half of eligible costs for establishment are covered with another 50% from a cost-share payment. Each year, farmers receive an annual rental payment of $150 per acre. Compliance in CP-42 entails a list of requirements including seasonally diverse seed mixes and woody habitat creation. Required seed mixes have an assortment of at least 3 pollinator friendly wildflower or shrub species for each of the following bloom periods: spring (April – June 15), early summer (June 15 – July 30) and late summer (August-October). Brush piles, edge feathering and downed tree structures are required for creating nesting habitat for wood nesting pollinator species (Vaughan & Skinner, 2015).

This significant legislation for pollinator conservation has seen much support amongst U.S. farmers. Although the benefits of CP-42 to famers are persuasive, not all interested farmers can enroll. To target areas of highest concern, enrollment in this program is limited by design. To enroll in these programs, farmers must apply and compete with other landowners for a contract, and limited funding is available (Vaughan & Skinner, 2015). Furthermore, for many farm operations these large-scale pollinator plots are unfeasible. Further discussion on the barriers limiting adoption of this program is offered in the next section.

Beyond the national level interventions described in previous paragraphs, encouraging farmers to voluntarily implement small-scale pollinator conservation practices is also considered as important. For many farmers, implementing such less extensive pollinator-friendly practices is also a more practical option. Although, the incentives may be less obvious, these practices offer more than just help to pollinators. For instance, by sowing strips of wildflower seed, crop pollination is enhanced especially in soft fruit operations and other systems that rely on pollinators. In a study of floral buffer strips on fruit orchards in Scotland, researchers observed pollinator visitation rates were 25% higher for crops with adjacent flower strips compared to those without (Feltham et al., 2015). Extensive evidence supports that programs designed for conservation of other natural resources can also benefit pollinators. Pollinators often benefit from landscapes with more abundant, high-quality sources of pollen and nectar forage (Hellerstein et al., 2017). A positive correlation was observed between floral density of leguminous cover crops, flowering taxa associated with high nectar values often preferred by bees for forage, and the average number of bees visiting a plot (Carvell et al., 2007). Cover crops used for soil conservation can also benefit pollinators. Removing arable field margins from the cropping system can potentially provide increased forage resources for bumble bees, a greater diversity of habitats for other invertebrates (Carvell et al., 2007), as well as improved cropland water and soil health (Vaughan & Skinner, 2015). Although most conservation practices can provide forage for pollinators, seed mixes designed specifically for pollinators offer additional and more diverse pollen and nectar sources (Vaughan & Skinner, 2015). One study of agriculture plots in Europe found that uncropped field margins sown with a legume species mixture attracted up to 269 times more bumble bees compared to both conventional and grass-based cover crop treatments (Carvell et al., 2007). Strategies used in other conservation practices can also benefit the goals of pollinator conservation or can be enhanced for this purpose.

Barriers to Adoption

Although CP-42 was a major accomplishment for pollinator policy, at least on study has identified limitations inherent to CP-42 in expanding pollinator forage on agricultural lands (Jones Ritten et al., 2017). Citing inadequate funding and ineffective policy based on poor foresight, they suggest that CP-42 prioritizes habitat establishment on marginal productive cropland whereas limited attention has been focused towards areas of most ecological importance They further suggest that this misdirected focus restricts habitat continuity in landscapes with highly heterogeneous productive values (Jones Ritten et al., 2017). Variations in the spatial heterogeneity of productive values likely play a role in habitat fragmentation, where areas with more diversity in productive land will probably experience increased fragmentation under this program. Because of this, they proposed that CP-42 may actually hinder the recovery of pollinator populations (Jones Ritten, et al., 2017). Nevertheless, this study observed these patterns in some highly heterogeneous land in Wyoming, USA. Productive values of land in

Illinois are likely to be significantly more homogeneous, which would likely mitigate much of the potential fragmentation risk given this logic. Although outside the scope of this study, further investigation into the regional regimes of productive land quality on CP-42 land in Illinois is necessary to determine the effectiveness of the program. As fragmentation is a main cause of declining pollinator populations, it is imperative that habitat connectedness is targeted in policy efforts.

CP-42 is also limited by barriers to enrollment. One of these barriers to adoption is in what one study referred to as its numerous “bureaucratic hurdles” (Gaines-Day & Gratton, 2017). Farmers compete for enrollment entry against one another based on subjective ‘environmental benefits index’ (EBI) scores, where scores could vary widely from state to state. With 1.9 million acres offered in 2016, only 400,000 acres were accepted in CP-42, an overall acceptance rate of 22% (Weaver, 2017). Each conservation practice denoted in the CRP allocated a specified amount of land to a specified conservation issue. Since the USDA manages the CRP to maximize enrollment given these statutory constraints on program acreage, it is critical that land owners make decisions not simply based on whether to enroll land in the program or not, but instead which acre for which conservation practice (Iovanna et al., 2017).

Although Illinois is second to Iowa in total CP-42 pollinator acreage, barriers to participation still limit support for this conservation effort in many Illinois counties. Like many places in the United States, the vast majority of private landowners in the southern portion of Illinois have yet to adopt this initiative (USDA-NASS, 2012). Farm-owner responses in this study will help to uncover motives behind this unwillingness to participate.

It is expected that a variety of reasons for participation reluctance will be uncovered in this study. For farmers, the question of whether or not they can enroll is not the only limiting factor.

Often the perceptions carried by farmers are more limiting than the policies that enable them to implement a conservation action. In 2017, significant challenges to some of the most important initiatives that incentivize these efforts on farmlands were faced. New enrollment and renewal of CRP contracts were temporarily suspended (Weaver, 2017). Also, seed mixtures designed for use on pollinator conservation plantings were found to have been contaminated with herbicide resistant weed seed. A recent unpublished study revealed that farms in Illinois and Missouri have identified herbicide resistant Palmer Amaranth in pollinator mixes sold commercially for the program (Oseland et al., 2017). With these and other obstacles to implementation, sustained support for these programs is unclear. The degree to which this issue affects farmers' land management decisions to employ conservation practices is currently unknown and necessitates future study. Through questionnaire and analysis, this research will seek to analyze the extent to which this fear of contamination is influencing farmers' land management decisions regarding the adoption of pollinator conservation practices and programs.

Herbicide Resistance as a Barrier to Adoption

In the Midwest, agricultural systems are dominated by transgenic glyphosate-resistant crops (GRC). The highly effective, broad-spectrum herbicide, glyphosate, used to control weeds in soybean, corn, and cotton production systems, is the most commonly used herbicide both regionally and globally (Powles, 2008). Five transgenic GRC species, soybean, cotton, maize, alfalfa and canola, have seen high rates of adoption, propagated in over 180 million acres in more than a dozen countries, since the inception of GRC in 1996 (Dill, CaJacob & Padgette, 2008). A 2008 US nation-wide study found that the majority of growers using GRC systems for more than four years noticed a discernible change in weeds and an overall reduction in weed pressure (Kruger et al., 2009). Studies like this abound as many farmers have come to rely on

GRC as an effective strategy. High adoption rates attest to the high level of confidence growers have in this technology, even as studies have shown the benefits of implementing more diversified weed control strategies (Schwartz et al., 2015).

Not surprisingly, after decades of extensive sub-lethal applications of GRC, an evolving population of weed species in GRC fields has developed resistance to the glyphosate herbicide (Powles, 2008). Palmer amaranth (*Amaranthus palmeri*) is one of the most problematic of these weed species in the Midwest with substantial economic implications (Powles, 2008; Ward, Webster & Steckel, 2013). Its dynamic growing habit, prolonged period of germination, genetic diversity, adaptability, and now, its resistance to several herbicides (Ward, Webster & Steckel, 2013) exemplifies the degree of difficulty in controlling this weed. Every Midwest state has now reported resistant populations of Palmer amaranth. Increased costs for controlling this weed and reduced yields (Edwards et al., 2014), combined with its control difficulty, has become a cause for concern for farmers in the Midwest.

In 2017, Palmer amaranth was discovered in multiple fields that were planted with commercial seed mixes sold for CRP pollinator conservation plantings and enhancements (USDA NRCS, 2017). Although multiple reports have confirmed the presence of Palmer amaranth and other highly prolific, herbicide resistant weeds including marestail (*Conyza canadensis*) and waterhemp (*Amaranthus tuberculatus*) in CRP pollinator seed mixes, only recently has this issue been described (Anderson & Hartzler, 2016). As early as May of 2016, this seed had been found in pollinator seed mixes, yet relatively little has been done to combat this problem. Farmers experiencing Palmer amaranth infestations in CRP that want to apply chemical control methods must receive special authorization by the NRCS before doing so. Given that multiple studies have revealed the potential risks posed to the health of pollinator species by certain herbicides, the NRCS's purpose for restricting herbicide applications in these areas is to minimize adverse effects in ecologically important areas, areas purposefully designated to serve as the major forage terminus for providing abundant, high-quality nutriment for the majority of pollinators. Protecting pollinator health at these sites should be prioritized. Alternative methods for weed removal are highly encouraged in these areas, depending on the extent of the infestation. According to the Iowa State University Extension office, because 95-100% of their seed is retained when manual elimination of these plants via hand removal is employed at or before soybean maturity (Schwartz et al, 2016), hand removal is considered the most preferred action for eradication of Palmer (Anderson & Hartzler, 2016). Yet, limiting farmers' autonomy to make management decisions in these fields, especially when the potential for weed infestations is high, may negatively influence farmers' decisions on the adoption of pollinator conservation programs. The extent of CRP field and seed mix contamination by these aggressive driver weeds is yet to be determined. More importantly for the issue of pollinator conservation, farmers looking to receive ecological and financial benefits from planting these seed mixes may be deterred by this risk of seed contamination.

One solution to this problem of controlling multiple herbicide-resistant Palmer amaranth comes in the form of the herbicide dicamba (3,6-dichloro-2-methoxybenzoic acid). Soybean and cotton have been genetically modified to allow broadcast applications of herbicide over the top of the crop after crop emergence. As *Amaranthus* spp. have demonstrated the capacity to evolve resistance to glyphosate and several other mechanisms of action (Heap, 2016) the broadleaf herbicide, dicamba may be one of the most effective herbicides for controlling this weed.

Staying ahead of the resistant issue, Monsanto (now Bayer) has developed a new genetically resistant, dicamba-tolerant (DT) soybean called RoundupReady® 2 Xtend®

Soybean. However, as dicamba is a restricted use herbicide which requires specific training to apply, only licensed applicators can actually apply this herbicide. The major issue with this pesticide, as with many over-the-top herbicides, is its potential for drift and volitization (USEPA, 2017). In 2015, the USDA announced the deregulation of dicamba-tolerant (DT) soybeans (USEPA, 2017). Immediately, 1.7 million acres of DT soybeans were planted in 2016. By 2018, it was predicted that nearly 40 million acres of Xtend soybeans were planted. With 90 million acres of soybean being planted that year, 55 percent of non-DT soybean crops were susceptible to damage by low levels of off-target dicamba movement (USEPA, 2018).

Following the registration of three over-the-top (OTT) dicamba products in 2017, the total amount of dicamba (including pre- and post-emergence) applied to cotton and soybean crops increased from 537,000 in 2016, to nearly 10 million pounds. By early July of 2017, the USEPA received hundreds of reported complaints about dicamba involving phytotoxicity to adjoining crops because of drift and volitization in Arkansas, Tennessee and Missouri (USEPA, 2017). In this report, the USEPA stated that damage was reported to non-dicamba-tolerant cotton, tree crops, tomatoes, watermelon, grapes and other ornamental and vegetable crops. Altogether, in 2017, there was a total of 2,242 dicamba related complaints in the US, as reported by the 19 state's Departments of Agriculture (Bradley, 2017). As drift and volitization associated with dicamba are potentially harmful to surrounding crops, there is potential for damage to nearby pollinator plantings. The Illinois Department of Agriculture (IDOA) reported a total of 246 dicamba-related complaints in 2017. In 2018, the number of complaints increased in Illinois to 330 (IDOA, 2019). As the number of complaints continues to increase, it is likely that the number of farmers concerned about the potential damage to their crops and conservation plantings will grow.

As dicamba affects many broadleaf plants, off-target exposure could lead to the loss of newly planted wildflower plots (Egan et al., 2014). Several hundred crop varieties are susceptible to low levels of dicamba, as well as around 250 weeds including annual and perennial broadleaf herbs and trees (USEPA, 2018). Ultimately, if farmers are worried about off-target movement of dicamba into recently planted pollinator conservation plots, they may opt to forgo implementation. As no known study has been conducted to understand farmers' views on this situation, research exploring the influence of these emerging issues on farmers' decision-making on the adoption of pollinator conservation practices is necessary. In this regard, the next section of the chapter further explores some of the conceptual issues on farmers' decision-making.

A Conceptual Framework for Understanding Farmers' Decision-Making Based on the Theory of Planned Behavior

A number of social science theories have been used to study human behavior in the field of agriculture and other sectors (Nowak, 1992; Thompson, Reimer & Prokopy, 2015). One such theory that is frequently used to explain individual behavior is Fishbein and Ajzen's Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1977). TRA posits that the immediate predictor of human behavior is the intention to undertake a particular action. The theory further posits that an actor's intention is a function of his/her attitudes and subjective norms. According to the Reasoned-Action Approach (Fishbein & Ajzen, 2011), behavioral change occurs through a planned, three-phase process. First, there is a change in relevant beliefs; second, a change in intentions; and third, a change in behaviors. Based on an extension of TRA, Ajzen's (1985) Theory of Planned Behavior (TPB) is another highly parsimonious model for explaining intentions (Mastrangelo et al., 2014). Intentions are the motivations that influence the actor's readiness to undertake a behavior (Ajzen, 2002). Entailed in TPB are three main constructs that help to predict intentions: subjective norms; attitudes; and perceived behavioral control (PBC). In this study, a conceptual model based on the TPB constructs is used to analyze the factors influencing farmers' adoption of pollinator conservation programs and practices (Fig. 2.1).

According to the TPB model, how a person interprets the perspectives of their peers influences his/her intentions to adopt a new behavior. Subjective norms refer to an actor's perceptions about the expectations of important others for him/her to perform a given behavior, as well as the social pressures to conform to those expectations (Ajzen, 1985; Liu, Smith & Safi, 2014). Perceived social norms have been identified as influential factors shaping conservation intentions (Mastrangelo et al., 2014). It is likely that farmers with neighbors who implement conservation practices will be more likely to adopt similar practices. Whether or not a farmer believes an action has ethical implications may result from his/her social identity, as well as his/her understanding of existing social norms (Sulemana & James, 2014). Furthermore, information networks, such as social interaction networks among neighboring farmers, may be a key factor determining whether or not a farmer adopts a farm conservation practice (Baumgart-Getz, Prokopy & Floress, 2012).

Another key component of the TPB model is perceived behavioral control (PBC) which refers to an actor's perceptions about his/her ability to perform a task. PBC is described as a person's perception of the ease or difficulty in performing a new behavior. In the case of farmers, their level of knowledge about carrying out the task (Gaines-Day & Gratton, 2017; Baumgart-Getz, Prokopy & Floress, 2012), ownership status of the land, and resource availability (Gaines-Day & Gratton, 2017) all shape PBC (Fig. 2.1). A farmer's sense of control over the outcome of a conservation action, as well as their actual skill and ability to carry out that action have been identified as significant precursors to the adoption of conservation practices (Price & Leviston, 2014). However, farmers may not always have the knowledge or logistical support to implement pollinator conservation practices even when they understand the economic and ecological importance of such practices. Although organizations such as the FSA and NRCS are integral in providing support for farmers, not all famers have the ability to convert productive or even marginal land beyond its current system. Hence, differences in the resource endowments of farmers is expected to reflect in differences in their intentions and actual adoption of pollinator conservation practices.

Attitudes, the actor's overall positive or negative evaluation of an action, also influence the intentions to act. Attitudes are a function of the actor's perceived likelihood that a particular action will yield the intended outcome, as well as the value he/she assigns to the outcome (Chancellor, 2012). Farmers' attitudes toward conservation agriculture have been identified as strong predictors of their intentions to implement conservation agriculture (Lalani et al., 2016). Attitudes are the beliefs about implementation outcomes which drive a farmer's intentions towards adoption behavior (Thompson, Reimer & Prokopy, 2015; Arbuckle, Morton & Hobbs, 2013). Perceived benefits (Wratten et al., 2012; Gaines-Day & Gratton, 2017; Iovanna et al., 2017), including financial outcomes and potential risks (Swinton et al., 2015; Roesch-McNally et al., 2018), such as those surrounding herbicide resistance issues (Oseland, et al. 2017; Schwartz et al., 2015), all affect a farmers' attitudes towards implementing pollinator practices. In addition to the key constructs of TPB, the proposed conceptual model also captures the effect of history and context on farmers' decision-making processes. Diversifying cropping strategies through the adoption of new practices may not always be a realistic for many farmers, such as those in corn-soybean cropping systems (Roesch-McNally, Arbuckle, & Tyndall, 2017). Management decisions are often influenced highly by past management strategies, whereby associated lock-in and path dependency play a large role in growers' future management decisions. Thus, farmers with the requisite financial resources may not adopt innovations, such as pollinator conservation practices due to the path-dependent effects of their prior investments (Roesch-McNally, Arbuckle, & Tyndall, 2018). Nonetheless, it is anticipated in this study that farmers' prior involvement in programs and farm activities related to pollinator conservation will have a positive effect on their intentions to adopt such programs and practices in the future. The logic is that farmers' past experience will enhance their access to the relevant information, social networks, as well as resources and skills for implementing pollinator conservation initiatives. This relationship is represented in the model by the arrow leading from "Adoption" to "Intentions."

Given the lack of well-developed conceptual frameworks in the existing literature for analyzing farmers' adoption of pollinator conservation practices, the framework developed in this study provided the theoretical basis for analyzing the effect of farmers' attitudes, subjective norms, resource capacity and past farm practices on their adoption of pollinator conservation programs and practices, as well as their intentions to adopt those programs and practices in the near future. Drawing from the established literature on TPB as well as the literature on pollinator conservation, the attitudes construct was operationalized as a function of personal environmental perspectives (Thompson, Reimer & Prokopy, 2015; Arbuckle, Morton & Hobbs, 2013), economic considerations (Swinton et al., 2015; Roesch-McNally et al., 2018), perceived benefits (Wratten et al., 2012; Gaines-Day & Gratton, 2017; Iovanna et al., 2017) and the potential risks due to herbicide resistance issues (Oseland, et al. 2017; Schwartz et al., 2015). The subjective norms construct was also operationalized as a function of farmer's perceptions of social norms (Ajzen, 1985; Liu, Smith & Safi, 2014) and their connectedness to scientific institutions.

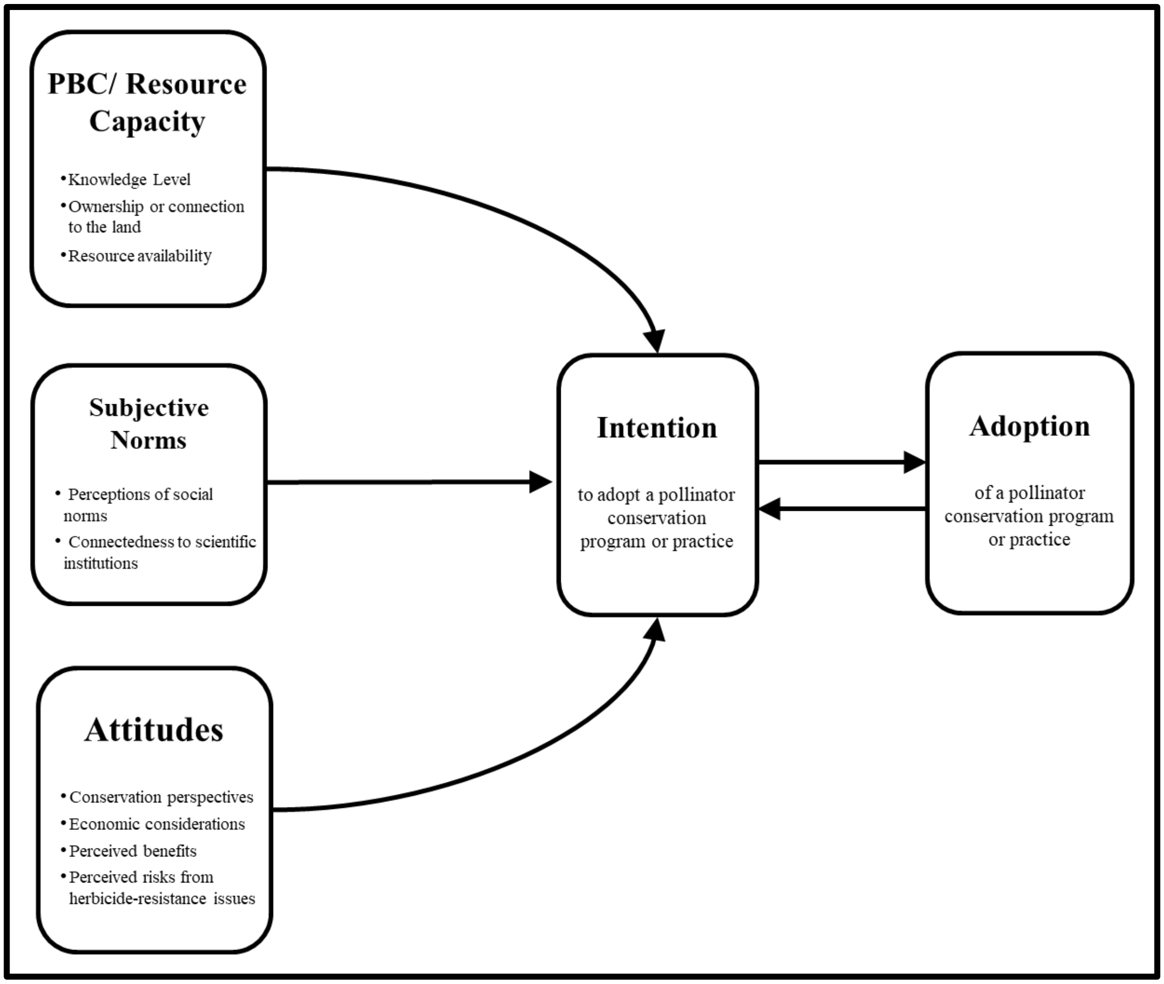

Figure 2.1: A Conceptual Framework for Understanding Farmers' Adoption of Pollinator Conservation Initiatives

Perceived behavioral control was measured as a function of farmers' knowledge level (Gaines-Day & Gratton, 2017; Baumgart-Getz, Prokopy & Floress, 2012), ownership or connection to the land, and their resource availability (Gaines-Day & Gratton, 2017). Finally, farmers' adoption of pollinator conservation initiatives was operationalized in terms of the enrollment in programs managed by government representatives, as well as the adoption of specific farm management practices. Specific research questions and hypotheses derived from the framework are presented in the next section of the chapter.

2.2 Research Questions and Hypotheses

Through a web-based survey of farmers in the state of Illinois, the purpose of this study was to test a proposed conceptual framework (Fig. 2.1.) for explaining farmers' decision-making processes regarding the adoption of pollinator conservation initiatives. Specifically, the study sought to address the following research questions:

i. What factors are associated with farmers' adoption of pollinator conservation practices and programs?

ii. What factors influence farmers' intentions to adopt pollinator conservation practices and programs?

To address these research questions, the following hypotheses, derived from the proposed conceptual framework, were tested:

i. Farmers' current adoption of pollinator conservation practices could be predicted by their attitudes (positive), subjective norms (positive), perceived behavioral control (positive), concern about herbicide resistance issues (negative) and sociodemographic characteristics.

ii. Farmers' current adoption of pollinator conservation programs could be predicted by their attitudes (positive), subjective norms (positive), perceived behavioral control (positive), concern about herbicide resistance issues (negative) and sociodemographic characteristics.

iii. Farmers' intentions to adopt new pollinator conservation practices could be predicted by their attitudes (positive), subjective norms (positive), perceived behavioral control (positive), current adoption of programs (positive), current adoption of practices (positive), concern about herbicide resistance issues (negative) and sociodemographic characteristics.

iv. Farmers' intentions to adopt new pollinator conservation programs could be predicted by their attitudes (positive), subjective norms (positive), perceived behavioral control (positive), current adoption of programs (positive), current adoption of practices (positive), concern about herbicide resistance issues (negative) and sociodemographic characteristics.

2.3 Conclusion

Critical declines in pollinator populations, mainly attributable to twentieth-century agricultural intensification, drastic losses to suitable habitat, and decline in floral food resources have raised awareness on the need for more sustainable agricultural systems. Federal land management agencies and policy makers are focusing conservation efforts towards pollination communities with an emphasis on reversing habitat and floral resource loss. Because the majority of U.S. land is privately owned, and one-third is managed agricultural land (USDA NASS, 2019), farmer and private landowner participation in pollinator habitat restoration is imperative. Programs that encourage private participation potentially are the most effective for restoring habitat and reversing the regression of wild and managed pollinating invertebrate species. However, due to a myriad of social, technical and political factors, these programs have encountered difficulties that limit their success. Importantly, a sound conceptual understanding of the factors influencing farmers' responses to these pollinator conservation initiatives is lacking. To fill these knowledge gaps, this chapter presented a proposed conceptual framework based on the theory of planned behavior to analyze the factors that might explain farmers' adoption of pollinator conservation programs and practices. The subsequent chapters of the thesis shall elaborate on the methods and results of the study.

CHAPTER 3

METHODS

3.1 Introduction/Background

Given the host of social and ecological complexities underlying pollinator conservation, research that contributes to a better understanding of farmers' decision-making processes is more necessary now than ever. Such research may serve to inform strategies for increasing the efficacy of pollinator habitat conservation initiatives which aim to improve habitat for the future security of pollinators and pollination services. The goal of this study is to identify the key factors that enable or constrain farmers' decisions to adopt conservation practices which promote high-quality pollinator forage and nesting habitat, subsequently benefiting pollinator health, abundance, and diversity. A quantitative research approach using survey methodology was used to understand farmers' perspective on this subject. This chapter provides a detailed explanation and justification of the steps involved in planning and carrying out this research. In this regard, a detailed description of the research design, sampling and administration of the survey is given. A summary of the steps used in analyzing the data to test the hypotheses is also reported.

3.2 Research Paradigm and Approach

Post-positivism was adopted as the foundation for the quantitative approach that was utilized in this study. Post-positivism is based on ontological assumptions about the existence of an objective reality, independent of human thinking, which a researcher must aim to explain for the purpose of prediction and control (Ponterotto, 2005). The post-positivist paradigm asserts that due to limitations inherent to the humanness of the researcher, reality can be understood, but only imperfectly (Chilisa & Kawulich, 2012). The human experience shapes personal truths, and what is known to be true is dependent on historical, cultural and contextual factors shaping one's belief systems. As error in empiricism can arise from researcher biases, the post-positivist paradigm emphasizes the value of objectivity in research through the rigorous application of the scientific method. The application of the assumptions of the positivist paradigm in this quantitative study was therefore aimed at enhancing objectivity in the explanation of the factors influencing farmers' decision-making regarding the adoption of pollinator conservation initiatives.

3.3 Questionnaire Development

A structured questionnaire was developed to gather data for this study. Given that the research questions and hypotheses were largely based on the theory of planned behavior (see fig 2.1), the existing literature was utilized in the operationalization of key constructs: perceived behavioral control; attitudes; subjective norms; and intentions. Additionally, the questionnaire was designed to capture data on farmers' current involvement in relevant agronomic practices and programs, concern about herbicide resistance issues, as well as respondent socio-demographic characteristics.

Qualifying Statements

The first question in the survey was used to limit participation in the questionnaire to only those within the sampling frame. Respondents that identified themselves as not the primary operator of the farm in which they worked were, therefore, exited from the online survey (6 cases). Furthermore, the second question asked respondents to enter the zip code from the home in which they resided. By design, participants not living in Illinois were to be removed from sampling. However, all respondents indicated they were Illinois residents.

Perceived Behavioral Control

Sixteen input variables, examining respondents' perceived resource availability and knowledge level, were used to measure PBC. In the third question of the survey, resource availability was measured with ten questions asking about the amount of control, time, and technical support available for respondents when implementing a pollinator conservation practice. Participants were prompted to express their level of control in (1) making land management decisions, (2) changing a practice and (3) implementing a pollinator conservation program on their farm. Further, participants were asked about the degree at which they thought that the following were available to them: (4) programs that offer financial benefit for creating pollinator habitat; (5) the amount of time necessary to complete the required paperwork for enrollment in a pollinator conservation program; (6) the time to implement a pollinator conservation program; (7) the financial resources for implementing pollinator habitat; (8) the technical support for creating pollinator habitat; and (9) in general, the necessary resources for implementing pollinator habitat. Additionally, participants were asked to elicit whether they believed that (10) their farmland meets the requirements for enrollment in a pollinator conservation program.

Question four in the survey used six variables to measure participants' level of knowledge regarding pollinator habitat. Respondents replied to six statements in this question about the extent to which they knew about the following: (11) pollinators' habitat requirements; (12) creating pollinator habitat; (13) managing pollinator habitat; (14) farming practices beneficial to pollinator communities; (15) pollinator habitat conservation programs; and (16) the requirements for enrollment in pollinator conservation programs.

All sixteen questions were coded on a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree). A composite index for the PBC construct was calculated using the mean score of all sixteen items used to measure that construct.

Concern about herbicide resistance issues

Concern about herbicide resistance issues was measured using twelve statements. Question five asked how much participants were (1) concerned about herbicide resistant weeds; (2) familiar with Palmer amaranth; and (3) familiar with the reported contamination of pollinator conservation seed mixes with Palmer amaranth seed in 2016. Additionally, respondents reported whether they (4) had Palmer amaranth on their farm; (5) were familiar with Roundup Ready® Xtend Crop Systems (dicamba); (6) had herbicide resistant weeds on their farm; (7) were concerned about off-target movement of dicamba; (8) used Roundup Ready® Xtend soybeans; (9) had neighbors that use Roundup Ready® Xtend soybeans; (10) had seen off-target movement of an herbicide from a neighboring field onto their farmland; (11) had seen off-target movement of an herbicide from their fields onto nearby plants; and/or (12) manage their field borders and ditch banks to remove potential herbicide-resistant weeds.

Responses to these questions were also coded using a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree). A composite index was then assigned from the mean of all items from the concern about herbicide resistance construct.

Attitudes

The attitudes construct was operationalized using thirty variables. Thirty response statements were separated into five questions in the survey (Questions 6, 7, 9, 10 and 11). To measure participants' understanding of conservation issues, question six asked participants to indicate how much they know about (1) local pollinators; (2) the native bees in their region; (3)

monarch butterfly declines (4) the ecosystem service that pollinators provide to plants; (5) the issue of pollinator declines; and (6) the issue of Colony Collapse Disorder (CCD) in honeybees. Question seven consists of nine statements aimed to determine how participants perceive the importance of pollinators for (7) their farm operations; (8) nearby farmland; (9) the amount of food produced (10) the quality of food produced in personal gardens; (11) crop yields; (12) nearby wild natural areas; and (13) human health. Negatively worded statements were also incorporated in this question set. These statements prompted participants to identify to what degree they believed that pollinators were unimportant for (14) wildlife and (15) game animal health. These negatively framed questions were reverse coded at the data analysis stage.

Statements in question nine measured how much participants thought that creating pollinator habitat would benefit (16) the soil on their farm, (17) the local watershed, (18) enhance hunting and (19) wildlife-viewing opportunities, (20) enhance wildlife hunting opportunities, (21) their local community, (22) their farm's aesthetics, and/or (23) pollinators on their farm.

Statements in question ten measured how much farmers believed that planting a pollinator conservation plot would (24) contaminate their fields with herbicide-resistant weeds; (25) increase the weeds on their farm already infesting their farm; and whether they thought that (26) off-target herbicide would drift into pollinator fields, potentially outweighing the benefits of planting pollinator a conservation plot. During the data analysis, these negatively worded variables were also reverse-coded.

Statements in question eleven prompted participants to indicate how much they agreed that managing pollinator habitat would (27) increase crop yields, (28) reduce production costs, (29) reduce their honeybee hive rental fees, and (30) how important pollinator conservation was for the long-term success of their farm.

Responses to all questions in this section were coded using a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree). A composite index for the attitude construct was calculated using the mean scores of the thirty items. The questionnaire contained five additional variables measuring the attitude construct. However, upon close examination, those items were deleted prior to data analysis as they were judged by the research team as having low validity.

Subjective norms

The subjective norms construct was operationalized using five variables, including how neighbors, close friends and family members influence participants' intentions, as well as, their connectedness to scientific institutions. In question twelve of the survey, respondents were asked the extent to which they agreed or disagreed that (1) any of their neighbors (2) close friends practices farm-based pollinator conservation, and whether or not they agreed that (3) any of their neighbors, (4) close friends, or (5) family members has encouraged them to implement a pollinator conservation practice. A final statement asked about (6) their connectedness to farming organizations that emphasizes pollinator conservation. As with the previous sections, each response statement was coded using a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree). The mean of responses to all six items was used to create a composite index for the subjective norms construct.

Sociodemographic Variables

Seven variables were used to measure the sociodemographic characteristics of participants in the survey. Age was measured on a six-point Likert scale where 1 = ages less than 25 years old, 2 = ages 25-34, 3 = ages 35-44, 4 = 45-54, 5 = ages 55-64, and 6 = ages 65 or older. Gender was coded so that 1 = male, 2 = female. Education was coded given the following options: 1 = High school diploma or comparable; 2 = Some college; 3 = Associates degree; 4 = Bachelor's degree; 5 = Some graduate coursework; 6 = Master's degree; 7 = Doctorate degree; and 8 = None of the above. Farming experience was coded where 1 = less than 1 year, 2 = 1-4 years, 3 = 5-14 years, 4 = 15-24 years, and 5 = 25 or more years. The farm acres variable was coded as: 1 = 0-40 acres; 2 = 41-80 acres; 3 = 81- 120 acres; 4 = 120-200 acres; and 5 = More than 200 acres. Ownership was measured in the survey with the question, "Are you the primary owner of all the acres that you farm?" This variable was coded where 1 = yes and 2 = no responses. Income was measured on a twelve-point Likert scale and coded as follows: 1 = less than $1,000; 2 = $1,000 to $2,499; 3 = $2,500 to $4,999; 4 = $5,000 to $9,999; 5 = $10,000 to $19,999; 6 = $20,000 to $24,999; 7 = $25,000 to $39,999; 8 = $40,000 to $49,999; 9 = $50,000 to $99,999; 10 = $100,000 to $249,999; 11 = $250,000 to $499,999; and 12 = $500,000 or more.

Dependent Variable: Current agronomic practices

Twelve variables were used to measure respondent's adoption of pollinator conservation practices. Question fifteen in the survey asked about current and past adoption in pollinator conservation practices. These practices were cited by the Xerxes society as best management practices for farm-based pollinator conservation (Mader et al., 2011). Twelve questions were developed asking respondents whether they currently (1) maintain field margins with flowering plants; (2) plant flowering crops that provides a floral food resource for pollinators; (3) plant legume-based cover crops between crop rotations; (4) maintain woody habitat to provide nesting area for cavity nesting pollinator species; (5) stagger plantings of single crop varieties or grow several varieties of a single crop such as early and late flowering varieties ensuring a succession of flowering plants throughout the growing season; (6) grow at least one flowering crop or cover crop consistently throughout rotations to ensure a food source for pollinators; (7) actively avoid plowing pollinator nesting sites; (8) follow the recommended pesticide application timeline such as limiting applications to late evenings or early mornings; (9) completely avoiding insecticide use when possible; (10) avoiding products, such as seed treatments, with insect growth regulators, neonicotinoids or organophosphates; (11) use non-chemical alternatives to pest control; and/or they (12) allow large tracts of plants (pastures, lawns, other) to go to seed before mowing.

Although four response options were given, (In the past, Currently, Never, and Not Sure), responses to each of these questions were ultimately coded “1” for adoption and “0” for non-adoption. A composite index was calculated for current adoption of pollinator conservation practices using the sum of the responses of the twelve items.

Dependent Variable: Current programs

To capture data on the current adoption of pollinator conservation programs, question thirteen in the questionnaire asked survey respondents about their current adoption of (1) CP42, (2) another CRP that provides cover for pollinators, (3) a pollinator enhancement through the CREP, (4) A pollinator conservation program through the EQIP, (5) Pheasants Forever, and (6) The Bee & Butterfly Habitat Fund. For this question, an (7) “Other” option was given as well as a fill in the blank box for respondents to specify any other program in this category in which they were enrolled.

Question fourteen asked respondents about their enrollment in (8) any CRP program, (9) any CREP program, (10) any EQIP, or any (11) other conservation program that may indirectly benefit pollinator communities.

For each listed program in this section, responses were coded as "0" for non-participation and "1" for participation. A composite index was computed using the sum of responses to all the programs. An attempt was also made to capture data on respondent's history of adoption of pollinator conservation programs, but a decision was made not to analyze that data due to limitations in wording of the questions that were used to generate the data.

Dependent Variable: Intentions to adopt pollinator conservation practices

Respondents' intentions to adopt pollinator conservation practices was assessed using sixteen variables. Three variables in this section measured intentions to implement practices used to control herbicide resistant weeds. Additionally, thirteen variables were cited as best management practices for supporting pollinator communities by the Xerxes Society (Mader et al., 2011). In question sixteen, participants were asked to what degree they plan to (1) grow flowering crops that provide food resources for pollinators; (2) stagger plantings of single crop varieties to ensure pollinator floral resources season-long; (3) grow early and late-flowering varieties of a single flowering plant species to ensure flushes of pollinator floral resources throughout the summer; (4) grow the same flowering crop consistently throughout rotations to ensure a food source for pollinator offspring; (5) avoid plowing pollinator nesting sites; (6) limit pesticide applications to the evenings or early mornings; (7) avoid the use of insecticides that could hurt pollinating species such as insect growth regulators, neonicotinoids and organophosphates; (8) use non-chemical alternatives to control pests; (9) allow large tracts of plants to go to seed before mowing; (10) certify my farm as organic or practice organic farming techniques; (11) scout to monitor insect pests; (12) maintain field margins with flowering plants; and (13) maintain honeybee colonies. There were three additional responses in this section used to identify future action towards controlling herbicide resistant crops. Participants were prompted to describe how likely they were to (14) grow Roundup Ready® Xtend soybeans, (15) apply the herbicide dicamba and (16) use seed that utilizes GMO technology, or is genetically enhanced to be planted with a specific herbicide.

All responses in this section were coded on a four-point Likert scale (1 = "Not at all likely, 2 = "Unlikely," 3 = "Likely," and 4 = "Very Likely" to enroll in that program). The mean score of all sixteen items was used to create a composite index for the construct representing intentions to adopt pollinator conservation practices.

Dependent Variable: Intentions to adopt pollinator conservation programs

To gather data on respondents' intentions to adopt conservation programs, five pollinator conservation programs and four conservation programs that may indirectly benefit pollinators were used as measurement variables. In question seventeen, participants were asked to identify how likely they were to enroll in a pollinator conservation program including: (1) CP42; (2) another CRP program that provides cover for pollinators; (3) a pollinator enhancement through CREP; (4) a pollinator conservation program through EQIP; and (5) another pollinator conservation program.

In question eighteen, four indicators were used to determine the willingness of respondents to enroll in conservation programs that could indirectly benefit pollinators. Respondents were asked to indicate their likelihood of enrolling in (1) a CRP; (2) a CREP; (3) an EQIP; and (4) another conservation program that may indirectly benefit pollinators.

All responses in this section were coded on a four-point Likert scale (1 = "Not at all likely, 2 = "Unlikely," 3 = "Likely," and 4 = "Very Likely" to enroll in that program). A composite dependent variable was then created for intentions to adopt pollinator conservation programs using the mean of all the items.

3.4 Study Area

Agricultural conservation schemes are implemented throughout the United States. Illinois, however, has one of the highest adoption rates of any state in the country. Of all Illinois farms, 37.8% (28,386 farms) were enrolled in a USDA sponsored conservation program in 2017. In Illinois, 8.9% of all agricultural CRP conservation land is enrolled in the Pollinator Habitat Conservation Practice (CP42) (USDA FSA, 2017; *see table 3.1*). However, adoption rates of CP42 are uneven across geographic regions in the state. Some areas of the state have high rates of CP42 adoption, while other regions report severely limited support. For instance, in the southeastern region of Illinois 17.8% (123,638 acres) of all managed agricultural land (600,771 acres) are designated as a CRP conservation area. However, only 0.6% (515 acres) of designated CRP are enrolled in CP42. In contrast, of the 71,971 CRP acres in eastern Illinois, CP42 has been implemented on 25.2% (18,115 acres) these. However, this region also has the lowest rate of adoption of CRP practices per managed acres of in Illinois (4.4%). In Illinois, the three regions with the smallest proportion of agriculture land enrolled in a CRP program conversely adopted the Pollinator Habitat CP42 at the highest rates per unit of managed agriculture land (USDA FSA, 2017; *see table 3.2)*.

According to 2012 USDA data, there were 2,109,303 principal farm operators in the United States. In Illinois, there were 75,087 farms covering 26,937,721 acres. Estimates for 2018 suggested a decrease in total farms and cultivated land area. An estimated 26.6 million acres were cultivated in Illinois in 2018, approximately 300,000 fewer than in 2012. Although 71,000 farms (ninth most in the US) in Illinois were in operation in 2018, there were nearly four thousand fewer operations (approx. 5% decrease) than in 2012 (USDA-NASS, 2018). However, Illinois farmers still produce a significant proportion of agricultural products sold in the United

States. In 2012, the value of crops sold in Illinois ranked the third largest ($14.1B US) in the US, with more than $17 billion in agriculture products sold, primarily from corn ($7.37B US) and soybean ($5.87B US) (USDA-NASS, 2012).

Table 3.1 *2012 Census of Agriculture: Illinois Farms*

	Total	(%)
Farms		
Number	75,087	-
Acres	26,937,721	-
Cultivated Cropland		
Farms	67,609	90.0
Acres	23,752,778	88.2
Conservation Enrollment[1]		
Farms	28,386	37.8
Acres	986,719	3.7
CP42 Enrollment[2]		
Acres	87,329	0.3[†] 8.9[††]

[1]Enrollment in Conservation reserve, Wetlands Reserve, Farmable Wetlands or Conservation Reserve Enhancement (CREP) programs
[2] Land enrolled in Pollinator Habitat Conservation Practice (CP42)[2]
† Percentage of all Illinois farmland in CP42
††Percentage of all Illinois conservation land in CP42
Source: (USDA-NASS Census of Agriculture, 2012)

Table 3.2 Illinois Farmland Enrollment in CRP and CP42 by Region

IL Region (USDA)	Agriculture Land (tot. acres)	Cultivated Land (acres)	Land in CRP (acres)	Ag. Land in CRP (%)	Land in CP42 (acres)	CRP in CP42 (%)
Central	1,596,032	1,510,000	86,032	5.4	17,150	19.9
East	1,640,971	1,569,000	71,971	4.4	18,155	25.2
East Southeast	1,644,430	1,486,000	158,430	9.6	17,816	11.2
Northeast	1,015,616	995,000	20,616	2.0	2,712	13.2
Northwest	2,041,768	1,916,000	125,768	6.2	6,256	5.0
Southeast	694,638	571,000	123,638	17.8	1,752	1.4
Southwest	600,771	519,000	81,771	13.6	515	0.6
West	1,179,451	1,093,000	86,451	7.3	6,221	7.2
West Southwest	1,682,137	1,541,000	141,137	8.4	16,752	11.9
IL Total	12,095,814	11,200,000	895,814	7.4	87,329	9.7

Source: (USDA FSA, 2017)

3.5 Data Collection

Sampling and Survey Administration

This study employed a web-based mode of survey administration. Given that the geographic scope of the study covered the entire state of Illinois, the use of other modes of survey administration, such as face-to-face personal interviews or mail would have been costly and/or time-consuming. The questionnaire used for this research was uploaded to Survey Monkey©, an online web-based survey software program. The use of Survey Monkey© to administer the questionnaire allowed for quick dissemination of this survey, and rapid retrieval of participants' data to be used in analysis. Employing this method required payment for service costing approximately $300 for twelve months of access. Although some comparable services offer less expensive rates, this method allows for ease of access and response to participants through many convenience features including a mobile-friendly website and app necessary to increase response rates of participants that rely on smart phones for internet access.

The population of interest in this study comprises farmers in the state of Illinois. The list of subscribers to FarmWeek, a weekly publication by the Illinois Farm Bureau, was used as the sampling frame. Although the selection of survey participants using an appropriate probability sampling technique would have been desirable, difficulties were encountered in accessing information on farmers in the state of Illinois for sampling purposes. In view of this constraint, self-selection sampling was employed. This sampling technique is used when the researcher wants members of the population of interest to choose to take part in the study on their own accord (Mujere, 2016).

A major aspect of the application of the self-selection sampling technique is to publicize the need for study participants (Mujere, 2016). To create farmers' awareness about the survey, a link to the survey was published three times by the Illinois Farm Bureau in their weekly newspaper, FarmWeek. FarmWeek's circulation comprises 70,000 households, of which 70 percent are farmers (which includes not only primary farm operators, but also farmers not involved in the planning process), 24 percent are non-farming landowners, and the remaining 6 percent are "other professionals" (source: personal contact with FarmWeek representative). As a sampling criterion, the study solicited the participation of one farm operator per farm. On October 23, 2018, the first announcement containing the initial link to the questionnaire was supplemented by a short article describing the scope and importance of the research. Three weeks following the initial contact, a follow-up prompt was distributed to remind non-respondents to submit their surveys. This second distribution, which included the link with a brief reminder of the survey deadline, was published on November 13th. Due to limited response, the deadline was extended to December 14th, and was published in the third, and final, announcement. Three waves of contact is a frequently used method to optimize response rate in survey research (Cook, Heath & Thompson, 2000).

Overall, a response rate of approximately 0.08% (41 responses of 49,000 possible Illinois farmers reached) was obtained. This response rate is very low when compared with what is reported in the existing literature. For instance, an analysis of 56 web-based surveys reported a mean response rate of 34.6% with a standard deviation of 15.7% (Cook, Heath & Thompson, 2000). For comparison, the average response rate to post-mailed paper surveys was determined to be 55.6% (Baruch, 1999), or with careful attention to design response rates could be consistently around 70% for general public populations (Dillman, 2000). However, a mailed surveys method of administration was not a viable option for this study due to its limited budget.

3.6 Data Analysis

Once the survey administration process using Survey Monkey was completed, the data were transferred to a spreadsheet (using Microsoft© Excel© 2013 Version 15.0.) for validation and cleaning. Survey data were then analyzed using the SPSS program (IBM SPSS Release 10.1.4).

The first step in the data analysis process was the reverse coding of all negatively worded items in the questionnaire. In all, five items measuring attitudes were reverse coded in SPSS. Next, given that each construct in the study was operationalized using several items, composite indices were computed for each of the constructs using the sum or mean of responses on the individual items as described in the section on construct operationalization in this chapter. Following the data reduction stage, the relationships among the dependent and independent variables were explored using correlation analysis. Finally, the research hypotheses were tested using multiple regression analysis. The output of the regression models were evaluated by interpreting the overall significance of the *F*-test, adjusted R^2 values, as well as the beta coefficients of the predictor variables. Given the constraints inherent to this study, the statistical significance was measured at the $\propto \leq 0.10$ level.

CHAPTER 4

RESULTS

This chapter presents the results of the analysis of data gathered from the survey. In this regard, data on the sociodemographic characteristics of respondents are first presented. Next, results of bivariate correlation analysis of the data are presented. Finally, the results of regression analysis are reported for each of the hypotheses. Concluding remarks are then provided at the end of the chapter.

4.1 Sociodemographic Characteristics

Data on a number of sociodemographic variables were gathered in the survey, including age, gender, and level of education. Results from the analysis of the data are reported in Table 4.1. Overall, the majority of respondents in this study were educated above high school level (88.5%), with 65.3% having a bachelor's degree or higher, and 23.1% having postgraduate degrees. As most farmers in Illinois are male, it was not surprising that men made up the majority of respondents in this survey (72%). However, as women principal operators make up only 10.1% (USDA NASS, 2018) of all farmers in Illinois, this study was somewhat overly represented by women compared to the state. Respondents between 55 and 65 years of age made up the largest age group of respondents in this study (28%), and 52% were 55 years of age or older. Overall, 92% of respondents were over the age of 34, and none were younger than 25. Expectedly, respondents were primarily corn and/or soybean farmers (73.1%), the most commonly cultivated crops in Illinois. With regard to income, 39.1% of respondents reported earning over $100,000 in farm operation income the previous year, compared to 33.0% of Illinois farmers (USDA NASS, 2018).

Table 4.1 Sociodemographic Characteristics of Survey Respondents

Demographic Variable	Response %
Gender (*n* = 25)	
Female (7)	28.0
Male (18)	72.0
Age (*n* = 25)	
Less than 25 (0)	0
25-34 (2)	8.0
35-44 (6)	24.0
45–54 (4)	16.0
55-64(7)	28.0
Over 65 (6)	24.0
Education (*n* = 26)	
Less than high school education (0)	0
High school diploma or comparable (3)	11.5
Some College (3)	11.5
Associates Degree (3)	11.5
Bachelor's Degree (7)	26.9
Some graduate coursework (4)	15.4
Master's degree (5)	19.2
Doctor Degree (1)	3.8
Farmer Experience (*n* = 26)	
1-4 years (3)	11.5
5-14 years (8)	30.8
15-24 years (5)	19.2
25 or more years (10)	38.5
Farmed Acreage (*n* = 26)	
0-40 acres (7)	26.9
81-120 acres (1)	3.8
120-200 acres (2)	7.7
More than 200 acres (16)	61.5
Is some farmland rented? (*n* = 26)	
Yes (9)	65.4
No (17)	34.6
Primary Crop (in 2018) (*n* = 26)	
Corn (12)	46.2
Soybeans (7)	26.9
Hay or animal feed (2)	7.7
Range Livestock (1)	3.8
Indoor Crops (1)	3.8
Fruits or vegetables (1)	3.8
Other (2)	7.7
Farm Operation Income (*n* = 23)	
$0 - $9,999 (7)	30.4
$10,000 - $49,999 (4)	17.4
$50,000 - $99,999 (3)	13.0
$100,000 - $499,000 (6)	26.1
$500,000 or more (3)	13.0

4.2 Data Exploration

To analyze potential relationships between the dependent and independent variables in the hypotheses, a bivariate correlation matrix was constructed. Pearson's correlation coefficients representing the magnitude and direction of relationships among these variables and the statistical significance of those relationships are presented in Table 4.2. The results show that at least one of the TPB constructs had a statistically significant relationship with each of the four outcome variables in the hypotheses being tested in this study: current adoption of pollinator conservation practices; current adoption of pollinator conservation programs; intentions to adopt pollinator conservation practices; and intentions to adopt pollinator conservation programs. However, the socio-demographic variables and other predictor variables performed less consistently.

Farm acreage was the only sociodemographic variable that was statistically significant in its bivariate relationship with current adoption of pollinator conservation practices, although the direction of the relationship was negative ($r = -0.40$, $p < 0.05$). Of the TPB constructs, attitudes ($r = 0.63$, $p < 0.01$) and subjective norms ($r = 0.39$, $p < 0.05$) had statistically significant bivariate relationships with current adoption of conservation practices.

PBC ($r = 0.63$, $p < 0.01$) was the only TPB construct that was significantly correlated with current adoption of pollinator conservation programs. None of the other hypothesized predictors of current adoption of conservation programs had a statistically significant relationship with that variable.

Table 4.2 Bivariate correlations among the model variables (*n* = 27)

Variables	1	2	3	4	5	6	7
1. Age							
2. Gender	0.24						
3. Education	-0.14	0.21					
4. Farming Experience	0.27	-0.16	-0.24				
5. Farmed acres	0.26	-0.31	-0.12	**0.63****			
6. Ownership	-0.14	-0.28	-0.08	0.26	**0.52****		
7. Farm operation income	0.07	-0.31	-0.06	**0.07****	**0.65****	0.39	
8. Perceived Behavioral Control	0.00	0.06	0.14	0.09	0.23	0.21	0.31
9. Concern about herbicide resistance issues	-0.01	-0.28	-0.09	**0.46***	**0.70****	**0.41***	**0.68****
10. Attitudes	-0.09	0.36	0.39	-0.32	-0.36	-0.08	-0.14
11. Subjective Norms	-0.10	0.08	0.30	-0.17	**-0.44***	-0.12	0.00
12. Current adoption of programs	0.13	-0.13	-0.17	0.22	0.25	0.14	0.35
13. Current adoption of practices	-0.17	0.23	0.10	-0.06	**-0.40***	-0.28	-0.03
14. Intentions to adopt programs	0.02	0.07	-0.01	-0.09	0.09	**0.41***	0.03
15. Intentions to adopt practices	-0.09	0.39	0.19	-0.18	-0.26	-0.08	-0.05
Mean	4.36	1.28	3.96	3.85	3.77	1.35	7.43
Standard Deviation	1.32	0.46	1.73	1.08	1.77	0.49	3.45

Boldface represents statistical significance: *p ≤ 0.05 (2-tailed) and **p ≤ 0.01 (2-tailed)

	8	9	10	11	12	13	14	15
8.								
9.	0.28							
10.	**0.57****	-0.13						
11.	0.04	-0.31	0.20					
12.	**0.63****	0.19	0.25	0.02				
13.	0.36	-0.26	**0.63****	**0.39***	0.37			
14.	**0.56****	0.04	**0.44***	0.03	**0.54****	0.29		
15.	**0.51****	-0.08	**0.85****	0.27	0.33	**0.78****	**0.42***	
Mean	3.79	3.46	4.11	2.96	1.48	7.41	2.03	2.89
St. Dev.	0.62	0.63	0.73	0.85	2.17	3.21	0.68	0.63

Only one socio-demographic variable, farm ownership, had a statistically significant association with intentions to adopt pollinator conservation programs (r = 0.41, $p < 0.05$). Additionally, PBC (r = 0.56, $p < 0.01$), attitudes (r = 0.44, $p < 0.01$) and current adoption of pollinator conservation programs (r = 0.54, $p < 0.05$) were all significantly correlated with intentions to adopt pollinator conservation programs.

A number of statistically significant relationships were also observed among some of the predictor variables in the correlation matrix. However, the strength of the correlation coefficients was not consistently high enough to raise concerns about multicollinearity in the regression analysis.

4.3 Hypothesis Testing

Current adoption of practices

To test the first hypothesis on the predictors of current adoption of pollinator conservation practices, two multiple regression models were run. The first model contained all the hypothesized predictor variables while the second model contained only the TPB constructs as predictor variables. The results were interpreted at the .10 significance level. Table 4.3 contains results on the first regression model with all the predictor variables. The results show that the overall model is statistically significant ($F = 2.65$, $p < .10$). With regard to the strength of the overall model, the adjusted R^2 value indicates that the model accounts for 45% of the variation in the outcome variable. However, an observation of the p values associated with the unstandardized beta coefficients of the predictor variables shows that none of the predictor variables had a statistically significant effect on the outcome variable.

Table 4.3 Regression Results for predictors of current adoption of practices.

Independent Variables	*B*	*SE B*	β	*p* value
Age	-0.56	0.47	-0.25	0.26
Gender	0.02	1.36	0.00	0.99
Education	-0.47	0.34	-0.26	0.19
Experience	1.25	0.75	0.47	0.12
Farmed acres	-0.12	0.70	-0.08	0.86
Ownership	-1.78	1.42	-0.29	0.24
Farm income	-0.03	0.28	-0.03	0.93
Perceived Behavioral Control	1.63	1.55	0.32	0.32
Concern about herbicide resistance issues	-1.35	1.21	-0.31	0.29
Attitudes	2.36	2.03	0.39	0.27
Subjective Norms	0.85	0.74	0.26	0.28
R-Square	0.73			
Adjusted R-square	0.45			
F Statistic	2.65			0.06

Table 4.4 contains results of the second regression model that was used to analyze the explanatory utility of the TPB constructs. The *F*-test shows that the overall model is statistically significant ($F = 6.78$, $p < .01$) and the adjusted R^2 value shows that the model explains 40% of the variability in the outcome variable. Consistent with the hypotheses, an observation of the parameters on the individual predictors also showed that two out of the three TPB constructs, attitude ($B = 2.41$) and subjective norms ($B = 1.04$) each had a statistically significant positive effect on the outcome variable at the .10 level.

Table 4.4 Regression Results for TPB predictors of current adoption of practices.

Independent Variables	*B*	*SE B*	β	*p* value
Perceived Behavioral Control	0.15	0.94	0.03	0.88
Attitudes	2.41	0.84	0.55	<0.01
Subjective Norms	1.04	0.58	0.28	0.09
R-Square	0.47			
Adjusted R-Square	0.40			
F Statistic	6.78			<0.01

Current adoption of programs

The second hypotheses explained the predictors of farmers' current adoption of pollinator conservation programs. Similar to the approach used in testing the first hypotheses, we used two regression models to test this hypothesis by first analyzing the effect of all the predictor variables, and subsequently specifically analyzing the effect of the TPB constructs. Table 4.5 shows the results of the regression model containing all the predictor variables in the hypothesis. The results of the *F*-test show that the overall model was not statistically significant ($F = 1.24$, $p = .36$), and the adjusted R^2 value shows that the model only explained 11% of the variation in the outcome variable. Only one variable, PBC ($B = 3.10$), was found to have a statistically significant positive effect on the outcome variable.

Table 4.5 Regression Results for predictors of current adoption of programs

Independent Variables	*B*	*SE B*	β	*p* value
Age	0.32	0.45	0.19	0.49
Gender	-0.12	1.29	-0.02	0.93
Education	-0.23	0.32	-0.17	0.49
Experience	-0.37	0.71	-0.18	0.62
Farmed acres	-0.01	0.66	-0.01	0.98
Ownership	-0.07	1.35	-0.02	0.96
Farm income	0.26	0.27	0.40	0.35
Perceived Behavioral Control	3.10	1.48	0.81	0.06
Concern about herbicide resistance issues	-1.07	1.15	-0.33	0.37
Attitudes	-1.15	1.93	-0.26	0.56
Subjective Norms	-0.11	0.70	-0.04	0.88
R-Square	0.55			
Adjusted R-Square	0.11			
F Statistic	1.24			0.36

Results from the second model containing only the TPB constructs are presented in Table 4.6. This model was found to be statistically significant ($F = 5.45$, $p < .01$) and the adjusted R^2 value shows that variations in the TPB constructs contained in the model explain 34% of the variation in the outcome variable, a marked improvement over the previous model. Similar to the previous model, however, PBC (*B* = 2.48) was the only predictor variable with a statistically significant effect on the outcome variable.

Table 4.6 Regression Results for TPB predictors of current adoption of programs.

Independent Variables	*B*	*SE B*	β	*p* value
Perceived Behavioral Control	2.48	0.67	0.73	<0.01
Attitudes	-0.53	0.59	-0.18	0.38
Subjective Norms	0.09	0.41	0.03	0.84
R-Square	0.42			
Adjusted R-Square	0.34			
F Statistic	5.45			<0.01

Intentions to adopt practices

The third hypothesis sought to explain the predictors of farmers' intentions to adopt pollinator conservation practices. Using a similar approach as in the previous hypotheses, one regression model was first used to test the hypothesis by including all the predictor variables, and a second model was also run by including only the TPB predictor variables. Table 4.7 shows the output of the first model containing all the predictor variables. The results show that the overall model was statistically significant ($F = 6.78$, $p < .01$), and the adjusted R^2 value shows that the model explained as much as 89% of the variation in the outcome variable. Three of the predictor variables in the model were also found to have a statistically significant effect on the outcome variable. Consistent with the hypothesis, attitudes (*B* = 0.93) and subjective norms (*B* = 0.23) both had a significant positive effect on the outcome variable. The effect of education (*B* = -0.11) on the outcome variable was, however, negative.

Table 4.7 Regression Results for predictors of intentions to adopt practices.

Independent Variables	*B*	*SE B*	β	*p* value
Age	-0.11	0.05	-0.23	0.17
Gender	0.21	0.15	0.18	0.21
Education	-0.11	0.04	-0.33	0.04
Experience	0.14	0.09	0.2	0.39
Farmed acres	0.13	0.08	0.48	0.12
Ownership	-0.19	0.16	-0.13	0.46
Farm income	-0.06	0.03	-0.37	0.13
Perceived Behavioral Control	-0.09	0.21	-0.13	0.61
Concern about herbicide resistance issues	0.06	0.14	0.13	0.54
Attitudes	0.93	0.23	0.81	0.01
Subjective Norms	0.23	0.08	0.36	0.05
Current adoption of programs	0.04	0.04	0.15	0.40
Current adoption of practices	-0.11	0.05	0.19	0.40
R-Square	0.89			
Adjusted R-Square	0.76			
F Statistic	6.78			<0.01

Output from the second model containing only the TPB constructs (Table 4.8) also showed that the overall model was statistically significant (F = 20.25, $p < .01$), and the model explained 69% of the variation in the outcome variable as judged by the adjusted R^2 value of 0.69. Surprisingly, only the attitude construct (B = 0.68) out of the three TPB constructs had a statistically significant effect on the outcome variable. The direction of the relationship was consistent with the hypothesis.

Table 4.8 Regression Results for TPB predictors of intentions to adopt practices.

Independent Variables	*B*	*SE B*	β	*p* value
Perceived Behavioral Control	0.04	0.13	0.04	0.78
Attitudes	0.68	0.12	0.80	<0.01
Subjective Norms	0.07	0.08	0.10	0.38
R-Square	0.73			
Adjusted R-Square	0.69			
F Statistic	20.25			<0.01

Intentions to adopt programs

The fourth hypothesis contained predictors of farmers' intentions to adopt pollinator conservation programs. Here too, two regression models were used to test the hypothesis with the first model containing all the predictor variables while the second model contained only predictors from the TPB. Results from the first model contained in Table 4.9 show that the overall model was not statistically significant (F = 0.65, p = .77). With regard to the explanatory utility of the model, the R^2 value of 0.51 suggests that the model explains a reasonably high proportion of the variation in the outcome variable. However, the more conservative adjusted R^2 value of -0.28 suggests the model actually explains a negligible proportion of the variance in the outcome variable. None of the individual predictor variables was found to have a statistically significant effect on the outcome variable at the .10 level.

Table 4.9 Regression results for predictors of intentions to adopt programs.

Independent Variables	*B*	*SE B*	β	*p value*
Age	0.06	0.17	0.13	0.73
Gender	0.07	0.45	0.05	0.88
Education	-0.03	0.12	-0.09	0.78
Experience	-0.03	0.31	-0.06	0.92
Farmed acres	-0.02	0.23	-0.06	0.93
Ownership	0.49	0.50	0.37	0.36
Farm income	-0.07	0.10	-0.36	0.54
Perceived Behavioral Control	0.35	0.62	0.33	0.59
Concern about herbicide resistance issues	0.04	0.42	0.04	0.93
Attitudes	-0.24	0.74	-0.18	0.75
Subjective Norms	0.05	0.26	0.07	0.86
Current adoption of programs	0.11	0.11	0.41	0.33
Current adoption of practices	0.02	0.10	0.07	0.88
R-Square	0.51			
Adjusted R-Square	-0.28			
F Statistic	0.65			0.77

In contrast to the poor performance of the first model, output of the regression model containing only the TPB constructs (Table 4.10) indicate that the overall model is statistically significant (*F* = 3.41, $p < .05$) and explains 23% of the variation in the outcome variable as judged by an adjusted R^2 value of 0.23. One of the predictor variables, PBC (*B* = 0.04) was also found to have a statistically significant positive effect on the outcome variable.

Table 4.10 Regression Results for TPB predictors of intentions to adopt programs.

Independent Variables	*B*	*SE B*	β	*p* value
Perceived Behavioral Control	0.04	0.13	0.48	0.06
Attitudes	0.68	0.12	0.14	0.57
Subjective Norms	0.07	0.08	0.02	0.92
R-Square	0.33			
Adjusted R-Square	0.23			
F Statistic	3.41			0.04

4.4 Concluding Remarks

This chapter reported the results from the analysis of the survey data using descriptive statistics, correlation analysis, and multiple regression analysis. The results from the correlation matrix showed significant positive correlations between each of the outcome variables and at least one of the TBP constructs, suggesting that the TPB constructs are likely to serve as good predictors of the outcome variables. Next, we used regression analysis to test the hypotheses. For each hypothesis, we first run a regression model using all the hypothesized predictor variables, followed by another model containing only the TPB predictor variables. The results showed that there was at least one statistically significant predictor in each of the regression models that were run using only the TPB predictor variables. However, results from the regression models containing all the predictors showed that only the models explaining farmers' current adoption of pollinator conservation programs and their intentions to adopt pollinator conservation practices contained at least one statistically significant predictor. The implications of these findings are further elaborated upon in the next chapter.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

5.1 Introduction

In recent years, the socio-economic and ecological consequences of the global decline in pollinator species have been gaining recognition. This has highlighted the need for more effective policies for the conservation of pollinator habitat across multiple scales from the local to the global. However, the success of such policies will depend, in part, on how farmers respond to their implementation. Using a modified version of the theory of planned behavior as a conceptual framework, the purpose of this study was to analyze the factors influencing farmers' intentions to adopt, as well as their adoption of pollinator conservation practices and programs in the state of Illinois. To address these issues, quantitative data were collected through the administration of a web-based survey. In the next section of this chapter, the key findings that emerged from the data analysis are presented and discussed by drawing from the relevant literature. Next, the limitations of the study are presented, followed by a discussion on directions for future research. The final section of the chapter discusses the policy implications of the findings of the study.

5.2 Summary of Findings

Factors influencing farmers' adoption of pollinator conservation practices

This study first hypothesized that farmers' adoption of pollinator conservation practices would be predicted by their attitudes (positive), subjective norms (positive), perceived behavioral control (positive), concern about herbicide resistance issues (negative), and their sociodemographic characteristics. This hypothesis was tested using two multiple regression models: one containing all the predictor variables; and the other containing only the predictor variables from the TPB (attitudes, subjective norms, and perceived behavioral control). The results were interpreted at the .10 significance level.

Although the overall effect of the model containing all the predictor variables was statistically significant, none of the predictor variables had a statistically significant effect on the outcome variable. However, analysis of the regression model containing only the predictors from the TPB showed that both subjective norms and attitudes were significant predictors of farmers' adoption of pollinator conservation practices. Attitude was the stronger of the two predictors of adoption of conservation practices as judged by the standardized beta coefficients. The stronger effect of attitudes suggests that farmers' adoption of pollinator conservation practices may be influenced more strongly by the perceived benefits associated with those practices than their willingness to conform to the expectations of their close associates.

Factors influencing farmers' adoption of pollinator conservation programs

The second hypothesis posited that farmers' adoption of pollinator conservation programs would be predicted by their attitudes (positive), subjective norms (positive), perceived behavioral control (positive), concern about herbicide resistance issues (negative), and sociodemographic characteristics. To test this hypothesis, one regression model was run using all the predictor variables in the hypothesis. Another model was also run using only the predictors from TPB.

In both models, only perceived behavioral control had a statistically significant positive effect on farmers' adoption of pollinator conservation programs. None of the other predictor variables had a statistically significant effect on the outcome variable. However, the model containing only the TPB predictor variables explained a larger proportion (34%) of the variation in the outcome variable and the overall model was also statistically significant. These results suggest that whether farmers adopt pollinator conservation programs or not is primarily influenced by their perceived ability to carry out that task based on access to the requisite knowledge, skills, resources and opportunities for enrollment in the programs. It must be noted that the pollinator conservation programs that were included in the survey were all managed by federal agencies and may be governed by rigid implementation guidelines. Therefore, policies aimed at identifying and overcoming farmers' capacity constraints could go a long way in increasing their enrollment in these federally managed pollinator conservation initiatives.

Factors influencing farmers' intentions to adopt pollinator conservation practices

The third hypothesis proposed that farmers' intentions to adopt pollinator conservation practices could be predicted by their attitudes (positive), subjective norms (positive), perceived behavioral control (positive), current adoption of programs (positive), current adoption of practices (positive), concern about herbicide resistance issues (negative) and sociodemographic characteristics.

In the regression model containing all the predictor variables, the attitudes construct had a strong significant, positive effect on intentions to adopt pollinator conservation practices. Thus, farm operators who perceive that adopting pollinator conservation practices would yield positive outcomes were more likely to have intentions to implement such pollinator conservation practices. This finding is consistent with the results reported in other studies on farm conservation. For instance, Lalani et al. (2016) found that attitude towards conservation agriculture was the strongest predictor of a farm operator's intention to implement conservation agriculture.

Consistent with the hypothesis, subjective norms also had a statistically significant positive effect on intentions to adopt practices. That is, a farmer surrounded by peers who expect him/her to implement pollinator conservation practices had increased intentions to adopt such practices.

Perceptions of how peers view a conservation behavior have been identified as one of the most influential factors shaping conservation intentions (Mastrangelo et al., 2014).

A third input variable, education, also had a statistically significant effect on farmers' intentions to adopt pollinator conservation practices. However, contrary to the expected relationship, this variable had a negative effect on the outcome variable. This suggests that as the level of education of farmers increases, they are less likely to have the intention to adopt pollinator conservation practices.

In the second regression model containing only the TPB predictor constructs, the attitude construct was also the only statistically significant positive predictor of farmers' intentions to adopt pollinator conservation practices, a further testimony to the influential role of attitudes in farmers' decision-making processes.

Factors influencing farmers' intentions to adopt pollinator conservation programs

The final hypothesis proposed by this study was that farmers' intentions to adopt pollinator conservation programs would be predicted by their attitudes (positive), subjective norms (positive), perceived behavioral control (positive), current adoption of programs (positive), current adoption of practices (positive), concern about herbicide resistance issues (negative), and their sociodemographic characteristics.

The model containing all the hypothesized predictor variables was not statistically significant, and no variable in this model had a significant effect on the dependent variable. However, the model containing only the TPB predictor variables was statistically significant. In this model, only perceived behavioral control had a statistically significant positive effect on farmers' intentions to adopt pollinator conservation programs. This further highlights the importance of perceived capacity and opportunity in farmers' decision-making processes regarding the adoption of federal pollinator conservation programs.

Overall model evaluation

The theory of reasoned action (TRA) posits that the immediate predictor of human behavior is the intention to act, and that intentions are predicted by attitudes and subjective norms. However, TRA has been seen as most useful in situations where actions are under the volitional control of the actor, i.e. the actor can decide whether or not to perform an action at his/her own will (Ajzen, 1991; Madden et al., 1992; Chang, 1998). To account for other forms of behaviors, TPB was developed as a modified version of TRA. Like TRA, TPB posits that the proximate predictor of behavior is intentions. However, TPB posits that intentions are predicted not just by attitudes and subjective norms, but also by perceived behavioral control, a construct capturing the actor's perception of the ease or difficulty of performing an action. Perceived behavioral control reflects the required resources and opportunities needed to execute an action (Ajzen, 1991).

As has been previously noted, this current study was informed by a conceptual framework based on TPB. In addition to the TPB constructs, the model included a construct capturing the path-dependent effect of current behavior on future intentions. Hypotheses based on the constructs in the framework, as well as farmers' socio-demographic characteristics and their concern about herbicide resistance were used to analyze the predictors of farmers' actual adoption and their intention to adopt pollinator conservation practices on their farms, as well as their actual enrollment and intentions to enroll in pollinator conservation programs managed by federal agencies. For each of the four hypotheses, two regression models were run, one containing the constructs from the proposed framework, and another containing only the predictors from TPB.

Overall, there was at least one statistically significant predictor for each of the hypotheses. Although the performance of the regression models based on the proposed framework were variable, each of the models containing only the TPB predictors yielded at least one statistically significant predictor, and each of the TPB constructs was statistically significant in at least one of the models. The adjusted R^2 values from the models with at least one significant predictor ranged from .11 to .76, and this compares favorably with results from other studies on TPB (e.g. Abrahamse & Steg, 2011; Chancellor, 2012). In all, these results lend some support to some of the components of the proposed conceptual framework, although the regression models based strictly on TPB generally performed better than the models that were based on the synthesized framework being tested in this study.

With regarded to the individual constructs, attitudes and subjective norms were statistically significant predictors of farmers' adoption of pollinator conservation practices, as well as their intentions to adopt these practices in the future. However, perceived behavioral control was the only statistically significant predictor of farmers' adoption of pollinator conservation programs, as well as their intentions to enroll in such programs in the near future. These results seem to reflect the conceptual distinction between TRA and TPB as explained in previous paragraphs (Ajzen, 1991). Consistent with TRA, it appears that attitudes and subjective norms were significant predictors in situations where farmers had the freedom to act on their own will, i.e. the adoption or intention to adopt pollinator conservation practices on their own farms. However, perceived behavioral control, which is a key construct in TPB, emerged as the only predictor in situations where the behavior in question is partly outside the control of the farmer, i.e.

enrollment in a government-managed pollinator conservation program. Thus, farmers' behavioral decisions in this case are determined largely by their perceived ability to meet the stipulated requirements of the programs. Other studies have highlighted the complex procedural requirements for enrollment in federally-managed agricultural conservation policies, and the results of this study suggest farmers' perceptions of their ability or lack of ability to navigate the federal bureaucratic procedures may be a deciding factor in whether or not they plan to enroll in these initiatives. This ability might entail having the right information, skills and resources as well as having the opportunity to be enrolled.

This study found that concern for herbicide resistance issues was not a statistically significant predictor of farmers' intentions to adopt pollinator conservation programs or practices or their current adoption of these programs and practices. The data suggest that farmers do not perceive seed mixes as a potential source for weed introduction. Furthermore, farmers in this study likely were not concerned about the incompatibility of new herbicide-tolerant soybean traits (Roundup Ready II Xtend) with pollinator conservation mixes.

Farmers' current adoption of pollinator conservation practices and programs was also expected to have a statistically significant positive effect on their intentions to adopt these programs and practices in the future, but the results did not support these hypothesized relationships. Similarly, farmers' socio-demographic characteristics did not have direct effects on farmers' intentions and adoption behaviors, suggesting that their effects may have been indirect through their influence on attitudes and other constructs.

5.3 Limitations of the Study

A number of limitations were encountered in the design and execution of the study. One of the limitations relates to the mode of survey administration. Due to the rural nature of the location of many farms and farmers in the state of Illinois, the use of a web-based survey in this study posed a serious constraint to participation in the survey. According to the Federal Communication Commission (FCC), 39 percent (23 million) of people in rural US locations lack access to adequate broadband internet speeds (25 Mbps/3 Mbps) necessary for uninterrupted internet access, and 20 percent have extremely (4 Mbps/1 Mbps) to no access to internet services (FCC, 2016). Thus, the use of a web-based survey may have contributed to the extremely low response rate during the survey administration process.

Further limiting responses, the timing of the survey administration coincided with corn and soybean harvest. As the link to the survey was first published in FarmWeek on October 23rd of 2018. Only 74% (soybeans) and 82% (corn) of farmers had completed harvest by this point in the season (USDA NASS, 2018). Thus, farmers were still conducting business at this point in the year, and busy farmers likely did not prioritize participation in this survey.

Another significant limitation to this study is the coverage error stemming from the choice of sampling frame. By relying only on the list of subscribers of the Illinois Farm Bureau's FarmWeek publication as the sampling frame, the study may not have offered all members of the target population, i.e. farmers in the state of Illinois, the opportunity to participate in the study.

Moreover, other limitations of the study relate to the choice of sampling technique. In view of the challenges encountered in obtaining relevant information on members of the sampling frame for sampling purposes, the study employed self-selection sampling, a non-probability sampling approach in which members of the population of interest volunteer to participate in the study on their own accord (Mujere, 2016). Thus, the responses received may not be representative of the population of farmers and the distinct geographic regions in the state of Illinois.

Additionally, due to the lack of access to the contact information of survey participants, it was not possible to tailor follow-up reminders to non-respondents. This may have reduced the effectiveness of the reminders and contributed to the low response rate. Follow-up reminders have been found to approximately double the 25% to 30% response rate that would normally be received for e-mail surveys when no follow-ups take place (Cook, Heath & Thompson, 2000). However, the benefits of reminders were not fully realized in this study.

Finally, data for this study were generated using a survey instrument that has not been tested in previous studies. Although it would have been desirable to explore the reliability and dimensions of the items used in measuring the various constructs before testing the stated hypotheses, relevant statistical tests (e.g. internal consistency reliability analysis and factor analysis) could not be conducted due to the small sample size. While the results from the regression analysis largely suggest that the key constructs from TPB were operationalized in a valid manner, the reliability of the measurement items will require further interrogation in future research.

5.4 Directions for Future Research

The results from this study have shown that the factors that shape farmers' decisions to implement conservation mechanisms on their farms are complex and multi-faceted. Farmer's attitudes, their subjective norms, and their perceived behavioral control were all important predictors of farmers' land use decisions on pollinator conservation. However, the factors that explain farmers' actions and intentions regarding conservation practices on their own farms over which they have full control, differed from those factors influencing farmers' actions and intentions regarding conservation programs that are managed by federal agencies. Future research should seek to further explore these relationships both in the state of Illinois and in other regions. The use of a mixed methods approach that combines qualitative and quantitative data to explore these relationships might yield richer insights.

The study also attempted to explore the effect of additional constructs on the overall explanatory utility of TPB. However, the regression models based on the proposed framework performed poorly in the explanation of farmers' intentions and actions. Other researchers are invited to further explore the role of past behavior, socio-demographic characteristics and other relevant constructs in enhancing the explanatory power of TPB. The integration of TPB with other behavioral theories may provide guidance on the choice of additional constructs that could further improve upon the TPB model.

With regard to the methodological approach, the current study employed a web-based survey to study farmers across the state of Illinois. Future studies should seek to explore how farmers' perspectives differ across various regions within the state. The use of other modes of survey administration, such as mail survey may offer more promise for generating the data needed for such as state-wide analysis. Alternatively, the use of a qualitative research to study smaller geographic areas could also provide a more context-specific understanding of farmers' decision-making processes. To optimize the effectiveness of pollinator conservation programs, it is paramount that more studies like this are carried out.

5.5 Policy Implications

The results of this study are largely tentative in the sense that they are based on a new questionnaire and a proposed framework that are being tested for the time using a small sample size. Nonetheless, a number of policy recommendations could be discerned from the strong performance of the TPB constructs as predictors of farmers' intentions and actual behavior.

First, given the strong effect of attitudes on farmers' adoption of pollinator conservation practices, as well as their intentions to adopt these practices in the future, policymakers could develop educational programs aimed at further reinforcing favorable attitudes toward pollinator conservation practices in order to motivate farmers to adopt such practices.

Second, the results also showed that farmers' subjective norms, i.e. their perception of whether their close associates would approve of a particular action or not, was another consistent predictor of farmers' intentions and actual adoption of pollinator conservation practices. This suggests that the promotion of membership in farmers' associations that focus on pollinator conservation could help amplify the role of peer influence on farmers' adoption behavior. Similarly, the promotion of mechanisms for sharing information about pollinator conservation through informal farmer-to-farmer initiatives could be more effective than the use of formal communication channels between government officials and farmers.

Finally, based on the finding on the role of perceived behavioral control as a predictor of farmers' intentions and actual enrollment in pollinator conservation programs, policy-makers could enhance farmers' interest and enrollment in these programs by providing more opportunities for farmers to enroll, reducing the procedural requirements for enrollment, and building farmers' capacity to enroll in these programs by providing them with the relevant information, skills and resources.

In all, devising agricultural policies that are effective in providing the information, incentives, resources and opportunities for farmers to adopt pollinator conservation programs and practices will require innovative institutional mechanisms, such as adaptive governance and adaptive co-management (Hurlbert, 2014; Floress et al., 2015; Akamani & Holzmueller, 2017). Such multilevel institutional mechanisms are needed to facilitate an integrative and dynamic approach to the conservation of pollinator habitat and other ecosystem components in complex agricultural landscapes through the coordination of responsibilities and sharing of knowledge among stakeholders across multiple scales (Saint Ville et al., 2017).

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APPENDICES

APPENDIX A

SURVEY QUESTIONNAIRE

Southern Illinois University CARBONDALE

Survey of On-Farm Pollinator Habitat Conservation Practices

October 15, 2018

Dear Farm Operators and Growers,

You are invited to take this survey because of your affiliation with the Illinois Farm Bureau. Your opinions are valuable and will help us understand the perspectives of Illinois farmers on pollinators and farming practices. Your responses can be used to help improve support for farm operations and farmer support organizations.

We know your time is valuable. This survey should take 10 to 15 minutes to complete. This survey from the Southern Illinois University College of Agricultural Sciences will help guide research and actions that enhance conservation programs near you. If you have any questions, please contact us, and thank you in advance for your help.

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Survey Instructions

This survey contains primarily multiple choice and a few yes/no questions. Please answer using your personal views and the practices you use on your farm. Some questions offer the option to fill in additional comments in the rows marked 'Other.' If at any point you wish to not answer a question or discontinue completion of this study you may do so.

Please submit your completed questionnaire by November15th,

Statement of Confidentiality

A blind copy format was used so that the list of other recipients will not be available to any other participant. All your responses will be kept confidential within reasonable limits. Only people directly involved with this project will have access to the surveys. Participation in this survey is voluntary, and you are free to withdraw your submission at any time. Submission of this survey indicates voluntary consent to participate in this study.

This project has been reviewed and approved by the SIUC Human Subjects Committee. Questions concerning your rights as a participant in this research may be addressed to the Committee Chairperson, Office of Sponsored Projects Administration, Southern Illinois University, Carbondale, IL 62901-4709. Phone: (618) 453-4533. E-mail: siuhsc@siu.edu

Section A: Resource Capacity

* 1. Are you currently acting as the primary farm operator for your farm?

Acting as the primary farm operator means handling day-to-day farm operations and making decisions regarding farming practices for production done on your farm.

◯ Yes ◯ No

* 2. What is the zip code of your home address?

[ ]

The following questions are about how you perceive your ability to implement pollinator conservation on your farm.

3. Please indicate how much you agree or disagree with the following statements about what you know of pollinator conservation programs and practices.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am aware of pollinators' habitat requirements.	◯	◯	◯	◯	◯
I am aware of how to create pollinator habitat.	◯	◯	◯	◯	◯
I am aware of how to manage pollinator habitat.	◯	◯	◯	◯	◯
I am aware of one or more farm practices beneficial to pollinator communities.	◯	◯	◯	◯	◯
I am aware of one or more programs that encourage pollinator habitat conservation.	◯	◯	◯	◯	◯
I am aware of pollinator conservation programs' enrollment requirements.	◯	◯	◯	◯	◯

1

4. Please indicate the extent to which you agree or disagree with the following statements regarding your capacity to enroll in and fully implement pollinator conservation programs.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am responsible for all of the land management decisions made on my farm.	○	○	○	○	○
If I wanted to change a practice on my farm, I could do so.	○	○	○	○	○
If I wanted to implement a pollinator conservation program on my farm, I could do so.	○	○	○	○	○
Programs that offer financial benefit (like cost share for example) for creating pollinator habitat are available to me.	○	○	○	○	○
I have enough time to complete the paperwork required for enrollment in a pollinator conservation program.	○	○	○	○	○
I have enough time to implement a pollinator conservation program on my farm.	○	○	○	○	○
I have the financial resources for implementing pollinator habitat.	○	○	○	○	○
Technical support for creating pollinator habitat is available to me.	○	○	○	○	○
My farmland meets the enrollment requirements for a pollinator conservation program.	○	○	○	○	○
In general, I have the necessary resources for implementing pollinator habitat.	○	○	○	○	○

2

Section B: Awareness

This section asks about your level of awareness of current herbicide resistance issues and new soybean technologies.

5. Please indicate the extent to which you agree or disagree with the following statements about herbicide resistance issues and new soybean technologies.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am concerned about herbicide resistant weeds.	○	○	○	○	○
I am familiar with Palmer amaranth (Palmer pigweed).	○	○	○	○	○
I am familiar with the reported contamination of pollinator conservation seed mixes with Palmer amaranth seed in 2016.	○	○	○	○	○
I have Palmer amaranth on my farm.	○	○	○	○	○
I am familiar with Roundup Ready® Xtend Crop Systems (dicamba).	○	○	○	○	○
I have herbicide-resistant weeds on my farm.	○	○	○	○	○
I am concerned about off-target movement of dicamba.	○	○	○	○	○
I use Roundup Ready® Xtend soybeans.	○	○	○	○	○
My neighbors use Roundup Ready® Xtend soybeans.	○	○	○	○	○
I have seen off-target movement of an herbicide from a neighboring field onto my farmland.	○	○	○	○	○

3

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I have seen off-target movement of an herbicide from my field onto plants around my fields.	◯	◯	◯	◯	◯
I manage my field borders and ditch banks to remove potential herbicide-resistant weeds.	◯	◯	◯	◯	◯

4

Section C: Attitudes

This section asks about your views on the benefits, risks and importance of implementing pollinator conservation practices on your farm.

6. This set of questions asks about your knowledge of pollinators. Please indicate how much you agree or disagree with the following statements.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I know about local pollinators including bees, butterflies, hummingbirds and moths.	○	○	○	○	○
I know about many of the native bees in my region.	○	○	○	○	○
I know about monarch butterfly declines.	○	○	○	○	○
I know about with ecosystem benefits that pollinators provide to plants.	○	○	○	○	○
I know about the issue of pollinator declines.	○	○	○	○	○
I know about the issue of Colony Collapse Disorder (CCD) in honeybees.	○	○	○	○	○

7. Please indicate how much you agree or disagree with the following statements regarding the importance of pollinators.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Pollinators help my farm operations.	◯	◯	◯	◯	◯
Pollinators help farmland near me.	◯	◯	◯	◯	◯
Pollinators improve the amount of food produced in my personal garden.	◯	◯	◯	◯	◯
Pollinators improve the quality of food produced in my personal garden.	◯	◯	◯	◯	◯
Pollinators improve the yield of my crops.	◯	◯	◯	◯	◯
Pollinators help nearby wild natural areas.	◯	◯	◯	◯	◯
Pollinators are unimportant for healthy wildlife.	◯	◯	◯	◯	◯
Pollinators are unimportant for healthy game animals.	◯	◯	◯	◯	◯
Pollinators are important to human health.	◯	◯	◯	◯	◯

8. Please indicate how much you agree or disagree with the following statements regarding the importance of pollinators.

	Strongly Disagree	Disagree	Agree	Strongly Agree
Someone in my household values food produced in our personal garden.	◯	◯	◯	◯
I value agricultural innovations that increase crop yields on my farm.	◯	◯	◯	◯
I value nearby wild natural areas.	◯	◯	◯	◯
I value wildlife.	◯	◯	◯	◯
I value game animals.	◯	◯	◯	◯

9. Please indicate how much you agree or disagree with the following statements regarding the benefits of implementing pollinator-friendly practices.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Creating pollinator habitat will benefit my farm's soil.					
Creating pollinator habitat will benefit my local watershed.					
Creating pollinator habitat will enhance wildlife-hunting opportunities on my farm.					
Creating pollinator habitat will enhance wildlife-viewing opportunities on my farm.					
Creating pollinator habitat will benefit my local community.					
Creating pollinator habitat will increase my farm's beauty.					
Creating pollinator habitat will benefit pollinators on my farm.					

10. Please indicate how much you agree or disagree with the following statements regarding the effectiveness of pollinator conservation practices on weed and pest management.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Planting a pollinator conservation plot will contaminate my fields with herbicide-resistant weeds.					
Planting a pollinator conservation plot will increase the weeds already infesting my farm.					
Off-target herbicide will drift into pollinator fields, outweighing the benefits of planting pollinator conservation plots.					

11. Please indicate how much you agree or disagree with each of the following statements on the economic benefits of pollinator conservation.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Managing pollinator habitat will increase crop yields on my farm.	◯	◯	◯	◯	◯
Managing pollinator habitat will reduce my farm's production costs due to the reduced production acreage.	◯	◯	◯	◯	◯
Managing pollinator habitat will reduce my farm's honeybee hive rental fees.	◯	◯	◯	◯	◯
Managing pollinator habitat is important for the long-term success of my farm.	◯	◯	◯	◯	◯

8

Section D: Social Influences

This section asks about your close associates and peers.

12. Please indicate how much you agree or disagree with the following statements.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
At least one of my neighbors practices pollinator conservation on their farm.	○	○	○	○	○
Someone I know closely practices pollinator conservation on their farm.	○	○	○	○	○
One of my neighbors has encouraged me to implement a pollinator conservation practice.	○	○	○	○	○
One of my close friends has encouraged me to implement a pollinator conservation practice.	○	○	○	○	○
One of my family members has encouraged me to implement a pollinator conservation practice.	○	○	○	○	○
I am a member of a farming organization that emphasizes pollinator conservation.	○	○	○	○	○

Section E: Historical and Current Agronomic Practices

The following questions are about your past and current farm practices and enrollment in pollinator conservation programs.

13. Below is a list of conservation programs that emphasize pollinator conservation. For each conservation program, please indicate if you have enrolled in that program in the past and if you are currently enrolled. (Select all that apply)

	I have enrolled, but am no longer enrolled	I am currently enrolled	I have never enrolled
Conservation Reserve Program (CRP) under the Pollinator Habitat Conservation Initiative CP-42	○	○	○
Another Conservation Reserve Program (CRP) that provides cover for pollinators	○	○	○
Pollinator enhancement through Conservation Reserve Enhancement Program (CREP)	○	○	○
A pollinator conservation program through the Environmental Quality Incentives Program (EQIP)	○	○	○
Pheasants Forever	○	○	○
The Bee & Butterfly Habitat Fund	○	○	○
Other	○	○	○

Other (please specify)

[ ]

10

14. Below is a list of conservation programs that may benefit pollinators indirectly. For each conservation program, please indicate if you have enrolled in that program in the past and if you are currently enrolled. (Select all that apply)

	I have enrolled, but am no longer enrolled	I am currently enrolled	I have never enrolled
Conservation Reserve Program (CRP)	○	○	○
Conservation Reserve Enhancement Program (CREP)	○	○	○
Environmental Quality Incentives Program (EQIP)	○	○	○
Other	○	○	○

Other (please specify)

15. Below is a list of pollinator-friendly farm practices that may benefit pollinator health. For each conservation practice, please indicate if you have used that practice in the past and if you currently use that practice. (Select all that apply)

	In the past	Currently	Never	Not sure
Maintaining field margins with flowering plants.	☐	☐	☐	☐
Planting flowering crops that provides a floral food resource for pollinators.	☐	☐	☐	☐
Planting legume-based cover crops between crop rotations.	☐	☐	☐	☐
Maintaining woody habitat to provide nesting area for cavity-nesting pollinator species.	☐	☐	☐	☐
Staggering plantings of single crop varieties or growing several varieties of a single crop such as early and late-flowering varieties ensuring a succession of flowering plants throughout the growing season.	☐	☐	☐	☐

	In the past	Currently	Never	Not sure
Growing at least one flowering crop or cover crop consistently throughout rotations to ensure a food source for pollinators.	☐	☐	☐	☐
Actively avoiding plowing pollinator nesting sites.	☐	☐	☐	☐
Following the recommended pesticide application timeline such as limiting applications to late evenings or early mornings.	☐	☐	☐	☐
Completely avoiding insecticide use when possible.	☐	☐	☐	☐
Avoiding products, such as seed treatments, with insect growth regulators, neonicotinoids or organophosphates.	☐	☐	☐	☐
Using non-chemical alternatives to pest control.	☐	☐	☐	☐
Allowing large tracts of plants (pastures, lawns, other) to go to seed before mowing.	☐	☐	☐	☐

Section F: Intentions

In this section, we are interested in understanding your future intentions to adopt pollinator conservation programs and practices.

16. Describe how likely you are to implement a pollinator conservation practice within the next twelve (12) months.

	Not At All Likely	Unlikely	Likely	Very Likely
I plan to grow flowering crops that provide a food resource for pollinators.	○	○	○	○
I plan to stagger plantings of single crop varieties to ensure pollinator floral resources season-long.	○	○	○	○
I plan to grow early and late-flowering varieties of a single flowering plant species to ensure flushes of pollinator floral resources throughout the summer.	○	○	○	○
I plan to grow the same flowering crop consistently throughout rotations to ensure a food source for pollinator offspring.	○	○	○	○
I plan to avoid plowing pollinator nesting sites.	○	○	○	○
I plan to limit pesticide applications to the evenings or early mornings.	○	○	○	○
I plan to avoid the use of insecticides that could hurt pollinating species such as insect growth regulators, neonicotinoids and organophosphates.	○	○	○	○
I plan to grow Roundup Ready® Xtend soybeans and/or apply the herbicide dicamba in my crop fields.	○	○	○	○

13

	Not At All Likely	Unlikely	Likely	Very Likely
I plan to use seed that utilizes GMO technology, or is genetically enhanced to be planted with a specific herbicide.	◯	◯	◯	◯
I plan to use non-chemical alternatives to control pests.	◯	◯	◯	◯
I plan to allow large tracts of plants to go to seed before mowing.	◯	◯	◯	◯
I plan to certify my farm as organic or practice organic farming techniques.	◯	◯	◯	◯
I plan to scout to monitor insect pests.	◯	◯	◯	◯
I plan to maintain honeybee colonies.	◯	◯	◯	◯
I plan to maintain field margins with flowering plants.	◯	◯	◯	◯
I plan to grow flowering crops that provide food resources for pollinators.	◯	◯	◯	◯

17. Below is a list of conservation programs that emphasize pollinator conservation. For each conservation program, please indicate your likelihood of enrolling in that program within the next twelve (12) months.

	Not At All Likely	Unlikely	Likely	Very Likely
I plan to enroll in a Conservation Reserve Program (CRP) under the Pollinator Habitat Conservation Initiative CP-42	○	○	○	○
I plan to enroll in another Conservation Reserve Program (CRP) that provides cover for pollinators	○	○	○	○
I plan to enroll in a pollinator enhancement through Conservation Reserve Enhancement Program (CREP)	○	○	○	○
I plan to enroll in a pollinator conservation program through the Environmental Quality Incentives Program (EQIP)	○	○	○	○
I plan to enroll in another pollinator conservation program.	○	○	○	○

18. Below is a list of conservation programs that may indirectly benefit pollinators. For each conservation program, please indicate your likelihood of enrolling in that program within the next twelve (12) months.

	Not At All Likely	Unlikely	Likely	Very Likely
I plan to enroll in a Conservation Reserve Program (CRP)	○	○	○	○
I plan to enroll in a Conservation Reserve Enhancement Program (CREP)	○	○	○	○
I plan to enroll in an Environmental Quality Incentives Program (EQIP)	○	○	○	○
I plan to enroll in another conservation program that may indirectly benefit pollinators.	○	○	○	○

(please specify)

Section G: Demographics

For each of the following questions, please indicate the selection that corresponds most closely with you. We understand that some of these questions may be difficult to answer, however, answers to these, and all questions in this survey, will be kept strictly confidential. If you prefer not to answer one or more of these questions, please skip that question and move on to the next.

19. What is your age?

- ◯ Less than 25 years old
- ◯ 25-34
- ◯ 35-44
- ◯ 45-54
- ◯ 55-64
- ◯ 65 or older

20. What is your gender?

- ◯ Male
- ◯ Female

21. What is your highest education level achieved: (Select one)

- ◯ High school diploma or comparable
- ◯ Some college
- ◯ Associates degree
- ◯ Bachelor's degree
- ◯ Some graduate coursework
- ◯ Master's degree
- ◯ Doctor degree
- ◯ None of the above

22. How many years have you been a farmer?

- ◯ Less than 1 year
- ◯ 1-4 years
- ◯ 5-14 years
- ◯ 15-24 years
- ◯ 25 or more years

23. How many acres of land do you farm?

- ◯ 0-40 acres
- ◯ 41-80 acres
- ◯ 81- 120 acres
- ◯ 120-200 acres
- ◯ More than 200 acres

24. Are you the primary owner of all the acres that you farm?

- ◯ Yes
- ◯ No

25. On average, how many acres of land do you rent to other farmers?

- ◯ 0-40 acres
- ◯ 41-80 acres
- ◯ 81- 120 acres
- ◯ 120-200 acres
- ◯ More than 200 acres

26. On average, how many acres of farmland do you have in cultivation?

- ◯ 0-40 acres
- ◯ 41-80 acres
- ◯ 81- 120 acres
- ◯ 120-200 acres
- ◯ More than 200 acres

27. What was/were the primary crop(s) or product(s) grown or produced on your farm this growing season? (select one)

- ◯ Corn
- ◯ Soybeans
- ◯ Wheat, oats or other grain
- ◯ Hay or animal feed
- ◯ Other (please specify)
- ◯ Indoor or penned Livestock
- ◯ Range Livestock
- ◯ Indoor crop(s)
- ◯ Fruits or vegetables

Some evidence shows the income level is associated with differing views about adopting farm-based conservation practices. This question will help to identify how your financial situation influences your intentions to adopt pollinator conservation practices.

28. Last year, what was your farm operation income?

- ◯ Less than $1,000
- ◯ $1,000 to $2,499
- ◯ $2,500 to $4,999
- ◯ $5,000 to $9,999
- ◯ $10,000 to $19,999
- ◯ $20,000 to $24,999
- ◯ $25,000 to $39,999
- ◯ $40,000 to $49,999
- ◯ $50,000 to $99,999
- ◯ $100,000 to $249,999
- ◯ $250,000 to $499,999
- ◯ $500,000 or more

You have now completed this survey. Your responses are valuable to us and are greatly appreciated. Thank you!

APPENDIX B

HSC APPROVAL

SIU Southern Illinois University
CARBONDALE

HUMAN SUBJECTS COMMITTEE
OFFICE OF SPONSORED PROJECTS
ADMINISTRATION
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ospa.siu.edu/compliance/human-subjects

To: Christopher Sedivy

From: Kimberly K. Asner-Self
Chair, Human Subjects Committee

Date: September 26, 2018

Title: *Farmer perceptions, intentions, and adoption of agronomic practices that support pollinating insects*

Protocol Number: 18218

The above referenced study has been approved by the SIUC Human Subjects Committee. The study is determined to be exempt according to 45 CFR 46.101(b)2. This approval does not have an expiration date; however, any future modifications to your protocol must be submitted to the Committee for review and approval prior to their implementation.

Best wishes for a successful study.

This institution has an Assurance on file with the USDHHS Office of Human Research Protection. The Assurance number is FWA00005334.

KAS:kr

cc: Kofi Akamani

SIU.EDU

VITA

Graduate School
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Christopher M. Sedivy
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Southern Illinois University Carbondale
Bachelor of Science, Forestry, May 2012

Thesis Title: Factors Influencing Farmers' Adoption and Intentions to Adopt Pollinator Conservation Programs and Practices in Illinois, U.S.A.

Major Professor: Dr. Kofi Akamani