GENDER, RISK, AND ADOPTION OF INDUSTRIAL HEMP BY MIDWESTERN GROWERS

by

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To myself!

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TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

This study examines the individual and business-related factors that lead to the adoption if industrial hemp in the Midwestern United States. This research comes from an online survey distributed to crop farmers in Michigan, Illinois, Indiana, Ohio, and Kentucky. Drawing from development economic literature, the role of gender in the decision to adopt new technologies is stressed. We also investigate the role of network tiers in relation to adoption. A five-part risk quiz to derive an individual risk perception variable is checked for reliability. Risk perception, gender, and network tier are all shown to be significant factors in the decision to adopt hemp.

INTRODUCTION

The recent legal shifts in industrial hemp growing have opened up a 'wild west' of sorts in understanding the future of the industry in the United States. In 1970, the Controlled Substance Act categorized hemp at all THC levels as marijuana, effectively banning such production (Johnson 2014). Nearly 50 years later, the failed Industrial Hemp Farming Act of 2013 and provisions within the Agricultural Act of 2014 foreshadowed the legalization of hemp production. Indeed, in conjunction with rapid state-by-state marijuana legalization, the Hemp Farming Act of 2018 was passed at the federal level. Currently, 46 states are permitted to license a certain number of commercial growers each year to produce hemp below a 0.3% THC level (Adesina et al. 2020; Johnson 2014). Unfortunately, due to how new American growers and researchers are to the crop and its habits on their own soil, much of the current literature on hemp production's best practices and environmental impact is varied.

Although the factors shaping the norm are widely contested, women are often thought of as more risk-averse than their male counterparts (Jianakoplos et al., 2007). This trait can be observed while studying women in decision-making positions on farms. Due to the resulting propensity to make more conservative investment decisions, tendency to negotiate against rapid expansion, and other behavior, women are generally thought to be later adopters of new crops and farming practices (Lubwama, 1999). On the other hand, risk-aversion suggests that women tend towards diversification to mitigate risk. This might come in the form of diversification of crop, and therefore personal/family income. Additionally, it is thought that female growers' utility includes forms of socio-emotional wealth in addition to financial gain, rather than acting purely as profit-maximizers (Newbert and Craig, 2017).

Risk, and how one proceeds with uncertainty, are key indicators of behavior. In particular, in observing farmers, risk perception is found to influence the decision to innovate and adopt new crops (Ghadim et al., 2005). Farmers who are more risk-averse tend to be later adopters of new crops, while risk-loving farmers tend to be first adopters (Barham et al., 2014). As such, the recent legal shifts in hemp production laws have prompted many growers eager to test out the crop to do so. A vast majority of current licensees planted less than 50 acres to start, despite being mostly corn and soy producers—implying large acreage access. The American 'hemp rush' provides us with a real-time display of adoption behavior and its gendered implications.

CHAPTER 1. LITERATURE REVIEW AND RESEARCH QUESTIONS

1.1 Literature Review

1.1.1 Hemp

Hemp's likelihood of economic success in the United States is a divided matter (Keller 2013; Mark et al. 2020). Hemp's primary product outputs are its fiber and seeds. Hemp fiber is exceptionally versatile and strong, with potentials for use in paper, cordage, insulation, plastic replacements, animal bedding, and more (USDA 2000; Vantreese 1997; Thompson et al. 1998; Fike 2016; Shahzad 2011). One primary potential use for hemp fiber is for textiles (Robbins et al. 2013; Boulder Hemp Initiative Project 1994). There is particular interest in replacing cotton-growing with hemp farming (Dwyer 1998; Rogers 2012). On the other hand, Cochran et al. (2000) frames cotton as a potential competitor; Ash (1948) confirms that cotton historically replaced hemp in the United States. However, seeds have been determined as profit-maximizers for many growers, specifically to create hempseed oil (Cochran et al. 2000; Fortenberry 2014; Johnson 2014). It is clear that growing hemp for seed provides the largest profit margins, to create hemp oil and hemp cake (Lane 2017). Many agricultural and economic researchers doubt the ability of hemp to catch on, citing the failure of other novel field crops such as the Jerusalem artichoke of the 1980's (Cherney and Small 2016). Withal, Sandler (2019) found that almost 90 percent of respondents to a survey distributed to certified organic farmers in the Midwest showed interest in gaining new information on hemp growth and legality.

Due to similar soil and water input requirements, it is thought that producers who already grow primarily row crops such as grain, corn, or soybeans are best-suited to incorporating hemp in rotation (Johnson 2014; Fortenberry 2014; Jeliazkov 2019). Hemp's cover crop potential further suits row croppers (Adesina et al. 2020). Transitioning tobacco growers in particular have been

identified as potential adopters, such as those in Kentucky (Dwyer 1998; Rogers 2012). Kaiser et al. (2015) states that labor requirements for hemp are similar to that of most specialty grain or oilseed crops. However, more recently growers and researchers have found that farming hemp may require more labor than their other crops, and more labor than originally predicted (Mark and Will 2019). Reports on yields vary widely (Ehrensing 1998; Robbins et al. 2013). Many sources indicate that yields on hemp are satisfactory, but not necessarily competitive with other annual crops and only with sufficient inputs (Werf et al. 1995; Fortenberry and Bennett 2001; Williams and Mundell 2016).

Both industry and literature are divided on the prospects of hemp as a sustainability solution. Hemp has been touted as the future of environmentally-friendly agriculture (Boulder Hemp Initiative Project 1994). For example, hemp was once seen with potential as a no-till or cover crop (Blanco-Canqui et al. 2011; Shekinah and Stute 2018). However, as growers gain more experience, tillage is generally recommended for optimal yields (Fike 2017). Several articles, including Ehrensing (1998) and Fortenberry and Bennett (2004) refer to the low pesticide-herbicide usage associated with growing hemp, and hemp in general has been stated to be well-suited for organic agriculture (Small and Marcus 2002). Werf et al. (1995) even claims hemp's ability to suppress weeds and soil-borne disease. Relatively low water requirements are cited by Vantreese (1997). However, the necessity of water retting, indicating high water input necessity, is noted in other hemp growing literature (Ehrensing 1998; Mussig et al. 2020). Werf et al. (1995) found that while disease was an infrequent issue, fungicide was a highly necessary input. Dwyer (1998) also associates hemp with soil-depletion issues.

Because industrial hemp has been legal for such a short period of time, industry and market frameworks are also taking time to set up and troubleshoot. This adds to perceived risk of hemp.

Institutional notions that are a given for other crops are still in fruition, such as contractual obligations, buyer reliability, and insurance policies. 2020 was the first year in which growers could include hemp in a Whole-Farm Revenue Protection (USDA 2019) insurance plan. Most recently, a pilot program for hemp insurance was launched through Multi-Peril Crop Insurance ("USDA Announces"). Hemp licensing guidelines are new, with cost and time being potential constraints for growers to gain their license (Johnson 2014). One thing that hemp literature is in nearly unanimous agreement of is that one of the greatest barriers for the future of hemp is the lack of clarity between industrial hemp and marijuana (Duppong 2009; Rogers 2012; Swanson 2014; Johnson 2018). This includes both public perception from the consumer and producer side. Another set of obstacles in the hemp market are the legal protocols. Should one's hemp crop exceed the legal 0.3% THC limit or "go hot", it is legally considered marijuana (Adesina 2020). To intensify these risks, THC testing centers are few and far between, contributing to long wait times for results. There is a lack of confirmation as to the growing conditions necessary to keep THC levels down, and mistrust of seed providers is common (Bolt 2020).

Dingha et al. (2019) found that organic farmers who have recently tried new technologies were more likely to adopt hemp, as were younger farmers. This study found education to have no significant effect on decision to adopt hemp. Although gender was included in Dingha et al. (2019)'s questionnaire, no gendered results are provided. Gender as an element in hemp literature is largely absent.

1.1.2 Risk perception

Risk and risk perception hold several definitions within the social sciences. Most economic interpretations encompass notions of an individual's recognition and judgement of a circumstance based on uncertainty. For example, Harding (1998) asks: "… how often is a particular potentially

harmful event going to occur, [and] what are the consequences of this occurrence?" Conceptions of what is considered 'risky' and to what degree are acknowledged to be influenced by culture and social context (Rappaport 1996; Cvetcovich and Earle 1991; Rosa et al. 1995). Some definitions stress a potential decrease or increase in something valuable to an individual (Blomkvist 1987; MacCrimmon and Wehrung 1986). Several studies stress the importance of deliberately mitigating risk as a business owner and farmer (Sassenrath et al. 2010; Hoag 2010).

Risk perception is at the heart of an individual's decision-making. Farming in general is typically deemed as inherently risky, due in part to the innumerable unknowns in weather, water, market, etc. (Botterill and Moazur 2004; Anderson et al. 1985; Musser and Patrick 2002). Hardwood et al. (1999) and Hoag (2010) both classify risk into five distinct categories for growers; including price and market, production, institutional, human and personal, and financial.

Instruments for measuring risk perception often use a combination of an individual's responses to a set of scenarios. For example, Hoag (2010) refers farmers to his online risk preference calculator, which asks one to pick between investment options, make decisions in the event of job loss, and more. 'Ag Survivor' is a lengthier tool for determining risk preferences, where a player is faced with various decisions in a more extensive game tree situation of uncertainty and reward (Hoag 2010). Pope et al. (2011) use a 5-question survey to determine risk aversion, applying a summation to prescribe a risk aversion score. This survey mimics a self-perceived risk-taking question from Hoag's quiz, prompting users to characterize themselves between functioning as a "risk avoider" a "real gambler" (Pope et al. 2011). This questionnaire was the blueprint for our model's individual risk perception variable.

Many individual, business, and individual-business relational factors can influence risk perception. In this study, we look to focus explicitly on the role of gender. Yordanova and

Alexandrova-Boshnakova (2011) found no gendered difference in risk perception. Similarly, Olofsson and Rashid (2011) conclude no significant difference in risk perception between men and women. However, risk literature addressing gender generally agrees that women tend to be more risk-averse than men (Jianakoplos and Bernasek 1998; Lee 2005; Jayathilake 2013; Dalborg et al. 2015). One way this is observed is in women entrepreneurs' expansion of their businesses, which they tend to do slowly, rather than quickly (Cliff 1998; Hoag et al. 2011).

1.1.3 Technology adoption

Adoption can be defined as "the decision of any individual or organization to make use of an innovation" (Frambach and Schillewaert 2002). Adoption in general is considered risky behavior (Zwarteveen 1998). Technology adoption can be considered in two main forms. The rate of adoption refers to the percentage of farmers that adopt the technology, irrespective of the extent to which it is used. Meanwhile, intensity of adoption refers to the level of use of the technology in those who have adopted (Doss and Morris 2000). In the context of crop adopting decisions, diversification of product is a risk mitigation strategy (Sassenrath et al. 2010). As such, risk-averse individuals might adopt at low intensities to start as a trial, increasing acreage as yields become more certain (Ghadim and Pannell 1999).

Conventionally, it is thought that farmers who are more risk-averse tend to be later adopters of technologies (Ghadim and Pannell 1999; Ghadim et al. 2004). Barham et al. (2013) states that the extent to which personal risk preference influences adoption depends on the crop. In addition to the individual risk perception of the farm owner, perceived risk of the new technology affects likelihood of adoption. Akudugu et al. (2012) found the cost of production technology adoption to have a negative correlation with adoption probability, although the effect was insignificant.

Similarly, Genius et al. (2013) conclude an insignificant effect of cost alone to the adoption of a new technology. However, expected net benefit from adoption has been found to play a significant role in the decision to adopt a farming technology (Robinson 1990; Mansfield 1993; Saltiel et al. 1994; Akudugu et al. 2012;). Additionally, the cost of inputs of the new technology has been found to correspond with adoption (Lee 2005). To summarize, early adopters tend to have the most to gain and least uncertainty (Barrett et al. 2010).

Sustainability-focused and international development economics literature in particular provide substantial conclusions on factors affecting technology adoption. Farmers with higher levels of education and younger farmers tend to be more likely to adopt technologies (Morris et al. 1999; Genius et al. 2013; Torres et al. 2017; Barrett et al. 2010; Lee 2005; D'Souza et al. 1993; Ghadim and Pannell 1999; Saltiel et al. 1994). However, Akudugu et al. (2012) found low likelihood to adopt in both younger and older farmers. Young farmers may lack the capital necessary to invest in new technologies, while older farmers are less willing to change behavior. Thus, a quadratic relationship between age and adoption might be observed. Race and ethnicity are largely absent as a variable in adoption literature. However, Bandiera and Rasul (2006) found in their case study that a farmer's religion influences adoption decisions; this may function in a similar way to race and/or influence social networks. Additionally, Torres and Marshall (2018) found that growers who were non-white were more likely to terminate their use of an adopted technology.

Doss and Morris (2000) found household size to have a positive effect on adoption; however, the variable was interpreted as a measure of labor availability rather than by number of dependents. A business's status as a family farm might also influence adoption rates, given that family firms are often observed to have different goals from non-family businesses (Chrisman et

al. 2012; Haynes et al. 2020). For example, a farm owner's lack of intention to expand or make more income than feeds the family might indicate lower motivation to adopt new technologies. In particular, copreneurs have been found to regard their business as a "way of life" rather than an avenue for income (Fitzgerald and Muske 2002). Again, this might imply lower propensity to adopt. Perceived success in general is critical to understanding a business owner's goals, which in both family and non-family firm contexts can differ from objective measures such as income or growth (Walker and Brown 2004). As such, this measure would likely influence adoption decision-making behavior.

Access to information is noted heavily in technology adoption literature. This might come in a formal capacity, such as interaction with Extension services, government farm programs, or NGO programs (D'Souza 1993; Morris and Doss 1999; Bandiera and Rasul 2006; Akudugu et al. 2012; Genius et al. 2013; Saltiel et al. 1994). Meanwhile, D'Souza et al. (1993) found that a farmer's participation in farm commodity programs had insignificant effect on adoption rates in the case of sustainable agricultural practices. Information access might also be informal, via a farmer's network. Farmers with social networks who have adopted a technology are more likely to adopt themselves (Ghadim and Pannell 1999; Frambach and Schillewaert 2002; Genius et al. 2013). Furthermore, a closer social connection, or a higher the network tier, indicates a higher likelihood of adoption (Bandiera and Rasul 2006). Adoption is largely found to be negatively influenced by years making farm-related decisions or years of experience (Barham et al. 2013; Paustian and Theuvsen 2017; Torres et al. 2017).

Farm size has been found to influence adoption decisions. Larger acreages indicate higher probability to adopt (McNamara et al. 1991; Abara and Singh 1993; Feder et al. 1985; Fernandez-Cornejo 1996; Morris et al. 1999). Income and sales of the farm have been found to be related to

adoption propensity (Uddin et al. 2016; Saltiel et al. 1994). A farm's number of employees has also been found to be related to an entrepreneur's decision to adopt a new technology (Morris and Doss 1999; Ghadim and Pannell 1999; Torres et al. 2017). The impact on whether or not a farmer is growing on rented land is a relatively unexplored concept in technology adoption in the US. However, Caralon (2005) declares the difficulty of new practices on rented land, with particular attention to types of rental agreements and the power dynamics between renter and landlord. Access to credit, an indicator of the ability to invest in new technologies, is also a positive indicator of technology adoption (Mohamed and Temu 2008; Obuobisa-Darko 2015).

Farmers with employment outside of the farm have been found to be less likely to adopt (D'Souza et al. 1993; Paustian and Theuvsen 2017). On the other hand, Akudugu et al. (2012) found off-farm activities to be an insignificant variable in predicting adoption likelihood. Another variable in adoption might be a knowledge gap: D'Souza et al. (1993) found that farmers who were aware of a sustainability-based issue were more likely to adopt the technology to resolve it. A farmer's previous experience with attempts at innovating has also been found to influence future adoption decisions (Ghadim and Pannell 1999). Residual feelings from negative experiences from past experiences may trigger a grower's disinterest or reluctance to adopt due to regret (Mishra and Tsionas 2020).

Organic farmers have been found to tend towards risk-neutrality, implying that they are more likely to adopt new crops (Lee 2005). Furthermore, characteristics of the crop itself can play a role in the decision to adopt. This is particularly pertinent to the case of hemp, given its relative newness legally and thus unfamiliarity to many producers. If a technology has a higher dexterity of trialability, or the ability to 'test out' a new technology, adoption rates tend to increase (Rogers 1995; Rezaei-Moghaddam and Salehi 2010). As stated earlier, many producers wish to attempt

technologies at lower intensities before deciding whether to increase usage levels. A grower's feelings and attitudes towards the new technology are also relevant. A producer with a positive attitude regarding usage of the new technology is more likely to adopt (Taylor and Todd 1995; Far and Rezaei-Moghaddam 2015); this is especially relevant to hemp. Specifically, the perceived simplicity and/or confusion levels towards the crop can impact adoption decisions (Torres et al. 2017).

1.1.4 Gender and technology adoption

Certain studies, such as Doss and Morris (2001) and Overfield and Fleming (2001) observe gender as an insignificant factor in likelihood to adopt new technologies. Yet, adoption literature has found overwhelmingly that woman farmers are less likely to adopt than farmers who are men (Kumar 1994; Doss 2001; Akudugu et al. 2012). Literature examining gender and entrepreneurship has found that the number of children in the household does affect a woman's employment status (Caliendo et al. 2009). Embrey and Fox (1997) also found that individuals with dependent children have different investment patterns than those without; however, no gendered effect is mentioned. These might imply the consequence of dependents on adoption decisions by someone who owns a farm, given the added constraint of financially providing for others. Lastly, Torres and Marshall (2018) concluded that woman growers were more likely to continue with technologies upon adoption than men. A bulk of research examining the impact of gender and technology adoption comes from cases in the low-income world, in particular sub-Saharan Africa. This article contributes to the literature by examining the relationship between gender and adoption in the United States.

1.2 Objective of this thesis

The relatively recent re-introduction of legalized industrial hemp to US growers provides us with a current, ongoing case with which to investigate the factors that lead to the adoption of a new crop. This thesis seeks to explore the relationships between risk, gender, and social networks with the adoption of industrial hemp.

1.3 Hypotheses

Risk and technology adoption literature indicate that since new technologies are risky, growers who seek risk tend to be earlier adopters of new technologies.

Hypothesis 1: Growers who are more risk-loving are more likely to have grown hemp.

Furthermore, risk literature tells us that women tend to be more risk-averse than men. Therefore, women tend to be later adopters of technologies and may be less likely to have adopted a new crop. Research on gender and technology adoption primarily comes from development literature. However, we believe this trend to also be relevant in the Midwestern US.

Hypothesis 2: Woman growers are less likely than men to have grown hemp.

Finally, adoption literature asserts the influence of social networks on the decision to adopt new technologies. Similar to Hypothesis 2, such work tends to come out of development literature with focus on sub-Saharan Africa in particular, but we believe these trends to also apply in the Midwestern US.

Hypothesis 3: Growers with friends or family who grow hemp are more likely to have grown hemp than those without family or friends that grow hemp.

1.4 Contributions

Hemp literature almost unanimously calls for expanded research and dialogue between private, public, and educational institutions on the economic future of industrial hemp (Small and Marcus 2002; Johnson 2014; Cherney and Small 2016). This thesis will provide those in the hemp supply-chain with an improved sense of producers' individual demographics, business characteristics, sense of risk, and social networks. These implications will also be crucial in negotiating the current ambiguity in legal hemp regulation. Understanding what factors influence the decision to grow hemp will benefit hemp policymakers at the state and federal level. Furthermore, this thesis will be a relevant scholarly contribution to academic researchers and extension specialists, who are still determining the most comprehensive approach to assisting local hemp farmers.

Research analyzing the effect of gender on technology adoption is virtually absent in high income countries. As noted in section 1.3 and referenced in the literature review, the concept is explored more frequently in development studies on communities in low income countries. This thesis contributes to the literature in its stress of gender in the decision to adopt hemp, a relatively new technology. Additionally, industrial hemp as a subject is relatively new to today's American growers and policymakers.

This thesis also addresses the impact of financial dependents on a farmer's decision to adopt. The presence of dependent children of a young age has been implemented in gender and entrepreneurship literature; we chose to extend this question to individuals of any age who are dependent on the farmer. This might include older children or the elderly. Furthermore, this study addresses whether or not growers own or rent land, a less explored subject in agriculture-adoption literature.

Finally, we improve on Hoag (2010) and Pope et al. (2011)'s five-part risk quiz. A reliability analysis is run on these questions to assess how well-related they are as a scale. Scores from the Cronbach, rather than a sum scale, are then used to create a risk perception variable in the regression analysis.

CHAPTER 2. DATA AND METHODS

2.1 Data collection

The survey followed general frameworks from past literature. Elements of note include use of a revised version of the risk preference quiz from Pope et al. (2011), as well as a subjective/self-perceived success inquiry. Rented land's relationship to technology adoption is a relatively under-explored strain of literature (Caralon 2005), one we included with our questions on rental agreements and the landlord's perceived receptivity to hemp-growing. We also asked farm owners for the number of people who depend on them financially, a concept that is prominent in entrepreneurship literature, but not yet caught on for farm owners specifically.

An online Qualtrics survey was distributed via email to a total sample of 56,585 crop growers in the Midwestern United States. Potential respondents were informed that expected time to complete the survey was 15 minutes, and that the first 200 respondents would receive a code for a $5 Amazon gift card. The survey was comprised of ten sections, as well as a general Extension help inquiry. For the first 200 respondents, a contact form was linked within the survey to receive the reward. The main sections included: screener questions, business demographics, risk questions, owner-firm relationship, hemp decisions, impression of hemp market, regulation clarity, community and resources, business financials, and owner demographics. The survey contained 108 questions, including two attention check questions. Attention check questions are commonly used in surveys both as a way to re-focus the respondent and check for data quality. Due to question branching, respondents were displayed less than 108 questions. Binary, categorical, continuous, and Likert-style questions were all incorporated into the survey.

For distribution, an initial 18,511 emails of crop farmers were purchased via Data Axle. This contact information was split equally between Kentucky, Ohio, Michigan, Indiana, and

Illinois. Personalized anonymous links to the survey were sent to a random sample of 49 contacts as a soft launch on January 19th, 2021; the next 500 contacts were sent on January 25th. The remaining 17,962 emails were sent on February 3rd. Overall, 6,858 emails bounced for a 37% bounce rate. Given the unusually high bounce rate, a replacement list of 6,855 emails was obtained from Data Axle. This replacement list was sent on March 1st, experiencing a similar bounce rate. Reminders to unfinished respondents to complete the survey were sent via email approximately every 10 days. Reminder dates and times were adjusted slightly in order to attempt improved response rates. A final reminder to the Data Axle contact lists were sent on March 22nd. The survey ran for 86 days in total. The last response was recorded on April 15th, 2021.

From the Data Axle list, 11 people refused to take the survey via email, requesting removal from the contact list. Four additional people refused by entering the survey and clicking "Disagree" to participation. From the entire Data Axle contact list, including the replacement list, 48 responses were received. Including refusals, the response rate was 0.3%.

Due to the low response rate, Purdue University Hemp Extension Specialist Marguerite Bolt forwarded an anonymous, but not personalized link to Purdue University's Hemp Listserv of 442 contacts on March 18th. The link was also distributed via the Midwest Hemp Council's online monthly newsletter, which has 275 members. In addition to these distribution channels, a list of 13,811 crop farmers' emails were also obtained from Dr. Ariana Torres, originally purchased from USFarm Data. The survey was distributed to the USFarm Data list via an anonymous link on April 8th. Including all avenues of distribution, the survey yielded 351 total responses. Out of the 351 responses, 303 came from a combination of Purdue University's Hemp Listserv, the Midwest Hemp Council's newsletter, and the USFarm Data list. We suspect that the jump in responses is due to the fact that these are self-registered contact lists. Subscribers of these lists will be more

likely to pay attention to emails about hemp and participate in a hemp-related survey. Meanwhile, the DataAxle list was a random contact list of general crop farmers. This might explain the difference in response rates between the sources.

Out the 351 total survey responses, recall that four clicked “Disagree” to participation. There were 58 datapoints with null values for the first attention-check question, and 63 null values for the second attention check question. This indicates that the respondent left the survey before completing either question. Those 63 total respondents who never got to the second question were excluded from analysis. Thus, our resulting sample size for this study is 284 completed surveys.

The survey included two attention-check questions. There were 96 failures for the first attention-check question, and 39 failures for the second attention-check question. Although previous survey work has systematically removed datapoints from respondents who failed attention-checks, Qualtrics Methodology Lab asserts that certain respondent groups may be more likely to fail such questions than others. Therefore, removing this data based on attention-check failure alone can result in bias. It is now recommended to use attention-check failure as one in many metrics for data quality, rather than as an automatic qualifier for data removal (Vannette 2017). As such, datapoints from failed attention checks were included in the analysis as responses were not statistically different from those that passed the attention checks.

2.2 Methodology

2.2.1 Dependent variable

This study investigates the likelihood, rather than intensity, of hemp adoption. Respondents were asked whether they had ever grown hemp in the screener question block of the Qualtrics survey. Note that this does not necessarily indicate that they currently possess a hemp-growing

license. Our dependent variable Hemp Grower is equal to 1 if a farmer has ever grown hemp, regardless of whether they possess a current license, and 0 if a farmer has never grown hemp.

2.2.2 Independent variables

2.2.2.1 Risk perception

This work's Risk Perception variable builds on Hoag (2010) and Pope et al. (2011)'s five-question risk quiz. The questions composing the risk quiz are shown in Table 1:

Table 1: Risk quiz as queried to survey respondents

I. *How would you describe your own risk-taking behavior?* 1. Very risk-averse 2. Risk-averse 3. Risk-neutral 4. Risk-loving
II. *You can sell your crop at three different times and not have an impact on taxable income. If given the following options, which would you choose?* 1. Sell at harvest 2. Retain until January with a 30% chance of netting an additional $0.10/bushel, 10% chance of losing $0.15/bushel, or 60% chance of netting no additional $/bushel. 3. Retain until March with a 30% chance of netting an additional $0.25/bushel, 15% chance of losing $0.35/bushel, or 55% chance of netting no additional $/bushel.
III. *Given the best and worst case potential outcomes from marketing your crop, which net return/loss prospect would you most prefer from the four listed below?* 1. $10/acre net return best case; $0/acre net return worst case 2. $35/acre net return best case; $20/acre loss worst case 3. $65/acre net return best case; $35/acre loss worst case 4. $100/acre net return best case; $75/acre loss worst case
IV. *A trusted contact of yours is putting together investors to fund a new innovative business venture. The venture could pay back more than 50 times the investment if successful. If the venture is a bust, the entire investment is worthless. Your contact estimates the chance of success is 20%. How much would you invest?* 1. Nothing 2. $1,000 3. $10,000 4. $50,000 5. $100,000 6. More than $100,000
V. *If your contact and lender each conclude that success of the venture in the above question is 60% instead of 20%, how much would you invest?* 1. Nothing 2. $1,000 3. $10,000 4. $50,000 5. $100,000 6. More than $100,000

Hoag (2010) and Pope et al. (2011) referenced the numeric values of each answer, using a summation scale to produce individual risk scores. The higher the score, the more risk-loving the respondent. Our research contributes to agricultural risk literature by running a reliability analysis on this group of questions. A Cronbach's alpha test measures how well-related a group of questions are and was used to check consistency of our risk-related questions. The formula for Cronbach's alpha is as follows:

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N-1) \cdot \bar{c}} \quad (1)$$

where N is the number of items, $\bar{c}$ is the average covariance between item pairs, and $\bar{v}$ is average variance. Schmitt (1996) proposes that low alphas can still provide useful information. However, most literature suggests that an acceptable alpha should be greater or equal to 0.7 (Taber 2017). The five risk quiz questions tested together produce an alpha of 0.62. These results indicate that the risk quiz is just adequately reliable, necessitating improvements to question design. Omitting questions I and III yielded an alpha of 0.65. We decided to omit questions I and III for our Risk Perception variable due to the characteristic differences in questions in addition to the superior alpha. We used II, IV, and V to determine the Cronbach scores for the variable risk perception. The scores can be either a sum or average of the three values at each point; we use an average for Risk Perception. This variable is scaled from 1 to 5; 1 referring to those most risk-averse and 5 being most risk-loving. The results of risk quiz question I were used for Self Risk Perception, the self-assessed risk perception variable in the model.

2.2.2.2 Culture positivity and License positivity

The Cronbach's alpha method with scores were also used to generate a Culture Positivity variable, referring to a respondent's perception of the hemp industry. Similarly, License Positivity is an indication of the respondent's attitudes towards the hemp licensing process. Both variables also scale from 1 to 5; 1 being a poor attitude and 5 being a positive attitude. The Likert-type statements used for both variables are shown in Table 2 and Table 3.

Table 2: Culture Positivity questions

Culture Positivity (α=0.69)
1. The hemp industry has a cooperative and supportive culture.
2. The hemp industry is accessible to women.
3. The hemp industry is welcoming to women.

Note: 1=Strongly disagree and 5=Strongly agree

Table 3: License Positivity questions

License Positivity (α=0.69)
1. Acquiring a hemp license is an easy-to-navigate process.
2. Acquiring a hemp license is financially affordable.
3. The hemp license acquisition process happens in a timely manner.

Note: 1= Strongly disagree and 5=Strongly agree

2.2.2.3 Other independent variables

Gender is applied via the binary variable Woman, equal to 1 if the respondent is a woman. Family in Network and Friend in Network equal 1 if the respondent has a family or friend who grows hemp, respectively. Other in Network is 1 if the farmer personally knows another farmer who grows hemp, who is not a friend or family member. None in Network, the baseline in the regression, is 1 if the respondent did not know anyone personally who grows hemp. Self Risk

Percep is the respondent's self-assessed description of their own risk-taking behavior, from very risk-averse to risk-loving.

Not White equals 0 if the farmer checked only "white", and no other options. Not White equals 1 if the farmer checked anything except "white", including if they checked white and another option. Age refers to the age of the farmer. For race, respondents were asked to check all that apply from a list of options. There are three dummy variables for education. College Grad includes 4-year college graduates and those with a graduate degree. Some College refers to those who completed some college or technical school. HS or Less includes those who have a high school diploma or GED, or never completed high school. HS or Less functions as the baseline variable in our regression. Num Dependents is an integer value for individuals, the number of people who currently depend on the respondent financially not including a spouse. Years Experience refers to how many years of farming experience the respondent has. Total Owner Experience is a sum of the years of experience shared by the owner and any co-owners.

Percent Household Income is a number from 0 to 100, referring to the percentage of the owner's household income that comes from the farm. Employment Status is a binary variable equal to 1 if the owner is fully employed in the business, and equals 0 if the owner also owns another business or works for another business. Perceived Success is the owner's response to the question: "How successful do you consider your business?", a subjective measure of success. Perceived Success is an ordinal variable scaled from 1 to 5, where 1 is not at all successful and 5 is very successful. Risk Mitigate is ordinal, referring to the degree to which they deliberately mitigate risk in their business. It is scaled from 1 to 5, at "Not at all" to "To a very great extent".

Total Acreage is the farm's total crop acreage, including land owned and rented. Total Employees is equal to the sum of the number of part-time/seasonal, full-time, and H2A employees

of the farm. Fam Bus is binary, equal to 1 if the farm is a family business. Hemp growers and non-hemp growers were branched to two different rented land-related questions. Non-hemp growers were asked whether they rent any land on which they farm from someone else; hemp growers were asked whether they rent any land on which they grow hemp from someone else. The binary variable Renter was then generated, equal to 1 if the farmer responded "yes" to their corresponding question. Row Cropper is a binary variable equal to 1 if they respondent's primary crop is a row crop (e.g. primary crop is corn or soybeans). Row Cropper equals 0 if they primarily grow specialty crops. Table 4 describes all of the above variables considered for the model.

Percent Organic is continuous and is the percentage of the farmer's current overall acreage that is certified organic. New Tech Ability 2018 and New Tech Ability 2019 refer to the extent to which the owner's farm had the ability to invest in new technologies in those years. This does not necessarily mean that they did invest in new technologies in those years. Hemp Risk refers to how risky the respondent perceives hemp-growing to be, from 1 at "Not at all risky" to 5 at "Extremely risky". Finally, Previous Diversify is how the respondent described the outcome of previous attempts at crop production diversification, had they attempted to. This is a regret-style variable, scaled from 1 at "Far worse than I had hoped" to 5 at "Far better than what I hoped".

Table 4: Variable names and definitions

Variable name	**Scale and definition**
Dependent variable	
Grown Hemp	=1 if ever grown hemp =0 if never grown hemp
Hypotheses Variables	
Woman	=1 woman =0 not woman
Family in Network	=1 if respondent has a family member who grows hemp
Friend in Network	=1 if respondent has a friend who grows hemp
Other in Network	=1 if respondent knows someone, who is not a family or friend, who grows hemp
None in Network	=1 if respondent does not personally know someone who grows hemp
Risk Perception	Owner's risk perception from scale of risk questions II, IV, and V scale of 1=risk-averse to 5=risk-loving.
Self-Risk Perception	Owner's self-assessed risk behavior scale of 1=risk-averse to 5=risk-loving
Control Variables	
Not White	Race of owner: 1= not white 0=white
Age	Owner's current age
HS or Less	1= high school graduate/GED or did not complete high school
Some College	1= 1-3 years of college; some college or technical school
College Grad	1= 4-year college graduate or graduate degree
Num Dependents	Number of people who currently financially depend on the owner, excluding a spouse
Years Experience	Years of farming experience the owner has
Total Owner Exper	Sum of years of experience by the owner and years of experience by one or more co-owners
% Household Income	Percentage of owner's household income that comes from the farm
Employment Status	1= full employment in the business 0= employment split between the business and another business, or another employer
Perceived Success	Subjective/owner-perceived success of the business: 1=not at all successful to 5= very successful
Risk Mitigate	Degree to which owner deliberately mitigates risk in the business: 1= not at all to 5= to a very great extent

Table 4 continued

Total Acreage	Farm's total crop acreage
Total Employees	Sum of the number of full-time, part-time/seasonal, and H2A employees
Fam Bus	1= farm is a family business 0=farm is not a family business
Renter	1= owner rents farmland 0=owner does not rent farmland
Row Cropper	1= primarily grows row crops
	0=primarily grows specialty crops
% Organic	Percentage of overall acreage that is certified organic
New Tech Ability 2018	Ability of the farm to invest in new technology in the year 2018: 1=not at all to 5= to a very great extent
New Tech Ability 2019	Ability of the farm to invest in new technology in the year 2019: 1=not at all to 5= to a very great extent
Hemp Risk	Perceived risk of hemp-growing: 1=not at all risky to 5= extremely risky
Previous Diversify	Regret variable; outcome of previous crop diversification if the farmer attempted to do so: 1= far worse than hoped to 5= far better than hoped
License Positivity	Positivity variable of owner's attitudes towards the hemp licensing process. Scale of: • Acquiring a hemp license is an easy-to-navigate process, 1=strongly disagree to 5=strongly agree • Acquiring a hemp license is financially affordable, 1=strongly disagree to 5=strongly agree • The hemp license acquisition process happens in a timely manner, 1=strongly disagree to 5=strongly agree
Culture Positivity	Positivity variable of owner's perception of the culture of the hemp industry. Scale of: • Hemp industry has a cooperative and supportive culture, 1=strongly disagree to 5= strongly agree • Hemp industry is accessible to women, 1=strongly disagree to 5= strongly agree • Hemp industry is welcoming to women, 1=strongly disagree to 5=strongly agree

2.3 Preliminary Data Exploration

2.3.1 Excessive missing values

In this online survey, a majority of questions did not force responses from respondents. A respondent was free to skip questions they did not desire to answer. Thus, some questions received fewer responses and resulted in null values for the variable at that datapoint. When a variable with a null value at a particular datapoint is included in a regression, all corresponding datapoints are removed from analysis. Thus, excessive null values in a variable can drive down sample size in a regression, reducing accuracy. Previous Diversify was one variable in which this issue is exhibited. Out of the 284-sized sample, Previous Diversify had 62 null values. Because of this issue, it was removed from the model.

2.3.2 Multicollinearity

Multicollinearity occurs when a model's predictor variables have high correlation, indicating that they are not independent of each other. In a regression, correlated variables impact the accuracy of the coefficients, and increase the coefficients' standard errors. Thus, p-values are impacted, affecting statistical significance (Wooldridge 2009).

The mean of the variable Row Cropper is 0.98, indicating that farmers whose primary crop is a row crop account for 98% of the entire sample. In R, Row Cropper produces NAs for coefficients. Row Cropper is linearly dependent on the other variables, so it is removed from the model.

One should certainly remove an independent variable if its correlation with another independent variable exceeds .5. One should also be suspicious of independent variables with correlation close to this number. After deciding to remove a variable, which variable to keep and

which to remove is a stylistic choice. This study uses variables that based on the literature are relevant to the dependent variable Grown Hemp. Highly correlated variables are shown in tables 5 and 6. Table 5 below displays the problematic correlations between Age, Years Experience, and Total Owner Experience.

Table 5: Correlations between Age, Owner Experience, and Total Owner Experience

Variable	Age	Owner Experience	Total Owner Experience
Age	1		
Owner Experience	0.61	1	
Total Owner Experience	0.51	0.85	1

Because correlations between Age, Owner Experience, and Total Owner Experience are individually correlated with one another, we will only keep one. This model will retain Owner Experience, since our hypotheses explore whether a business owner has ever grown hemp. Next, Table 6 displays the problematic correlations between New Tech Ability 2018 and New Tech Ability 2019.

Table 6: Correlation between New Tech Ability 2018 and New Tech Ability 2019

Variable	New Tech Ability 2018	New Tech Ability 2019
New Tech Ability 2018	1	
New Tech Ability 2019	0.44	1

The correlation between New Tech Ability 2018 and New Tech Ability 2019 is not quite .5, however, it is high enough to raise suspicion. It makes sense to keep one of these variables as a self-perceived capability to invest in new technologies, relevant to the farm owner's perceived ability to adopt a new crop. This model will keep New Tech Ability 2018, since an earlier year might better encompass the state of a business during the decision to adopt hemp.

2.4 Model

This study aims to observe the relationship between predictor variables of various types and Grown Hemp, a binary variable. We seek to predict a binary outcome, or the odds ratio that Grown Hemp equals 1 based on the explanatory variables. Thus, we use a logit regression. A logit regression uses a linear model to apply coefficients to the input variables, or Betas as notated β_1, β_2, etc. Coefficients are then converted to marginal effects. Marginal effects allow for a more direct interpretation of the impact of the independent variables on the dependent variables. Our model attempts to determine the effect of each explanatory variable on the likelihood that a farmer has grown hemp, while controlling for the other independent variables.

2.4.1 Logit model

$$\Pr(\text{Grow Hemp}_i = 1)$$

$$= F(\beta_0 + \beta_1 \text{Woman} + \beta_2 \text{Family in Network} + \beta_3 \text{Friend in Network} + \beta_4 \text{Other in Network}$$
$$+ \beta_5 \text{Risk Perception} + \beta_6 \text{Self Risk Percep} + \beta_7 \text{Not White} + \beta_8 \text{Some College}$$
$$+ \beta_9 \text{College Grad} + \beta_{10} \text{Num Dependents} + \beta_{11} \text{Years Experience}$$
$$+ \beta_{12} \% \text{ Household Income} + \beta_{13} \text{Employment Status} + \beta_{14} \text{Perceived Success}$$
$$+ \beta_{15} \text{Risk Mitigate} + \beta_{16} \text{Total Acreage} + \beta_{17} \text{Total Employees} + \beta_{18} \text{Fam Bus}$$
$$+ \beta_{19} \text{Renter} + \beta_{20} \% \text{ Organic} + \beta_{21} \text{New Tech Ability 2018} + \beta_{22} \text{Hemp Risk}$$
$$+ \beta_{23} \text{Culture Positivity} + \beta_{24} \text{License Positivity} + \varepsilon_i) \quad (2)$$

with ε_i as the error term. The cumulative logistic distribution is

$$F(z) = {e^z}/{1 + e^z} \quad (3)$$

where z is the sum of our betas and error term. Table 7 displays the hypothesized sign for each independent variable in the model. If a predictor variable's coefficient is positive, it indicates that a higher predictor variable's value corresponds with a higher likelihood of Grown Hemp. A negative coefficient implies that a lower predictor variable's value corresponds with a higher likelihood of Grown Hemp.

Table 7: Predicted signs on coefficients

Variable name	**Predicted coefficient sign**
Woman	-
Family in Network	+
Friend in Network	+
Other in Network	+
Risk Perception	+
Self Risk Percep	+
Not White	-
Some College	+
College Grad	+
Num Dependents	-
Years Experience	-
% Household Income	-
Employment Status	+
Perceived Success	-
Risk Mitigate	-
Total Acreage	+
Total Employees	+
Fam Bus	-
Renter	-
% Organic	+
New Tech Ability 2018	+
Hemp Risk	-
Culture Positivity	+
License Positivity	+

We suspected that as a grower's likelihood of adopting hemp may peak once they reach a certain year of experience. Since a quadratic relationship was predicted, we tried squaring Years Experience in the model. However, the squared term was not significant. Thus, we removed the squared term and ran the regression as shown in equation 2.

CHAPTER 3. RESULTS AND DISCUSSION

3.1 Descriptive statistics

Table 8: Descriptive statistics

Variable name	Mean (n=284)	Std. Deviation
Grown Hemp	0.74*	0.44
Woman	0.19*	0.41
Family in Network	0.33*	0.47
Friend in Network	0.47*	0.49
Other in Network	0.49*	0.50
Risk Perception	2.86	0.77
Self Risk Percep	2.25	0.77
Not White	0.44*	0.49
Some College	0.37*	0.48
College Grad	0.32*	0.47
Num Dependents	2.69	1.86
Experience (years)	14.78	13.70
% Household Income	72.76	23.23
Employment Status	0.66*	0.48
Perceived Success	3.61	0.88
Risk Mitigate	3.00	0.84
Total Acreage	650.39	1403.62
Total Employees	32.23	45.89
Fam Bus	0.62*	0.49
Renter	0.63*	0.48
% Organic	56.81	29.49
New Tech Ability 2018	3.04	0.90
Hemp Risk	2.72	0.82
License Positivity	3.06	0.65
Culture Positivity	3.41	0.66

*Mean= percentage of datapoints equal to 1

General descriptive statistics for each variable in the model are shown in Table 8. Observe that 74 percent of the sample has grown hemp before. Only 19 percent of respondents overall were women. Initially, this number was thought to be too low for analysis, especially given Woman's place as a hypothesis variable in this thesis. However, only 36 percent of all U.S. growers, and 3.6 percent of U.S. row croppers are women (USDA 2017, p. 62, p. 68). Thus, our sample accurately reflects the overall population in terms of gender. Forty-four percent of our sample was not white. This starkly contrasts the most recent US Census of Agriculture, which states that 95 percent of U.S. farmers are white (USDA 2017).

We notice the difference between average self-perceived risk perception, Self-Risk Percep and the average of our derived variable Risk Perception. This implies that as a whole, people perceived themselves to be more risk-averse compared to how they may actually behave given certain decision-making scenarios. Average response to whether growers deliberately mitigate risk in their business was 3 on a scale of 1 to 5, which falls at "To a moderate extent" on our Likert-type scale.

Average total acreage for our sample was 650.39, compared to an overall US average farm size of 444 acres (USDA 2020). Our sample may have slightly higher acreages due to their location in the Midwest. Correspondingly, it also reflects the high percentage of row crop farmers in our sample, who tend to maintain higher acreages than other farmers. Almost 96 percent of all farms in the US are family farms, compared to 62 percent of our sample. Such a difference may be due in part to divergent definitions of a family business. The USDA defines a family business as "any farm organized as a sole proprietorship, partnership, or family corporation" (USDA). This likely encompasses a far larger group than those who would respond "Yes" to our query: "Is your farm a family business?" Next, Table 9 provides average values for each variable, disaggregated by

Table 9: Hemp VS. non-hemp grower descriptive statistics

Variable name	**Grown hemp mean (N=210)**	**Not grown hemp mean (N=74)**
Woman	0.14	0.31*
Family in Network	0.43	0.42***
Friend in Network	0.53	0.22***
Other in Network	0.53	0.38*
Risk Perception	3.07	2.23***
Self Risk Percep	2.21	2.39
Not White	0.57	0.07***
Some College	0.36	0.39
College Grad	0.32	0.34
Num Dependents	2.87	2.22*
Years Experience	10.78	26.33***
% Household Income	75.85	63.67**
Employment Status	0.65	0.67
Perceived Success	3.56	3.77$^{\tau}$
Risk Mitigate	2.99	3.03
Total Acreage	688.55	546.03
Total Employees	40.70	9.23***
Fam Bus	0.57	0.76**
Renter	0.69	0.43**
New Tech Ability 2018	3.14	2.74**
Hemp Risk	2.56	3.18***
% Organic	59.81	46.07*
License Positivity	3.09	2.99
Culture Positivity	3.41	3.40

*$^{\tau}$p<.1,*p<.05, **p<.01, ***p<.0001; t test shows difference in means.*

those who have grown hemp and those who have not grown hemp. A standard two-sample t test was administered to the two groups, which are independent of each other. Significance on difference in means are displayed in the final column.

Table 9 provides some preliminary evidence to support our hypotheses on factors that indicate who grows hemp. Out of the sample of 284 farmers, 210 had grown hemp and 74 had not grown hemp. Fourteen percent of hemp-growers are women, compared to 31 percent of non-hemp growers being women. Hemp growers and non-hemp growers had similar percentages of people who had family members who grow hemp. However, the hemp-grower group had far larger percentages of friends and other farmers in their network who grew hemp. Mean differences in network tiers between the two groups were all significant.

The hemp-grower group perceived hemp-growing as notably less risky than the non-hemp growers. This may reflect the notion that upon adopting a crop, it is perceived as less risky. Withal, the hemp-growers Risk Perception variable indicates that they may be markedly more risk-seeking than the non-hemp growing group. Hemp-growers also reflect the trends of the overall sample in their impression of themselves as far more risk-averse than their behavior might demonstrate. However, the non-hemp growers have relatively similar levels of derived and self-perceived risk perception; in fact, they believe themselves to be less risk-averse than their decision-making patterns show. Non-hemp growers have a Self-Risk Percep average of 2.39, to a 2.23 average on their Risk Perception variable.

Only about five percent of farmers in the U.S. are classified as non-white (USDA 2017). However, in our sample fifty-seven percent of hemp-growers were Not White, compared to less than one percent of non-hemp growers being Not White. This may preemptively indicate that racial and ethnic minority farmers have a propensity to grow hemp. Education levels were also shown to

be relatively similar between the two groups, with the difference in means were not statistically significant. Those who have grown hemp have on average three dependents, while those who have not grown hemp have two. This difference is significant. However, it contradicts our prediction that because those without dependents have less to lose, hemp growers would have less dependents than non-hemp growers. Those who have grown hemp had 11 years of farming experience on average, compared to about 26 years of experience for those who have not. A higher average percentage of household income came from the farm for hemp-growers than non-hemp growers.

On average, hemp growers had far more employees than non-hemp growers. They also had a higher mean total acreage, but the difference was not significant. Family businesses composed a higher percentage of the non-hemp growing group than the hemp-growing group. This reflects family business literature, supporting the idea that family firms might have goals other than or completely different from expansion and/or profit maximization. Thus, they may be less motivated to adopt a new crop.

As expected, on average non-hemp growers had a lower ability to invest in new technologies compared to hemp growers. Hemp-growers' average percent certified organic acreage was 30 percent higher than for non-hemp growers. This is consistent with literature on organic farming, which recognizes that organic farmers are more likely to adopt new technologies. It might also demonstrate hemp literature's assertion that hemp and organic farming are well-suited for each other. Furthermore, it reflects the positive response to opportunities for hemp growing from Sandler (2019) on organic farmers in the Midwest. Average attitudes towards culture of the hemp industry, as well as of the hemp-licensing process, were on relatively even levels between the groups. The difference in means on these positivity variables were not significant.

3.2 Regression results

Table 10: Results from logit regression for Hemp Grower

Variable name	Estimate	Marginal Effect	Std. error
Woman	-0.7357***	-0.1810	0.0510
Family in Network	0.0119**	0.1478	0.0467
Friend in Network	0.3895	0.0519	0.0422
Other in Network	0.2802	-0.0021	0.0451
Risk Perception	0.3314***	0.1731	0.0359
Self Risk Percep	0.1094	-0.0200	0.0321
Not White	0.9962***	0.3625	0.0399
Some College	0.6387	0.0736	0.0500
College Grad	0.6148	-0.0074	0.0560
Num Dependents	-0.1471**	-0.0364	0.0115
Years Experience	-0.1697**	-0.0066	0.0022
% Household Income	0.2925	0.0014	0.0011
Employment Status	-0.4125	-0.0393	0.0461
Perceived Success	0.4320	-0.0088	0.0243
Risk Mitigate	0.1646	0.0206	0.0238
Total Acreage	0.0412**	0.00004	0.00001
Total Employees	0.0837***	0.0019	0.0005
Fam Bus	0.3428	-0.02002	0.0442
Renter	0.2092**	0.1315	0.0461
% Organic	0.1011**	0.0023	0.0009
New Tech Ability 2018	-0.3228	0.0076	0.0284
Hemp Risk	-0.2276*	-0.0562	0.0279
License Positivity	0.4520	0.0247	0.0383
Culture Positivity	0.3572	-0.0715$^{\tau}$	0.0397

$^{\tau}$p<.1,*p<.05, **p<.01, ***p<.0001

The logit regression confirms all three hypotheses. The coefficient on Woman is negative and statistically significant, meaning that women have a lower likelihood of being hemp-growers. The coefficient on Risk Perception is positive and statistically significant, indicating that all else equal, growers who are more risk-seeking have a higher likelihood of growing hemp. The coefficient of Friend in Network is positive and Other in Network is negative coefficient, but these variables are not statistically significant in the model. However, Family in Network's coefficient is positive and statistically significant. Thus, we state that having a family member who grows hemp indicates a higher likelihood for the farmer themselves to grow hemp. As an "or" statement was used between family or friends in hypothesis 3, we can conclude that hypothesis 3 was confirmed. Table 10 displays the results for the logit regression.

We fail to reject Hypothesis 1 that more risk-seeking farmers were more likely to have grown hemp. This is consistent with the general findings from adoption literature, which states that more risk-averse individuals tend away from newer technologies (Ghadim and Pannell 1999; Ghadim et al. 2004). Hemp Risk's negative coefficient also indicates that those who perceive hemp as less risky are more likely to adopt it, confirming the works of Barham et al. (2013) and Barrett et al. (2010). Whether or not a grower indicated that they deliberately mitigate risk on their farm was an insignificant variable.

Hypothesis 2's implication of women as less likely to grow hemp confirms the general agreement in adoption literature (Kumar 1994; Doss 2001; Akudugu et al. 2012). Our regression shows the gender variable as significant at less than the 0.05 level. This is contrary to the findings of Doss and Morris (2001) and Overfield and Fleming (2001), who found gender to have no significant effect in likelihood to adopt new technologies. This also contributes to Cliff (1998) and Hoag et al. (2011)'s statements that woman entrepreneurs tend to expand their businesses more

slowly than men; in this context, hemp adoption may be interpreted as an expansion decision in the sense of expanding which crops the farmer grows. As discussed in the literature review, there is disagreement amongst researchers on the influence of gender on risk preference. Table 11 shows the averages for Risk Perception and Self Risk Perception as disaggregated by gender.

Table 11: Risk preference averages by gender

Variable	Mean for Women	Mean for Men	T-test	P-value
Risk Perception	2.55	2.94	-2.92	0.005
Self-perceived risk perception	2.19	2.27	-0.59	0.552

Note that differences in means do not control for other variables as a regression would. However, there is some evidence to support the claim that on average, women do tend to be more risk-averse than men. In particular, the difference in means for our quiz-derived Risk Perception variable is significant. This evidence contradicts the findings of Yordanova and Alexandra-Boshnakova (2011), as well as Olofsson and Rashid (2011), who found no significant gendered difference in risk perception. However, our findings contribute to the majority notion in risk literature that women do tend towards risk-aversion when compared to men (Jianakoplos and Bernasek 1998; Lee 2005; Jayathilake 2013; Dalborg et al. 2015).

Hypothesis 3's confirmation supports Bandiera and Rasul (2006)'s claims that individuals with higher network tiers who have adopted a new technology are more likely to themselves decide to adopt. In this case, both Family in Network and Friends in Network did have a positive coefficient, indicating that these network tiers correspond with a higher likelihood for a farmer to themselves grow hemp. However, Friends in Network alone was not significant. Ghadim and

Pannell (1999) and Frambach and Schillewaert (2002) both argue that the network tier effect has to do with acceptance and decreasing uncertainty of an innovation. Meanwhile, Genius et al. (2013) claims that the spread of information is a key explanation for such results.

Our race variable was statistically significant in the regression. As recognized in the literature review, race and ethnicity are under-examined in adoption work. This thesis concludes that racial and ethnic minority farmers are more likely to have grown hemp. Although Torres and Marshall (2018) found that non-white growers were more likely to terminate use of an adopted technology, there is little literature to compare these findings with. Education had no significant effect on the decision to grow hemp, mimicking the results from Dingha et al (2019). Development-focused literature finds overwhelmingly that higher levels of education positively correspond with the decision to adopt (Morris et al. 1999; Doss and Morris 2000; Torres et al. 2017). However, this may be one way in which our case differs from cases in low-income countries. The number of people financially dependent on a farm owner is a factor that was carried over from gendered entrepreneurship literature, although Doss and Morris (2000) did use household size as an indicator of labor availability. Given the added pressures and constraints of financially caring for another person, we expected Num Dependents to have a negative relationship to Grown Hemp. This prediction holds true to our regression, contradicting our preliminary findings from the hemp-non hemp disaggregated data. The regression also shows a negative coefficient on Years Experience, confirming the literature's agreement that years of experience negatively influences likelihood of adoption (Barham et al. 2013; Paustian and Theuvsen 2017).

Percent of household income coming from the farm is shown to have a positive coefficient but is not statistically significant. This challenges our assumption that the higher this percentage is, the less willing an owner might be to take a risk and adopt a new technology. Employment

Status had a negative coefficient, which parallels the findings of D'Souza et al. (1993) and Paustian and Theuvsen (2017). However, the variable was not statistically significant in the regression, echoing Akudugu et al. (2012).

Total acreage and hemp-growing were shown to have a positive relationship, as were total employees. These findings are consistent with the literature (Abara and Singh 1993; Feder et al. 1985; Morris and Doss 1999; Ghadim and Pannell 1999; Torres et al. 2017). We hypothesized that family farms would be less likely to adopt a new crop, given that family firms in particular tend to demonstrate varied goals from profit-maximization. Thus, they may have a lower motivation to adopt hemp (Chrisman et al. 2012; Haynes et al. 2020). The regression did show a negative coefficient for Fam Bus; however, the result was not significant. Similarly, Perceived Success of the business was also negative, but not significant.

The relationship between land ownership and adoption is a less-explored branch of literature. We predicted a negative relationship between Renter and Grown Hemp, given the demonstrated issues with introducing new practices on rented land (Caralon 2005). However, land renters were found to be more likely to grow hemp, and the result was significant. We anticipate that this may have to do with the negative relationship between age and adoption. Young people are more likely to adopt hemp. However, they also tend to have less funds with which to purchase land, so they may rent at higher rates than older people. The outcome is a positive relationship between land renting and hemp adoption.

Higher percentages of certified organic land correspond to a higher likelihood to adopt hemp. This complements the significantly higher mean percent organic acreage in hemp growers than non-hemp growers from Table 9. This finding is also in line with Lee (2005)'s assertion that

organic farmers are more likely to adopt new crops, and the assumption that hemp is suitable for organic agriculture (Small and Marcus 2002).

Although the average owner's perception in their ability to invest in new technologies was far higher, and significant, for hemp growers than for non-hemp growers, the variable was not significant in the regression model. Our positivity variable on the hemp licensing process was also not significant, reflecting our preliminary averages from Table 9. However, the positivity variable on hemp industry culture is significant in the regression. We expected that a more positive perception of the culture would lead to higher likelihood to adopt. However, the opposite was found. This may be an indication that there is a problem with our Culture Positivity variable. We believe that this has to do with the survey questions used to create the variable. Two out of the three questions referred to the admittance of women into the hemp industry. However, 81 percent of respondents were men. Thus, our Culture Positivity variable would be less relevant to their decision to adopt and subsequent entrance into the hemp industry.

3.3 Issues and limitations

Several strains of development literature stress the importance of differentiating between land access and ownership in farming. Women may be in decision-making positions on a farm which they do not own, affecting adoption decisions (Doss and Morris 2000). In our case, this might translate to gathering demographic and perception information about co-owners or managers. For example, if the owner responding to our survey was a man, but the co-owner was a woman, our gendered understanding of the adoption may be limited. In our findings, it may have been the case that women or men were in varying decision-making positions on the farm; this limits our understanding of gender's place in the decision to adopt hemp.

Additionally, our understanding of adoption in this case is limited in that it only addresses likelihood of adoption as a binary variable. We intended to investigate intensity of adoption, interpreted as the number of acres on which hemp is grown. From here, the possibility of investigating hemp acreage to total acreage ratios, in addition to percent growth in hemp acreage year-to-year was anticipated. Trialability is an important concept in risk perception and technology adoption literature (Ghadim and Pannell 1999). Our survey did query respondents on indoor and outdoor hemp acreage for years 2018, 2019, and 2020. Unfortunately, this analysis was unfeasible due to the low response rate for these questions.

CONCLUSION

The purpose of this study was to examine the individual and business-related factors that lead to the adoption of hemp. A logit model was used to assess the role of risk perception, gender, and network tiers in the decision to adopt hemp as a new crop. This thesis found that growers who are more risk-loving in their decision-making behavior had a higher likelihood of adopting hemp, as did growers with a family member who also grew hemp. Women were found to have a lower likelihood to adopt hemp. Additionally, the women in are sample were more risk-averse than men, although this statement is not necessarily ceteris paribus.

This thesis also built on the work of Hoag (2010) and Pope et al. (2011) in conducting a reliability analysis on the 5-part risk quiz. It was observed that the five questions together are not quite well-related as a set. Additionally, a deviation between these risk quiz results and self-assessed risk perception was observed.

This thesis provides a 'real time' case with which to observe why a farmer may or may not decide to adopt a new crop. The important role of social networks and network tiers, piloted by development literature, is demonstrated in a high-income country context. A community-based approach will thus be practical to policy and Extension services who wish to grow the number of hemp farmers. In particular, focusing on spreading hemp growing between family members would be the most constructive strategy as shown in this thesis.

Policymakers and Extension services would do well to take note of the pronounced demographical characteristics of hemp-growers. Women's risk-aversion and propensity against hemp adoption heeds the attention of the industry. This may come in the form of woman-led and woman-oriented knowledge-sharing platforms and social media campaigns. Finally, our research

showed that those with financial dependents were less likely to grow hemp. A financially dependent person, such as a child or elderly parent, likely also requires a certain amount of time for care. Thus, Extension services and policy workers might also make hemp information or skills-training sessions more time-flexible for those who care for others, and for women in particular.

Our research also showed that racial and ethnic minorities have a stronger likelihood of growing hemp than white people. Thus, it is only sensible to orient hemp-growing resources towards people of color, as well as making the industry more welcoming to non-white people. This thesis's research occurs at the same time as a national conversation on the situation of those incarcerated for marijuana possession, overwhelmingly comprised of black men. These findings are a particularly pertinent chapter in the long history between race and hemp. President Nixon's aforementioned Controlled Substance Act of 1970 was a landmark of the ongoing, highly racialized "War on Drugs" (Chin 2002). Nixon's deliberate rhetoric operated against people of color, associating Black and Latinx people in particular with hemp/marijuana. Similarly, the anti-Latinx policies and rhetoric of the 1970's are reflected today in former President Obama's mass deportation orders, as well as former President Trump's "bad hombres" remarks. It is clear that hemp/marijuana has been historically used as a social weapon against people of color. It is ironic and striking that now that hemp is desirable by primarily white institutions such as the US government, communities of color are leading the way to revitalize it.

APPENDIX

Appendix 1: Purdue University Potentials for Hemp Production Survey

IRB Disclaimer:

A Comprehensive Assessment of Industrial Hemp As A Potential Crop for Farmers

Key Information: Please take time to review this information carefully. This is a research study. Your participation in this study is voluntary which means that you may choose not to participate at any time without penalty or loss of benefits to which you are otherwise entitled. You may ask questions to the researchers about the study whenever you would like. If you decide to take part in the study, you will be asked to click "Agree" in place of signing a consent form, be sure you understand what you will do and any possible risks or benefits. Consumer demand for hemp has been growing in recent years. We are conducting this survey of both conventional and organic growers as well as processors to better understand your production and marketing challenges in this rapidly evolving market.

What is the Purpose of this study? You are being asked to participate in this study because you own a business. We would like to enroll 500 people in this study.

What will I do if I choose to be in this study? You will be asked to respond to a series of questions. Data will be collected based on the answers that you provide to each question.

How long will I be in the study? The total time commitment to participate in this study is 10-15 minutes.

What are the possible risks or discomforts? The risk level is minimal and no greater than you would encounter in daily life or during the performance of routine physical or psychological exams or tests. Breach of confidentiality is always a risk with data, but we will take precautions to minimize this risk as described in the confidentiality section.

Are there any potential benefits? There are no anticipated direct benefits to participants. The benefits are to farmers that are interested in growing hemp and policy makers that would want to decrease barriers to entry.

Will information about me and my participation be kept confidential? The project's research records may be reviewed by the study sponsor/funding agency, Food and Drug Administration (if

FDA regulated), US DHHS Office for Human Research Protections, and by departments at Purdue University responsible for regulatory and research oversight. This study is funded by a United States Department of Agriculture NIFA Grant. Confidentiality of responses will be maintained. Only the research team will have access to the information that you provide. If any identifiable data is collected, identifiable data will be maintained for one year in a secure electronic service and then destroyed. The results will be disseminated in aggregate form through Extension presentations and publications and academic journals.

What are my rights if I take part in this study? You do not have to participate in this research project. If you agree to participate, you may withdraw your participation at any time without penalty by ending the survey.

Who can I contact if I have questions about the study? If you have questions, comments or concerns about this research project, you can talk to one of the researchers. Please contact Dr. Maria Marshall at 765-494-4268 or mimarsha@purdue.edu.

To report anonymously via Purdue's Hotline see www.purdue.edu/hotline. If you have questions about your rights while taking part in the study or have concerns about the treatment of research participants, please call the Human Research Protection Program at (765) 494-5942, email (irb@purdue.edu) or write to: Human Research Protection Program - Purdue University Ernest C. Young Hall, Room 1032155 S. Grant St., West Lafayette, IN 47907-2114

Screener Questions

SQ1

I am prepared to participate in the research study described. By choosing "agree" below, you are agreeing to participate in the survey and stating that you are 18 years of age or older.

Agree (1)

Disagree (2)

Skip To: End of Survey If I am prepared to participate in the research study described. By choosing "agree" below, you are... = Disagree

SQ2

Do you currently possess a license to grow hemp in your state?

Yes (1)

No (2)

SQ3

Have you ever grown hemp?

Yes (1)

No (2)

Business Demographics

In this section, we will be asking about your business.

BD1

Your farm is owned:

Solely owned (1)

Co-owned with one other person (2)

Co-owned with multiple people (3)

BD2

Are you married or in a marriage-like relationship?

Yes (1)

No (2)

Display This Question:

If Are you married or in a marriage-like relationship? = Yes

BD3

Is your spouse or marriage-like partner involved in the day-to-day management of your business?

Yes (1)

No (2)

Display This Question:

If Your farm is owned: = Co-owned with one other person

BD4

What is the nature of your relationship to the other owner of your business?

Spouse or marriage-like partner (1)

Other family member (Ex. sibling, parent, in-law, cousin) (2)

Business partner (3)

Other (please specify) (4)

Display This Question:

If Your farm is owned: = Co-owned with multiple people

BD5

What is the nature of your relationship to the other owner(s) of your business? Please check all that apply.

Spouse or marriage-like partner (1)

Other family member (Ex. sibling, parent, in-law, cousin) (2)

Business partner (3)

Other (please specify) (4)

BD6

What is the configuration of your business?

Sole ownership/sole proprietorship (1)

Partnership (2)

Limited Liability Corporation (LLC) (3)

Corporation (4)

Trust (5)

Other (please indicate) (6)

BD7

In what year was your business founded? *(Continous)*

BD8

For how many years have you owned your business?

(Continuous)

BD9

Not counting yourself, how many employees work for your business who are:

- ○ Full time? (1)
- ○ Part time/seasonal? (2)
- ○ H-2A (Temporary Agricultural Program employees)? (3)

Display This Question:

If If Not counting yourself, how many employees work for your business who are: Full time? Is Greater Than 0

Or Or Not counting yourself, how many employees work for your business who are: Part time/seasonal? Is Greater Than 0

Or Or Not counting yourself, how many employees work for your business who are: H-2A (Temporary Agricultural Program employees)? Is Greater Than 0

BD10

How many of your employees are family members? This includes both full and part time/seasonal.

(Continuous)

BD11

Is your farm a family business?

Yes (1)

No (2)

BD12

Please indicate what percentage of your crop acreage in **2019** was comprised of:

Hemp (1)

Soybeans (2)

Corn (3)

Wheat (4)

Other row crop (hay, cotton, barley, etc.) (5)

Specialty crops (fresh fruits, vegetables, etc.) (6)

Other (please indicate) (7)

BD13

Please indicate what percentage of your crop acreage in **2020** was comprised of:

Hemp (1)

Soybeans (2)

Corn (3)

Wheat (4)

Other row crop (hay, cotton, barley, etc.) (5)

Specialty crops (fresh fruits, vegetables, etc.) (6)

Other (please indicate) (7)

BD14

What percentage of your current overall acreage is certified organic?

(Continuous)

Display This Question:

If Have you ever grown hemp? = Yes

BD15

Do you rent any land on which you grow hemp from someone else?

Yes, I rent some of or all land that I grow hemp on. (1)

No, I own all land that I grow hemp on. (2)

Display This Question:

If Have you ever grown hemp? = No

BD16

Do you rent any land on which you grow from someone else?

Yes, I rent some or all land that I grow on. (1)

No, I own all land that I grow on. (2)

Display This Question:

If Do you rent any land on which you grow hemp from someone else? = Yes, I rent some of or all land that I grow hemp on.

BD17

What type of lease arrangement do you have?

Cash-rent [fixed cash?] (1)

Flexible cash (2)

Crop-share (3)

Other (please explain) (4)

I don't know (5)

Display This Question:

If Do you rent any land on which you grow hemp from someone else? = Yes, I rent some of or all land that I grow hemp on.

And Have you ever grown hemp? = Yes

BD18

To what degree is your landlord supportive of you growing hemp?

Not at all (1)

Slightly (2)

Somewhat (3)

Very (4)

Extremely (5)

Unsure (7)

Display This Question:

If Have you ever grown hemp? = No

And Do you rent any land on which you grow from someone else? = Yes, I rent some or all land that I grow on.

BD19

Would your landlord support you growing hemp?

Yes (1)

No (2)

I don't know (3)

Risk Questions

In this section, we will ask about how you think about risk.

RQ1

How would you describe your own risk taking behavior?

Very risk-averse (1)

Risk-averse (2)

Risk-neutral (3)

Risk-loving (4)

RQ2

You can sell your crop at three different times and not have an impact on taxable income. If given the following options, which would you choose?

Sell at harvest (1)

Retain until January with a 30% chance of netting an additional $0.10/bushel, 10% chance of losing $0.15/bushel, or 60% chance of netting no additional $/bushel. (2)

Retain until March with a 30% chance of netting an additional $0.25/bushel, 15% chance of losing $0.35/bushel, or 55% chance of netting no additional $/bushel. (3)

RQ3

Given the best and worst case potential outcomes from marketing your crop, which net return/loss prospect would you most prefer from the four listed below?

$10/acre net return best case; $0/acre net return worst case (1)

$35/acre net return best case; $20/acre loss worst case (2)

$65/acre net return best case; $35/acre loss worst case (3)

$100/acre net return best case; $75/acre loss worst case (4)

RQ4

A trusted contact of yours is putting together investors to fund a new innovative business venture. The venture could pay back more than 50 times the investment if successful. If the venture is a

bust, the entire investment is worthless. Your contact estimates the chance of success is 20%. How much would you invest?

Nothing (1)

$1,000 (2)

$10,000 (3)

$50,000 (4)

$100,000 (5)

More than $100,000 (6)

RQ5

If your contact and lender each conclude that success of the venture in the above question is 60% instead of 20%, how much would you invest?

Nothing (1)

$1,000 (2)

$10,000 (3)

$50,000 (4)

$100,000 (5)

More than $100,000 (6)

RQ6

How risky do you perceive hemp-growing to be?

Not at all risky (1)

Somewhat risky (2)

Moderately risky (3)

Very risky (4)

Extremely risky (5)

RQ7

How risky do you perceive your other crops to be?

Not at all risky (1)

Somewhat risky (2)

Moderately risky (3)

Very risky (4)

Extremely risky (5)

RQ8

To what extent do you deliberately mitigate risk in your business?

Not at all (1)

To a small extent (2)

To a moderate extent (3)

To a great extent (4)

To a very great extent (5)

Owner-Firm

In this section, we will ask about you in relation to your farm.

Display This Question:

If Your farm is owned: = Solely owned

OF1

How many years of farming experience do you have?

(Continuous)

Display This Question:

If Your farm is owned: = Co-owned with one other person

Or Your farm is owned: = Co-owned with multiple people

OF2

How many total years of experience do:

You have? *(Continuous)*

Your co-owners have (combined)? *(Continuous)*

OF3

What is your employment status relative to your business?

Full employment in the business (1)

Employment split between the business and another employer (2)

Employment split between the business and one or more other businesses (3)

OF4

On average, how many hours per week do you work for your business?

(Continuous)

OF5

Approximately what percentage of your household income comes from your farm?

(Continuous) (1)

Prefer not to answer (2)

Display This Question:

If Approximately what percentage of your household income comes from your farm? = Prefer not to answer

OF6

If you are uncomfortable providing the percentage of household income that comes from your farm, can you please indicate a range?

100% (1)

80-99% (2)

60-79% (3)

30-59% (4)

10-29% (5)

Less than 10% (6)

OF7

How successful do you consider your business?

Not at all successful (1)

Somewhat unsuccessful (2)

Neither successful nor unsuccessful (3)

Somewhat successful (4)

Very successful (5)

Hemp Decisions

In this section, we will ask about your diversification decisions.

Display This Question:

If Have you ever grown hemp? = No

HD1

Have you ever tried to diversify your crop production before?

Yes (1)

No (2)

Display This Question:

If Have you ever grown hemp? = Yes

HD2

Other than hemp, have you ever tried diversifying your crop production?

Yes (1)

No (2)

Display This Question:

If Have you ever tried to diversify your crop production before? = Yes

Or Other than hemp, have you ever tried diversifying your crop production? = Yes

HD3

How would you describe the outcome?

Far worse than I hoped (1)

Worse than I hoped (2)

About what I hoped (3)

Better than what I hoped (4)

Far better than what I hoped (5)

Display This Question:

If Do you currently possess a license to grow hemp in your state? = No

Or Have you ever grown hemp? = No

HD4

Have you ever considered growing hemp?

Yes (1)

No (2)

Display This Question:

If Have you ever grown hemp? = Yes

HD5

Are you growing hemp primarily as a diversification strategy?

Yes (1)

No (2)

HD6

Have you ever personally used a hemp-based product?

Yes (1)

No (2)

I don't know (3)

Display This Question:

If Have you ever grown hemp? = Yes

HD7

How many varieties/cultivars of hemp did you grow in 2020?

(Continuous)

Display This Question:

If Have you ever grown hemp? = Yes

HD8

How did you plant hemp this year?

_____ % from seed (1)

_____ % from cutting (2)

Display This Question:

If Have you ever grown hemp? = Yes

HD9

In what month did you plant most of your hemp crop in 2020?

(Jan to Dec)

Display This Question:

If Have you ever grown hemp? = Yes

HD10

In what month did you harvest most of your hemp crop in 2020?

(Jan to Dec)

Display This Question:

If Have you ever grown hemp? = Yes

HD11

On how much land did you grow hemp in the following years:

	Outdoor (acres) (1)	Indoor (square ft.) (2)
2018		
2019		
2020		

HD12

From your previous hemp acreage, by what percent do you expect to grow your outdoor hemp acreage:

Previous acreage to next season? (2021) *(Continuous)*

Previous acreage to 5 years from now? *(Continuous)*

Previous acreage to 10 years from now? *(Continuous)*

HD13

From your previous square footage, by what percent do you expect to grow your indoor hemp square footage:

Previous footage to next season? (2021) *(Continuous)*

Previous footage to 5 years from now? *(Continuous)*

Previous footage to 10 years from now? *(Continuous)*

Display This Question:

If Have you ever grown hemp? = Yes

HD14

Did you include hemp in your Whole-Farm Revenue Protection (WFRP) plan in 2020?

WFRP is a USDA insurance plan protecting against loss of revenue on farm commodities, under a single policy.

Yes (1)

No (2)

Did not know I could include hemp in WFRP (3)

Display This Question:

If Have you ever grown hemp? = Yes

HD15

Do you plan on including hemp in USDA's Whole-Farm Revenue Protection (WFRP) for your next growing year?

Yes (1)

No (2)

Unsure (3)

Display This Question:

If Have you ever considered growing hemp? = Yes

HD16

If you were to grow hemp, would you include it in USDA's Whole-Farm Revenue Protection (WFRP)?

Yes (1)

No (2)

Unsure (3)

Display This Question:

If Have you ever grown hemp? = Yes

HD17

I grow hemp for the purpose of (check all that apply):

Experimentation (1)

Diversification (2)

Profit (3)

Necessity (4)

Managing risk (5)

Display This Question:

If Have you ever grown hemp? = No

HD18

_____ is a primary barrier in my decision to begin growing hemp:

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Limited information(1)	○	○	○	○	○
Licensing is inaccessible (2)	○	○	○	○	○
Licensing is unaffordable (3)	○	○	○	○	○
Inputs are unaccessible (4)	○	○	○	○	○
Inputs are unaffordable (5)	○	○	○	○	○

Impression of Market

In this section, we will ask about your experience as a grower.

Display This Question:

If If On how much land did you grow hemp in the following years: 2019 - Outdoor (acres) Is Greater Than 0

Or Or On how much land did you grow hemp in the following years: 2019 - Indoor (square ft.) Is Greater Than 0

IM1

Please indicate the outcome of your **2019** hemp season in the following categories:

	Significantly worse than expected	Worse than I expected	About what I expected	Better than expected	Significantly better than expected
Input costs (1)	○	○	○	○	○
Yield (2)	○	○	○	○	○
Selling price (3)	○	○	○	○	○
Revenue (4)	○	○	○	○	○

Display This Question:

If If On how much land did you grow hemp in the following years: 2020 - Outdoor (acres) Is Greater Than 0

Or Or On how much land did you grow hemp in the following years: 2020 - Indoor (square ft.) Is Greater Than 0

IM2

Please indicate the outcome of your **2020** hemp season in the following categories:

	Significantly worse than expected	Worse than I expected	About what I expected	Better than expected	Significantly better than expected	Unsure
Input costs (1)	○	○	○	○	○	○
Yield(2)	○	○	○	○	○	○
Selling price (3)	○	○	○	○	○	○
Revenue (4)	○	○	○	○	○	○

Display This Question:

If Have you ever grown hemp? = Yes

IM3

If you were to grow hemp next season, please indicate how you predict the outcome of the following categories in relation to your **previous hemp season**:

	Far worse than the last season I grew hemp	Worse than the last season I grew hemp	About the same as the last season I grew hemp	Better than the last season I grew hemp	Far better than the last season I grew hemp
Input costs (1)	○	○	○	○	○
Yield (2)	○	○	○	○	○
Selling price (3)	○	○	○	○	○
Revenue (4)	○	○	○	○	○

IM4

If you were to grow hemp next season, please indicate how you predict the outcome of the following categories in relation to your **other crops**:

	Far worse than my other crops	Worse than my other crops	About the same as my other crops	Better than my other crops	Far better than my other crops
Input costs (1)	○	○	○	○	○
Yield (2)	○	○	○	○	○
Selling price (3)	○	○	○	○	○
Revenue (4)	○	○	○	○	○

IM5

To what extent do you think that industrial hemp as a crop is:

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Environmentally friendly? (1)	○	○	○	○	○
Sustainable? (2)	○	○	○	○	○
Resource-efficient? (3)	○	○	○	○	○
Organic? (4)	○	○	○	○	○

Display This Question:

If Have you ever grown hemp? = Yes

IM6 Were the following years a profitable hemp crop?

Display This Choice:

If If On how much land did you grow hemp in the following years: 2018 - Outdoor (acres) Is Greater Than 0

Or Or On how much land did you grow hemp in the following years: 2018 - Indoor (square ft.) Is Greater Than 0

Display This Choice:

If If On how much land did you grow hemp in the following years: 2019 - Outdoor (acres) Is Greater Than 0

Or Or On how much land did you grow hemp in the following years: 2019 - Indoor (square ft.) Is Greater Than 0

Display This Choice:

If If On how much land did you grow hemp in the following years: 2020 - Outdoor (acres) Is Greater Than 0

Or Or On how much land did you grow hemp in the following years: 2020 - Indoor (square ft.) Is Greater Than 0

	No, lost money	Broke even	Yes, profitable	Unsure
Display This Choice: *If If On how much land did you grow hemp in the following years: 2018 - Outdoor (acres) Is Greater Than 0* *Or Or On how much land did you grow hemp in the following years: 2018 - Indoor (square ft.) Is Greater Than 0* 2018 (1)	○	○	○	○
Display This Choice: *If If On how much land did you grow hemp in the following years: 2019 - Outdoor (acres) Is Greater Than 0* *Or Or On how much land did you grow hemp in the following years: 2019 - Indoor (square ft.) Is Greater Than 0* 2019 (2)	○	○	○	○

Display This Choice: *If If On how much land did you grow hemp in the following years: 2020 - Outdoor (acres) Is Greater Than 0* *Or Or On how much land did you grow hemp in the following years: 2020 - Indoor (square ft.) Is Greater Than 0* 2020 (3)	○	○	○	○

Display This Question:

If If On how much land did you grow hemp in the following years: 2019 - Outdoor (acres) Is Greater Than 0

And Have you ever grown hemp? = Yes

IM7

What was your outdoor hemp crop yield in pounds/acre in **2019**?

(Continuous) (1)

Prefer not to answer (2)

Display This Question:

If What was your outdoor hemp crop yield in pounds/acre in 2019? = Prefer not to answer

And Have you ever grown hemp? = Yes

IM8

The average yield per acre for outdoor industrial hemp is 1000 pounds. Was your yield below, about the same, or above this average?

Below (1)

About the same (2)

Above (3)

Display This Question:

If If On how much land did you grow hemp in the following years: 2019 - Indoor (square ft.) Is Greater Than 0

And Have you ever grown hemp? = Yes

IM9

What was your indoor hemp crop yield in pounds/acre in **2019**?

(Continuous) (1)

Prefer not to answer (2)

Display This Question:

If What was your indoor hemp crop yield in pounds/acre in 2019? = Prefer not to answer

And Have you ever grown hemp? = Yes

IM10

The average yield per square foot for indoor industrial hemp is 1 pound. Was your yield below, about the same, or above this average?

Below (1)

About the same (2)

Above (3)

Display This Question:

If If On how much land did you grow hemp in the following years: 2020 - Outdoor (acres) Is Greater Than 0

IM11

What was your outdoor hemp crop yield in pounds/acre in **2020**?

(Continuous) (1)

Prefer not to answer (2)

Display This Question:

If What was your outdoor hemp crop yield in pounds/acre in 2020? = Prefer not to answer

IM12

The average yield per acre for outdoor industrial hemp is 1000 pounds. Was your yield below, about the same, or above this average?

Below (1)

About the same (2)

Above (3)

Display This Question:

If If On how much land did you grow hemp in the following years: 2020 - Indoor (square ft.) Is Greater Than 0

IM13

What was your indoor hemp crop yield in pounds/square foot in **2020**?

(Continuous) (1)

Prefer not to answer (2)

Display This Question:

If Have you ever grown hemp? = Yes

And What was your indoor hemp crop yield in pounds/square foot in 2020? = Prefer not to answer

IM14

The average yield per square foot for indoor industrial hemp is 1 pound. Was your yield below, about the same, or above this average?

Below (1)

About the same (2)

Above (3)

Display This Question:

If Have you ever grown hemp? = Yes

IM15

Did you have a production contract?

Yes (1)

No (2)

Display This Question:

If Did you have a production contract? = Yes

IM16

Did your production contract ever fall through?

Yes (1)

No (2)

Display This Question:

If Have you ever grown hemp? = Yes

IM17

Did you have a marketing contract?

Yes (1)

No (2)

Display This Question:

If Did you have a marketing contract? = Yes

IM18

Did your marketing contract ever fall through?

Yes (1)

No (2)

Display This Question:

If Have you ever grown hemp? = Yes

IM19

Please indicate at what point you knew to whom you would sell hemp:

Before planting (1)

During planting (2)

After planting, before harvest (3)

During harvest (4)

After harvest (5)

Still do not know (6)

Display This Question:

If Have you ever grown hemp? = Yes

IM20

To what extent would you describe your relationship with your 2020 buyer(s) as transparent?

Not at all (1)

Slightly (2)

Moderately (3)

Very (4)

Extremely (5)

No 2020 buyer (6)

Display This Question:

If Have you ever grown hemp? = Yes

IM21

To what extent would you describe your relationship with your 2020 buyer as long-term?

Not at all (1)

Slightly (2)

Moderately (3)

Very (4)

Extremely (5)

No 2020 buyer (6)

Display This Question:

If Have you ever grown hemp? = Yes

IM22

Please indicate which statement is most relevant to your experience of growing hemp thus far:

I am seeing adequate financial returns, and plan to continue growing (1)

I am seeing adequate financial returns, but am unsure if I will continue growing (2)

I am seeing adequate financial returns, but will not continue growing (3)

I am not seeing adequate financial returns, but plan to continue growing (4)

I am not seeing adequate financial returns, but am unsure if I will continue growing (5)

I am not seeing adequate financial returns, and will not continue growing (6)

IM23

If you are paying attention, choose "Very much" for your response here.

Not at all (1)

Slightly (2)

Somewhat (3)

Very much (4)

Extremely (5)

Display This Question:

If Have you ever grown hemp? = Yes

IM24

Were tetrahydrocannabinol (THC) levels on your crop below the .3% legal limit in:

Display This Choice:

If If On how much land did you grow hemp in the following years: 2018 - Outdoor (acres) Is Greater Than 0

Or Or On how much land did you grow hemp in the following years: 2018 - Indoor (square ft.) Is Greater Than 0

Display This Choice:

If If On how much land did you grow hemp in the following years: 2019 - Outdoor (acres) Is Greater Than 0

Or Or On how much land did you grow hemp in the following years: 2019 - Indoor (square ft.) Is Greater Than 0

Display This Choice:

If If On how much land did you grow hemp in the following years: 2020 - Outdoor (acres) Is Greater Than 0

Or Or On how much land did you grow hemp in the following years: 2020 - Indoor (square ft.) Is Greater Than 0

	Yes	No
Display This Choice: *If If On how much land did you grow hemp in the following years: 2018 - Outdoor (acres) Is Greater Than 0* *Or Or On how much land did you grow hemp in the following years: 2018 - Indoor (square ft.) Is Greater Than 0* 2018 (1)	○	○
Display This Choice: *If If On how much land did you grow hemp in the following years: 2019 - Outdoor (acres) Is Greater Than 0* *Or Or On how much land did you grow hemp in the following years: 2019 - Indoor (square ft.) Is Greater Than 0* 2019 (2)	○	○
Display This Choice: *If If On how much land did you grow hemp in the following years: 2020 - Outdoor (acres) Is Greater Than 0* *Or Or On how much land did you grow hemp in the following years: 2020 - Indoor (square ft.) Is Greater Than 0* 2020 (3)	○	○

Display This Question:

If Have you ever grown hemp? = Yes

IM25

Please rank, in order, the difficulty of navigating the following aspects you have faced thus far as a grower in the hemp industry. You can drag and drop:

Suppliers (1)

Production (2)

Marketing (3)

Selling (4)

IM26

How important is your use of social media to the success of your business?

Not at all important (1)

Little importance (2)

Average importance (3)

Very important (4)

Essential (5)

Display This Question:

If Do you currently possess a license to grow hemp in your state? = Yes

Or Have you ever grown hemp? = Yes

Or Have you ever considered growing hemp? = Yes

IM27

Did you apply for a bank loan specifically for hemp growing needs in 2020?

Yes (1)

No (2)

Display This Question:

If Did you apply for a bank loan specifically for hemp growing needs in 2020? = Yes

IM28

Did you successfully get the loan?

Yes (1)

No (2)

IM29

To what degree has the COVID pandemic impacted your business in 2020?

Not at all (1)

Slightly (2)

Somewhat (3)

Very much (4)

Extremely (5)

Regulation Clarity

This section will ask about your experience with legal entities and purchasers/processors.

RC1

Please respond to the following statements on the hemp licensing process:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Acquiring a hemp license is an easy-to-navigate process. (1)	○	○	○	○	○
Acquiring a hemp license is financially affordable. (2)	○	○	○	○	○
The hemp license acquisition process happens in a timely manner. (3)	○	○	○	○	○

RC2

Please respond to the following statement(s) on legal THC levels:

Display This Choice:

If Have you ever grown hemp? = Yes

Display This Choice:

If Have you ever grown hemp? = Yes

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Government regulations on permitted THC levels for industrial hemp growing are clear. (1)	○	○	○	○	○
Display This Choice: If Have you ever grown hemp? = Yes I have a system in place to follow legal protocol should my crop "go hot" (exceed .03% THC). (2)	○	○	○	○	○
Display This Choice: If Have you ever grown hemp? = Yes My crop "going hot" has been a major concern to me. (3)	○	○	○	○	○

RC3

Please respond to the following statements on THC level testing:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Getting a hemp sample tested for THC levels is an accessible process. (1)	○	○	○	○	○
Getting a hemp sample tested for THC levels is an affordable process. (2)	○	○	○	○	○
Results from testing labs come back within a reasonable period of time. (3)	○	○	○	○	○

Display This Question:

If Have you ever grown hemp? = Yes

RC4

Please respond to the following statements regarding your purchaser/processor:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Applicable
Quality standards from purchasers/processors on hemp are clear. (1)	○	○	○	○	○	○
I am clear of my rights and responsibilities under my current processing contract. (2)	○	○	○	○	○	○

Display This Question:

If Have you ever grown hemp? = Yes

RC5

Please respond to the following statements regarding your supplier:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I trust the quality of the product received from my supplier. (1)	○	○	○	○	○
I get a good deal on product from my supplier. (2)	○	○	○	○	○
I trust the given predicted THC level of my supplier's product. (3)	○	○	○	○	○

Display This Question:

If Have you ever grown hemp? = Yes

RC6

The processor I sell to processes hemp primarily for:

Oil (1)

Seed finishing (2)

Fiber (3)

Other products (please specify) (4)

I don't know (5)

Community and Resources

This section will ask about the resources and networks available to you as a grower.

CR1

Please indicate whether you believe the following resources are useful or not useful in answering hemp-related questions:

	Useful	Not useful	I've never used this resource
Online articles or forums (1)	○	○	○
Farming cooperative (2)	○	○	○
Informal network (friends, family, neighbors, etc.) (3)	○	○	○
Farmer/grower Association (4)	○	○	○
University Extension (5)	○	○	○
Government resources (6)	○	○	○
Social media (Facebook, Instagram, LinkedIn, etc.) (7)	○	○	○

CR2

Please respond to the following statements regarding the hemp farming network/community:

Display This Choice:

If Have you ever grown hemp? = Yes

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
Display This Choice: If Have you ever grown hemp? = Yes					
My network of hemp farmers has been beneficial to my own progress. (1)	○	○	○	○	○
The hemp farming community has a cooperative and supportive culture. (2)	○	○	○	○	○
The hemp farming community is accessible to women. (3)	○	○	○	○	○
The hemp farming community is welcoming to women. (4)	○	○	○	○	○
I intend on joining or forming a hemp knowledge-sharing association within the next 5 years. (5)	○	○	○	○	○

CR3

Please respond to the following statements regarding the hemp industry as a whole:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The hemp industry has a cooperative and supportive culture. (1)	○	○	○	○	○
The hemp industry is accessible to women. (2)	○	○	○	○	○
The hemp industry is welcoming to women. (3)	○	○	○	○	○

CR4

Please select your relationship to any hemp-growers you know personally:

- Family member (1)
- Friend (2)
- Other farmer (3)
- I don't know anyone personally who grows hemp (4)

CR5

In your interactions with hemp farmers (formal or informal), about what percentage have been women?

(Continuous)

CR6

You should select "Always" for this question.

Never (1)

Seldom (2)

Sometimes (3)

Often (4)

Always (5)

Business Financials

In this section, we will ask about your business.

BF1

What is your farm's total crop acreage? This includes both land you own and land you rent from someone else.

(Continuous)

BF2

In **2020**, what was your farm operation's **total generated sales**? If unsure, please estimate to the closest $1,000.

(Continuous) (1)

Prefer not to answer (2)

Display This Question:

If In 2020, what was your farm operation's total generated sales? If unsure, please estimate to the... = Prefer not to answer

BF3

If you are not comfortable providing your farm operation's 2020 total generated sales, can you please indicate a range in which your sales fell?

Less than $10,000 (1)

$10,000 - $25,999 (2)

$26,000-$49,999 (3)

$50,000-$99,999 (4)

$100,000-249,999 (5)

$250,000-$499,999 (6)

$500,000-$999,999 (7)

$1,000,000 or more (8)

BF4

In **2020**, what was your farm operation's **total profit**? If unsure, please estimate to the closest $1,000. Profit generated annually by your farm operation:

(Continuous) (1)

I don't know yet (2)

Prefer not to answer (3)

Display This Question:

If In 2020, what was your farm operation's total profit? If unsure, please estimate to the closest $... = Prefer not to answer

BF5

If you are not comfortable providing your farm operation's 2020 total profit, can you please indicate a range in which your profits fell?

Less than $10,000 (1)

$10,000 - $25,999 (2)

$26,000-$49,999 (3)

$50,000-$99,999 (4)

$100,000-249,999 (5)

$250,000-$499,999 (6)

$500,000-$999,999 (7)

$1,000,000 or more (8)

I don't know yet (9)

BF6

To what extent did your farm have the ability to invest in new technologies in the following years? Note that this does not mean you necessarily did invest in new technologies.

	Not at all	To a small extent	To a moderate extent	To a great extent	To a very great extent
2017 (1)	○	○	○	○	○
2018 (2)	○	○	○	○	○
2019 (3)	○	○	○	○	○
2020 (4)	○	○	○	○	○

Owner Demographics

This section will ask some basic demographic questions.

OD1

Which best describes your gender?

- Man (1)
- Woman (2)
- Other gender(s) (3)

OD2

What is your current age?

(Continuous)

OD3

In what state is your business located?

(States provided)

OD4

Which of the following best describes your race? Please check all that apply.

- Black or African-American (1)
- Hispanic/Latinx (2)
- White (3)
- Asian (4)
- Middle Eastern/North African (5)
- Native American/Indigenous (6)
- Native Hawaiian or other Pacific Islander (7)
- Other (8)

OD5

What is the highest level of school you completed?

Less than high school (1)

High School Graduate or GED (2)

1-3 Year College (Some college or Technical school) (3)

4-year college graduate (4)

Graduate degree (5)

OD6

Not including a spouse, how many people currently depend on you financially? (Ex. child, parent, etc.)

(Continuous)

Extension Question

EQ1

What is the best resource that Extension can offer you?

(Text input)

REFERENCES

Abara, Isaac and S. Singh. (1993). Ethics and biases in technology adoption: The small-farm argument. *Technological Forecasting and Social Change. 43*(3-4). 289-300.

Adesina, Ifeoluwa, Arnab Bhowmilk, Harmandeep Sharma and Abolghasem Shahbazi. (2020). A Review on the Current State of Knowledge of Growing Conditions, Agronomic Soil Health Practices and Utilities of Hemp in the United States. *Agriculture. 10.*

Akudugu, Mamudu Abunga, Emelia Guo and Samuel Kwesi Dadzie. (2012). Adoption of Modern Agricultural Production Technologies by Farm Households in Ghana: What Factors Influence their Decisions? *Journal of Biology, Agriculture and Healthcare. 2*(3).

Anderson, J.R., J.L. Dillon, and J.B. Hardaker. (1985). Farmers and Risk. Invited paper presented for the theme: `Theoretical developments: farm management and organization' at the XIX International Con-ference of Agricultural Economists, 26 August-4 September, Malago, Spain.

Ash, Anne L. (1948). *Hemp—Production and Utilization.* U.S. Department of Congress.

Bandiera, Oriana and Imran Rasul. (2006). Social Networks and Technology Adoption in Northern Mozambique. *The Economic Journal. 116.* 869-902.

Barham, Bradford L., Jean-Paul Chavas, Dylan Fitz, Vanessa Ríos Salas, and Laura Schechter. (2013). The roles of risk and ambiguity in technology adoption. *Journal of Economic Behavior & Organization. 97.* pp. 204-218.

Barrett, Christopher, Michael Carter and Peter Timmer. (2010). A Century-Long Perspective on Agricultural Development. *American Journal of Agricultural Economics. 92*(2). 447-468.

Blanco-Canqui, Humberto, Maysoon M. Mikha, DeAnn R. Presley, and Mark M. Claasen. (2011). Addition of Cover Crops Enhances No-Till Potential for Improving Soil Physical Properties. *Soil & Water Management & Conservation. 75*(4).

Bolt, Marguerite. Personal communication. May 19 2020.

Boulder Hemp Initiative Project. (1994). *Industrial Hemp as a Cash Crop for Colorado Farmers.* Nederland, CO.

Caliendo, Marco, Frank Fossen, and Alexander Kritikos. (2009). Risk attitudes of nascent entrepreneurs—new evidence from an experimentally validated survey. *Small Business Economics. 32.* 153-167.

Caralon, Michael. (2005). Barriers to the Adoption of Sustainable Agriculture on Rented Land: An Examination of Contesting Social Fields. *Rural Sociology. 70*(3). 387-413.

Cherney, Jerome H. and Ernest Small. (2016). Industrial Hemp in North America: Production, Politics, and Potential. *Agronomy.*

Chin, Gabriel. (2002). Race, The War on Drugs, and the Collateral Consequences of Criminal Conviction. *Gender, Race and Justice. 253.*

Chrisman, James, Jess Chua, Allison Pearson and Tim Barnett. (2012). Family Involvement, Family Influence, and Family-Centered Non-Economic Goals in Small Firms. *Entrepreneurship Theory and Practice.*

Cochran, Mark, Tony Windham and Billy Moore. (2000). *Feasibility of Industrial Hemp Production in Arkansas.* University of Arkansas.

Cvetcovich and Earle. (1991). Special issue on 'Risk and Culture'. *Journal of Cross-Cultural Psychology.*

Dalborg, Cecilia and Yvonne von Friedrichs. (2015). Risk perception matters: why women's passion may not lead to a business start-up. *International Journal of Gender and Entrepreneurship. 7*(1). pp. 87-104.

Doss, Cheryl. (2001). Designing Agricultural Technology for African Women Farmers: Lessons from 25 Years of Experience. *World Development. 29*(12). 2075-2092.

Doss, Cheryl and Michael Morris. (2000). How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana. *Agricultural Economics. 25.* 27-39.

D'Souza, Gerard, Douglas Cyphers & Tim Phipps. (1993). Factors Affecting the Adoption of Sustainable Agricultural Practices. *Agricultural and Resource Economics Review. 22.*

Duppong, Thomas. (2009). Industrial Hemp: How the Classification of Industrial Hemp as Marijuana Under the Controlled Substances Act Has Caused the Dream of Growing Industrial Hemp in North Dakota to Go Up In Smoke. *North Dakota Law Review.*

Dwyer, Susan. (1998). The Hemp Controversy: Can Industrial Hemp Save Kentucky? *Kentucky Law Journal. 86*(4). 1143-1181.

Ehrensing, Daryl. (1998). *Feasibility of Industrial Hemp Production in the United States Pacific Northwest.* Station Bulletin 681, Agricultural Experiment Station at Oregon State University.

Embrey, Lori and Jonathan Fox. (1997). Gender Differences In The Investment Decision-Making Process. *Financial Counseling and Planning. 8*(2).

Far, Somayeh Tohidyan and Kurosh Rezaei-Moghaddam. (2015). Determinants of Iranian agricultural consultants' intentions toward precision agriculture: Integrating innovativeness to the technology acceptance model. *Journal of the Saudi Society of Agricultural Sciences. 16*. 280-286.

Feder, Gershon, Richard Just and David Zilberman. (1985). Adoption of Agricultural Innovations in Developing Countries: A Survey. *Economic Development and Cultural Change.* 33(2). 255-298.

Fernandez-Cornejo, Jorge. (1996). The Microeconomic Impact of Ipm Adoption: Theory and Application. *Agricultural and Resource Economics Review. 25*(2). 1-12.

Fike, John. (2016). Industrial Hemp: Renewed Opportunities for an Ancient Crop. *Critical Reviews in Plant Sciences. 35*(5-6). 406-424.

Fitzgerald, Margaret and Glenn Muske. (2002). Copreneurs: An Exploration and Comparison to Other Family Businesses. *Family Business Review. 15*(1).

Fortenberry, T. Randall. (2014). *Industrial Hemp: Opportunities and Challenges for Washington.* Washington State University.

Fortenberry, T. Randall and Michael Bennett. (2001). *Is Industrial Hemp Worth Further Study in the U.S.? A Survey of the Literature.* Staff Paper Series, Department of Agricultural & Applied Economics at University of Wisconsin-Madison. Madison, WI.

Fortenberry, T. Randall and Michael Bennett. (2004). Opportunities for Commercial Hemp Production. *Review of Agricultural Economics. 26*(1). 97-117.

Frambach, Ruud and Niels Schillewaert. (2002). Organizational innovation adoption: A multi-level framework of determinants and opportunities for future research. *Journal of Business Research. 55.* pp. 163-176.

Ghadim, Amir K. Abadi, David J. Pannell, and Michael P. Burton. (2005). Risk, uncertainty, and learning in adoption of crop innovation. *Journal of the International Association of Agricultural Economics. 33*(1). pp. 1-9.

Harding, Ronnie. (1998). *Environmental Decision-making: The Roles of Scientists, Engineers, and the Public.* The Federation Press. Sydney.

Haynes, George, Maria Marshall, Yoon Lee, Virginia Zuiker, Cynthia Jasper, Sandra Sydnor, Corinne Valdivia, Diane Masuo, Linda Niehm, and Renee Wiatt. (2020). Family business research: Reviewing the past, contemplating the future. *Journal of Family and Economic Issues.*

Hoag, Dana. (2010). *Applied Risk Management in Agriculture.* CRC Press.

Hoag, Dana L.K., Catherine MH Keske, and Rebecca Goldbach. (2011). Risk Individuality in Crisis Planning: the Case of Gender in American Agriculture. *Journal of Risk Analysis and Crisis Response. 1*(1).

Jayathilake, Pradana. (2013). Gender Effects on Risk Perception and Risk Behavior of Entrerprenuers at SMEs in Sri Lanka. *Asia Pacific Journal of Marketing & Management Review. 2(*2).

Jeliazkov, V.D., J. Noller, S. Angima, S. Rondon, R. Rosberg, S. Summers, G. Jones, and V. Sikora. (2019). *What is Industrial Hemp?* Oregon State University Extension Service. Oregon State University.

Johnson, Renee. (2014). *Hemp as an Agricultural Commodity.* Congressional Research Service.

Kaiser, Cheryl, Christy Cassady and Matt Ernst. (2015). *Industrial Hemp Production.* Center for Crop Diversification Crop Profile. University of Kentucky.

Keller, Nicole. (2013). The Legalization of Industrial Hemp and what it Could Mean for Indiana's Biofuel Industry. *Indiana International & Comparative Law Review. 23*(3). 555-589.

Kumar, Shubh. (1994). *Adoption of Hybrid Maize in Zambia: Effects on Gender Roles, Food, Consumption, and Nutrition.* Research Report 100 of the International Food Policy Research Institute. Washington, D.C.

Lane, Luke T. (2017) An Assessment of Economic Considerations for Industrial Hemp Production. *Agricultrual Economics and Agribusiness Undergraduate Honors Theses. 6.*

Lee, David. (2005). Agricultural Sustainability and Technology Adoption: Issues and Policies for Developing Countries. *American Journal of Agricultural Economics. 87*(5). 1325-1334.

Mansfield, Edwin. (1993). The diffusion of flexible manufacturing systems in Japan, Europe and the United States. *Management Science. 39*(2). pp. 135-253.

Mark, Tyler, Jonathan Shepherd, David Olson, William Snell, Susan Proper, and Suzanne Thornsbury. (2020). *Economic Viability of Industrial Hemp in the United States: A Review of State Pilot Programs.* Economic Information Bulletin Number 217, Economic Research Service. United States Department of Agriculture.

Mark, Tyler, and Snell Will. (2019). *Economic Issues and Perspectives for Industrial Hemp.* "Industrial Hemp as a Modern Commodity Crop". Print.

McNamara, Kevin, Michael Wetzstein and G. Douce. (1991). Factors Affecting Peanut Producer Adoption of Integrated Pest Management. *Review of Agricultural Economics. 13*(1). 129-139.

Mishra, Ashok and Mike Tsionas. (2020). A Minimax Regret Approach to Decision Making Under Uncertainty. *American Journal of Agricultural Economics. 71*(3).

Mohamed, Khalid and Andrew Temu. (2008). Access to Credit and its Effect on the Adoption of Agricultural Technologies: The Case of Zanzibar. *African Review of Money Finance and Banking.* 45-89.

Morris, Michael L. and Cheryl R. Doss. (1999). How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana. *American Agricultural Economics Association.*

Musser, Wesley and George Patrick. (2002). How Much does Risk Really Matter to Farmers? *Natural Resource Management and Policy.* pp. 537-556.

Mussig, Jorg, Stefano Amaducci, Alain Bourmaud, Johnny Beaugrand and Darshil Shah. (2020). Transdisciplinary top-down review of hemp fibre composites: From an advanced product design to crop variety selection. *Compos. Part C Open Access* 2020, 100010.

Obuobisa-Darko, Ernest. (2015). Credit Access and Adoption of Cocoa Research Innovations in Ghana. *Research on Humanities and Social Sciences. 5*(12).

Olofsson, Anna and Saman Rashid. (2011). The White (Male) Effect and Risk Perception: Can Equality Make a Difference? *Risk Analysis. 31*(6).

Overfield, Duncan and Euan Fleming. (2001). A Note on the Influence of Gender Relations on the Technical Efficiency of Smallholder Coffee Production in Papua New Guinea. *Journal of Agricultural Economics. 52*(1). 153-156.

Paustian, Margit and Ludwig Theuvsen. (2017). Adoption of precision agriculture technologies by German crop farmers. *Precision Agriculture. 18.* 701-716.

Rappaport, Roy. (1996). Risk and the Human Environment. *Annals of the American Academy of Political and Social Science. 545*(1). pp. 64-74.

Rezaei-Moghaddam, Kurosh and Saeid Salehi. (2010). Agricultural specialists' intention toward precision agriculture technologies: Integration innovation characteristics to technology acceptance model. *African Journal of Agricultural Research 5*(11). 1191-1199.

Robbins, Lynn, Will Snell, Greg Halich, Leigh Maynard, Carl Dillon, and David Spalding. (2013). *Economic Considerations for Growing Industrial Hemp: Implications for Kentucky's Farmers and Agricultural Economy.* University of Kentucky.

Robinson, William. (1990). Product Innovation Start-Up Market Share Performance. *Management Science. 36*(10). pp. 1137-1292.

Rogers, Vanessa. (2012). The Future of Hemp in Kentucky. *Kentucky Journal of Equine, Agriculture, & Natural Resources Law. 4*(2). 479-499.

Saltiel, John, James Bauder, and Sandy Palakovich. (1994). Adoption of Sustainable Agricultural Practices: Diffusion, Farm Structure, and Profitability. *Rural Sociology. 59*(2). 333-349.

Sandler, L. (2019). *An Agronomic and Social Perspective of Industrial Hemp Adoption by Organic Farmers in the Midwest.* [Unpublished doctoral dissertation]. Purdue University.

Sassenrath, G.F., J.M. Halloran, D. Archer, R.L. Raper, J. Hendrickson, P. Vadas and J. Hanson. (2010). Drivers Impacting the Adoption of Sustainable Agricultural Management Practices and Production Systems of the Northeast and Southeast United States. *Journal of Sustainable Agriculture.*

Schluttenhofer, Craig and Ling Yuan. (2017). Challenges towards Revitalizing Hemp: A Multifaceted Crop. *Trends in Plant Science. 22*(11).

Schmitt, N. (1996). Uses and abuses of coefficient alpha. *Psychological Assessment. 8*(4).

Shahzad, Asim. (2011). Hemp fiber and its composites—a review. *Journal of Composite Materials 46*(8). 973-986.

Shekinah, D. Esther and James K. Stute. (2018). Sunn Hemp: A Legume Cover Crop with Potential for the Midwest? *Sustainable Agriculture Research. 7*(4).

Small, Ernest and David Marcus. (2002). *Hemp: A New Crop with New Uses for North America.* Trends in new crops and uses. ASHS Press, Alexandria, VA.

Swanson, Thaddeus. (2014). Controlled Substances Chaos: The Department of Justice's New Policy Position on Marijuana and What It Means for Industrial Hemp Farming in North Dakota. *North Dakota Law Review.*

Taber, Keith. (2017). The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education. *Research in Science Education.* 48: 1273-1296.

Taylor, Shirley and Peter Todd. (1995). Understanding Information Technology Usage: A Test of Competing Models. *Information Systems Research 6*(2). 144-176.

Thompson, Eric, Mark Berger and Steven Allen. (1998). Economic Impact of Industrial Hemp in Kentucky. *Center for Business and Economic Research.*

Torres, Ariana, Maria Marshall, Corinne Alexander, and Michael Delgado. (2017). Are local market relationships undermining organic fruit and vegetable certification? A bivariate probit analysis. *Agricultural Economics. 48*(2). 197-205.

Torres, Ariana and Maria Marshall. (2018). Identifying Drivers of Organic Decertification: An Analysis of Fruit and Vegetable Farmers. *HortScience. 53*(4). 504-510.

Uddin, M., A. Dhar and M. Islam. (2016). Adoption of conservation agriculture practice in Bangladesh: Impact on crop profitability and productivity. *Journal of the Bangladesh Agricultural University. 14*(1).

USDA. "Family Farms". National Institute of Food and Agriculture. https://nifa.usda.gov/family-farms.

USDA. (2000). *Industrial Hemp in the United States: Status and Market Potential.* Washington, D.C.

USDA. (2017). *Census of Agriculture.* United States Summary and State Data. Volume 1. Part 51.

USDA. (2019). *Whole-Farm Revenue Protection*. Risk Management Agency Fact Sheet. Washington National Office—Washington, DC. https://www.rma.usda.gov/en/Fact-Sheets/National-Fact-Sheets/Whole-Farm-Revenue-Protection-2020.

USDA (2020). *Farms and Land in Farms. 2019 Summary.*

"USDA Announces Detail of Risk Management Programs for Hemp Producers". (6 February 2020). Press Release No. 0148.20. U.S. Department of Agriculture. https://www.usda.gov/media/press-releases/2020/02/06/usda-announces-details-risk-management-programs-hemp producers#:~:text=A%20pilot%20hemp%20insurance%20program,against%20losses%20associated%20with%20lower.

Vannette, Dave. 28 June 2017. "Using Attention Checks in Your Surveys May Harm Data Quality". Qualtrics. https://www.qualtrics.com/blog/using-attention-checks-in-your-surveys-may-harm-data-quality/.

Vantreese, Valerie. (1997). Industrial Hemp: Global Markets and Prices.

Walker, Elizabeth and Alan Brown. (2004). What Success Factors are Important to Small Business Owners? *International Small Business Journal. 22*(6). 577-594.

Werf, Hayo van der, Willem Van Geel and M. Wijlhuizen. (1995). Agronomic research on hemp (Cannabis sativa L.) in the Netherlands, 1987-1993). *Journal of the International Hemp Association. 2*(1). 14-17.

Williams, D.W. and Rich Mundell. (2016). *Agronomic Recommendations for Industrial Hemp Production in Kentucky-2016.* UK Industrial Hemp Research Program**.**

Wooldridge, Jeffrey M. (2009). *Introductory Econometrics: A Modern Approach.* 4th Edition. South-Western Cengage Learning. Ohio.

Yordanova, Desislava and Matilda Alexandrova-Boshnakova. (2011). Gender effects on risk-taking of entrepreneurs: evidence from Bulgaria. *International Journal of Entrepreneurial Behavior & Research. 17*(3).