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Challenges from the field: experiences of first-year hemp farmers in Nebraska

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Research Paper

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Abstract

Despite its recent history as a controlled substance, hemp holds promise in contributing to more resilient and sustainable agricultural systems in the United States. Due to reclassification in the 2018 Farm Bill, hemp grown for fiber, grain, and cannabidiol has become an intriguing new crop for many farmers. However, the introduction of hemp into an established agricultural landscape has been met with challenges. This qualitative study explores the experiences of 15 first-year hemp producers in Nebraska, United States. The producers in this study describe the complexities they encountered, including navigating stringent state and federal regulations, securing insurance and loans, and overcoming the public and political stigma associated with cannabis. Additionally, gaps in research and development have contributed to producers' difficulties in accessing credible information, high production costs, and labor shortages. Lastly, farmers expressed having a lack of control options to combat the presence of weeds and insects. Based on these findings, we conclude that, although challenges are to be expected with any new crop, many of the issues encountered by the farmers in the study could be overcome or lessened by research, agricultural extension, and government support. We recommend continued research in hemp production, both in crop production and processing, along with dissemination of meaningful results, to aid producers in building their knowledge base. Additionally, government agencies that oversee hemp production could improve accessibility through revisions to regulations and financial resources for producers.

Introduction

Cannabis sativa is one of the world's oldest and most recognized crops. It has had a profound influence on agricultural, economic, and cultural developments in many regions around the globe (Warf, 2014). The unique properties of cannabis have been utilized for medical, recreational, spiritual, and industrial purposes. While some cultures and governments have celebrated cannabis, others have feared, regulated, or outlawed its possession and determined it to be an illicit drug (Decorte, Potter, and Bouchard, 2011). When consumed as a drug, the plant's primary psychoactive compound, delta-9-tetrahydrocannabinol (THC), interacts with the human endocannabinoid system, causing the body to experience a euphoric effect or 'high' (Lu and Mackie, 2021). Thus, cannabis with a more robust concentration of THC, often cultivated with the intent to make medical or recreational drug products, is commonly known as marijuana. The name 'hemp' or 'industrial hemp' is used to describe cannabis with a lower THC content that is produced for non-psychoactive cannabinoids, fiber, or grain. Many countries, including the United States, have recently used the percentage of THC in cannabis to legally differentiate hemp and marijuana (Johnson, 2018; Health Canada, 2024).

Cannabis has had an intriguing history in the United States that remains influential to the development of the hemp industry. Hemp was introduced as an agricultural crop in the region during the colonial era, when, at the time, it was used globally to make rope, sails, and cordage, among other textiles (Fike et al., 2020; Warf, 2014). The crop was initially successful as an agricultural commodity but was soon undermined in the mid-19th century by a booming and competitive cotton industry, in conjunction with advancements in maritime technologies reducing the demand for hemp sailing products (Jenkins, 2016). Although it is widely believed that marijuana was first introduced in the United States by immigrants fleeing violence during the Mexican Revolution of 1910–1911, the accuracy of these origins is contested (Campos, 2018). As marijuana use became primarily concentrated in Mexican American communities and later in African American communities in the early 20th century, the revolt against marijuana was fed by racist ideology depicting its users as violent individuals (Warf, 2014). Interestingly, this cannabis propaganda was further spread by stakeholders of the cotton industry, who feared competition from industrial hemp (Baum, 1996; Galliher and Walker, 1977).

By the 1930s, many states prohibited the cultivation of cannabis at the state level, and in 1937, the Marijuana Tax Act severely limited the practical cultivation of hemp at the federal level (Galliher and Walker, 1977). The act placed legal control of cannabis under the Drug

Enforcement Agency (DEA), and it did not differentiate between hemp and marijuana. During World War II, hemp made a brief resurgence when the federal government relegalized and promoted it to meet war demands (Jenkins, 2016; Warf, 2014). However, after the war, the DEA continued an anti-hemp agenda, and hemp was recriminalized. Further legislation impacted hemp production during the latter half of the 20th century. Most notably, The Controlled Substance Act of 1970 classified all cannabis as a Schedule 1 Drug (Johnson, 2018). Consequently, hemp production, research, and development mostly halted in the United States over the next 50 years.

Global agriculture competition encouraged the United States to reconsider its research position on hemp in the 21st century. The 2014 Farm Bill allowed research institutions and state departments of agriculture to apply for permits for research and development of hemp (Mark et al., 2020). While this legislation allowed limited permits for pilot hemp research, the 2018 Farm Bill set the stage for a potential resurgence of the hemp industry across the United States. The 2018 Farm Bill removed hemp as a Schedule 1 Drug and classified hemp as cannabis with a 0.3% THC content or less on a dry-weight basis. The regulating agency over hemp was also shifted from the DEA to the United States Department of Agriculture (USDA). The USDA provided states with regulatory guidance on pathways for farmers to legally cultivate hemp under federal regulation.

Modern use of hemp

Johnson (2018) reported that there are over 25,000 products made from hemp. The modern cultivation of hemp can be distinguished by three production avenues: non-psychoactive cannabinoids, grain, and fiber. The production of hemp for cannabinoids is comparable to marijuana cultivation and targets cannabinoids that are found in the highest concentrations on the glandular trichomes of female hemp flowers (Livingston et al., 2020). The cultivation practices of floral hemp are comparable to other horticultural or specialty cash crops, typified by requiring high labor and input costs but with the potential to make lucrative profits.

The primary cannabinoid sought from hemp is cannabidiol (CBD), a compound that has emerged in the health and wellness market. Although more clinical studies are needed, medical research has shown that CBD may be effective as a therapeutic agent for anxiety, pain, inflammation, and post-traumatic stress disorder, among other ailments (Bonaccoroso et al., 2019; Sholler, Schoene, and Spindle, 2020). However, Epidiolex, a treatment for a rare seizure condition, remains the only CBD product approved by the FDA (Sholler, Schoene, and Spindle, 2020). In the broader health and wellness industry, CBD has been found in a plethora of non-prescription products, ranging from cosmetics to infused beverages (Miller et al., 2022; Mouton, Gerber, and Van der Kooy, 2024). CBD products have also been promoted in the pet industry to reduce canine inflammation, stress, and anxiety (Di Salvo, Conti, and Rocca, 2023). Beyond CBD, other non-psychoactive cannabinoids (e.g., cannabigerol [CBG]; cannabinol) found in hemp have been understudied, and these minor cannabinoids hold unique traits that may attract more attention in the future (Bonn-Miller et al., 2024; Cai et al., 2024). In 2021, hemp grown as floral hemp was valued at $687 million, which was over 80% of the total hemp value in the United States (United States Department of Agriculture [USDA], 2022). The National Hemp Report (USDA, 2022) documented that 310,000 pounds of floral hemp were grown under controlled protection, and 16,000 acres were grown in open-air environments.

The cultivation practices of hemp grown for grain or fiber are similar to other conventionally grown agronomic crops. Typically, hemp is grown on large tracts of land and mechanically planted and harvested. Varieties of hemp grown for grain are shorter in height and bred to produce large seed heads (Small and Marcus, 2002). After harvest, the grain can be processed into hempseed oil or used whole. In addition to human consumption, hempseed oils have been incorporated into cosmetic and industrial products (Burton et al., 2022). A foreseeable market is also anticipated for hemp-based animal feeds (Mohamed et al., 2024). In 2021, the United States grew approximately 8255 acres of hemp in the open for grain (USDA, 2022). Fiber hemp varieties produce tall stalks that are harvested for their high-quality hurd and bast fibers. In 2021, fiber hemp was cultivated on approximately 12,690 acres in the United States and was valued at $41.4 million (USDA, 2022). Hemp fibers are utilized in a variety of products, including fabrics, papers, ropes, and construction materials (Crini et al., 2020).

Sustainability attributes

National and international investment to improve the sustainability of agricultural systems is imperative to conserve resources and combat a changing climate. Although no single crop will be a magic bullet in this pursuit, hemp can be used to improve agricultural sustainability. Hemp has been shown to capture high volumes of carbon, making it a potential plant for carbon sequestration and climate-smart agriculture practices (Tripathi and Kumar, 2022). The robust root system of hemp can also add organic biomass, improve soil aeration, and reduce erosion (Nath, 2022). The root system also affords the plant a high capacity for phytoremediation, which hemp has been historically used for (Placido and Lee, 2022). Lastly, prior research has reported that hemp may have a good natural ability to defend against pests and suppress weeds (Small and Marcus, 2002; Visković et al., 2023), potentially reducing the need for synthetic pesticides. However, additional research on hemp pests is needed to further assess these attributes (Cranshaw et al., 2019).

Increasing crop diversification is an important component of improving environmental and economic sustainability. Tenkorang (2016) indicated that hemp grown for fiber or grain can be easily implemented into agronomic crop rotations, including corn and soybeans, which are common row crops in the Midwest United States. Additionally, hemp grown for cannabinoids (e.g., CBD) can be a cash crop for small-scale or new farmers with limited acreage, potentially improving economic sustainability.

Karche and Singh (2019) described that many products made from hemp are eco-friendly and can be used to support a green economy. Hemp-based products such as hempcrete, hempwood, and hemp biofuels have the potential to supplement traditional construction materials and fossil fuels (Crini et al., 2020; Malabadi, Kolkar, and Chalannavar, 2023; Parvez, Lewis, and Afzal, 2021). Despite the potential for hemp to foster sustainable advancements, additional research and development are needed to support informed decision-making.

Known challenges

Limited academic research has systematically explored the challenges faced by hemp growers. A review of industrial hemp

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pilot programs established after the 2014 Farm Bill identified several overarching challenges: '(a) establishing State legislation that allowed hemp to be grown or cultivated; (b) acquiring critical production inputs (e.g., seeds, insecticides, herbicides) and credit; (c) inconsistency between state requirements; and (d) lack of basic data and information for decision-making' (Mark et al., 2020, p. 1).

The long history of hemp being prohibited or highly regulated in the United States has undermined years of potential research and development of the crop, resulting in gaps in infrastructure, knowledge, and resources (Adesina et al., 2020). For example, researchers have postulated that a lack of hemp processing facilities impedes the practicality of growing hemp (Johnson, 2018; Stevenson, 2017). Additionally, with uncertain and evolving cannabis regulations, hemp farmers may encounter difficulty accessing loans and insurance (Barker, 2020), conflicting regulatory information (Mark et al., 2020), and a lack of approved pesticides for hemp production (Cranshaw et al., 2019). Cultivation concerns have also been reported for floral hemp, including high labor requirements and open wind pollination in outdoor growing conditions from feral hemp populations. Diseases impacting hemp have also been identified as a detrimental pest (McPartland, Clarke, and Watson, 2000)

As seen with the adoption of novel crops, markets can initially be highly volatile while supply and demand for the crop adjusts. In the first several years of hemp production, unstable markets were reported (Tancig et al., 2021; Quaicoe, Asiseh, and Isikhuemhen, 2023). Due to market saturation occurring in 2021, total hemp production decreased by 71% in 2022 (USDA, 2023). Although economic modeling has demonstrated some opportunity for profitable hemp operations (Khanal and Shah, 2024; Lambert and Hagerman, 2022), it is yet to be seen how changes to market volatility will impact future production risks.

The association of hemp with marijuana has been described as catastrophic for the hemp industry (Cherney and Small, 2016). Although hemp and marijuana are now legally distinct classifications of cannabis in the United States, poor public knowledge and unfavorable attitudes toward cannabis may impede hemp adoption. In previous research on public hemp perceptions, researchers found participants to have low knowledge of hemp and often associated the psychotropic properties of marijuana with hemp (Colclasure et al., 2021; Rampold et al., 2021). A qualitative study on conventional farmers in Nebraska also identified that farmers associated hemp with marijuana, although farmers described having indifferent attitudes toward hemp (Colclasure, Gray, and Young, 2024).

Research purpose

The re-legalization of hemp in the United States, its attributes supporting sustainability, and new avenues for products may position the crop as a viable option for farmers. As US farmers begin to grow hemp, it is imperative to capture their experiences through systematic research. Perspectives from farmers who are early adopters of hemp cultivation can be used to inform policymakers, extension agencies, farmers, and other stakeholders of hemp to improve this reemerging industry in the United States. Thus, the purpose of this study was to explore the challenges that first-year hemp farmers in Nebraska experienced growing hemp.

Conceptual framework

The use of social science research to explore farmers' adoption of new crops, technologies, and farming practices has been identified as a critical component to improve agricultural sustainability (Huyghe, Bergeret, and Svedin, 2016). In these pursuits, Rogers' (2003) *Diffusion of Innovations* theory has guided researchers to explore the characteristics of both the innovation and of the adopter to uncover factors influencing the rate that innovations spread through a population (Hubbard and Sandmann, 2007). Rogers (2003) defined the earliest 2.5% of a population who adopt an innovation as 'innovators'. In this study on first-year hemp farmers, all our research participants were considered innovators, as these farmers were the first farmers in the state to adopt hemp within their farming operations. Rogers (2003) also defined perceived attributes of the innovation that influence its adoption: (a) relative advantage, (b) compatibility, (c) complexity, (d) trialability, and (e) observability.

Prior research has examined challenges faced by farmers who were 'innovators' or 'early adopters' of emerging farming methods or technologies. Han and Grudens-Schuck (2022) conducted interviews with organic grain farmers in the United States. Their findings indicated these organic farmers experienced social rejection by the farming community and were confronted with an array of technical challenges including fluctuating markets, weed and pest pressures, and an inadequate infrastructure. Similarly, Arditi et al. (2023) explored obstacles facing early adopters of Industry 4.0 technology in agriculture. They identified a skilled labor shortage and a lack of a well-developed infrastructure as significant barriers in the process of early adoption. In this study we examine the challenges experienced by first-year hemp farmers who were in the process of a similar early adoption.

Methods

Our study was driven by the desire to explore the experiences of first-year hemp producers in Nebraska and to uncover their perceptions of growing a newly legal crop. To best address the purpose of this exploratory research, we used a qualitative research approach (Creswell, 2005). Through conducting one-on-one interviews with first-year hemp producers in Nebraska, we aimed to uncover their first-hand knowledge, subjectivity, perspectives, and interpretations toward the challenges they experienced growing hemp.

Population and sample

The 2018 Farm Bill declassified hemp as a Schedule 1 Drug and allowed states to implement cultivation regulations, following minimum federal standards, to legally grow hemp. In 2020, Nebraska producers were permitted to cultivate hemp, given they obtained a state license and followed regulatory procedures established by the Nebraska Department of Agriculture (Nebraska Department of Agriculture, n.d.). These first-year licensed hemp producers comprised the population for our study. The names and addresses for licensed producers were publicly listed on the Nebraska Department of Agriculture's website, and each licensed producer was mailed a letter inviting them to participate in our study. Of the 84 hemp cultivation permit holders, 15 farmers volunteered to participate in our research. We believe that 15 participants served as an appropriate sample size for our study given: (a) between five and 50 participants have been described as an adequate sample size for research using in-depth, one-on-one interviews (Dworkin, 2012); and (b) data saturation, a phenomenon where no new findings are present when additional interviews are conducted (Fusch and Ness, 2015),

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Table 1. Characteristics of hemp farmer participants

Name	Age range	Gender	Targeted hemp product	Farming background	Interview length in minutes
Randy	40–50	Male	CBD	Conventional corn/soybean and diversified agriculture	43
Jacob	60–70	Male	CBD	Conventional corn/soybean	41
Mark	40–50	Male	CBD	Conventional corn/soybeans/wheat	34
Ted	70–80	Male	Grain	Conventional corn/soybean/wheat	33
Larry	20–30	Male	CBD	New farmer	45
Keith	40–50	Male	CBD	Entrepreneur/rancher	38
Dylan	40–50	Male	Fiber/grain/CBD	Diversified agriculture	46
Rhett	40–50	Male	Grain	Diversified agriculture	37
Molly	30–40	Female	CBD	Conventional corn/soybean	56
Timothy	50–60	Male	CBD	Agricultural research	37
Jared	40–50	Male	Fiber/grain/CBD	Agricultural research	39
Mitch	20–30	Male	CBD	New farmer	37
Donald	70–80	Male	CBD	Diversified horticulture	55
Alan	50–60	Male	CBD, CBG	Organic agriculture	53
Jean	50–60	Male	CBD	Organic agriculture	27

was achieved. To incentivize participation, interviewees were given a $50 stipend to complete an in-depth interview. Characteristics of the 15 hemp farmers participating in our study are described in Table 1.

Data collection and analysis

To uncover our participants' experiences, a semi-structured interview guide (Appendix A) was developed and used by the research team. The semi-structured interview guide consisted of specific and general discussion points and open-ended questions to collect thick and rich data (Morse, 2015). The interview guide was used by a larger study, and approximately 50% of the data derived from the interview was used specifically for this study. An external panel of experts, consisting of one college faculty with expertise in qualitative research and two college faculty with expertise in hemp, was used to improve the content validity of the interview guide (Kerlinger, 1986). In the summer of 2020, each interview was conducted virtually through Zoom or by telephone in response to the coronavirus pandemic to ensure the safety of both interviewees and the interviewer. Cachia and Millward (2011) described remote modes to be effective for semi-structured interviews when in-person interviews are not feasible. Member-checking strategies were used at the end of each interview to increase data clarity and accuracy (Creswell, 2005; Lincoln and Guba, 1985).

All interviews were transcribed verbatim and uploaded into NVivo, a qualitative data analysis tool used for coding data. The two researchers used inductive coding, a process where codes used to analyze the data are derived from identified emerging themes (Bingham and Witkowsky, 2022). The transcripts were coded separately by each researcher; then the identified codes were compared between researchers. Once the researchers reached a consensus, the transcripts were coded together in NVivo. Initially, 14 codes were developed by the two researchers. Additional codes were added throughout the process, totaling 20 codes. The final codebook (Appendix B) detailed codes and code definitions. Secondary coding was conducted with the categorized codes as needed and themes were produced. To ensure the trustworthiness of the research, an audit trail was implemented by researchers as deemed necessary for reliable qualitative research (Lincoln and Guba, 1985). Findings were triangulated through researcher field notes, audit trails, and identified emerged themes (Carter et al., 2014).

Results

All 15 participants completed an interview in full. The length of interviews ranged from 22 to 56 min and averaged 41 min. Three themes and nine subthemes were identified that we used to describe the challenges experienced by first-year hemp growers in Nebraska. To best conceptualize our results, we produced a model of the themes and subthemes found (Fig. 1). Each theme and subtheme are further discussed below using participant narrative.

Theme 1: regulations

Of the challenges that first-year hemp farmers encountered, they commonly discussed regulations on hemp cultivation. Subthemes we identified related to regulations included *state and federal regulations*, *insurance and banking*, and *public stigma*.

State and federal regulations

Farmers described experiencing challenges with the complexity of following state and federal regulations associated with hemp cultivation. Eight of the 15 farmers perceived the newly established regulations as stringent and meticulous. Recounting his experience with planting regulations, Ted stated:

> It was rather challenging from the fact [governing agencies] wanted so much detail. Each field had about four different legal descriptions you had to give them because they had to have a lot number, field number, latitude, longitude…it was challenging, especially for the first year.

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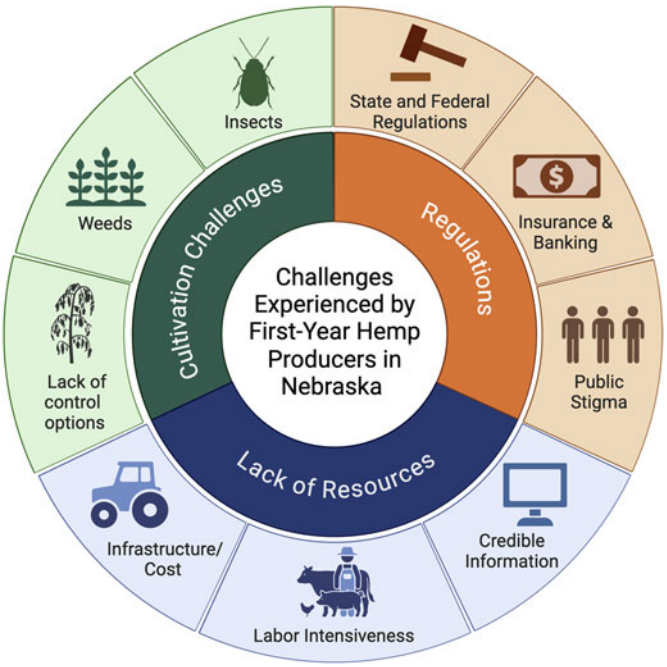

Figure 1. Challenges experienced by first-year hemp producers in Nebraska. Created using https://BioRender.com.

Another farmer, Larry, was eager to begin hemp cultivation but like Ted, found himself stalled with planting parameters of the application process. Larry expressed that 'the application process was very rigorous' as the Nebraska Department of Agriculture required exact growing details 'down to almost a square inch'. Jared, who was an organic producer, had existing corporate attorneys to handle a 'decent chunk of [his] regulatory licensing [requirements]'. However, other first-year producers were not equipped with the same amenities and handled the regulations themselves or with assistance from the Nebraska Department of Agriculture government administrators.

Farmers also described concern with the requirements of state and federal THC levels from their crop to be below 0.3% on a dry-weight basis. Jacob described concerns with abiding by the THC testing requirements and harvesting timeline:

> The Department of Agriculture requires us to notify them a month, I believe it is, ahead before we harvest it. Well, they have to come out and they have to take samples themselves… you got to have that time period, you know, in there to allow for that.

Producers also expressed concern at a lack of testing facilities available to them, as if the results from the Department of Agriculture returned above a 0.3% THC concentration, the crop must be destroyed, and producers would face a 100% loss. Illustrating this concern, Jacob stated, 'I want to know where my THC levels are right now. I'd like to have known at least a week or two ago'. Ted succinctly stated the consensus farmers shared toward the regulations. He said, 'You got some guys that will try it, but if you want it to be a normal crop rotation like corn, wheat, soybeans, anything like that, you got to do away with all of these [extensive] regulations'.

Insurance and banking

Ten of the 15 farmers reported having trouble finding and obtaining insurance coverage or loans for initial production. Molly provided a synoptic statement regarding insurance for hemp by saying, 'It's just not part of the game yet'. Alan was one producer who already had an insurance agent but still reported difficulty with the process. He said his agent faced a 'whole lot of rigmarole [with his banking institution]', and still received very few crop insurance options. When searching for insurance coverage, Jacob reported only being able to receive a maximum of $1000 which barely covered one-tenth of his input cost before accounting for labor. Upon seeking higher coverage, Jacob was hindered by expensive premiums that 'just wouldn't work' for him.

Often, producers will take loans out to purchase equipment or other vital resources to begin crop production and use profits to pay back the loan. If not loans, producers sometimes have private investors who use local banks for the cash flow. This was Larry's approach, but he found working with banks to be unfeasible. 'We can't have you associated with hemp… we would rather you not be associated with hemp at all' are the words Larry was met with from his bank. The strong negative perceptions toward hemp from his banking agency persuaded Larry to forgo his planned hemp operation, even though he already had obtained a state permit to grow hemp on 2 acres. Aside from Larry's challenge, 5 of the 15 interviewees did not seek crop insurance for various reasons unrelated to the process. These experiences ranged from planting too late in the season to small experimental planting in which the farmer did not see crop insurance as a necessity.

Public stigma

We identified public stigma as a commonality between issues in both federal and state regulations and insurance/loan acquisition. Alan experienced what he regarded as 'political pushback' when researching information about hemp from the State Department of Agriculture. Alan elaborated on this experience with the following:

> I think part of it is there is still a stigma of the difference between cannabis (marijuana) and hemp. They see it as marijuana, as 'whacky weed,' all of this stuff that there's all of this negativity around it, and they're not open-minded enough to listen to people say that people don't like to be told they're wrong about something, and when they are, they generally push back a lot harder. The head of the Department of Ag, they're not really the most open-minded about it. They see it as a threat in some way, and it's really hard to explain things like that to people. When they hear a certain word, they just put their heels in the ground and say, nope, I don't really give a crap what you say; you're wrong, and I'm right, and I'm going to make your life difficult.

This stigma perceived by Alan was also experienced by Mitch. Mitch found the overall loaning process 'confusing' and littered with 'issues'. The issue Mitch detailed the most was, 'getting people on board with the hemp crop'. He elaborated, 'Banks don't want to work with me, lenders don't want to give me any money'. He found most of his challenges came from 'people not being open to working with someone that's growing hemp'.

The public stigma faced by producers stretched beyond banking, loans, and political pushback. Donald experienced repetitive interactions with local law enforcement inspecting the validity of his license due to complaints from his neighbors. This stigma also affects processing, according to Molly. She offered, 'People are so skeptical about what is going to happen with hemp'. Alan described his belief of Nebraska being of a conservative nature and denoted Nebraska as 'very much fence setters … [that] likes to wait until [they] know which way the wind is blowing'. This idea was also shared by Molly, who added, 'We're

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always the last man standing as far as these new accepted norms'. The public stigma identified by farmers led to a variety of challenges that created a difficult climate for first-year hemp producers in Nebraska.

Theme 2: lack of resources

As pioneers of hemp production within their state, first-year hemp farmers reported a significant lack of viable resources to support their hemp farming operations. Encompassing this distinct scarcity of resources was a lack of credible information, a labor discrepancy, and the absence of infrastructure necessary for hemp cultivation, harvesting, and marketing.

Credible information

Eleven out of 15 farmers reported some type of unmet need for credible information. Ted plainly stated, 'I don't think there's any credible information out there'. Producers like Randy searched the USDA and FDA for credible information but found that 'there wasn't a lot of information there' either. Randy attempted to outsource information from other states like Kentucky and Colorado, a common route other producers took. Randy searched other state's Department of Agriculture websites while 'waiting for Nebraska to actually come out with something'. Farmers reported seeking information on growing from states such as Oregon, Colorado, Wisconsin, and North Carolina, while one farmer even reached out to connections in Canada. Without credible sources in their state, producers turned to resources predominantly for marijuana. Alan found YouTube videos helpful as they contained transferable cultivation techniques, while farmers like Larry stated, 'Google was my best friend'. Producers used a combination of university studies, videos of other farmers detailing trial-and-error experiences, and experimentation of their own as the foundation for their knowledge.

Some producers obtained knowledge by traveling to other states to meet other producers or participate in seminars on hemp cultivation. Some experienced more success in making meaningful contacts than others. Ted shared his experience seeking information, 'In fact, I talked to a person from Colorado who I talked to at machinery shows and everything and was selling all of this expensive seed. I went out to Colorado to find his operation, and really nothing existed'. Randy, on the other hand, found success from expos such as the NoCo Hemp Expo in Colorado, stating that 'being able to talk to growers, vendors, processors, and packaging facilities" was very educational and helped him in his hemp production.

Labor intensiveness

Two-thirds of the producers interviewed mentioned labor intensity as a challenge they faced in hemp cultivation, particularly farmers growing hemp for cannabinoids. Jacob compared hemp cultivation with his prior farming experience by saying, 'As far as growing an acre, [hemp] is the most work I've ever done to grow an acre of anything'. The labor intensity of hemp cultivation varies by targeted product. Producers who elected to grow hemp for CBD saw a higher labor intensity than those who grew for grain or fiber.

Many producers found the labor associated with growing hemp to be too rigorous regardless of the potentially higher profit. Ted elaborated on this point by stating, 'CBD is just too labor intensive… one person probably couldn't take care of one to two acres'. Rhett had a similar experience as Ted, dissuaded by the 'high intensity' of CBD production. He stated, 'I don't have the labor force to manage something like that'. Mark, who pursued CBD cultivation, compared tending to the crop as, 'babysitting every day'. Dylan elaborated, 'It's just labor intensive'. He commented on a means to offset the labor intensity with equipment, but explained his operation 'just wasn't big enough [to] buy a lot of equipment to get the operation going'.

A few producers sought outsourced labor to help offset the intensive labor they experienced, which also proved challenging. Rhett and his father worked together to farm roughly 2000 acres of crops. When asked about the challenges growing hemp, he stated, 'Me and dad are getting old, and it's getting hard to find help'. Mark recruited help from his own children and his growing partners' young adult children. He jokingly remarked, 'We have free labor anytime we need it; we tell them if they want supper they have to help out on the farm'. We found that even though some farmers outsourced labor, they still reported labor intensity as a major challenge.

Infrastructure/cost

Seven of the 15 first-year hemp producers in our study explicitly reported infrastructure challenges regarding harvesting and marketing. Mark elaborated on his experience by describing the large initial cost of being able to purchase the equipment needed to harvest hemp:

> To an average farmer or average person, it's very prohibitive right now to get into any sort of a [hemp operation]… you know, we're not a large-scale producer by any means, but it's just the cost, the startup costs, and stuff like that. The initial investments are just astronomical for such a specialty crop.

Many producers can have '$20,000 tied up in an acre' in seed cost alone, according to Ted, who also encountered additional costs in permitting and testing fees. Alan commented on an average cost of $25,000 for a bucker, a machine used for disbudding/destemming hemp stalks, which was not financially viable for most of the first-year producers. Alan suggested a company to lease equipment or a crew to do the bucking as a cost-effective alternative; however, he did not implement this idea beyond discussing it with the Nebraska Farm Bureau. Jared shared a similar experience, remarking, 'Different methods [of hemp production] require different pieces of equipment, and it gets expensive in the long term'. He later commented about harvesting and stated, 'It is extremely difficult because we haven't developed equipment for it'.

Interestingly, many of the producers took an unorthodox approach to meeting the need for equipment without spending large sums of money by engineering their own equipment. For example, Jacob 'looked at the pricing of some equipment' but then 'decided to build [his] own seedbed machine and then used the same machine for transplanting'. Randy went as far as beginning construction on a processing plant of his own. Most producers reported having intent to apply for their own processing licenses and detailed the retrofitting of existing facilities to accommodate hemp. Alan used his existing 'Quonset building to hang the crop' to dry, while Mitch obtained his license and used his facilities for 'ethanol extractions'. For drying his hemp, Jean used a 'building downtown that used to be a meat plant with unused coolers'. Producers who did not take this approach were forced to outsource equipment rentals and crop processing from other states, given the significant lack of accessible equipment in Nebraska

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The challenge of infrastructure regarding harvesting and marketing was apparent. A few producers elected to destroy the crop altogether and experienced a total loss. Ted was one of these producers and stated, 'There's no way I'd put any more money into that crop'. A combination of insufficient credible information, labor intensity, and limited infrastructure created a volatile environment for first-year hemp producers that demanded creative solutions from producers or abandonment of production.

Theme 3: cultivation challenges

First-year hemp producers faced a variety of cultivation challenges ranging from insects, weeds, and diseases to irrigation and cross-pollination. The overarching issue producers encountered was a lack of control options.

Insects

The most damaging reported biotic pests that posed the greatest threat to first-year hemp producers' crops were insects. The type of insect and severity varied greatly, but 7 of the 15 reported at least some type of insect damage. Both Alan and Mitch reported moderately extensive damage from hemp borers, specifically. Alan experienced 'significant damage', while Mitch stated hemp borers were 'really bad'. Other pests experienced by producers include silkworms, aphids, grasshoppers, spider mites, and leaf miners. Rhett described unexpected issues with avian pests. He remarked the 'biggest problem' he faced was doves, and when asked about dissuasion techniques he commented, 'The state needs to open dove season earlier'.

Weeds

Another cultivation challenge experienced by producers was weed management. The effect weeds had on producers, while less damaging than insects, was more common. Alan was one producer who destroyed his entire outdoor crop due to weed competition. He reported, 'Amaranth is our biggest problem', as the rapid growth from amaranth overtook his outdoor crop. Other weeds, such as orchard grass, were also reported. Feral hemp was the most reported weed that uniquely threatened producers with cross-pollination. Jean was one producer who caught the effects of feral hemp too late. He comically recalled, 'I was proud of myself until we found out we had seeds in the hemp'. Some producers like Keith were aware of the threat feral hemp posed and proactively elected to grow hemp indoors to avoid cross-pollination. Keith stated, 'My motivation for growing indoors is because outdoor [hemp] will cross-pollinate with feral hemp'. Timothy shared a similar experience, 'There's probably more feral hemp in the area that I would like … but I don't know if there is a good site in Nebraska where there isn't a ton'. Additionally, some producers experienced hermaphroditic plants in batches of all female seeds, leading to pollination challenges. Mark described the experience as a significant problem that required 'daily attention'.

Lack of control options

First-year producers were also challenged by a lack of approved chemical control methods. Jacob stated, 'There just aren't a lot of FDA-approved control options'. Molly shared this challenge and recalled the 'restrictions on fertilizers, insecticides, and herbicides' she encountered when seeking control options. Randy believed his overall growing experience was hampered by 'trying to actually find what was on the Nebraska Department of Agriculture's approved pesticide list'. He had further issues obtaining the approved pesticides.

The restriction on control options prompted producers to utilize unconventional pest management options. Randy created a mixture of cayenne pepper, neem oil, and paprika to combat his spider mite infestation. Both Mitch and Alan used biological controls by employing praying mantises in their hemp fields to combat aphids. Several producers, like Jacob, implemented plastic mulch, which was effective at weed management and keeping his soil moist. Despite the success of these innovative tactics, Jared succinctly expressed his frustration with the restrictions placed on producers by stating, 'It's really hard to keep pests at bay with the tools that we've been given by the state'.

Discussion

It is important to note that the emphasis of this qualitative study was on the challenges that first-year hemp farmers in Nebraska encountered during hemp production. Despite the many challenges described in our findings, most farmers also described various successes in growing hemp for the first time. Most notably, farmers described this year as being a trial year to work through challenges and discover opportunities to improve hemp production techniques in years to come. Therefore, many farmers expected the challenges that come with growing a new crop. Some farmers were successful in overcoming these challenges and anticipated modifying their operations to be more efficient in years to come. Other farmers described the barriers to growing hemp as too prohibitive and were adamant they would not grow the crop again.

The findings from this study align with the limited prior research on hemp production challenges and barriers. The participants in our study described experiencing challenges relating to insurance and banking, difficulty in distinguishing and following state and federal regulations, and limited options for Environmental Protection Agency (EPA)-approved pesticides for hemp. The same challenges were identified by Mark et al. (2020) in a report summarizing the significant issues encountered by growers in hemp pilot programs. Other researchers accurately anticipated the lack of approved pesticides as a challenge (Cranshaw et al., 2019), in addition to difficulty accessing loans and insurance (Barker, 2020).

Adesina et al. (2020) postulated that due to the long period of hemp being an illegal crop in the United States, a lack of hemp research and development occurred, thus creating a shortcoming of knowledge, resources, and infrastructure. The experiences shared by our participants support Adesina et al. (2020) conclusions. They described having difficulty in finding credible information and relying on information generated in other states or countries where hemp cultivation tactics may vary. Additionally, their need for resources often led them to non-credentialed information on the web through platforms such as YouTube, mostly on hobby growing or marijuana cultivation. Prior researchers anticipated that a lack of infrastructure would be problematic for hemp producers (Johnson, 2018; Stevenson, 2017). Our findings supported this issue, as our participants expressed frustration with the high cost and low availability of specialized hemp equipment. However, many farmers successfully used alternative methods in lieu of purchasing this equipment.

The participants in our study described experiencing a public stigma toward hemp that threatened their production ability or efficiency. Prior researchers reported that a public misconception

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exists between hemp and marijuana (Colclasure et al., 2021; Colclasure, Gray, and Young, 2024; Rampold et al., 2021); however, the extent to which misconception impacts hemp farmers remains mostly unknown. We found that hemp farmers had visits from law enforcement due to complaints from neighbors, experienced political opposition toward hemp, and believed their difficulty with obtaining financing may have been due to negative perceptions toward cannabis from lenders.

Contrary to prior reports suggesting that hemp has a good natural ability to defend against pests and suppress weeds (Small and Marcus, 2002; Visković et al., 2023), our participants encountered both insects and weed pressure that challenged their operations. These findings support recommendations from Cranshaw et al. (2019) that pests combatting hemp in the United States are still emerging, and that additional research on integrated pest management plans in hemp production should be established to aid current and future hemp producers. Although diseases impacting cannabis have been well documented (McPartland, Clarke, and Watson, 2000), the farmers in our study did not indicate encountering any issues with disease.

Conclusions, limitations, and recommendations

This qualitative study explored the challenges experienced by 15 first-year hemp farmers in Nebraska, United States. Our findings indicate that first-year hemp farmers experienced a wide range of challenges. Farmers described navigating complex regulations, including state and federal hemp regulations, in addition to difficulty finding insurance and loans due to banking regulations. Many of our participants believed these extensive regulations were due to the public and political stigma toward cannabis in the state.

A gap in research and development toward hemp production is apparent in the United States due to hemp being labeled as a Controlled Substance for nearly 50 years. Farmers described challenges in finding credible and reliable information to guide their decision-making. Additionally, they described high costs and lack of availability of specialized equipment for hemp production, likely also a result of the gap in infrastructure caused by the decades long ban on the crop. Hemp grown for cannabinoids is very labor intensive, and farmers growing for CBD were caught off-guard by the high labor requirements. Finding additional labor was a barrier for them and highlighted the known agricultural labor shortages (Mathewson, 2022). Lastly, farmers described the presence of insects and weeds within their hemp crop, and a lack of control options due to limited approved pesticides, only compounded the issue.

This exploratory, qualitative research provides value by describing the challenges hemp farmers encountered through the collection of thick and rich data (Morse, 2015). However, we acknowledge that our study utilized a small sample of hemp growers specific to one state, and therefore caution should be taken in generalizing our findings to hemp growers in other US states who may face different challenges due to the political, social, and environmental climates unique to varying regions. Additionally, prior research has illustrated volatility in hemp markets (Tancig et al., 2021; Quaicoe, Asiseh, and Isikhuemhen, 2023). We conducted interviews prior to farmers marketing their crop. Therefore, any potential challenges farmers experienced in the sale of their crop was not expressed or reported. Lastly, most of the farmers interviewed in our study were growing hemp for cannabinoids, which vary in cultivation and processing practices from hemp grown for grain and fiber. Future studies can further explore and differentiate the challenges faced by hemp farmers growing specific targeted products (i.e., cannabinoids, grain, fiber).

Summarizing the challenges experienced by first-year hemp producers aid in providing recommendations to alleviate these challenges in the future. With any new crop, infrastructure, including transportation channels, storage facilities, and processing facilities, will be vital to the success of the industry but will take time to develop. Government initiatives and subsidies could fast-track this process but may be undermined by political pushback. Additional campaigns to educate consumers, political leaders, and farmers on the differences between hemp and marijuana, as well as the sustainable benefits of hemp, could lead to improved attitudes and greater acceptance of the crop (Colclasure et al., 2021). Additional research on consumer perceptions and the use of hemp-derived products could also be used to educate farmers and Extension educators to inform decision-making.

Most farmers in our study perceived the required rules and regulations to grow hemp to be burdensome and complicated. We recommend that governing agencies clarify ambiguous language and improve easy-to-follow guidelines that are required by state and federal regulations. Additionally, government agencies could aid in resource creation and allocation. The producers in our study identified a lack of credible, straightforward resources almost unanimously. Government initiatives partnered with extension directives are the most feasible means to address this deficiency. We recommend additional research and development through state university extension programs. Results from state-level research, such as genetic improvements, pest management strategies (Cranshaw et al., 2019), farmer adoption (Colclasure, Gray, and Young, 2024), and economic modeling (Lambert and Hagerman, 2022) can improve viable production strategies that are specific to targeted products and regions. Lastly, the attributes of hemp as a sustainable crop are well documented (Karche and Singh, 2019; Nath, 2022; Tripathi and Kumar, 2022). Additional funding, research, and development that are focused on sustainable advancements from hemp may lead to greater potential, acceptance, and adoption of this ancient crop in our modern world.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S1742170524000334

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