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Untangling the Economic and Social Impediments to Producer Adoption of Organic Wheat

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UNTANGLING THE ECONOMIC AND SOCIAL IMPEDIMENTS TO PRODUCER ADOPTION OF ORGANIC WHEAT

by

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ABSTRACT

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by

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Consumer demand for organic products has shown double-digit growth in recent years encouraging the development of a wider range of organic goods (Greene, 2017). Americans with an annual household income under $30,000 actively purchase organic foods at nearly the same rate as households with over $75,000 in annual income, 42% versus 49% (Greene et al., 2017). Previous research observed the adoption of organic farming practices on a combination of different grains, fruits and vegetables, meat, and dairy products from across the globe. However, this is the first study to examine the adoption of organic wheat in the Western U.S. By addressing recent challenges and discussing the current demands of the U.S. consumers, future research and decision making (including policy updates and grant opportunities) may become more impactful.

The data for this study was collected via online survey through Qualtrics where the survey link was emailed to producers by farming-related organizations of which they were a member. These organizations included state Farm Bureau Federations, grower

associations, grain commodity groups, and grower leagues. The usable responses totaled 82. An ordered logit model was used to examine the impacts of farm characteristics, operator characteristics, concerns about organic production, concerns about adopting new technology, and the use of resources on the likelihood of organic adoption.

Findings suggest growers not in arid areas and those with smaller farms are more likely to be organic producers. Wheat growers willing to take risks to increase profits and those who considered financing availability a hurdle to adoption were also more likely to use organic methods. Interestingly, operator gender and years of experience had no impact on adoption. Using resources such as university research, consultants, etc. decrease the likelihood of becoming an organic producer.

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PUBLIC ABSTRACT

Untangling the Economic and Social Impediments to Producer Adoption of Organic Wheat

Donya L. Ralph-Quarnstrom

Consumer demand for organic products has shown double-digit growth in recent years encouraging the development of a wider range of goods (Greene, 2017). Americans with an annual household income under $30,000 actively purchase organic foods at nearly the same rate as households with over $75,000 in annual incomes, 42% versus 49% (Greene et al., 2017). Previous research observed the adoption of organic farming practices on a combination of different grains, fruits and vegetables, meat, and dairy products from across the globe. However, this is the first study to examine the adoption of organic wheat in the Western U.S. By addressing the recent challenges and by discussing the current demands of the U.S. consumers, future research and decision making (including policy updates and grant opportunities) may become more impactful.

Through an online survey of western wheat growers, we look at potential patterns in farm characteristics, grower characteristics, concerns about growing organic products, factors discouraging adoption production technology, and the use of resources on the likelihood of becoming an organic grower. A total of 82 valid surveys were collected. Findings suggest operators of smaller farms are more likely to be organic growers. Wheat growers willing to take risks to increase profits and those who considered financing availability a hurdle to adoption were also more likely to use organic methods. Interestingly, operator gender and years of experience had no impact on adoption. Using

resources such as university research, consultants, etc. decrease the likelihood of becoming an organic producer.

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Consumer demand for organic products has shown double-digit growth in recent years encouraging the development of a wider range of organic goods (Greene, 2017). Organic and natural food stores number in the tens of thousands in the U.S. and organic products can be found in approximately three out of every four conventional grocery stores (Greene, 2017). In fact, organic consumers are increasingly mainstream, exhibiting a wide range of demographics (Greene, 2017). Buyers choose to bypass conventionally produced foods due to concerns about health and the environment and are willing to pay the additional cost (price premium) to consume these goods (Greene, 2017). What was previously a lifestyle choice for a small number of consumers has become a common purchase for the majority of Americans, who now purchase organic items at least on occasion (Greene, 2017).

Americans with an annual household income under $30,000 actively purchase organic foods at nearly the same rate as households with over $75,000 in annual income, 42% versus 49% (Greene et al., 2017). The Organic Trade Association found the percentage share of at-home organic food purchases in 2015 had more than doubled since 2005 to 5% of the total share (Greene, et al., 2017). Major U.S. food retailers, such as Walmart, Target, and Costco have expanded their selection of organic food offerings in recent years (Greene, et al., 2017). The Organic Trade Association estimates organic retail sales in the U.S. at $43.3 billion in 2015 (Greene, et al., 2017).

With the increasing demand for organic wheat flour for large customers such as restaurants and food manufacturing companies, Ardent Mills (a major supplier of flour in North America) is now attempting to meet the demand with its Organic Initiative 2019 (Ardent Mills, 2015). The initiative will assist growers with adoption of organic wheat and the associated concerns. Possible challenges for producers are frequently related to transition costs, weed and pest control, USDA organic certification compliancy, production yields, etc. (Ardent Mills, 2015).

U.S. organic wheat acres grew by 10% in 2017 (Koory, 2018b). Organic winter wheat is primarily produced in the Northern Planes region of the U.S. with Montana and Wyoming the top two producing states. Together they supply 15% of all organic wheat acres (Koory, 2018b). Ryan Koory, Senior Economist for Mecaris (an information source on market conditions for organic and non-GMO commodities), found the U.S. to have a total acreage increase of 22% in 2017/2018 (Koory, 2018b). Organic wheat only increased by 10%, which has been attributed to struggling yields (Koory, 2018b). According to the National Agricultural Statistics Service, Utah produced nearly $29 million in total wheat production in 2017 (NASS, 2017).

Significant barriers to adopting organic farming include lack of production knowledge, higher cost of inputs, transition costs, concerns regarding weed and pest control, potential volatility of organic premiums, access to markets, and perceived risk. These concerns are often overcome through educating growers on organic production methods, government grants (policy incentives), and the profit margins from organic premiums. Common organic producer characteristics include women, a relatively higher income level, young in age, fewer years of farming experience, and smaller size farms

(Kallas et al., 2010). Additional commonalities between organic growers are personal belief in an organic lifestyle, environmental protection concerns, and believing organic production methods produce better quality outputs (Padel, 2008).

This study will focus on what motivates and what discourages growers to adopt organic wheat production methods in the West. Previous research observed different grains, fruits and vegetables, meat, and dairy products from across the globe (Kallas et al., 2010; Kuminoff & Wossink, 2010; Uematsu & Mishra, 2012; Lewis et al., 2011; Nelson et al., 2015; McBride et al., 2015). However, this is the first study to examine the adoption of organic wheat in the Western U.S. Researchers seek to better understand why and when organic wheat production is chosen over conventional methods. By addressing recent challenges and by discussing the current demands of the U.S. consumers, future research and decision making (including policy updates and grant opportunities) may be more impactful.

The data collection survey was created based off of extracted analysis from previous literature findings. Questions revolved around farm characteristics, such as size, property ownership, income, and production methods. Sales prices per bushel, wheat varieties grown, the use of cover cropping, composting, and choices made on current profit opportunities and long-term success were also requested. Additionally included, were inquiries related to concerns for successful organic production and most reliable information sources. History of farming practices, including previous experience with organic or conventional farming were included.

The survey was conducted online through Qualtrics. The survey link was emailed to growers by farming-related organizations of which they were a member. These

organizations included state farm bureau federations, grower associations, grain organizations, and grower leagues. Data was collected over two months. A total of 82 surveys were used from 111 that were submitted.

CHAPTER 2

LITERATURE REVIEW

Numerous studies have attempted to understand why organic adoption does and does not occur. Despite increasing demand and organic goods one of the fastest growing segments in food sales in recent years, researchers have found growers are slower to adopt than otherwise expected. The previous research spans many commodities including grains, produce, as well as dairy and meat products across the globe. Table 1 provides an overview of findings from previous studies on grower adoption of organic farming.

Table 1: Variable Effects on Grower Organic Adoption

Variables	Direction of the effect	Variables	Direction of the effect
Farm size	-	Risk averse producer	-
Family size	-	Perceived risk	-
Gender (female)	+	Environmental protection concerns	+
Education level	+	Organic policy incentives (government grants)	+
Age	-	Personal belief in organic lifestyle	+
Years of farming experience	-	Concern for health	+
Knowledge about organic farming	+	Believes organic produces better quality product	+
Organic marketing concerns	-	Worried about organic product yields	-
Distance from processing services	-	Competition from other labels	-
Higher cost of inputs	-	Concerns about weed and pest control	-
Transition costs	-	Volatility of organic premiums	-

Source: Overview of previous literature.

Factors that Discourage Adoption

Lack of Information

A well-known barrier to innovation on farms is lack of information. This has also proven true for adoption of organic farming practices. Lack of knowledge regarding organic production is significantly related to a decrease in the probability of adoption (Shams and Fard, 2017). Without facts showing relative costs and returns of organic versus conventional production systems, a grower is unprepared to approach or discover if a financial benefit is present using alternative production methods (McBride & Greene, 2015).

Along with the need for information is the information's locational availability. Education and information accessibility within close proximity to urban centers increases the probability of a grower perusing new technology and production innovations (Genius, Pantzios, & Tzouvelekas, 2006). In the present day, the internet is more widely available in rural areas, unlike ten years ago. Information in populous urban centers is still likely to be helpful to growers, however the increased accessibility of internet service in more farming areas is likely to be an additional resource for information. Material available must come from a source reputable to a grower. Sources of information include university research, neighboring growers, consultants, federal agencies, etc.

Marketing is also a commonly found to be a concern for potential organic producers and some current producers. From the findings of Khaledi et al. (2010, p. 49), "a one-unit increase in perception of organic marketing problems results in a 19% decrease in complete adoption and 12% decrease in organic share for partial adopters." The fear of the challenges to market organic products instead of items produced

conventionally strongly impacts adoption rates. By providing information about organic networks and how to market to wholesalers, restaurants, etc., fears may lesser for some growers enough to potentially increase adoption rates. Constance and Choi (2010) findings also support providing marketing assistance to growers to encourage the increase of organic adoption rates.

Communicating historical outcomes, resources, detailing practices, and creating avenues for growers to market to buyers opens up opportunities to increase adoption. Well educated growers have the ability to make the best-informed decisions for their farm and with respect to potential profits. Alleviating fears of producers with education may encourage adoption and increase supply to better meet consumer demand (Shams and Fard 2017). Also, appropriate education could protect growers from making decisions that may not be optimal for their case. For example, partial adoption, as opposed to complete adoption, may be the best choice for a producer.

Weed and Pest Control

Despite potential for higher returns, adoption among field crop producers has remained low partially due to concerns about low crop yields and challenges with weed/pest control. Some organic wheat cropping systems may experience lower yields due to some of growers who use lower yielding varieties (McBride & Greene, 2015). However, findings suggest a large gap in knowledge exists regarding organic practices and outcomes between adopters and non-adopters of organic production (Läpple & Rensburg, 2011). One way to address non-organic producers concern with weed and pest control may be to educate growers on best organic practices to control the issue and outcomes from organic adoption on other farms (Läpple & Rensburg, 2011).

In addition to weed control, growers have expressed concern for disease-related loss, also more from non-organic producers. Johnston (2010) found fifty-six percent of conventional growers with no interest in organic adoption were highly concerned about protecting crops from disease. Significantly less (only 6%) of organic/organic currently transitioning growers considered disease to be a barrier (Johnston, 2010). The large percentage difference between organic growers and conventional producers who have no interest in organic adoption may suggest solutions to disease-related losses are present but may not be as well known by conventional producers. The hardship of pests (including weeds) might also be a factor, since drier areas may have fewer pests.

Volatile Premiums and Risk

Risk can be found in many aspects of converting a farm to organic production. A central concern around risk is for the volatility of organic price premiums. Growers who are not risk-averse are more likely to adopt organic methods (Kallas et al., 2010). One of the greatest impacts on the motivation of growers to maximize profit is risk perception (Peterson et al., 2012). Profit-maximizing growers tend to be concerned with losing their market niche where the organic sector becomes more like the conventional sector (Peterson et al., 2012). Concern about the volatility of organic price premiums is well-founded based off of economic foundations. As more firms enter the market, the price premium is expected to decrease as a response from increased supply (ceteris paribus).

In addition to the potential for decreases in organic price premiums, growers used historically based market conditions (as a way to judge risk in the future market), such as when the U.S. economy was weaker and a decrease in demand occurred for organic products (Greene et al., 2010). This decrease in demand discouraged growers from

adoption (showing them how the market looked when it was down) with great concern for the volatility of organic price premiums and potentially little or negative net profits. Additionally, the USDA Organic label is often in competition with other labels, such as GMO-free and "locally grown" (Greene et al., 2010). Due to the variety of new labels emerging in the markets, consumers will reveal their preferences (local versus nonlocal, organic versus non-organic, GMO versus Non-GMO, and any combination of other labels) giving growers more information to make production decisions.

Farm Size

Gardebroek (2006) discovered organic growers tend to be less risk averse compared to conventional growers based on perception from a study in the Netherlands. "Highly risk averse growers may diversify or participate in relationships (e.g. co-operatives, contracts) that air at reducing risks more than mildly risk averse growers do. Moreover, highly risk averse growers will be more responsive to policies that aim at reducing risks" (Gardebroek, 2006, p. 504). One study performed a sensitivity analysis based on farm size (small, medium, large) in the Midwestern U.S. found organic adoption to be optimal under all market conditions, from very low to high price premiums (Delbridge & King, 2016). Khaledi et al., (2010) and Greene et al. (2010) also found smaller farms to be more likely to adopt organic practices. Organic transition is less likely to be optimal for large farms, yet the probability remains sustainable for organic transition success (Delbridge & King, 2016). These results are sensitive to yield assumptions per acre.

Cost of Certification and Transition Costs

The USDA defines organic as grown and processed according to federal guidelines which consider soil quality, pest and weed control, animal raising practices, and the use of additives. Organic growers may use only natural substances and mechanical, physical, or biologically based production practices to the fullest extent possible. Prohibited substances include most synthetic pesticides and fertilizers within the soil or application directly on the produce itself (USDA, 2012). Producing organically certified products requires participating in a USDA certification program. Which specific regulations govern organic requirements is dependent upon the category (crops, livestock, processed products, or wild crops) that a commodity falls within. The stringencies of the USDA are high and include testing and record-keeping.

According to the USDA Agricultural Marketing Service, the direct cost to be certified can vary from a few hundred dollars up to several thousand dollars dependent upon the size and complexity of the farm. There are some opportunities to reduce this fee, including from the USDA Organic Certification Cost-Share Program. The USDA also provides technical assistance in addition to financial assistance while transitioning via a program called the Environmental Quality Incentives Program as explained by the USDA Agricultural Marketing Service.

For many growers, the largest cost in organic conversion is not the cost, but number of year it takes to transition to organic (usually three) and the challenges they face in learning new farming methods. On average, organic wheat yields are lower per acre (approximately 32% less) than conventional (McBride & Greene, 2015). Lower yields mean more pressure to capture the price premium of organic wheat. Additionally, a

grower who produced conventionally will need to produce organic wheat for three years before receiving an organic certification (Becoming a Certified Operation, n.d.). Lower yields for three years combined with practicing organic production and selling bushels at conventional prices may take a significant portion of the grower's profit until certification is achieved.

Higher Cost of Inputs

An analysis of USDA survey data showed "operating plus capital costs per acre for crop production were generally less for organic than for conventional farms" by mean operating costs (McBride & Greene, 2015, p. 11). McBride and Greene (2015) found organic growers spend more in fuel, capital, and labor cost, particularly for tillage. However, conventional corn growers experienced significantly greater expenses related to seed, chemicals, and fertilizer costs than organic corn growers. The average total economic costs per bushel were found to be significantly higher for organic crop farms per planted acre largely due to lower crop yields (McBride & Greene, 2015).

In a 2012 study done by Uematsu and Mishra using data from growers in the 2008 Agricultural Resource Management Survey (ARMS), the average gross cash income for certified organic farms was $1 million higher than for conventional farms. However, they also concluded the cost of production costs for organic producers is high enough to reduce the operators' profits such that there is not a significant income difference between producer types (Uematsu & Mishra, 2012). Profits were most reduced by insurance, marketing expenses, and labor costs.

Factors the Encourage Adoption

Organic Premiums

The premiums consumers pay for organic foods are a major driving force in organic adoption. In fact, the reason for greater per-bushel returns to organic wheat is due to a price premium paid in addition to the price paid for conventional wheat (McBride et al., 2015). Among different types of the same product, such as food versus feed-grade wheat, a premium may vary dependent upon a number of factors including how much supply of that wheat is available and how strong the current demand for the organic commodity. For example, McBride et al. (2015) discovered the premium for wheat was different for each type of wheat (hard red spring, hard red winter, soft white spring, etc.) and whether it was grown for food or for feed. The premium is a profit-driven incentive for organic production. Additional income from premiums is not only important to increase profits, but it is required to cover increased input costs that organic production demands. "Consumer demand and willingness to pay price premiums for organic produce are essential requirements as this provides an opportunity for organic farmers to supplement their incomes" (Läpple & Rensburge, 2011, p.1412)

Growers of all farm sizes are motivated by potential profits that can be extracted through the organic price premium (Peterson et al., 2012). Though certified organic crop producers earn a greater revenue due to the premium paid, they incur higher costs to produce as well (Uematsu & Mishra, 2012). Organic production has been found to create a slightly greater margin of income (Uematsu & Mishra, 2012). However, it is important to recall that different commodities can yield different profit margins. Other components

to consider are the seller's market (wholesale versus small businesses versus large contracts with schools, etc.), and location of production and sales.

Benefits of Grant/Government Funding

Transition costs, including costs related to transition time and direct costs to certify, are often a significant and overwhelming financial expense for a grower. These costs can be a barrier to transition. Based on a study of soybeans by Kuminoff and Wossink (2010), organic farmland has not been converted in the U.S. based partially due to the sunk costs associated with organic adoption and the potential volatility of price premiums. Outcomes of adoption are sensitive to grower expectations, willingness to take on risk, and various aspects of the market. The financial impact of adoption has been lessened for some growers by access to a grant or government funding opportunities.

Constance and Choi (2010) found the lack of government support in the U.S. contributes to the suppression of organic transition such that covering transition costs may increase adoption. Even for existing governmental subsidies, increasing the subsidy level is expected to persuade somewhat risk averse growers to convert their farms (Acs et al., 2009). Assisting growers with transition costs also brings the break-even point (where the cost to produce, both fixed and variable expenses, are equal to total revenue) to a more easily attainable time frame and an easier financial target to reach in order to cover investment costs. For example, a producer may become profitable in two years instead of four with financial assistance to convert. The decreased time to profit entices some growers to adopt who might have chosen not to otherwise.

After the National Organic Program was implemented in 2002, which was created "as a way to support organic farmers and processors and provide consumer assurance"

(Greene, 2016, para. 1). USDA certified organic systems in the U.S. increased from 1.3 million acres in 2002 to nearly 3.1 million acres in 2011 (Charts of Note, 2018). Of the crops found in this growth, a major player was wheat. This may be attributed to the use of large equipment to harvest the wheat acres. The use of equipment allows growers to harvest more acres in a day than producers of other commodities, such as blue berries, that do not use such machines.

Environmental Protection and Product Quality

The price premium paid for an organic commodity may increase revenue, or it may not depend on the market. There is measured risk associated with the costly adoption (even for partial adoption) of organic production methods. Government or other types of funding support aids growers in the adoption process and does eliminate some of the transition costs. However, financial assistance or a large enough price premium to increase revenue is not guaranteed. Researchers have found, despite the potential for lower profits, a grower's personal beliefs and views on environmental protection can encourage organic adoption. Kallas et al. (2010) found environmental and sociocultural concerns are relatively more important to organic growers versus conventional producers.

Organic adopters (partially and fully converted) often have a strong pro-environmental orientation (Läpple & Rensburg, 2011). Producers who adopted organic relatively late when compared to other growers frequently did so based on risk considerations (Läpple & Rensburg, 2011). Late adaptors are found to be more profit-oriented (Läpple & Rensburg, 2011). The many motivations of organic producers create a challenge for policymakers (Peterson et al., 2012). Growers are not just concerned with the environment or just focused on profit maximization, the motivation of a grower to

adopt tends to be a combination of multiple incentives. Another example of a producer's motivation is the belief that organic products can be produced at higher quality than conventional commodities (Kallas, et al., 2010).

Health and Personal Beliefs

In addition to a strong belief in environmental protection associated with organic farming, producers also frequently are found to have personal beliefs related to the organic lifestyle (Peterson et al., 2012). Kallas, et al. (2010) found growers who have concerns about the health of their families are more likely to adopt. Producers who believe organic products are healthier for people are much more likely to adopt organic methods (Kallas, et al., 2010). A study by Padel (2008) observed the motivation of organic conversion for Austria, Italy, Netherlands, Switzerland, and the UK. Every country agreed that health and the organic lifestyle was an important reason for adoption (Padel, 2008). Mountain growers from Switzerland and some from the UK found conversion to organic production easy, since their practices were similar to organic beforehand (Padel, 2008).

Organic Wheat Production

Producer Profiles

Common organic producer characteristics identified are similar across scenarios. A grower's age is inversely related to adoption, meaning older growers are less to adopt organic (Kallas et al., 2010). Producers with less experience who are more youthful tend to farm organic commodities (Shams and Fard, 2017). Yet, growers with more knowledge of organic production, increases the likelihood for organic farming (Shams

and Fard, 2017). The more formal education producers have received, the more likely they are to produce organically (Shams and Fard, 2017). McBride, et al. (2015) found the education level with the highest chance of conversion was a college education.

Women are also more likely to convert to organic farming (Kallas et al., 2010). Those who gather information, especially from multiple sources, have a significant chance of being an organic producer (Kallas et al., 2010). Family and household characteristics also play a major role in adoption decision-making. Houses with more debt or who experience difficulties with securing a loan are less likely to adopt (Kallas et al., 2010). The proximity to other organic farms increases organic adoption likelihood (Kallas et al., 2010).

Another common characteristic of an organic producer is smaller farm size. This is because smaller organic farms tend to be more successful than large farms. For example, Delbridge and King (2016) conducted a study observing the sensitivity of three different firm sizes (small, medium, and large) and optimal organic transition with varying levels of organic price premiums randing from 0% to 100%. Small is defined as 320 acres for conventional and organic, medium as 560 acres or organic with 880 acres for conventional, and large as 800 acres for organic and 1,360 acres for conventional (Delbridge & King, 2016). Delbridge and King find organic transition is optimal under the entire range of market conditions for small farms. Organic transition is less likely to be optimal for large firms. However, the probability remains substantial for organic transition success.

Wheat vs. Other Grains and Concern with Soil Quality

Corn and wheat, though both field crops, may face different organic production challenges. From the ARMS survey, corn and wheat producers agree controlling weeds is a major concern in organic production of the crops (McBride & Green, 2015). Concern with achieving desired yields proved much less of a concern with 17% of wheat growers and only 12% of corn producers reporting challenges with their organic production (McBride & Green, 2015). Organic certification paperwork, however, displayed the largest gap between the two commodities, as over a third of all sampled organic corn producers found certification paperwork to be a difficult aspect of production while only 17% of wheat growers expressed the same concern (McBride & Green, 2015).

Maintaining and improving soil quality protects productivity, improves the nutrition in food products, and generally keeps the plant healthy for maximum benefits in production (Healthy Soils are the Basis for Healthy Food Production, 2015). Quality soil helps plants resist physical degradation, holds water and nutrients, and cycles nutrients to meet plant needs (DuPont, 2012). Strong crops are then better able to suppress pests (including weeds) that may otherwise hurt the plant (DuPont, 2012). Soil quality can be higher on organic farms rather than on conventional farms that use synthetic chemicals (Lewis et al., 2011).

Study Contributions

The purpose of this study is to examine why wheat producers choose to adopt organic production practices. Focus is placed on what resources, knowledge, and motivations are required to increase the likelihood of adoption. Previous studies have

observed organic fruits, vegetables, grains, etc. from many areas around the world. This study seeks to observe solely wheat growers in the western U.S. and the factors that contribute to their adoption of organic techniques.

Profit margins encourage the income-driven portion of a grower's decision to transition to organic production. Profit margins range widely based on commodity, production region, and local market. Additionally, input costs, soil types, irrigation practices can be different between commodities and vary based on production region and environment. Locational differences across market areas will yield different organic wheat prices. Therefore, studies from other parts of the U.S. and abroad will not accurately represent the decisions of wheat growers in the Western U.S. This study uses an ordered logit model to explain the impact factors, including grower's willingness to take risks, farm size, major business decisions, contract types, and other variables often associated with adoption choice.

CHAPTER 3

DATA DESCRIPTION

Survey Description

Data for this study were collected through an online survey using the Qualtrics platform. Agricultural producers across fourteen western states were contacted and emailed the survey link by various farming and grain growers associations with which they were associated, such as the Utah Farm Bureau Federation and the Washington Grain Growers Association, for example. Since the main goal of this study is to understand why wheat growers do and do not adopt organic wheat production methods, surveys were administered to both conventional and organic (partial or complete) growers.

There was a total of 111 completed responses, 82 of which are used in this analysis as 29 of the completed surveys didn't include responses for key questions required for the analysis in order to address key study objectives. Additionally, only responses from growers who regularly produce wheat were included. The states of Utah (30) and Colorado (20) had the highest response rates, and no responses were provided from wheat growers in Arizona, New Mexico, Nebraska, or Alaska (see Table 2 for respondent numbers by state).

A total of 34 questions were asked in the survey. Questions covered topics relating to basic primary grower socio-demographics, farm characteristics, history of production practices, the grower's trust in various information resources, and concerns about organic production and implementing new technologies on their farm in general.

Questions related to current farm irrigation strategies (if any), preferred information delivery methods, and knowledge needs were also included. The grower's past wheat production practices (always organic, used to be conventional but presently organic, always conventional, etc.) were obtained through a series of questions. These questions were used to clarify any changes made in the past, the reasons for change, and their rational for not using organic methods.

Table 2: Survey Responses by State

State	Number of Participants
California	3
Colorado	20
Idaho	5
Montana	10
Nevada	1
Oregon	1
Utah	29
Washington	9
Wyoming	4
Total Participants	82

The survey questions were chosen based on findings from a review of literature and the goals of this study. Grower socio-demographics, such as first-generation grower status, gender, age group, etc. are common questions in most surveys revolving around organic adoption. Authors such as Kallas et al. (2010), Shams and Fard (2017), and Peterson, et al. (2012) all found significance in one or more demographics for growers who chose organic methods (partial or complete). Often times these results were largely related to age and gender. Details related to the farm, including the number of wheat

acres, annual profit and production, sales contracts, wheat varieties, etc., have also been found to be significant in adoption results (Khaledi et al., 2010; Greene et al., 2010).

The survey asked growers which sources of information they found most useful. This question was important because organic adoption is more likely to be present when a grower receives education on how to produce organically, meeting USDA certification standards, and how to deal with common challenges (Shams and Fard, 2017). The trustworthiness of resources will also determine whether a grower believes the presented data, research, and information.

Additional questions regarding grower concerns about organic production were posed, such as the suppression of weed and pest control, for example. Studies by McBride and Greene (2015), Läpple and Rensburg (2011), and Johnston (2010) have found statistical significance around organic adoption and growers' concerns about these topics. An additional article by DuPont (2012) also directly addressed grower concern about weed and pest control during organic transition time and throughout organic production.

Overview of Survey Sample Statistics

Of the total survey respondents, 64 growers used only conventional methods in their 2017 harvest (Figure 1). Thirteen growers produced only organically, of which seven were certified. Five grew a combination of both organic and nonorganic wheat. Two of the partial adopters were certified organic. Approximately 78% of the sample were conventional growers, so 22% were organic growers, including complete or partial adopters, both with or without organic certification.

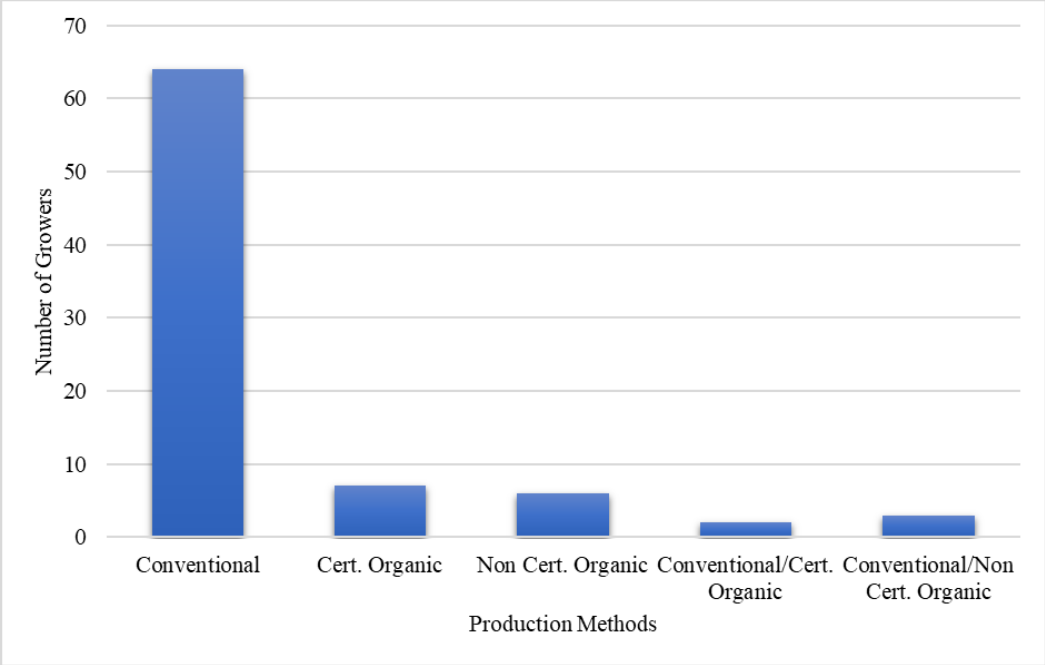

Figure 1. Number of Participants by Production Method.

Two growers with all conventionally grown wheat farmed organically at first and then switched to conventional production. Four respondents used to grow both, organic and nonorganic wheat, but now produce only conventional. Of the organic producers, two began with conventional farming. One switched to all noncertified organic and the other one switched to all certified organic.

Respondents were asked to rank their preferred information provider regarding farming practices and related issues on a scale of 1-8, where one is the most preferred and eight is the least preferred. Respondents ranked Cooperative Extension workshops/field days as their most preferred source of information (see Table 3). Running a trial their farm/land followed by Cooperative Extension publications and video and observing trials on other farms were also highly ranked by mode. The least preferred method for information by mode was production/financial assessment tools. By sum of all responses

(lower values indicate more preferred sources), trials on other farms was the most preferred by one point over Cooperative Extension field days/workshops. These were closely followed by trials on the grower's land and Cooperative Extension publications/videos. The least preferred method to receive information was by production/financial assessment tools, the same outcomes as measured by mode.

Table 3: Ranking of Preferred Information Providers

Rank of preferred method for receiving information or tools (1 = most preferred)	Mode of responses	Rank of preferred method for receiving information or tools (1 = most preferred)	Sum of responses
Coop. Extension publications and videos	2	Coop. Extension publications and videos	168
Coop. Extension field days or workshops	1	Coop. Extension field days or workshops	146
Production/financial assessment tools	7	Production/financial assessment tools	201
On-site consultant	4	On-site consultant	179
Commodity association	3	Commodity association	175
Trial on personal land	1	Trial on personal land	152
Trial on other farms	2	Trial on other farms	145

Source: Based on primary data gathered through organic wheat adoption survey of growers in the western U.S.

Respondents were also asked to rank information sources in terms of their level of trust in that source on a scale of 1-8, where one is the most trusted and eight is the least trusted. Table 4 shows the frequency of rank (mode) given by respondents to each as well as the sum of responses (right). The most trustworthy sources by mode are university research and neighboring growers. The least trusted are federal agencies. By sum of the total responses, university research and neighboring growers are also highly ranked. The least trusted by sum were consultants and federal agencies.

Table 4: Ranking of Trusted Information Sources

Rank of trust in information source (1 = most trusted)	Mode of responses	Rank of trust in information source (1 = most trusted)	Sum of responses
University	1	University	134
Neighbor	1	Neighbor	140
Extension resources	3	Extension resources	157
Product companies	4	Product companies	201
Consultant	5	Consultant	205
Commodity association	5	Commodity association	199
Federal loans/programs	7	Federal loans/programs	239

Source: Based on primary data gathered from organic wheat adoption survey of growers in the western U.S.

Respondents were asked to indicate their most commonly used resources. Their reported use of resources is provided in Figure 2. Soil testing and magazines were the most commonly used resources. Extension workshops/field days and Extension publications/website were used by approximately half of all participants. USDA publications were used by one third of the responding growers and consultants were used with similar frequency. Videos and apps can be a great way to study the success and experiences of other people. However, only around one quarter of the respondents reported using them as a source for information. The least used resource were federal agency programs, including loans. This is consistent with responses about trusted information sources. Federal agencies were the least trusted source by respondents. A few respondents reported using no information source.

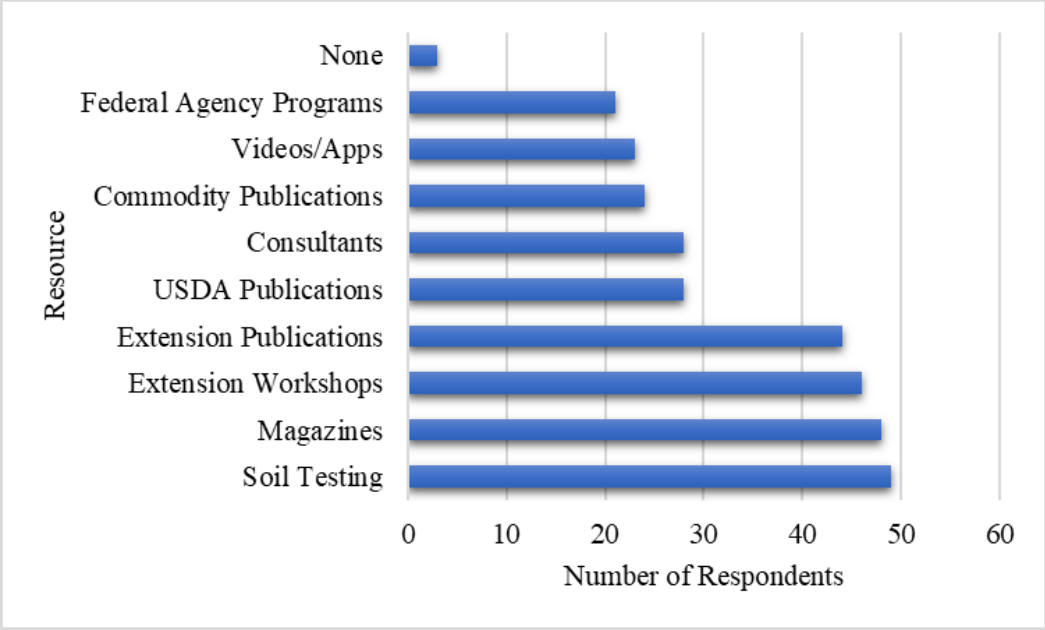

Figure 2. Respondent Resource Usage.

Nearly half of the respondents produce wheat on 701 or more acres annually (Figure 3). Of the respondents who run a large wheat farm (≥ 701 acres), one uses a combination of production practices and 32 only produce conventionally. One respondent began production with conventional practices and adopted organic. Another has only ever used organic, and three report beginning as organic producers and switching to conventional. From the group that produces wheat on large farms, three reported being unprofitable. Of those reporting unprofitable, one grower switched from organic to conventional and two other growers have only practiced conventional production.

Approximately one quarter of participants had medium sized farms with wheat acres ranging from 151 acres to 700 acres. These growers were majority conventional producers (17 out of 21). However, two growers were all certified organic and two used a combination of conventional and organic methods. Three of the growers had used both methods throughout their farming career, even though their current methods may have

changed. A single producer began production with conventional practices and is currently using all organic methods.

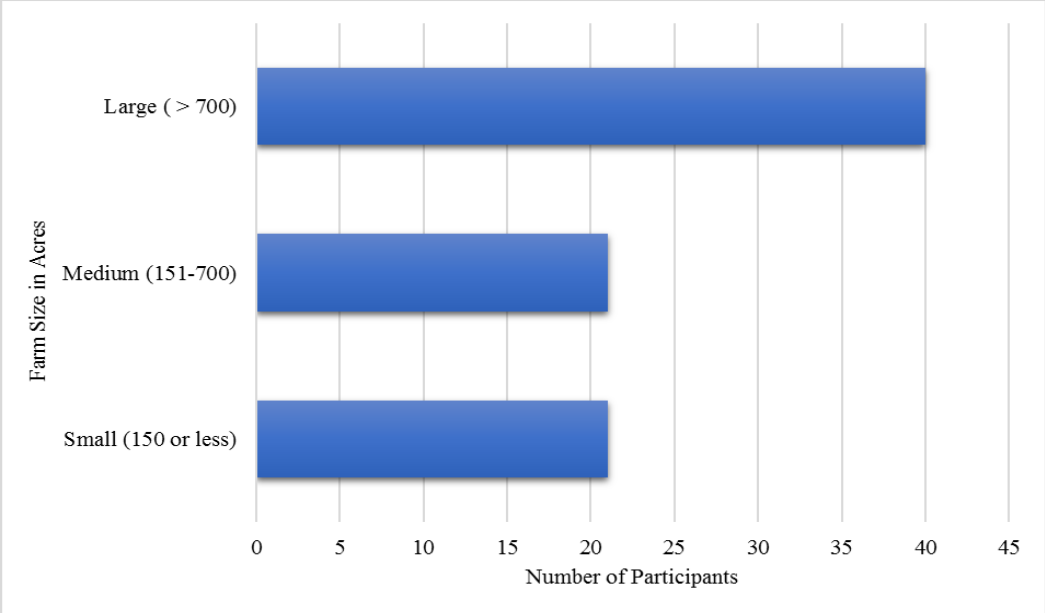

Figure 3. Small, Medium, and Large Farm Categories by Acres.

Approximately one quarter of the respondents had relatively small wheat farms of less than 150 acres. Thirteen producers used only conventional production and two have used organic methods throughout their farming career. Five growers did use a combination of production methods, which included organic and nonorganic wheat. Fifteen of those growers were all conventional during the 2017 harvest. Three are certified organic with one uncertified. Two of the growers began with conventional practices and had switched to organic farming by 2017.

The survey offered growers five different ranged to choose from to indicate the size of their wheat farm. These were broken into less than 50 acres, 51 to 150 acres, 151 to 400 acres, 401 to 700 acres, and 701 acres or more. These categories were condensed

into farm sizes of small, medium, and large for analysis and discussion. The definitions for each farm size were determined predominantly by two papers. Delbridge and King (2016) described a small farm as 320 acres, but Greene et al. (2010) determined a small far was 280 acres, lesser than that of Delbridge and King Based on these articles with the survey's given intervals in this research project, a small farm was defined as 150 acres or less. Delbridge and King went on to define medium farms at 560 acres. This was just above one range in the survey (151-400 acres), but not as much as the top value of next range (401-700). Therefore, medium farms were determined as 151 to 700 acres. Later, Greene at al. (2010) defined a large farm as having 800 acres or more. This number was relatively closest to the last given range in the survey, 701 acres or more, which became the definition of a large farm in this study.

The survey sample contains 18 producers who grow organically, nine of which are certified. Ten organic growers (certified or not) responded to the questions regarding motives for organic adoption. As shown in Figure 4, the most common response (70%) indicated their reason for adoption to be the profit opportunity at the time of transition. The next most popular response was for personal beliefs (40%) which supports Constance and Choi's (2010) findings that personal beliefs have a significant impact on adoption. Other responses included receiving a subsidy (30%), long-term profitability (30%).

Additional reasons given include being dissuaded from conventional farming due to continually rising input costs and the need for a more efficient way to kill herbicide-resistant weeds. Contrary to much of the previous literature, adoption chosen based off of information received was the least common response chosen on average. The availability

of a subsidy was also a significant reason for adoption, but still less than expected profit in the long and short-term.

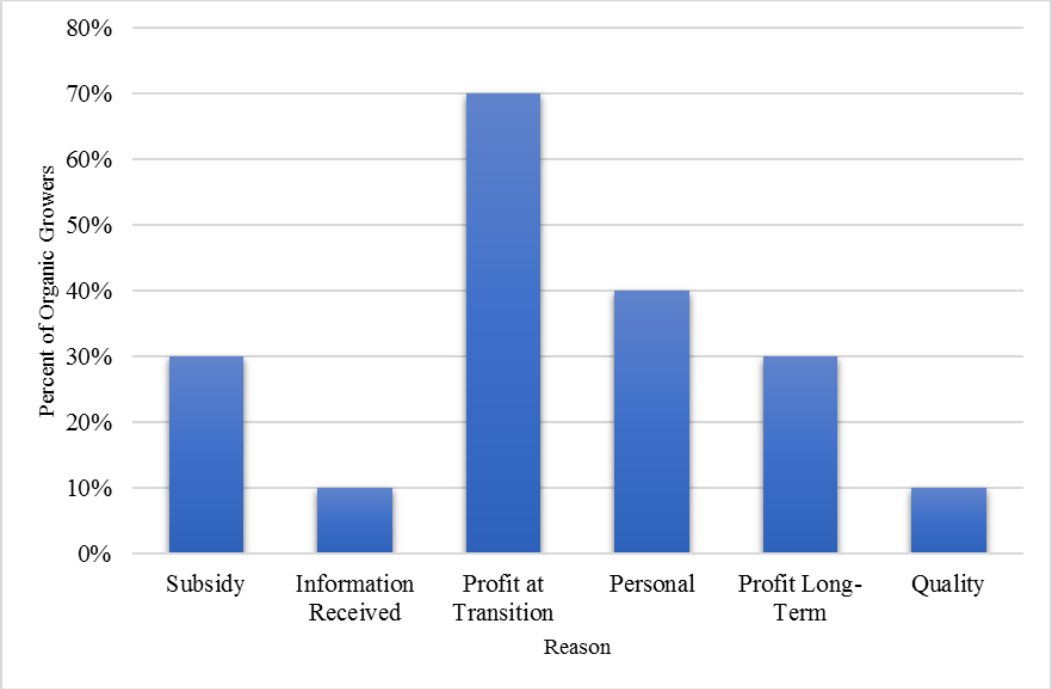

Figure 4. Motivations for Organic Adoption.

A total number of 64 respondents provided a response when asked about their concerns regarding organic farming (Figure 5). The most common response was weed and pest control (92%). This is consistent with that found by McBride and Greene (2015) and Johnston (2010). Next was the concern for long-term profitability in organic farming (42%), then the time required to certify (41%), followed by marketing (36%), and soil impacts (34%). Greene et al. (2010) found price volatility to be a top concern for growers when it came to organic production. However, in this survey only 28% of growers were concerned about the actual volatility of organic premiums. Additional concerns listed

include the hassle of protecting organic products from exposure to chemicals, especially upon delivery and storage, and the impact on neighboring farms.

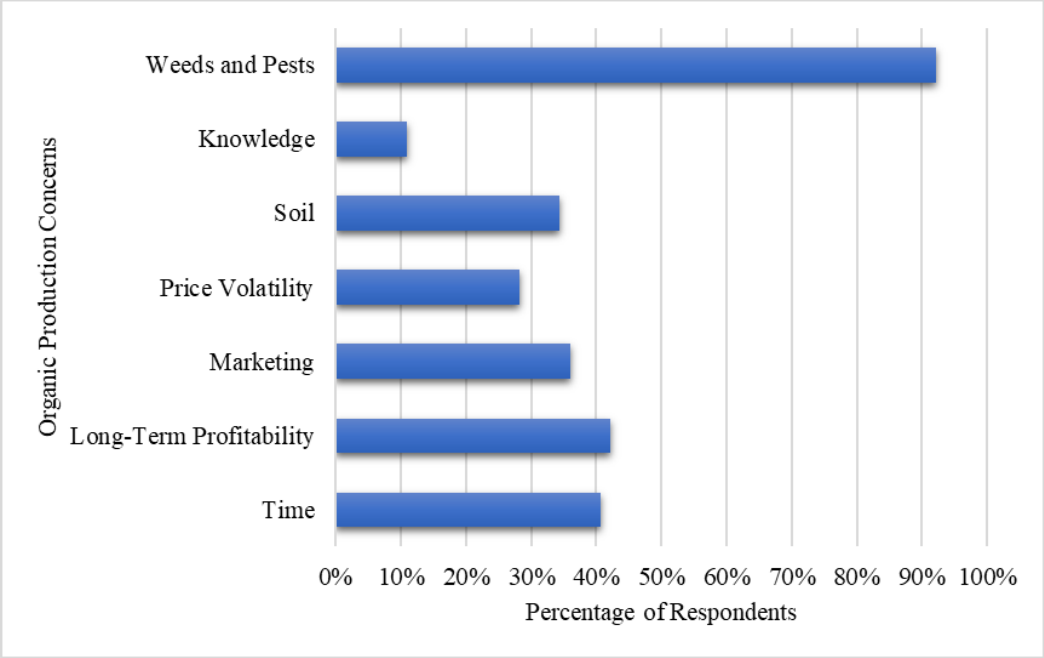

Figure 5. Concerns Regarding Organic Production.

Table 5 provides the survey sample statistics for all variables used in the models included in the analysis in Chapter 4. A significant portion of the survey allowed for multiple responses to a given question (choose all that apply). In these cases, categorical or binary variables were created for each potential response or response grouping.

An indicator variable, arid location, was created to represent operations located in Utah or Nevada where the area is particularly dry. Just over one third of the farm locations in this study are in an arid location. Small gross income, representing farms with income less than $100,000, was also included in the study to see if smaller incomes were a predictor of organic adoption, similar to small farm size. More than half of the farms (56%) grossed $200,000 or more in 2017. Nearly 30% grossed a half million or

higher. Almost 20% of respondents brought in under $50,000 in gross income, with 35% with a gross income under $100,000. The average farm size was above a medium-sized operation. This is not surprising since nearly half of the respondents produced on large farms that were greater than 701 acres. Twenty-six percent of the respondents had a small farm of less than 150 acres.

Over three quarters of the respondents would take on risk to increase profits. Almost 80% of participants carried Federal Crop Insurance. All large growers carried insurance. One medium-sized producer and most small growers did not have it.

A couple of indicator variables were created to observe a producer's business choices. One variable was created using the percentage of land leased where a farm growing on more than 59% leased acres indicates a large percentage of leased land. Approximately 40% of respondents leased more than 59% of their farm land.

A second binary variable was created as a method to observe what form of business ownership a grower chooses. A grower may choose sole proprietorship, partnership, corporation or an LLC in the question asked. Only a couple responses, such as a trust, were giving in addition to the main four options. A corporation or LLC protects the business from any personal financial loss a producer may experience. A sole proprietorship or partnership does not and personal finance of the owner(s) can impact the farm business. The form of business variable = 1 when a producer operates under a corporation or LLC since these choices better protect the operation, and = 0 otherwise. Significantly less than half (36%) of the respondents had their farm secured in a corporation or LLC. Current production method had a mean of 1.64 (Table 5), which is explained by the large % of conventional growers (conven. = 1) in the sample.

High resource use, defined as a participant who indicated the use of five or more resources for information, was created to test Shams and Fard's (2017) outcome of organic adoption being related to access to resources. Over half of the respondents in this sample used at least five resources.

An alternative way to measure resource reliability was tested with the creation of a series of dummy variables for information resources (including universities, product companies, Extension resources, etc.) ranked by respondents as a top three trusted source. Any ranking greater than three (meaning a less trusted source) received an outcome of zero. This resulted in seven new binary variables. On average, university research was the most trusted source of information. This was followed by neighboring growers, and Extension resources. Federal programs/loans received the fewest indications and is consistent with results from Table 5.

Current farming methods were coded categorically with five options, including fully conventional, partial adoption of noncertified organics, partial adoption of certified organics, full organic noncertified production, and fully organic certified organic. Of the total respondents, 78% grew wheat conventionally, 4% used conventional and uncertified organic methods, 2% conventional and certified organic, 7% all uncertified organic, and 9% used all certified organic operations. Around 22% of the respondents farmed with organic methods. This included certified, noncertified, complete and partial adoption. Just over 10% had received organic certification. Only 8% of producers were female. Only one female grower grew organically and was certified. No participants were under 30 years of age. The highest category was 60 years or older. Around 11% of respondents were first-generation growers.

Table 5. Sample Summary Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Arid location (Utah or Nevada = 1)	82	0.37	0.48	0	1
Small farm size (≤ 150 acres)	80	0.26	0.44	0	1
Large % of acres leased (> 59% of total)	82	0.40	0.49	0	1
Small gross income (< $100 k)	66	0.35	0.48	0	1
Sell directly to retailer (yes = 1)	70	0.06	0.23	0	1
Form of business (Corp. or LLC = 1)	66	0.36	0.48	0	1
Marketing plan (yes = 1)	66	0.45	0.50	0	1
Female (yes = 1)	66	0.08	0.27	0	1
Age	66	3.05	1.16	1	4
First-generation grower (yes = 1)	66	0.11	0.31	0	1
Take risk for profit (yes = 1)	66	0.77	0.42	0	1
High resource use (use ≥ 5 info resources)	65	0.58	0.50	0	1
Discourages new tech: cost (yes = 1)	65	0.94	0.24	0	1
Discourages new tech: knowledge (yes = 1)	65	0.38	0.49	0	1
Discourages new tech: risk (yes = 1)	65	0.38	0.49	0	1
Discourages new tech: financing (yes = 1)	65	0.31	0.47	0	1
Discourages new tech: none (yes = 1)	65	0.03	0.17	0	1
Organic farming concern: knowledge (yes = 1)	66	0.11	0.31	0	1
Organic farming concern: time (yes = 1)	66	0.39	0.49	0	1
Organic farming concern: marketing (yes = 1)	66	0.35	0.48	0	1
Organic farming concern: price volatility (yes = 1)	66	0.27	0.45	0	1
Organic farming concern: soil impacts (yes = 1)	66	0.33	0.48	0	1
Organic farming concern: weed and pest control (yes = 1)	66	0.89	0.31	0	1
Top three reliable source: university (yes = 1)	58	0.79	0.41	0	1
Top three reliable source: neighbor (yes = 1)	57	0.77	0.42	0	1
Top three reliable source: product company (yes = 1)	50	0.40	0.49	0	1
Top three reliable source: Extension resources (yes = 1)	51	0.65	0.48	0	1
Top three reliable source: consultant (yes = 1)	46	0.30	0.47	0	1
Top three reliable source: commodity association (yes = 1)	44	0.30	0.46	0	1
Top three reliable source: federal loans/programs (yes = 1)	39	0.08	0.27	0	1
Current method: (conven. = 1, some org. uncert. = 2, some organ. cert. = 3, org. uncert. = 4, organ. cert. = 5)	82	1.64	1.33	1	5

CHAPTER 4
MODELING AND RESULTS

Several model types have been used in organic adoption studies. For, example Acs et al. (2009) used a discrete stochastic dynamic utility-efficient programming model (DUEP). This allowed the authors to observe specifically the relationship between risk and adoption. Since the study discussed here focuses on determining explanatory factors in organic adoption, and not just risk, the DUEP model is not a good fit. Kallas et al. (2010) used duration analysis model to determine the reasons farms adopt organic production methods and what impacts the time of adoption. This study doesn't observe time to adoption, therefore duration analysis is also inappropriate to meet the goals of this study.

Nelson et al. (2015) chose to estimate producer's perception to barriers in organic production using a logit model based off of a categorical dependent variable. The research in this study also uses a categorical outcome variable. Shams and Fard (2017) chose a logistic regression model to observe factors affecting attitudes toward organic farming. Their data was similarly collected by survey and they observe factors in a similar way to the analysis in this study. Additionally, Peterson et al. (2012) use an ordered logit model with a categorical dependent variable and similar explanatory variables, such as grower characteristics, farm characteristics and management practices, and some risk concerns, as is in this study.

Model Description

Based off of similarity of research goals from previously reviewed literature, this study uses an ordered logit model. When a dependent variable has more than two categories and the values of each category have a meaningful sequential order where a value is indeed higher than the previous one, an ordered logit can be used. As the point of this is to observe what encourages a grower to fully adopt, the dependent variable is current farming methods in terms of percentage under organic production. Thus, the dependent variable is coded as conventional = 1, partially organic uncertified = 2, partially organic certified = 3, fully organic uncertified = 4, and fully certified organic = 5. Only organic production with organic certification represents complete organic adoption. Using a logit model with a binary dependent variable where conventional = 0 and all other current methods (which included some level of organic farming = 1) is possible. However, the ordered dependent variable provides more information on the degree of adoption choice (Carson and Groves, 2007)

The ordered logit model is estimated by (Greene, 2012) in equation 1,

(1) $$y^* = \mathbf{x}'\boldsymbol{\beta} + \varepsilon$$

where y^* is the dependent variable representing organic wheat adoption based on current farming practices. The set of independent variables represented by

$$\boldsymbol{x} = (x_1, x_2, x_3, \dots, x_{J-1}),\ \boldsymbol{\beta} = (\beta_1, \beta_2, \beta_3, \dots, \beta_{J-1}),$$

and the stochastic error is represented by ε. The underlying model structure is estimated by:

(2) $$y = 1\ if\ y^* \leq \mu_1$$

$$y = 2\ if\ \mu_1 < y^* \leq \mu_2$$

.

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$$y = J\ if\ \mu_{J-1} \geq\ y^*$$

where μ_i represents the parameters to be estimated and *y* indicates the level of response. The set of probabilities derived from the model structure are:

(3) $$Prob\ (\ y = 1 \mid \boldsymbol{x}\ )\ = \Phi\ (\mu_1 - \boldsymbol{x}'\beta)$$

$$Prob\ (\ y = 2 \mid \boldsymbol{x}\ )\ = \Phi\ (\mu_2 - \boldsymbol{x}'\beta) -\ \Phi\ (\mu_1 - \boldsymbol{x}'\beta)$$

.

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$$Prob\ (\ y = J \mid \boldsymbol{x}\ ) = 1 -\ \sum_{i=1}^{J-1} Prob\ (y = i)$$

$$where\ 0 <\ \mu_1 <\ \mu_2 < \cdot \cdot \cdot <\ \mu_{J-1}$$

where the cumulative distribution function of the logistic distribution is represented by $\Phi\ (\cdot)$. Preliminary estimates were regressed with robust standard errors.

A total of seven ordered logic models are used in the analysis. Model 1 looks at farm characteristics and Model 2 observes operator characteristics. Models 3 and 4 include both farm and operator characteristics. Model 3 also includes financing discouraging new technology adoption and Model 4 alternatively used knowledge as a concern for organic production. Model 5 examines six common organic farming concerns and Model 6 similarly looks at common factors that discourage adoption of new technology. Lastly, Model 7 examines the impact of top reliable sources of information.

Discussion of Results

Results for Models 1-4 can be found in Table 6. While one might think the characteristics of an operation would have a large impact on its producer selecting organic or conventional methods, only two of the characteristics modeled were found to be important. The first is the location of the operation in an arid location, the states of Nevada and Utah, which decreased the likelihood of producing organic wheat. This effect may be due to the increased risk of crop loss due to drought in dryland production systems. However, weeds tend to be less prevalent in dry areas which would increase organic wheat yields and quality. Hence, this result does not make intuitive sense unless wheat acreage is primarily irrigated. Just over 50% of the 30 respondents from Utah and Nevada used irrigation of some kind.

The second statistically significant variable was farm size where smaller farms (≤ 150 acres) increased the likelihood of organic adoption. This follows with the findings of Khaledi et al. (2010) and Greene et al. (2010). Alternatively, having a small gross income (< $100k) was not found to be significant, which one might think would be related to a small farm size. Also, selling directly to a retailer, small or large, and running the operation as corporation or LLC were not significant. Having a marketing plan was not significant, although Khaledi et al. (2010) found this to be a concern in organic production. Leasing a large percentage of wheat acres (>59%) also had no effect.

A large number of articles searching to find commonalities between operator characteristics and organic adoption. Khaledi et al. (2010) found women and younger adults were more likely to adopt organic production methods. Shams and Fard (2017) also found more youthful participants in their research were likely to be adopters. This

study, however finds no relationship between female gender and organic production as shown in Table 6.

Shams and Fard (2017) found strong evidence that having resources and access to information was highly likely to encourage organic production. However, a concern for knowledge/information was not statistically significant in Model 4. Additionally, producers who indicated the use of five or more resources was not statistically significant in choosing organic production. This also contradicts the findings of Genius et al. (2006), who also found similar findings to Shams and Fard (2017).

The results for age are strongly statistically significant and indicate a grower in this study who is older is more likely to use organic methods, which contradicts findings from previous studies. Newer growers, or first-generation producers, was not statistically significant, which contradicts the relationship between age and adoption found by Khaledi et al. (2010) and Shams and Fard (2017). It's possible that farming families who have introduced organic production on their land have done so due to younger family members managing this side of the operation. This strategy is common on larger family farms with multiple generations on the farm. It would also translate to a younger newer grower actually involved as previous literature indicates.

Peterson et al. (2012) found profit maximization to be a motivator for organic adoption. Taking on risk for profit was found to be significant and have a positive impact on adoption in all models, which strongly agrees with the findings of Peterson et al. Obtaining financing was a concern when adopting new technology and highly significant in both models and increased the likelihood of adoption. This result may be stemming from transitioning organic growers and partial adopters being the concerned growers.

This would make sense, since those seriously considering or currently taking on a large transition would naturally be actively working through financing the operation.

Table 6. Farm and Grower Characteristics Results

Dependent Variable:	Models			
Current Method	(1)	(2)	(3)	(4)
Arid location	-2.734*		-3.619*	-2.970*
	-1.491		(1.97)	(1.71)
Small farm size	2.345**		2.244*	2.638*
	(0.94)		(1.41)	(1.44)
Large % of acres leased	-0.005		0.617	0.0172
	(0.85)		(0.92)	(1.01)
Small gross income	-0.896		-1.033	-0.196
	(0.69)		(0.83)	(0.76)
Sell directly to a retailer	1.288		-0.122	0.439
	(1.22)		(1.10)	(1.18)
Form of business	0.615		0.768	0.241
	(0.64)		(0.77)	(0.81)
Marketing plan	-0.215		0.387	0.090
	(0.67)		(0.89)	(0.85)
Female		-0.070	-0.469	-0.616
		(1.40)	(1.33)	(1.24)
Age		0.676**	0.772**	0.729*
		(0.27)	(0.34)	(0.43)
First-generation grower		-0.126	0.168	-0.781
		(1.34)	(1.18)	(1.01)
Take risk for profit		1.25*	1.963*	1.891*
		(0.76)	(1.03)	(1.00)
High resource use		-0.326	-0.245	0.335
		(0.61)	(0.82)	(0.77)
Discourages new tech: financing		1.511**	2.330***	
		(0.68)	(0.76)	
Organic farming concern: knowledge				-1.127
				(1.10)
Wald chi2	13.56	9.41	24.87	12.79
Log likelihood	-50.71	-52.72	-44.50	-47.60

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

This analysis didn't result in any statistical significance across areas of concern surrounding organic production. Ordered logit results are displayed in Table 7. Like in model 4, the concern about knowledge of organic practices was also insignificant. Marketing, time to certify, price volatility, soil impacts, and weed and pest control were all found to have no statistical impact on increasing or decreasing the likelihood of organic adoption.

Table 7. Organic Farming Concerns Results

Dependent Variable:	Model
Current Method	(5)
Time	-0.213
	(0.69)
Marketing	0.414
	(0.67)
Price volatility	-0.213
	(0.70)
Soil impacts	-0.135
	(0.63)
Weed and pest control	-0.791
	(0.87)
Knowledge	-0.799
	(1.47)
Wald chi2	2.02
Log likelihood	-57.15

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 8 provides results of an ordered logit model looking at factors that discourage adoption of new technologies on the farm. Time, cost, knowledge, perceived risk, and none were all found to be statistically insignificant in impacting the likelihood of a grower producing organically. As previously discussed, this is opposite of the findings of McBride and Greene (2016), Shams and Fard (2017), and others. However,

like in Models 2 and 3, financing the adoption of new technology was statistically significant and increased the likelihood of organic adoption. Therefore, while the total cost of the change was not significant, the ability inancing the process was.

Table 8. Discouraging Factors of New Technology Adoption Results

Dependent Variable:	Model
Current Method	(6)
Time	0.225
	(0.61)
Cost	-1.667
	(1.21)
Knowledge	-0.365
	(0.65)
Risk	0.665
	(0.65)
Financing	1.171*
	(0.62)
None	-0.085
	(1.56)
Wald chi2	6.73
Log likelihood	-54.80

Note: Robust standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 9 shows the results of an ordered logit model observing which sources of information participants considered most useful. Producers ranked the resources from most useful = 1, to least useful = 7. The responses were turned into binary variables where if a source was in the top three most trustworthy options, it received a 1 and everything else = 0. Extension and commodity associations had no statistical significance in the likelihood of adoption. Growers who consider university research to be a useful source were less likely to be organic producers (significant to the 5% level). Considering the use of consultants and information from neighbors and federal agencies to be helpful

also decreased the likelihood or organic adoption. The use of seed/product companies was the most statistically significant to the sample (1% level). Those who chose seed/product companies as a top three most useful source also had a decreased likelihood of being and organic producer. This goes against the findings of Shams and Fard (2017) who suggest information increases likelihood of organic adoption.

Läpple and Rensburg (2011) found non-adopters on average access information from magazines, TV, the internet and other sources about as much as organic adopters. However, they discovered non-adopters use consultations with a farm advisor and agriculture information and training events less on average than organic producers. This contradicts the results in this study which concludes that all four statistically significant information resources are more likely to be used by non-adopters.

Table 9. Top Three Trusted Sources of Information Results

Dependent Variable	Model
Current Method	(7)
University	-7.175**
	(2.85)
Neighbor	-5.153
	(3.14)
Product companies	-7.508***
	(2.74)
Extension resources	-1.815
	(2.24)
Consultant	-5.395**
	(2.57)
Commodity association	-2.03
	(2.68)
Federal loans/programs	-6.304**
	(2.88)
Wald chi2	26.36
Log likelihood	-21.04

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Resources available for financing or other opportunities meant to promote an increase in organic productions on an open information source, such as local channels or the radio (Läpple and Rensburg, 2011), may be good opportunities to reach individuals more likely to participate in organic growing. Additional opportunities may be targeted toward those who are older (e.g. 40 years +) may also find a more interested audience.

CHAPTER 5
DISCUSSION AND CONCLUSIONS

In this study, we examine what factors increase the likelihood of organic adoption in wheat production. Ordered logit models are used to examine the impacts of farm characteristics, operator characteristics, concerns about organic production, hurdles to adopting new technology, and the use of resources on the likelihood of adoption. Several grower characteristics showed significant effect on the choice to produce organically, as well as two farm characteristics

According to Kallas et al. (2010), women in vineyard production are more likely to convert to organic farming. This study finds no significance between gender and adoption. Shams and Fard (2017) in wheat production concluded more youthful growers have a higher likelihood of growing with organic methods. However, this study finds the opposite to be true. The largest age population in the sample was for age 60 and above. The data may have captured the older parents as the primary farmer, who may likely have adult children managing organic wheat acres on the farm. Also, those more willing to take on risk have a greater likelihood of adoption, which is similar to Kallas et al.'s 2010 paper which discovered growers who are not risk-averse tend to be adopters. Läpple and Rensburge (2011) concludes that the willingness of a consumer to pay a premium for organic products are important to producer decisions to convert their production. This price premium is what entices growers to take on risk to grow organic products.

Several previous studies found that grower concerns may discourage them from adopting organic production. However, this study finds no connection between concerns and adoption/non-adoption, except for the need for financing to fund the transition.

Surprisingly, contrary to the findings of Johnston (2010) who discovered conventional growers lack interest in organic production due to a concerns about disease, weed and pest control also had to statistical significance in adoption in this study.

Shams and Fard (2017) concluded information availability was highly correlated with organic adoption and Kallas et al. (2010) found those who gather information, especially from multiple sources, have a significant chance of being an organic producer. However, this study found no impact on adoption for participants who used a larger number of information resources. Additionally, no significance in growing organically and using resources such as neighboring growers, Extension resources, and commodity association. Accessing resources from universities, consultants, seed/product companies, and federal agencies decreased the likelihood of organic adoption. Which is opposite of the findings by Constance and Choi (2010) who suggest more government support in the U.S. will increase organic production.

The results of this study can help support the organizations who seek to increase the availability of organic products in the market. While several of the study results are contradictory to previous studies. However, this may be a factor of observing solely wheat producers, the geographical area in which the sample was taken from, or the fact that all participants were members of some farming-related association. This study's findings provide alternate information and discussion to contribute to finding new ways to reach producers, including some illuminating relationships between information resources and a greater likelihood of being a conventional producer. While the government has made attempts to aid growers seeking organic adoption, this study finds that grower use of federal resources are more likely to be used by non-adopters.

Differences between the findings of previous literature and this study may also be due to the analysis of differing commodities. Wheat requires more costly equipment to farm than vegetables such as tomatoes, squash, or even fruits like strawberries. For this reason, a farm size must be large enough to be profitable and cover equipment and other start-up costs that may not be needed for other crops. Additionally, wheat is not commonly sold, for example, direct to consumer, such as at a farmer's market straight from the field, because additional processing is required for the product to be ready for common use, such as in the form of flour. Variables otherwise found to be significant in other research, such as marketing, may not be significant with wheat as access to the consumer is different.

Age may be different as well because the high costs of wheat farming. Farmers who have financial ability to try organic growing may be the older farmers who have paid for farms or low debts in general. While the main farmer may be 65 years old, their more-youthful children may be using a portion of the farm in organic production where their partially adopted farm may have been only conventional if they were selecting all production methods themselves. Since the 65-year-old is the main farmer, we may have gathered data that the farm is partially organic and the grower is in a higher age category than expected. In general, this research may have concluded different results than others because there is not a lot of research within the same area of the U.S. with the same commodity.

Producing on a small farm increased the likelihood in this paper and has been shown to be possibly the more profitable choice relative to larger operations. By encouraging more development of small farms, we may introduce less risk for persons

who are new to organic farming due to lesser land purchase and likely smaller startup costs. One way of supporting small land purchases is through a federally backed loan available at credit unions and banks. Other ways to increase success of such opportunity would be to include business planning, organic farming education, and on-farm consultation assistance.

Neighboring farmers were ranked as a top trusted resource for information. Another possible path to encourage organic adoption may be to incentivize growers for referring other producers to organic farming assistance programs. Possible incentives may include free organic products to use in production. Another opportunity may be found in small tax deductions.

Another option to consider is to offer more subsidies and assistance for organic transition and production help through universities. Universities were found to be a top trusted resource. They also the likelihood of adoption. However, this tells us this is a resource accessed by conventional producers and, if the program was only for organic production, connection with the program could only increase likelihood of adoption.

Aiding a university-assistance organic farming education program could be operated by provide grants to universities in order assist growers. This also creates possibilities for students to receive hands-on experience and practice in consulting and creatively thinking about the individual needs of a farm to increase production and profit. Graduating students will be better prepared for the job market and more experienced to continue similar employment, which continues to improve the farming assistance industry.

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APPENDICES

Appendix A: Data Collection Survey

Q1
Thank you for your interest in this study. Before you choose to participate in this study, please read the following information carefully.

Dr. Kynda Curtis in the Department of Applied Economics at Utah State University and graduate student assistant, Donya Quarnstrom, are working with university researchers and Extension personnel across the West on a wheat production study which examines the soil quality and yield impacts of using cover crops, compost applications, and specialty wheat varieties in conventional and organic wheat production systems.

This survey will be used to assess preferred information delivery types and methods, needed tools and knowledge, as well as potential hurdles or impediments to producer adoption of successful study production strategies. The results of this survey will be used to identify significant factors impeding and encouraging adoption of study wheat production strategies and to design effective outreach and educational materials. There are no "right" or "wrong" answers and if you choose to participate in this study, it is very important that you provide answers that reflect your true opinions.

Procedures
We are asking for your participation in this survey due to your affiliation with wheat production in the west. Participation is entirely voluntary and if you choose to participate we ask that you complete an anonymous short survey. You may refuse to participate or withdraw at any time without consequence or loss of benefits. It should take you no longer than 15 minutes to complete the survey. You do not need to complete the survey in one sitting. If you initiate the survey and you wish to complete it at a later time, you can save your answers and come back to the survey later.

Risks
This is a minimal risk research study. That means that the risks of participating are no more likely or serious than those you encounter in everyday activities.

Benefits
There is no direct benefit to you in participating in this research study. This study will help the researchers learn more about current wheat production practices and hurdles or impediments to implementation of wheat production technologies. Study results are expected to provide insight to wheat producers, wheat product manufacturers and marketers, Cooperative Extension publications and activities, and/or researchers interested in related topics in the future.

Confidentiality

The researchers will make every effort to ensure that the information you provide as part of this study remains confidential. Your identity will not be revealed in any publications, presentations, or reports resulting from this research study.

We will collect your information through Qualtrics and it will be stored on the Qualtrics platform. We will not receive information about your name, and thus, we will not be able to identify you or link your responses to you in any way. The demographic data that we will collect will be aggregated and used only to make comparisons across groups of producers.

It is unlikely, but possible, that Utah State University and state or federal officials may require us to share the information you give us from the study to ensure that the research was conducted safely and appropriately. We will only share your information if law or policy requires us to do so.

The research team works to ensure confidentiality to the degree permitted by technology. It is possible, although unlikely, that unauthorized individuals could gain access to your responses because you are responding online. However, your participation in this online survey involves risks similar to a person's everyday use of the Internet.

Voluntary Participation and Withdrawal

Your participation in this research study is completely voluntary. If you agree to participate now and change your mind later, you may withdraw at any time by exiting your browser, as long as you have not received the message confirming "your response has been recorded". You will not be able to withdraw after you have fully completed the survey, as your participation is completely anonymous and we will not be able to track your responses.

IRB Review

The Institutional Review Board (IRB) for the protection of human research participants at Utah State University has reviewed and approved this study. If you have questions about the research study itself, please contact the Principal Investigator, Dr. Kynda Curtis, at (435) 797-0444 or kynda.curtis@usu.edu. If you have questions about your rights or would simply like to speak with someone other than the research team about questions or concerns, please contact the IRB Director at (435) 797-0567 or irb@usu.edu.

Q2 Please indicate whether you have read the information about the study and if you agree or not to participate in the study.

- ○ I confirm I have read the information and I agree to participate in the study.
- ○ I have not read the information or I do not agree to participate in the study.

Q3 Does your farming or ranching operation produce wheat on a regular basis?

- ○ Yes
- ○ No

Q4 In which state is your primary wheat farming operation located?

- ○ Colorado
- ○ Idaho
- ○ Montana
- ○ Nevada
- ○ Oregon
- ○ Utah
- ○ Washington
- ○ Wyoming
- ○ California
- ○ Other (California) _____

Q5 If you grow wheat in other states please note those states here.

_____

Q6 How many total acres do you have in wheat production on average annually?

- ○ less than 50
- ○ 51 - 150
- ○ 151 - 400
- ○ 401 - 700
- ○ 701 or more

Q7 What percentage your total wheat acres are leased?

- ○ None
- ○ Less than 10%
- ○ 11 - 30%
- ○ 31 - 59 %
- ○ 60 - 79%
- ○ 80% or more

Q8 How do you currently produce your wheat?

- ○ All conventional methods
- ○ All certified organic methods
- ○ Using organic methods, with NO certification
- ○ Some wheat is produced with conventional methods and some with organic methods organic certified
- ○ Some wheat is produced with conventional methods and some with organic methods, NOT organic certified

Q9 Which best describes your conventional/organic practices since you began farming?

- ○ Have used only conventional methods
- ○ Have used only organic methods
- ○ Have used a combination of conventional and organic methods
- ○ Stared with conventional methods and transitioned to organic methods
- ○ Started with organic practices and transitioned to conventional methods

Q10 If you transitioned to organic methods from conventional, which options below best describe your reasoning? (Select all that apply)

- ☐ Received a subsidy/program payment
- ☐ Received information that convinced me to switch to organic farming
- ☐ Organic farming was more profitable at the time of transition
- ☐ Personal reasons/opinion on farming practices
- ☐ Organic farming is the best choice for long-term profit
- ☐ Organic farming is the best choice for long-term product quality
- ☐ Not applicable
- ☐ Other _____

Q11 If you transitioned to conventional methods from organic, which options below best describe your reasoning? (Select all that apply)

- ☐ Received a subsidy/program payment
- ☐ Received information that convinced me to switch to conventional farming
- ☐ Conventional farming was more profitable at the time of transition
- ☐ Personal reasons/opinion on farming practices
- ☐ Conventional farming is the best choice for long-term profit
- ☐ Conventional farming is the best choice for long-term product quality
- ☐ Not applicable
- ☐ Other _____

Q12 Please check all contract types you use and list how many total bushels of wheat sold through each type in 2017.

- ☐ Small retailer (e.g. bakery)

  _____

- ☐ Large retailer (e.g. Trader Joe's)

  _____

☐ Wholesale, such as a grain elevator or cooperative

_____

☐ Export outside the U.S.

_____

☐ Other contracts _____

☐ Not under contract _____

Q13 How much did your wheat sell for on average ($/bushel) in 2017? Select each area that you sell through (should match the selection in the previous question) and indicate price.

☐ Small retailer (e.g. bakery)

_____

☐ Large retailer (e.g. Trader Joe's)

_____

☐ Wholesale, such as a grain elevator or cooperative

_____

☐ Export outside the U.S.

_____

☐ Other contracts _____

☐ Not under contract _____

Q14 Please check which wheat varieties you produce and indicate how many acres of each type are in production regularly.

- ☐ Hard Red Spring Wheat _____
- ☐ Hard Red Winter Wheat _____
- ☐ Soft Red Winter Wheat _____
- ☐ Soft White Spring Wheat _____
- ☐ Soft White Winter Wheat _____

Q15 Have you ever used cover crops on your wheat acres?

- ○ No
- ○ Yes, please describe which cover crops you have used, why you chose to do so and the outcome? _____

Q16 Have you ever used compost applications on your wheat acres?

- ○ No
- ○ Yes, please describe why you chose to do so and the outcome? _____

Q17 If you haven't used cover crops or compost applications on your wheat acres, why? (Select all that apply)

- ☐ Not applicable
- ☐ Have no information on these practices
- ☐ Cost of implementation too high
- ☐ Unsure about the benefits of these practices
- ☐ No suppliers
- ☐ Other _____

Q18 If you were to explore implementing new wheat varieties, organic methods, or cover crop and compost applications on your wheat acres, please rank your preferred method for receiving information or tools, where 1 is the most preferred.

_____ Cooperative Extension publications and videos
_____ Cooperative Extension field days or workshops
_____ Production/financial assessment tools
_____ On-site consultation
_____ Workshops or information provided through your commodity association
_____ Conducting a research trial on your land
_____ Visit other farms or farm trials
_____ Other

Q19 Rank the following sources of information related to farming practices where 1 is the most useful.

_____ University research
_____ Neighboring farmers
_____ Seed/product companies
_____ Extension
_____ Consultants
_____ Commodity association/organization
_____ Federal agencies
_____ Other:

Q20 Which of the following resources do you use? (Select all that apply)

- ☐ Trade magazines
- ☐ Cooperation Extension publications/website
- ☐ Videos or apps
- ☐ USDA data/publications
- ☐ Commodity data/publications
- ☐ Soil testing
- ☐ Consultants
- ☐ Cooperative Extension workshops/field days
- ☐ Federal agency loans/programs
- ☐ None
- ☐ Other (please specify)

_____

Q21 Which of the following discourages adoption of new technology, equipment, etc. on your operation? (Select all that apply)

- ☐ Time
- ☐ Cost/expense
- ☐ Knowledge/training
- ☐ Perceived risk

- [ ] Financing
- [ ] None
- [ ] Other (please specify)

_____

Q22 What are your main concerns regarding organic wheat farming? (Select all that apply)

- [ ] Time required to certify
- [ ] Long-term profitability
- [ ] Marketing
- [ ] Pricing or price volatility
- [ ] Pest control
- [ ] Soil impacts
- [ ] Weed management
- [ ] Knowledge required
- [ ] Other (please specify)

_____

Q23 What are your main concerns regarding the use of cover crops and compost applications in wheat production? (Select all that apply)

- [ ] Cost to implement
- [ ] Benefits to wheat production
- [ ] Knowledge and procedures
- [ ] Pest control
- [ ] Soil impacts
- [ ] Weed management
- [ ] Suppliers

- [ ] Uses or market for cover crops
- [ ] Financing
- [ ] Other (please specify)
_____
- [ ] Long-term profitability

Q24 Describe your information/skills/knowledge needs regarding the introduction of organic production, cover crops, composting, and alternative varieties on your operation.
_____

Q25 What is your primary method of irrigation?

- ○ Flood
- ○ Pivot/sprinkler
- ○ Other (please specify)
_____
- ○ Not applicable

Q26 What is your main source of irrigation water?

- ○ Surface
- ○ Underground
- ○ Other (please specify)
_____
- ○ Not applicable

Q27 What was your irrigation water use in acre feet for the 2017 season?
_____

Q28 What is the gender of the primary farm operator?

- ○ Male
- ○ Female
- ○ Other

Q29 In which age range is the primary farm operator?

- ○ 30 - 39 years old
- ○ 40 - 49 years old
- ○ 50 - 59 years old
- ○ 60 or above

Q30 Is the primary operator a first-generation farmer?

- ○ Yes
- ○ No

Q31 What was your operation's gross farm income in 2017?

- ○ $9,999 or less
- ○ $10,000 - $49,999
- ○ $50,000 - $99,999
- ○ $100,000 - $199,999
- ○ $200,000 - $499,999
- ○ $500,000 or higher

Q32 Do you normally carry Federal Crop Insurance?

- ○ Yes
- ○ No

Q33 What form of business does your operation use?

- ○ Sole proprietorship
- ○ Partnership
- ○ Corporation
- ○ LLC
- ○ Unknown
- ○ Other (please specify)

_____

Q34 Which of the following tools does your operation have in place? (Select all that apply)

- ☐ Business plan
- ☐ Marketing plan
- ☐ Production plan
- ☐ Financial plan
- ☐ None
- ☐ Other _____

Q35 How willing are you to take risks in order to increase the profitability of your operation?

- ○ Extremely willing
- ○ Willing
- ○ Unsure
- ○ Unwilling
- ○ Very unwilling

Q36 How profitable is your operation?

- ○ Extremely profitable
- ○ Profitable
- ○ Unsure
- ○ Unprofitable
- ○ Very unprofitable