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Hemp in the United States: An Analysis of Policy and Consumption

Amanda Falkner
University of Vermont

HEMP IN THE UNITED STATES:
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Amanda Falkner

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Thesis Examination Committee:

Jane M. Kolodinsky, Ph.D., Advisor
Jeffrey S. Buzas Ph.D., Chairperson
Trisha R. Shrum, Ph.D.
Tyler B. Mark, Ph.D.
Cynthia J. Forehand, Ph.D., Dean of the Graduate College

ABSTRACT

As highlighted by its history, the association between hemp and marijuana has proven to be a barrier to success for industrial hemp production for decades. Once a prevalent agricultural crop in the United States, prohibitive legislation discouraged its production and formally made hemp an illegal crop in 1970. Consequently, hemp and its myriad applications remained underutilized by the United States for over forty years. It wasn't until the 2014 Farm Bill that hemp production was reintroduced as an option for farmers. This hemp hiatus has created the need for interdisciplinary research in order for the market for the crop to be successful.

Given the relative novelty of hemp as an agricultural commodity and an increased interest in its production, the purpose of this thesis is twofold. First, it analyzes whether or not there is consistency across state and tribal government hemp production plans. Adopting legislative consistency would ensure an even playing field across state and tribal borders, mitigate any confusion that comes with the variation among plans, and provide an opportunity for the integrity of these hemp programs to be preserved. Using the results of this analysis, suggestions are provided for the appropriate governing bodies.

Second, this thesis provides insight into consumer preferences for hemp-based products. Such information can be used by hemp growers, CBD producers, and other actors along the supply chain, and is particularly valuable given the oversaturation the United States industrial hemp market has experienced in recent years. By differentiating their hemp and hemp-based products, producers will be able to better match their production to market demand, thereby aiding in their success. The findings of this thesis contribute to the developing area of current hemp-based research in the United States.

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CHAPTER 1: INTRODUCTION

1.1 Research Questions

In this thesis, I investigate the topic of hemp by looking at both the policy behind its production and consumer preferences for products derived from the plant. Specifically, this thesis is guided by the following research questions:

1. Is there consistency across state and tribal hemp production plans?

    1b. What implications may this have on the success of the hemp industry in the United States?

2. How are product attributes of CBD oil related to consumer willingness to pay controlling for demographic characteristics?

    2b. Is willingness to pay heterogeneous across demographic groups?

While both articles in this thesis share an overarching focus on hemp and identify ways to bolster its success in the United States, their wide scope called for distinctive research methods to find these answers.

1.2 Quantitative vs Qualitative Methods

A continuum exists on which research methods are categorized, with qualitative and quantitative methods positioned at each end (Balnaves & Caputi, 2001; Creswell & Creswell, 2017). Quantitative methods are defined as "research that explains phenomena according to numerical data which are analyzed by means of mathematically based methods, especially statistics" (Yilmaz, 2013, p. 311). These methods span countless research fields and are used when the data must be in numerical form for analysis. Qualitative methods, however, are used when the data is non-quantitative. While a widely accepted definition for qualitative research has yet to be reached, it is understood that this

approach involves interpretation, identification of patterns, and the process of making meaning of this type of data (Sofaer, 1999; Willig, 2017; Aspers & Corte, 2019). Both quantitative and qualitative methods were used in this thesis to answer the research questions presented.

1.3 Article 1: Analysis of State and Tribal Hemp Production Plans

The purpose of this study is to analyze the consistency across state and tribal hemp production plans, which can provide policy-making groups with insight into where the industry can benefit from more formal regulation. With an already provocative history in the U.S., the regulations outlined in these hemp production plans are the first step to fostering a successful reintroduction of the crop. Mark et al. (2020) noted that the introduction of the 2014 pilot program for hemp production resulted in variability between state regulations. While the 2018 Farm Bill addressed some of this variation, it was unclear whether it decreased the ability of some states and tribes to have competitive advantages over others because of the ability to tailor each plan to their specific needs. By ensuring that there is an even playing field and clear guidelines across state and tribal borders, improved consistency provides an opportunity for the integrity of these hemp programs to be preserved.

1.3.1 Qualitative Content Analysis

To address questions 1 and 1b, the state and tribal government hemp production plans provided by the United States Department of Agriculture were examined. To evaluate consistency among these plans, the research team completed a multi-step content analysis to translate the qualitative data into clear quantitative measures. Translating the

qualitative data into quantitative data was integral to answering the research questions so that the consistency between the plans could be empirically determined.

1.3.2 Units of Analysis

The unit of analysis for this study is each individually approved state and tribal hemp production plan and the 2014 pilot plan and USDA Hemp Producer License. In total, there are 69 units analyzed throughout this study.

1.4 Article 2: Consumer Preferences of CBD Oil

This study aims to provide insight into consumer preferences, which can be used by hemp growers, CBD producers, and other actors along the hemp CBD supply chain. This information is particularly valuable given the oversaturation of the United States industrial hemp market which has caused sharp drops in hemp biomass prices, affecting producer profits. With its reintroduction to U.S. agriculture, hemp has been identified as an opportunity for producers to replace formerly profitable cash crops, such as tobacco (Pal & Lucia, 2019). In 2017, Hemp Business Journal estimated the annual value of retail sales for hemp products to be $820 million and predicts this value to jump to $1.9 billion by 2022 (Vote Hemp, 2018). With the removal of prohibitive legislature, 90,000 acres of hemp were planted in 2018 and this number rose to 146,065 acres in 2019 (Mark et al., 2020).

However, the excitement of farmers to jump at this economic opportunity resulted in an oversupplied market, causing prices for hemp and hemp-based products to drop substantially. Hemp biomass prices nation-wide dropped over 90 percent from July 2019 to December (New Frontier Data; PanXchange Hemp 2022). A similar trend has been seen with hemp-based products, such as CBD Isolate which dropped from $6,077/kg in

April 2019 to $392/kg in February 2022 (PanXchange, 2022). By differentiating their hemp and hemp-based products, producers will be better suited to meet market demand and increase profits through high-value product attributes.

1.4.1 Discrete Choice Experiment

To address questions 2 and 2b, a Discrete Choice Experiment (DCE) was designed to determine consumer willingness to pay (WTP) for certain CBD oil attributes as well as examine if this WTP changed across demographic groups. To determine the WTP premium for CBD oil attributes, multiple mixed logit models were run on different sample subsets to determine which attribute elicited the strongest WTP results. To analyze the presence of demographic influence on consumer WTP, several logistical tests were run including bivariate analyses, Ordinary Least Squares regression and Poisson regression. Including this variety of analyses allowed the research team to analyze numerous potential relationships between consumer demographics and their CBD oil preferences.

1.4.2 Units of Analysis

The unit of analysis for this study is each choice between CBD oil products with specific attributes. Throughout the study, a total of 27 decisions from 144 respondents were analyzed, clustering the units by respondents.

CHAPTER 2: COMPREHENSIVE LITERATURE REVIEW

2.1 What is Hemp?

While hemp and marijuana are both derived from the same plant, *Cannabis sativa L.*, the difference between the two is determined by their delta-9 tetrahydrocannabinol (THC) content. THC is the primary psychoactive component of cannabis that is responsible for the "high" produced by consuming marijuana (U.S. Drug Enforcement Administration, 2020). As defined by the United States Department of Agriculture (USDA), cannabis with a THC content above .3 percent on a dry weight basis is legally considered marijuana, while cannabis with a THC content below this threshold is hemp (Johnson, 2018). When discussing cannabis, it is also important to distinguish between THC and CBD. CBD (cannabidiol) is one of many cannabinoids found in cannabis that is considered nonpsychotropic and is used for numerous purposes, including in alternative medicine (Corroon & Phillips, 2018). The distinction between these two plants is incredibly important and has been overlooked for decades as hemp has continuously been made synonymous with marijuana, muddying its reputation in the eyes of the consumer.

2.2 History of Hemp

The first evidence of hemp use by human civilization can be traced back to 8,000 BCE in East Asia where it was used for pottery, food, and medicine (Ministry of Hemp, 2019). Introduced to North America in the 1600s, industrial hemp was valued for its versatility and utilized primarily for its fiber. It was so valuable that British Colonies were required by law to cultivate it in the 1700s due to its economic importance (Hemp Acres USA, 2022). Early drafts of the Declaration of Independence were written on paper made from hemp fiber, and Abraham Lincoln even used the seeds of the hemp plant to

fuel his household lamps (Ministry of Hemp, 2019). The crop garnered formal federal support when the USDA published its findings on the ability of hemp to produce four times more paper than trees on the same amount of land and to assist in mitigating the imbalance between traditional forestry practices and paper demand (Dewey & Merrill, 1916).

However, despite its flexibility and favorability, hemp production was effectively curbed with the introduction of the 1937 Marihuana Tax Act. Reasons for this act were likely multifaceted, including the lack of differentiation between hemp and marijuana and its association with lower-income citizens, minority groups, and crime (Musto, 1972). As Mexican immigrants came to the United States to fill farm labor positions in the 1920's, those who opposed their entry began to pin crimes on their presence and made associations between these immigrants and marijuana. In 1931, New Orleans's Prosecuting Attorney declared marijuana to be a "developer of criminals" (Stanley, 1931) and in 1936 a newspaper editor from Alamosa, Colorado claimed a link between issues associated with marijuana and these "Spanish speaking persons" (Musto, 1972, p.105).

It is clear that the fear surrounding cannabis was racially fueled and, as a result, the federal government responded by introducing the 1937 Marihuana Tax Act. This Act imposed taxes on the sale of all Cannabis and discouraged its production, thus forcing producers to shift their focus to other, more profitable crops (USDA, 2000). The production of hemp was then formally made illegal in 1970 by the Controlled Substances Act, which effectively classified it as a Schedule I drug (Johnson, 2018).

For nearly 45 years, hemp remained an illegal agricultural crop in the United States. This changed with the introduction of the 2014 Farm Bill, which allowed state-

level pilot programs for hemp production. Hemp's inclusion in the 2014 Farm Bill was spurred by an interest from farmers to identify alternative, profitable crops as commodity prices fell. "The Legitimacy of Hemp Research" (section 7606 of the Bill) gained support from both sides of the political spectrum and kicked off the reintroduction of the crop (Fike, 2019). The 2018 Farm Bill then removed its Schedule I drug classification, officially making hemp production legal. For the past four years, the United States has been navigating changing policies, consumer confusion, and market oversaturation as hemp makes its way back into the agricultural sector (Cherney & Small, 2016; Mark et al, 2020). However, the multitude of uses for the crop, as highlighted by its history, provides an opportunity for the crop to be reintroduced successfully through several different markets.

2.3 Uses for Hemp

All parts of the hemp plant can be used for different purposes, lending to its versatility (Hemp Foundation, 2019). Depending on the intended end-use, the grower can choose from several varieties that are specialized for the production of a specific part of the plant. Uses for the hemp plant can be broadly categorized into three sectors: floral, fiber, and grain and seed. The floral sector is comprised of products such as CBD and essential oils, pharmaceuticals, and smokables. These products utilize the hemp flower, which is the part of the plant that contains the highest level of CBD. The fiber sector utilizes the stalks of the hemp plant, specifically the bast and hurd, which is made into textiles, paper, building materials, and other fiber-based products. The grain and seed sector utilizes hemp seeds for food products, beauty and personal care, nutritional supplements, fuel alternatives and more (Hemp Foundation, 2019). The multitude of uses

for hemp has been acknowledged since its cultivation thousands of years ago. However, producers and processors are still working to fully take advantage of this as the crop battles market oversaturation and regulatory confusion.

2.4 Current Hemp Production

With the removal of prohibitive legislature, annual hemp acreage planted reached 90,000 acres in 2018 and increased to 146,065 acres in 2019 (Mark et al., 2020). Current hemp production in the United States is primarily focused on CBD, with fiber and seed falling significantly behind. Included in their *2021 Annual Hemp and CBD Industry Factbook*, Hemp Industry Daily reported that in 2020, 73 percent of United States hemp producers grew the crop with the intention of CBD extraction. With an estimated retail sale of $1.9 billion in the same year, the size of the CBD industry is projected to reach $6.9 billion by 2025 (Hemp Industry Daily, 2021). Hemp grown for seed and grain made up a very small amount of production, with only 10 percent of producers growing hemp for this purpose in 2020. Totaling $195 million that year, hemp seed sales are also expected to rise, reaching $215 million in 2025 (Hemp Industry Daily, 2021).

While the CBD industry may appear like a lucrative business, especially when comparing its estimated sales with those of seed and grain, it must be noted that most producers are growing hemp with the intention of entering this profitable market. As a result, this hemp market sector is experiencing oversaturation, resulting in decreasing biomass prices for the crop and a barrier to entry for smaller producers (USDA, 2000; Fortenbery & Bennett, 2004; Cherney & Small, 2016). By switching to hemp production for grain and seed, or ensuring that their CBD product meets the demands of the market, producers may better situate themselves to secure market power.

2.5 Environmental Benefits of Hemp

While it is clear that hemp has a multitude of uses, the question may arise about why we need to grow hemp to make these products. Afterall, there was no shortage of food and fiber products during the long hiatus of hemp in the United States agricultural sector. While these products can be made using more 'traditional' inputs – corn, fossil fuels, wood, etc. – hemp offers a long list of environmental benefits while providing an opportunity to refrain from the depletion of valuable natural resources.

One benefit of hemp cultivation is its ability to act as a remediating rotation crop (Piotrowski & Carus, 2011). When planted before other crops in rotation hemp has been found to remove harmful substances from the soil, allowing subsequent crops to flourish. Additionally, hemp requires less water inputs than traditional commodity crops, such as cotton. When comparing the amount of water needed to produce 1kg of cotton lint versus 1kg of hemp fiber, a UK study found that cotton lint required 9,758 liters while hemp required only 2,123 liters (Cherrett et al., 2005).

Further, when considering the use of pesticides and herbicides that are commonly applied to traditional commodity crops, hemp is unique in that it requires little or no application of these chemicals to propagate (Fortenbery & Bennett, 2004; Lin & Chan-Halbrendt, 2005). One of the reasons behind this is that many varieties of hemp plants have a pronounced leafy canopy, shading out weed growth (Piotrowski & Carus, 2011). Finally, hemp has been found to adapt to a diverse array of growing climates, making it a suitable crop in most locations globally (Lin & Chan-Halbrendt, 2005). The environmental benefits of growing industrial hemp as opposed to other commodity crops provides an additional, eco-friendly reason to support its successful reintroduction

2.6 Barriers to Success

While the benefits of growing hemp and utilizing the plant for value-added products are well documented, there are major barriers faced by the industry that must be addressed in order for hemp-based food products to succeed in the United States. As a result of its illegal status in the United States for almost five decades, the hemp industry has a lot of damage control to do as it reemerges into the agricultural sector. As seen throughout its history, the association between hemp and marijuana has led to a residual negative view of the crop by those who do not support recreational cannabis (Campbell et al., 2021). Additionally, because of this temporary illegal status in the United States, hemp markets are well established in other countries around the world (Carus & Sarmento, 2016; Horner et al., 2019; USDA Foreign Agricultural Service, 2020). Finally, the current discordance of hemp production regulations and lack of regulatory guidance for hemp does not aid in successfully bolstering the market and may be its biggest downfall (Mark et al., 2020; Falkner et al., 2022).

2.6.1 Association with Marijuana

As stated by Dr. David West (1998, pg. 3), "surely no member of the vegetable kingdom has ever been more misunderstood than hemp". Highlighted by its history, the erroneous association between hemp and marijuana has proven to be a barrier to success for industrial hemp for decades, even with the removal of its Schedule I drug classification and its legal production status. Despite this fact, the distinction between the two is often not recognized by members of the American public. A 2019 study of the consumer understanding of hemp discovered a lack knowledge from the participants,

which researchers attributed to “insufficient knowledge and limited flow of information about the plant” (Borkowska & Bialkowska, 2019, pg. 12).

A 2020 study of Southeastern United States residents reported 29 percent of respondents associating hemp with recreational marijuana (Campbell et al., 2020). Furthermore, when asked to complete a word association with the word “hemp” by sharing the first thing that came to their mind when they think of the crop, a 2021 study showed that consumers most frequently responded with “weed” and “marijuana” (Campbell et al., 2021). This link between the two plants is important to address when considering the longevity of the hemp industry, especially with the current political debate over the state-level legalization of recreational marijuana which has received pushback from many states who do not agree with this advancement. This recurring theme has led to the identification of the need for improved education and outreach on the topic to inform the public of the distinction between the two plant varieties (Pal & Lucia, 2019).

2.6.2 International Competition

While hemp production has been suppressed until recently in the United States because of prohibitive regulations, it has continued to be a valuable agricultural actor in other countries. Though it is still a relatively new market, recent estimates crown China as the largest producer of hemp in the world, providing more than half of the global supply (USDA Foreign Agricultural Service, 2020). Banned nation-wide in 1985 after joining the U.N. Convention of Psychotropic Substances, hemp production was re-legalized in 2010. While the Chinese government does not release official cultivation, production or sales data related to the hemp industry, a Congressional Research Service

report stated China "has had and likely will continue to have major influence on market prices and … (profits) in other countries" (Johnson, 2014; Moreno, 2020).

Canada is another major international competitor for hemp production, legalizing industrial hemp in 1998 after a push to find alternative economic opportunities for farmers. A rapidly growing industry, Canada is now the second-largest producer of hemp in the world (Government of Canada, 2018). In 2018, roughly $50 million worth of hempseed was exported from Canada, with approximately 70 percent of it going to the United States. Canada is also home to large and well-recognized hemp food brands, such as Manitoba Harvest, which produces a variety of products sold in 22 countries around the globe (Horner et al., 2019).

In addition, a rising competitor in the hemp market is the European Union (EU). Between 1993 and 1996, industrial hemp cultivation was legalized in a large portion of EU member states (Carus & Sarmento, 2016). France is a particularly important hemp producer, ranking as the largest producer in the EU at 70 percent of the total market and just recently dropped down to the fourth largest in the world (USDA Foreign Agricultural Service, 2021; European Commission, n.d.).

As a result of the late adoption of hemp legalization policies, the United States now faces competition from countries that have been established, in some cases, for decades. The United States has continued to gain traction in the industrial hemp market, claiming the spot as the third-largest producer in 2020 (Parkes, 2020). However, the country's status as the most recent to adopt industrial hemp legislation out of the top four countries is not the only obstacle that it has encountered. In addition, recent changes in

production legislation have threatened the viability of the industrial hemp market in the United States.

CHAPTER 3: THE REINTRODUCTION OF HEMP IN THE UNITED STATES: A CONTENT ANALYSIS OF STATE AND TRIBAL HEMP PRODUCTION PLANS

3.1 Introduction

In 1937, the Marihuana Tax Act imposed taxes on the sale of cannabis, discouraging the production of industrial hemp due to the failure of the Act to differentiate between hemp and its close relative, marijuana (1). Attitudes toward hemp were further tainted when it was classified as a Schedule I drug in 1970 under the Controlled Substances Act, which effectively made its production illegal (2,3). Hemp regained support beginning in 2014, as the 2014 Farm Bill permitted state-level pilot programs for hemp production (4). Four years later, the 2018 Farm Bill removed hemp's Schedule I drug classification, re-legalizing its production in the United States after an almost 75-year ban (5). However, the reintroduction of the crop into the agricultural sector has been complex and remains confounded by its association with marijuana (6).

As highlighted by its history, the inaccurate association between hemp and marijuana has proven to be a barrier to success for industrial hemp production for decades. Botanically, both hemp and marijuana are derived from the same plant: Cannabis sativa L. The United States Department of Agriculture (USDA) formally distinguishes the two plants based on THC (delta-9-tetrahydrocannabinol) content, which is the primary psychoactive component of the Cannabis sativa L. plant (7). A plant is considered hemp if the THC content is less than 0.3 percent on a dry weight basis and is considered marijuana if the THC content exceeds the 0.3 percent threshold (5). Despite this differentiation, the distinction between the two plants is not easily discerned by

members of the American public, with one 2020 study of Southeastern United States residents reporting 29% of respondents associating hemp with recreational marijuana (8).

The reintroduction of hemp to the United States agricultural landscape with the passing of the 2014 Farm Bill was a momentous development. However, the creation of individualized state hemp research and development pilot programs, with each state seizing the opportunity to pursue legislation to maximize its competitiveness within the burgeoning industry, may have impeded industry growth. What ensued was the creation of individualized state hemp research and development pilot programs, where each state seized the opportunity to pursue legislation to maximize its competitiveness within the burgeoning industry (9). For instance, states implemented different THC testing protocols, licensing fees, sampling procedures, and data collection processes. The result is a patchwork of hemp legislation across the country that is inconsistent in its terminology and processes, threatening the viability of this new sector.

The 2018 Farm Bill made significant changes to the existing regulatory framework the 2014 pilot plan set forth, further complicating the existing disparities across state plans. First, it broadened the scope to include tribal governments, whereas previous regulations had only allowed states to develop independent plans (10). Additionally, it created the interim final rule and final rule for hemp production, resulting in the USDA Hemp Producer License under which states and tribal governments could choose to operate. Enacted on March 22, 2021, the final rule for hemp production partially clarified the regulation requirements for U.S. state and tribal governments by providing a regulatory baseline that must be adhered to (11). State and tribal governments have been allowed to submit initial or revised individualized plans - and will continue to

be able to do so until December 3, 2021 - that incorporate the USDA Hemp Producer License regulations and include any clauses specific to their needs. While this allows for individual amendments, it has also perpetuated the ongoing lack of consistency between plans.

While the 2018 Farm Bill sought to clarify the program framework and address inconsistencies resulting from the rulemaking process for newly legalized hemp, this has been complicated by the 2014 Farm Bill still being active. In addition, the original sunset date of October 31, 2020, for the 2014 Farm Bill language has been extended twice, first to September 30, 2021, and then to January 1, 2022 (Figure 1). State governments that passed hemp legislation prior to the 2018 Farm Bill have continued to regulate hemp production under the 2014 Farm Bill, while those who passed legislation in 2018 and later regulate according to the 2018 Farm Bill. As a result, this infant industry is now trying to overcome regulatory hurdles from two different Farm Bills in addition to varying state and tribal government regulations.

It is important to note that these state and tribal hemp production plans only address the process of growing hemp up through pre-harvest THC compliance testing. After harvest (from the farm gate to retail product), regulations for hemp are also state and tribal government dependent but are not addressed by any of these plans. There are no federal-level retail regulations or industry standards that regulate the final hemp-based products in terms of consistency, quality, or analysis of claimed attributes of a hemp product in the retail sector. However, the U.S. Food and Drug Administration (FDA) has launched a Data Acceleration Plan to learn more about the safety of cannabis-derived products, indicating that regulations for this sector are in progress (12). Since the plans

analyzed in this study only tackle hemp production up to harvest, inconsistencies between regulations have perverse effects on the development of the industry, which may be compounded throughout the supply chain. In this interim period between THC compliance testing and harvest, biological changes can result in a hemp plant that pushes its THC content over the allowable threshold (13). This results in a producer having the proverbial 'green light' from given state authorities to harvest what was legally hemp at the time of testing but is legally marijuana at the time of harvest. Suppose testing is done post-harvest by a processing facility or is tested entering another state. In that case, serious issues can arise and result in the confiscation of the crop because of its illegal THC content (13). As highlighted by this example, the lack of consistency between current regulations and the absence of successive regulations can impact the intra- and interstate flow of hemp and THC performance testing requirements, licensing fees, capital investment, and many other aspects of the industry.

Given the current lack of consensus regarding hemp production legislation, the objective of this study is twofold. First, the research team performed a content analysis to examine the consistency of terms between state and tribal hemp plans by introducing the final rule for hemp. Second, the study's findings are used to provide recommendations to U.S. governing bodies on how to improve clarity for hemp producers, thus mitigating regulatory confusion impeding the industry's success. The format for the remainder of this manuscript is a review of methods for the content analysis, results, discussion, and conclusions.

3.2 Methods

To analyze the consistency of terms between state and tribal hemp plans, the full narratives of each plan needed to be thoroughly examined and recorded. Once this was completed, a content analysis was used to translate the information provided by approved state and tribal government hemp plans into quantitative data. A similar content analysis approach was used in an analysis of sub-national insect pollinator legislation by Hall and Steiner (14), where the content analysis allowed for both quantitative and qualitative descriptions of U.S. policy. As defined by Krippendorff, content analysis is "a research technique for making replicable and valid inferences from texts … to the contents of their use" (15 p. 24). In addition, the content analysis provides a systematic approach for quantifying and describing specific aspects of qualitative data (16). Originating in journalism, content analysis has grown in popularity and is used throughout varying disciplines, including business, communication, sociology, and medicine (15-17). Once the information from the hemp plans was translated into its quantitative form, the data were then used to identify common and idiosyncratic uses of terms and their definitions.

The cutoff date for this analysis was July 14, 2021. At that point, 67 states and tribal governments had approved independent plans, six were operating under the USDA Hemp Producer License, 20 were continuing to operate under the 2014 pilot, two were drafting a plan for USDA review, seven were under review and two were pending legislation (Table 1) (19). This study analyzed 69 state and tribal hemp production plans found on the official USDA Agricultural Marketing Service webpage (18) including approved independent plans, the 2014 pilot plan and the USDA Hemp Producer License. States electing to operate under the 2014 pilot plan were not assessed individually.

Instead, the common pilot plan was analyzed and counted as one plan in the final plan count. The same approach was applied to plans operating under the USDA Hemp Producer License. As mentioned above, the 2014 pilot plan is not representative of the USDA Hemp Producer License. For this reason, we included both the 2014 pilot plan and USDA Hemp Producer License to evaluate consistency between the two.

Researchers from the Universities of Vermont and Kentucky conducted a preliminary analysis of all approved state and tribal plans. This study used three human coders to ensure coding consistency and accelerate data coding efficiently once intercoder reliability was assured. While intercoder reliability is essential to establish whenever research involves more than one coder, this is especially true when quantifying qualitative data (20). To begin, the team documented all terms and definitions included in the 69 plans. Appendix A contains the form utilized by all coders to collect the required information [see Additional File 1]. A second coder completed a subsequent round of this step to ensure that all terms had been identified. During these rounds of analysis, coders identified terms they felt were "common knowledge." If a term that had initially been identified as "common knowledge" by one coder was considered necessary to include by another, the coders revisited the plans to ensure that the term was included in the final list of terms for the analysis. Examples of the terms not included due to their "common knowledge" designation are GPS, laboratory, USDA, and secretary. The coding team determined that these terms had definitions well-known by the public and did not provide any added information specific to hemp regulations. These terms were not included in the formal analysis.

Due to the large number of terms included across plans, the research team took two steps to establish inter-plan consistency. Figure 2 details each step of the content analysis completed for this study. First, the team established which terms were most frequently used by employing percentile ranks. For this part of the analysis, terms deemed "most frequently" included were those which fell in the 95th percentile or higher, based on the number of plans to include a term (of the 69 analyzed). The research group then scrutinized definitions provided for each term to determine if consistent definitions were given throughout all plans that included the term. Intercoder reliability was achieved for this part of the analysis by requiring all three coders to review and agree upon the consistency of the definitions provided by plans. This study discounted slight variations in verbiage when determining whether the definitions were consistent. To provide a percentage of definition consistency across plans, the number of times a definition was provided for each term was divided by the total number of plans that included the term. For example, the term "Hemp" occurred in 51 of the 69 plans (73.91%), and the most common definition appeared in 37 of the 51 plans (72.55%) (Figure 3; Table 2).

Terms included between two and 17 times were reviewed for consistency between definitions across terms with different names (Figure 2). As with the first consistency analysis described above, this study disregarded slight variations in verbiage when determining whether the definitions were the same. Intercoder reliability was ensured for this step by requiring all group members to sort through the terms which occurred between two and 17 times to identify those which fit this criterion. Similarly defined terms with different names were grouped based on the content of their definitions. Terms

that did not fit this criterion were not analyzed further. Additionally, terms that were included in only one plan were not analyzed further.

3.3 Results

In the 69 plans analyzed, 421 different terms were identified. Twenty-four terms fell on or above the 95th percentile, meaning they were included in 18 or more plans (Figure 3). The term most frequently cited in plans was "hemp," which appeared in 51 of the 69 plans. The research team found substantial variation in term definitions across plans, with inter-plan consistency ranging from zero percent to 100 percent (Table 2). Only one term, "commercial sales," was defined consistently across all plans that included the term, while "License" and "Licensee" had no consistency between definitions across plans. All definitions for these two terms refer to the same concept, yet the wording varied drastically enough to be deemed inconsistent.

The terms "THC" and "Hemp Product" were defined consistently in 30 percent of plans. The terms "Lot," "Variety," and "Producer" were defined consistently in fewer than 50 percent of plans. "Culpable Mental State Greater Than Negligence" and "Dry Weight Basis" were defined consistently in 50 percent of the plans. "Acceptable Hemp THC Level" was defined consistently in fewer than 70 percent of plans. "Hemp," "Applicant," "Cannabis," and "Corrective Action Plan" were consistently defined in 75 percent of plans. Definitions of "Key participant," "Negligence," "Cultivate," "Measurement of Uncertainty," and "Negligence" were consistent in more than 80 percent of plans. Table 2 shows the analyzed terms, the percentage of total plans that the term appeared in, and the percentage of those plans that use the most common definition to appear throughout all plans.

Terms that appear more than once but less than those in the 95th percentile were analyzed further. For this analysis, terms that had the same or similar definitions, but different names, were grouped together and categorized by the research team. As with the other consistency analysis, slight variation in verbiage was disregarded when determining whether the definitions were the same. The eight groups that were identified were "Area to Grow Hemp," "Hemp," "Legal THC Level," "Marijuana," "Postdecarboxylation," "THC," "Typologies of Hemp," and "Volunteer Hemp" (Figure 4). All terms listed within each group were described using the same or very similar definitions. For example, in the "Hemp" category, the terms "Hemp or Industrial Hemp," "Industrial Hemp," and "Hemp" are listed, meaning that the definitions for these terms all define hemp. The least common terms were included in the analyzed plans only once. Of the 421 total terms identified for analysis, 241 (57.24%) were only included in only one plan. The complete list of singularly included terms as well as the number of plans they occurred in can be found in Appendix B.

3.4 Discussion

When beginning this study, the research team expected to discover that the introduction of the final rule on March 21, 2021, would provide relatively more consistency across state and tribal government plans than was seen after the deployment of the 2014 pilot plans. However, it appears that providing each state and tribal government the opportunity to submit an independent plan for approval has done the opposite. This is emphasized by the 241 terms included only in one plan. Furthermore, inconsistent term names were provided for the same definition among the 180 terms that appear between two and 17 times throughout the 69 plans analyzed. Lastly, the majority

of the terms which appeared most frequently across plans were given incongruous definitions, demonstrating different understandings of the term. The findings of this study highlight the persistent inconsistencies of hemp production regulations among U.S. states and tribal governments.

While the varying terminology in state and tribal plans is likely due to different colloquialisms across the country, these disparities can potentially create regulatory confusion. Since hemp is highly likely to be transported and marketed across state, tribal, and international borders, differences in regulatory language at such an early stage create challenges for actors throughout the supply chain, including producers, input suppliers, processors, marketers, and consumers. Inconsistencies limit future expansion by creating additional barriers, such as new market entry, customer loyalty and acquisition of new and valuable venture capital (Mark et al. 2020).

It is important to note that while our team has concluded that the independent state and tribal hemp plans are noticeably inconsistent, the presence of this varying terminology is not indicative of a true discrepancy in the production of hemp between these entities. Without being familiar with the intricacies of each hemp production plan, we are unable to say for certain the degree to which the practices of each entity differ. However, the findings of this study suggest that there is likely some discordance between hemp production in each state and tribal government that has an approved independent plan.

As highlighted by its tumultuous history, a major barrier to the success of the reintroduction of hemp in the U.S. agricultural sector is its association with marijuana (Williams et al. 2020; Campbell et al. 2021). If we suppose the objective of federally

approved hemp production plans is to mitigate the ability of hemp producers to abuse their license to grow Cannabis sativa L. and cultivate marijuana instead of hemp, it is reasonable to believe that the incongruent composition of state and tribal plans makes this challenging to prevent. By allowing states and plans to determine different windows for post-test harvest, for example, the current regulations may unintentionally allow for the distribution of marijuana (Pearce et al. 2021). This presents several threats to the success of hemp: notably the confusion of consumers and inability of producers to engage in interstate commerce. Therefore, ensuring that the two plants remain separate crops will be integral to the prosperity of the hemp market.

Findings from this study point to areas in need of uniformity and consistency as the regulatory framework is modified and provides a starting point for federal policymakers. Based on the conclusions of our analysis, it appears that current regulatory flexibility has created an environment that fosters competitive advantages amongst state and tribal governments depending upon the content of their independent plans. However, more research is needed to fully understand the scope and depth of any potential competitive advantage. Further, the democratic process will have to play out as states and tribal governments will most likely be interested in maintaining any advantage they currently possess, whether intentional or unintentional.

3.5 Conclusions

Based on the findings of this study, there are significant areas for improvement in federal policy guidelines for hemp production. The research team has curated two suggestions for how to mitigate the inconsistencies seen in state and tribal hemp programs. First, we recommend that the USDA provide and define the basic regulatory

language for independent plans to follow. While the USDA Hemp Producer License provides some terminologies and definitions, it is not required that plans choosing to operate under individually approved plans adhere to them. By creating an expanded list of terms and corresponding definitions that must be ubiquitous among all state and tribal plans, the USDA can provide a lexicon for hemp producers to alleviate discrepancies in how production is approached and defined.

Additionally, we suggest the creation of regulations for the rest of the hemp supply chain. While we are aware that the USDA does not have jurisdiction over the processing of hemp or any other steps post-harvest, we feel that it will be beneficial to provide these regulations to ensure that, once cleared on the pre-harvest side, the integrity of the hemp programs is maintained and are not allowed to infiltrate the marijuana business. By creating clear separations between hemp and marijuana supply chains, hemp producers may find relief from the longstanding erroneous association between the two crops. For the U.S. to steward a victorious reemergence of hemp in the agricultural sector, we must work to attenuate pre-existing barriers and provide a way for hemp to safely and equitably make its way to the consumer.

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Table 1. Status of State and Tribal Government Plans

Plan Status	Tribal Governments	States
Independent Approved Plan	Blackfeet Nation Tribal Council, Cayuga, Cheyenne and Arapaho Tribe, Cheyenne River Sioux, Chippewa Cree, Colorado River Indian Tribes, Comanche Nation, Confederated Tribes of Warm Springs, Cow Creek Band of Umpqua Tribe of Indians, Eastern Band of Cherokee Indians, Flandreau Santee Sioux, Fort Belknap Indian Community, Iowa Tribe of Kansas and Nebraska, La Jolla Band of Luiseno Indians, Lac Courte Oreilles, Little Traverse Bay Bands of Odawa Indians Waganakising Odawak, Lower Sioux Indian Community, Miccosukee Tribe of Indians of Florida, Nez Perce Tribe, Oglala Sioux Tribe, Otoe-Missouria Tribe, Pala Band of Mission Indians, Pawnee Nation of Oklahoma, Prairie Band Potawatomi Nation, Pueblo of Picuris Tribe, Red Lake Band of Chippewa, Rosebud Sioux Tribe, Sac & Fox Tribe of the Mississippi in Iowa, San Carlos Apache Tribe of Arizona, Santa Rosa Band of Cahuilla Indians, Santee Sioux Nation, Seminole Nation of Oklahoma, Seneca Nation, Sisseton-Wahpeton Oyate, Soboba Band of Luiseno Indians, Standing Rock Sioux Tribe, Torres Martinez Desert Cahuilla Indians, Turtle Mt. Band of Chippewa Indians, Winnebago Tribe of Nebraska, Ysleta Del Sur Pueblo, Yurok Tribe	Delaware, Florida, Georgia, Indiana, Iowa, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, Nevada, New Jersey, Ohio, Oklahoma, Pennsylvania, Puerto Rico, Rhode Island, South Carolina, South Dakota, Texas, U.S. Virgin Islands, Washington, Wyoming,
Operating Under USDA Hemp Producer License	Assiniboine and Sioux Tribes of the Fort Peck Reservation, Confederated Salish & Kootenai Tribes of the Flathead Reservation, Lower Brule Sioux Tribe,	Hawaii, Mississippi, New Hampshire
Continuing Under 2014 Pilot	—	Alabama, Alaska, Arkansas, Colorado, Connecticut, Illinois, Kentucky, Maine, Montana, New Mexico, New York, North Carolina, North Dakota, Oregon, Tennessee, Utah, Vermont, Virginia, West Virginia, Wisconsin
Drafting Plan for USDA Review	Ute Mountain Ute, Yankton Sioux Tribe	—
Under Review	Cahuilla Band of Indians, Kanosh Band of Paiute Indians, Pauma Band of Luiseno Indians, Saint Regis Mohawk Tribe, Shoshone-Bannock Tribes	Arizona, California,
Pending Legislation	—	Idaho, Northern Marianas Island
2014 Pilot Plan	—	—
USDA Hemp Producer License	—	—

Adapted from: U.S. Department of Agriculture Agricultural Marketing Service, 2021.

Table 2. Definition Consistency of the 95th Percentile of Terms

Term	Percent of Plans that Include Term	Percentage of Plans that Include Most Common Definition	Most Common Definition
Hemp	73.91	72.55	"The plant Cannabis sativa L. and any part of that plant, including the seeds thereof and all derivatives, extracts, cannabinoids, isomers, acids, salts, and salts of isomers, whether growing or not, with a delta-9 THC concentration of not more than 0.3 percent on a dry weight basis."
Key Participant(s)	72.46	80.00	"A sole proprietor, a partner in partnership, or a person with executive managerial control in a corporation. A person with executive managerial control includes persons such as a chief executive officer, chief operating officer and chief financial officer. This definition does not include non-executive managers such as farm, field, or shift managers."
Acceptable Hemp THC Level	71.01	67.35	"When a laboratory tests a sample, it must report the delta-9 tetrahydrocannabinol content concentration level on a dry weight basis and the measurement of uncertainty. The acceptable hemp THC level for the purpose of compliance with the requirements of the Tribe's hemp plan is when the application of the measurement of uncertainty to the reported delta-9 tetrahydrocannabinol content concentration level on a dry weight basis produces a distribution or range that includes 0.3% or less. For example, if the reported delta-9 tetrahydrocannabinol content concentration level on a dry weight basis is 0.35% and the measurement of uncertainty is +/-0.06%, the measured delta-9 tetrahydrocannabinol content concentration level on a dry weight basis for this sample ranges from 0.29% to 0.41%. Because 0.3% is within the distribution or range, the sample is within the acceptable hemp THC level for the purpose of plan compliance. This definition of "acceptable hemp THC level" is not meant to affect either the statutory definition of hemp in the 2018 Farm Bill (codified at 7 U.S.C. § 16390(1)) or the definition of "marihuana" in the Controlled Substances Act (codified at 21 u.s.c. § 802(16))."
Applicant	62.32	74.42	"A person, or a person who is authorized to sign for a business entity, who submits

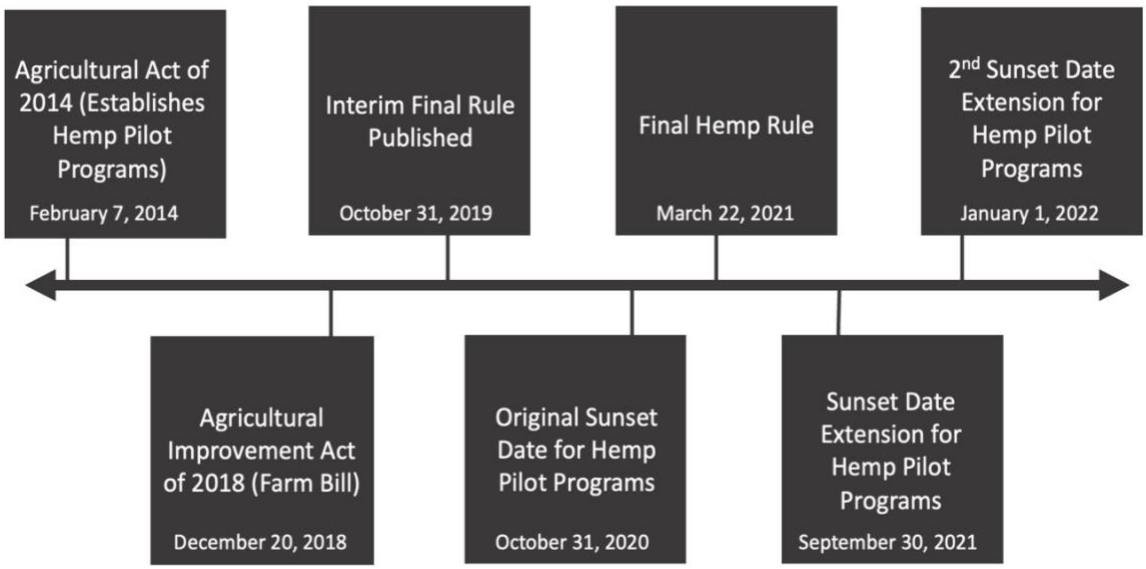
			an application to participate in the Hemp program."
Licensee	55.07	0	N/A
Decarboxylated	50.72	54.30	"The completion of the chemical reaction that converts THC-acid ("THC- A") into delta-9-THC, the intoxicating component of cannabis. The decarboxylated value is also calculated using a conversion formula that sums delta-9-THC and eighty-seven and seven tenths (87.7) percent of THC-A."
Cannabis	47.83	69.70	"A genus of flowering plants in the family Cannabaceae of which Cannabis sativa is a species, and Cannabis indica and Cannabis ruderalis are subspecies thereof. Cannabis refers to any form of the plant in which the delta-9 tetrahydrocannabinol concentration on a dry weight basis has not yet been determined."
Lot	47.83	39.40	"A contiguous area in a field, greenhouse, or indoor growing structure containing the same variety or strain of cannabis throughout the area."
Dry Weight Basis	46.38	50.00	"The ratio of the amount of moisture in a sample to the amount of dry solid in a sample. A basis for expressing the percentage of a chemical in a substance after removing the moisture from the substance. Percentage of THC on a dry-weight basis means the percentage of THC, by weight, in a cannabis item (plant, extract, or other derivative), after excluding moisture from the item."
Variety	46.38	46.88	"A subdivision of a species that is uniform, in the sense that the variations in essential and distinctive characteristics are describable, stable, in the sense that the variety will remain unchanged in its essential and distinctive characteristics and its uniformity if reproduced or reconstituted as required by the different categories of varieties, and distinct, in the sense that the variety can be differentiated by one or more identifiable morphological, physiological, other characteristics from all other publicly known varieties, or other characteristics from all other publicly known varieties."
THC	42.03	27.59	"Tetrahydrocannabinol and has the same meaning as delta-9 THC, measured post-decarboxylation."
Negligence	39.13	96.30	"A failure to exercise the level of care that a reasonably prudent person would exercise in complying with this Plan."

Culpable Mental State Greater Than Negligence	37.68	50.00	"To act intentionally, knowingly, willfully, or recklessly."
License	37.68	0	N/A
Conviction	34.78	79.17	"Any plea of guilty or nolo contendere, or any finding of guilt, except when the finding of guilt is subsequently overturned on appeal, pardoned, or expunged. For purposes of this Plan a Conviction is expunged when the Conviction is removed from the individual's criminal history report and there are no legal disabilities or restrictions associated with the expunged Conviction, other than the fact that the Conviction may be used for sentencing purposes for subsequent Convictions. When an individual is allowed to withdraw an original plea of guilty or nolo contender and enter a plea of not guilty and the case is subsequently dismissed, the individual is no longer considered to have a Conviction for purposes of this Plan."
Hemp Product(s)	33.33	30.43	"Means a finished product with the Acceptable Hemp THC Level that is derived from, or made by, processing a Hemp Crop, and that is prepared in a form available for commercial sale. The term includes, but is not limited to cosmetics, personal care products, Consumable Products, cloth, cordage, fiber, fuel, paint, paper, particleboard, plastics, and any product containing one or more Hemp Ingredients such as cannabidiol."
Measurement of Uncertainty	33.33	86.96	"The parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the particular quantity subject to measurement."
Corrective Action Plan	28.99	75.00	"Means a plan for a licensed hemp producer to correct a negligent violation or non-compliance with a hemp production plan and this program."
Cultivate	27.53	84.21	"To plant, water, grow, and harvest a plant or crop."
Handle	27.53	31.58	"To harvest or store hemp or hemp plant parts prior to the delivery of such plants or plant parts for further processing. "Handle" also includes the disposal of cannabis plants that are not hemp for the purposes of chemical analysis and disposal of such plants."
Phytocannabanoid(s)	27.53	89.47	"Cannabinoid chemical compounds found in the cannabis plant, two of which are Delta-9 tetrahydrocannabinol (delta-9 THC) and cannabidiol (CBD)."

Commercial Sale(s)	26.10	100.00	"The sale of a product in the stream of commerce at retail or at wholesale, including sales on the internet."
Person(s)	26.10	27.78	"A natural person, corporation, foundation, organization, business trust, estate, limited liability company, licensed corporation, trust, partnership, limited liability partnership, association, or other form of legal business entity, as well as a tribal, state or local government entity."
Producer	26.10	44.44	"An owner, operator, landlord, tenant, or sharecropper, who shares in the risk of producing a crop and who is entitled to share in the crop available for marketing from the farm or would have shared had the crop been produced. A producer includes a grower of hybrid seed."

Note: N=69. Slight variation in verbiage was disregarded when determining the most consistent definition.

Figure 1. Hemp Policy Timeline



Adapted from: U.S. Department of Agriculture Agricultural Marketing Service, 2021.

Figure 2. Schematic of Content Analysis Methods

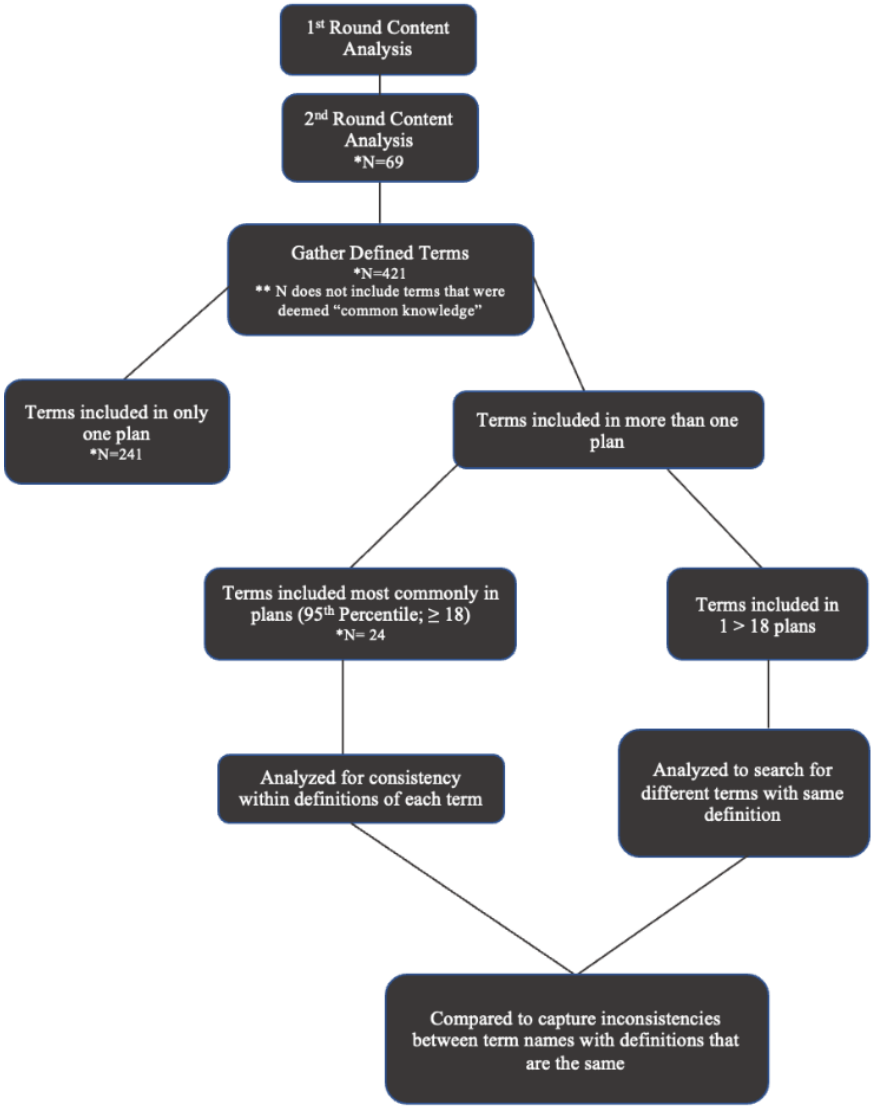
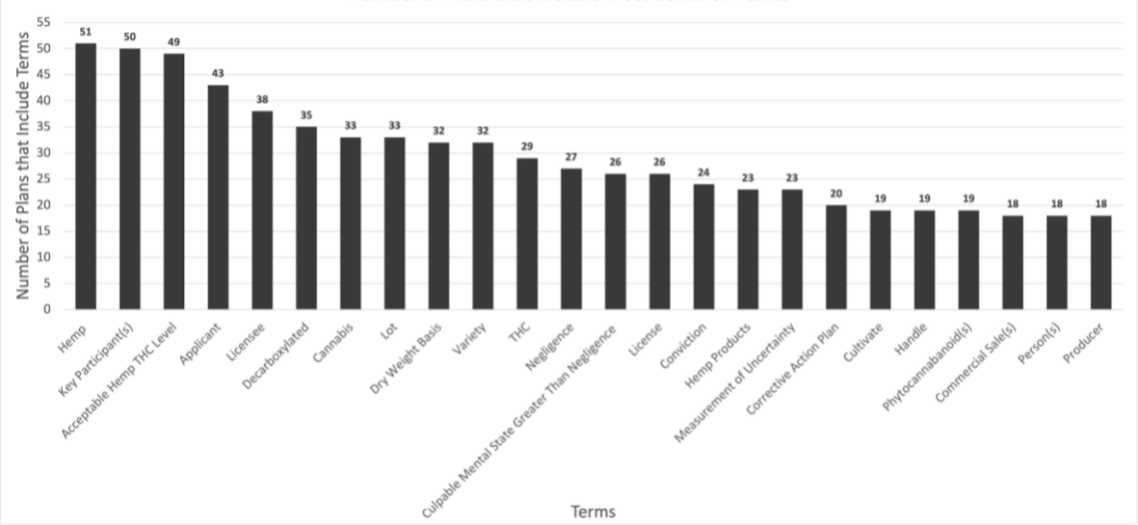
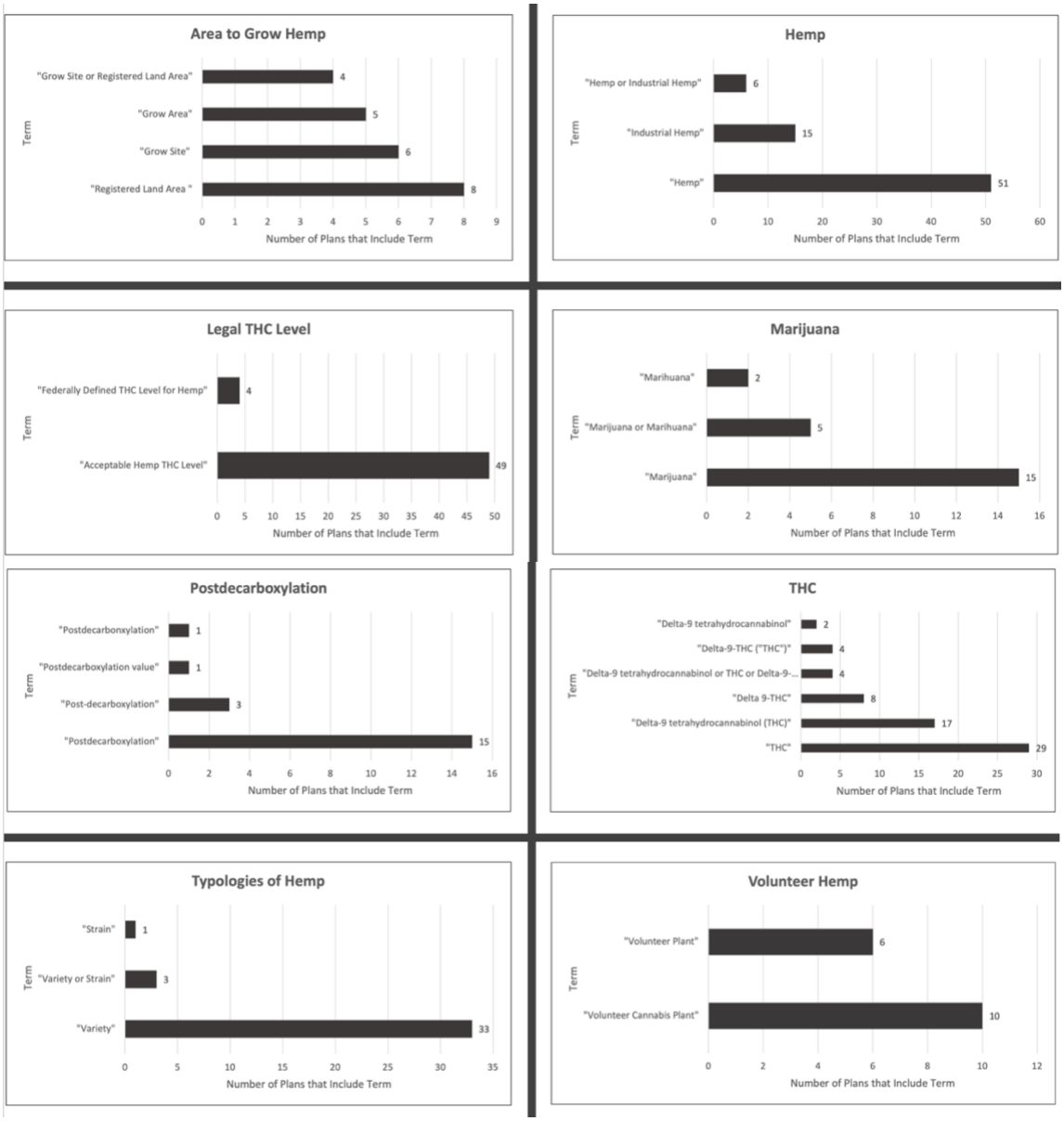


Figure 3. Number of Plans to Include Most Common Terms



Note: N = 69

Figure 4. Terms Grouped by Similar Definition Content



Note: Slight variation in verbiage was disregarded when determining similarities between definitions.

CHAPTER 4: CONSUMER PREFERENCES OF CBD OIL: A DISCRETE CHOICE EXPERIMENT

4.1 Introduction

The industrial hemp industry in the United States has fought a lengthy battle to regain traction after a nearly 45-year hiatus. Reemerging onto the agricultural scene in 2014 with the "Legitimacy of Hemp Research" program and relegalized in the 2018 Farm Bill, hemp was quickly adopted by farmers looking for profitable alternatives to traditional commodity crops (Pal & Lucia, 2019). In the years since its relegalization, the United States has seen a substantial increase followed by a significant decrease in registered and planted hemp acres (New Frontier Data, 2022).

The removal of prohibitive legislature led to an increase in licensed hemp acreage in the United States, reaching 580,000 acres in 2019 (Hemp Benchmarks, 2021). However, the excitement of farmers to jump at this economic opportunity created an oversupply in the market (USDA, 2000; Fortenbery & Bennett 2004; Cherney and Small, 2016), causing hemp biomass prices nation-wide to drop by over 90 percent from July 2019 to December 2021 and leading to a decline in U.S. hemp production (New Frontier Data 2022; PanXchange Hemp 2022). In 2020, registered hemp acreage dropped to 430,000 acres and reached only 195,000 acres in 2021 (Hemp Benchmarks, 2021). Importantly, these numbers do not reflect the actual number of acres that were planted each year, which were estimated to be only 146,065 acres in 2019: a mere 25.18% of registered acres that year (Mark et. al, 2020; Hemp Benchmarks, 2021). Despite the decrease in biomass price value, there remain opportunities for value added hemp products in the market (Hemp Benchmarks, 2021; New Frontier Data, 2021).

Hemp-based products have made their way back onto the market over the past seven years, with Hemp Industry Daily (2021) noting that CBD (cannabidiol) has been the driving force behind the hemp boom. Annual estimates of hemp-based CBD sales hit $1.9 billion in 2020, are on track to hit $3.5 billion in 2021, and are projected to reach $6.9 billion in 2025 (Hemp Industry Daily, 2021). Despite this growth, hemp is still a relatively new industrial crop and producers lack information about consumer preferences and demand (National Hemp Research and Education Conference, 2020). A better understanding of how consumers value product attributes can reduce producer uncertainty and improve production and marketing decisions.

This research study utilizes a discrete choice experiment (DCE) to gauge consumer willingness to pay (WTP) for CBD oil attributes. This provides valuable information to producers who can tailor their products to better meet the preferences of consumers. Because of the need to identify areas in which producers can differentiate their products, the objective of this research study has two parts. First, we offer an analysis of the WTP results of the DCE, providing information on the ways in which producers can maximize the value of their product. Second, we examine respondent demographics to offer a more in-depth analysis of how these characteristics influence product preferences. The format for the remainder of this article is a brief history of hemp in the United States, a background on DCEs, an exploration of the attributes of CBD oil, explanation of the methods and experimental design used for the study, a description of the survey participants, details of data analysis, results, and a discussion of the relevance of the findings of this research study.

4.2 A Brief History of Hemp

Hemp and marijuana are both from the plant species *Cannabis sativa L.* (Johnson, 2019). However, the distinct difference between the two is the level of tetrahydrocannabinol (THC): Cannabis is classified as hemp if it has a THC concentration of .3% or less and any concentration higher than this threshold is considered marijuana. Historically, this differentiation is not commonly known by the public, which has impacted the perceptions of hemp as an industrial crop (Borkowska & Bialkowska, 2019, pg. 12; Campbell et al., 2021). This was reflected in the passing of the 1937 Marihuana Tax Act which imposed taxes on the sale of all cannabis (USDA, 2000). Failing to differentiate between hemp and other cannabis plants, the production of industrial hemp was discouraged by this tax.

Furthermore, hemp was classified as a Schedule I drug by the Controlled Substances Act in 1970, formally making its production illegal. Hemp remained largely taboo in the United States until 2014 when the Agricultural Act of 2014 (the 2014 Farm Bill) allowed for the introduction of state-level pilot programs for hemp production. These policy reforms were a successful step in the reintroduction process of industrial hemp (Mark et al., 2020). The passage of the 2018 Farm Bill officially restored the legal status of industrial hemp in the United States with the removal of its Schedule I drug classification, allowing producers the opportunity to grow the crop for the first time in several decades.

4.3 Discrete Choice Experiments

The research questions presented in this study required a stated preference evaluation method, in which individuals express preferences between products with

unique bundles of attributes from a series of distinct choices. This allows for the establishment of preference orderings not for the product itself, but for the combination of attributes the product possesses (Lancaster, 1966). Originally developed in the fields of economics, psychology, and statistics, DCEs have gained popularity in a wide variety of research disciplines as a method of stated preference evaluation (Hoyos, 2010).

Rooted in Thurstone's law of comparative judgement, DCEs allow for a comparison between paired choices (Thurstone, 1927). The choice analysis of DCEs is based on the Nobel Prize-winning random utility approach developed by economist Daniel McFadden (1973), which postulates the probability that each alternative presented in an experiment will be chosen (Walker & Ben-Akiva, 2002). Including price attributes in the DCE allows for an estimation of consumer's willingness to pay (WTP) for particular product attributes (Carson & Louviere, 2010).

4.4 Key Product Attributes for CBD Oil

Even in a competitive market, product differentiation can help producers obtain the highest revenue while providing consumers with the ability to choose products boasting characteristics they value most. In this study, we focus on four primary attributes: organic certification, local production, CBD concentration, and price.

One way producers can differentiate their CBD oil is through organic certification. Like other crops seeking this certification, hemp must be grown according to the USDA organic regulations (U.S. Department of Agriculture Agricultural Marketing Service, 2019). To produce CBD oil, the ingredients are typically CBD that has been extracted from hemp and a carrier (usually an oil of some sort) that is used to dilute the CBD. For a product to be labeled as "organic," it must contain a minimum of 95 percent

organic ingredients (Coleman, 2012). This means that the CBD extracted from the hemp as well as the carrier must together meet this required percentage. However, depending on the size of the operation, organic certification can be costly, with a USDA estimate of "a few hundred to several thousand dollars" (U.S. Department of Agriculture Agricultural Marketing Service, n.d.). Producers must consider this cost when determining the economic gain that may come from a certified organic product.

Another way that CBD oil can be made unique is through local production. Unlike organic certification, the definition of what makes a product local is not well defined or widely agreed upon (Lang et al., 2014). The definition may vary from consumer to consumer, with some drawing distinctions based on distance from the point of purchase. However, several other variables may influence their definition including geographical, physical, psychological and cultural elements (Durham et al., 2009). Though there is a lack of consensus on what makes a product "local," this distinction nonetheless provides producers a way to make their product stand out.

Several studies suggest a relationship between a product being locally or organically produced and consumer WTP. A 2020 study in Serbia found that consumers were willing to pay a premium for honey that had been locally or organically produced, with a higher value for organic certification (Vapa-Tankosić et al. 2020). Most respondents were willing to pay 10-20% more for honey that was local, and 20-30% more for organic honey as opposed to a conventional version. When looking at potatoes, a Colorado study found that consumers were willing to pay a 10% premium for locally produced and a 7% premium for organically produced potatoes (Loureiro & Hine, 2002). Similarly, consumers in Spain expressed a WTP a 25% premium for locally produced

almonds and a 5% premium for organic almonds (de-Magistris & Garcia 2016). While the WTP percentages vary between products, a positive price premium can be seen for both local and organic versions. Like the products included in these studies, CBD oil is ingestible. Consequently, consumers may be more conscientious about the characteristics of products they ingest as opposed to those they simply wear or use (Hinsley & 't Sas-Rolfes, 2020). As such, these findings provide insight into how the presence of these attributes in CBD oil may influence the price that consumers are willing to pay.

It has also been noted that the socio-demographic characteristics of DCE respondents are related to WTP, providing information about which market segments have the highest demand for these products and attributes. In a study of consumers in the United Arab Emirates (UAE), Muhammad et al. (2015) found that study participants' willingness to pay for organic food products varied significantly with socio-demographic characteristics. It was determined that respondent nationality, monthly income, education, and age influenced WTP. Age, monthly income, and education all had a positive correlation with WTP, and respondents who are from the UAE (as opposed to those of non-UAE origin) were more willing to pay for organic food products. In their study on organic honey, Vapa-Tankosić et al. (2020) found education and monthly income to be significant demographics in their survey sample. Respondents with a higher level of education were willing to pay more for local honey, while respondents with a higher monthly income were willing to pay more for organic honey. These previously demonstrated relationships between WTP for organic and local ingestible products and certain socio-demographic variable groups suggest that a trend may also be observed for CBD oil consumers.

To our knowledge this is the first published DCEs on CBD oil. While several studies discuss consumer preferences of cannabis flower products (Smart et al., 2017; Shi et al., 2019; Donnan et al., 2022) and cannabis policy (Shanahan et al., 2014), as well as the potential for other hemp-based products (building materials and paper) to receive price premiums when marketed to the certain groups (Goliath, 2021; Smith, 2021), none of these studies analyze preferences of CBD oil.

4.5 Methods

The methods used to conduct this research survey are multi-tiered. First, the research team determined which product attributes should be included in the analysis. Then, the research team designed the DCE to ensure the maximization of D-efficiency, an essential step in DCE creation. Next, data was collected using Qualtrics, an online survey platform. Finally, the data was analyzed using several mixed logit models to calculate the WTP premium for each attribute, and additional statistical analysis were used to examine the presence of any demographic influence on these premiums.

4.5.1 Product Attributes

The four attributes chosen for the DCE- locally grown, organic, CBD concentration, and price- were determined through conversations with stakeholders in the hemp community, informal interviews with local growers and processors, and research of current products in the market. Local and organic were treated as binary indicator variables. Since this survey recruited respondents nation-wide, local was not specified as being from a particular location. CBD concentration levels were determined from market analysis, ranging from 250mg to 3000mg with a total of 12 levels at 250mg increments.

Price levels were also determined from market analysis, with levels representing the log price of analysis from $20 to $120 with a total of 15 levels.

4.5.2 Experimental Design

A well-structured model is one that is efficient, meaning the parameters of the model are estimated with the utmost accuracy (Zwerina et al., 1996). Design (D-) efficiency (also referred to design (D-) optimality) is the numerical representation of how well a chosen fractional factorial design represents the full factorial design (Vanniyasingam et al., 2018). If our DCE were to utilize a full factorial approach (a D-efficiency score of 100), each possible combination of attributes would have to be considered. With 4 attributes- locally produced, organic, CBD concentration and price- having two, two, 15 and 12 levels respectively- this would result in a design matrix with 720 rows that could then be combined into 258,840 pairs. This is far too many choices to present to survey respondents, providing justification for the use of a fractional factorial design.

Using Stata statistical software, the research team ensured the maximization of the D-efficiency of the DCE by utilizing the "dcreate" command. Evolved from the Fedorov Algorithm (Fedorov, 1972), the command employs the modified Fedorov Algorithm which works to create the most efficient linear design by choosing a subset of choice set alternatives from the full factorial design, which are then repeatedly swapped for candidate alternatives until D-efficiency is maximized (Cook & Nachtrheim, 1980; Carlsson and Martinsson, 2003). Hole (2016) provides a detailed explanation of the mathematics behind this process, which guided our implementation and understanding.

The model for this DCE required that we use a minimum of 27 choice sets to optimize D-efficiency. With a maximum possible value of 100, this provided a D-efficiency of 83.15. This exceeds the threshold for "reasonable" efficiency, which is 80 or above (Nijs, 2018). With no previous DCEs on this topic we were unable to use a previously estimated β, which specifies the weight given to each attribute by respondents (Sándor & Wedel, 2001; Zwerina et al., 1996). Instead, we used a prior estimate of zero for the β parameter in our efficient design calculation, indicating that we began our experiment with no assumption of attribute significance for the respondents.

4.5.2 Data Collection

The DCE was implemented using the online survey platform Qualtrics, using Weber's (2019) guide as a reference. The survey sections included: introduction and consent, demographics, hemp knowledge, basic information about CBD oil, DCE choice tasks, and post-DCE hemp-related questions. The 27 choice sets were presented in random order and with random assignment of which choice was offered as choice A and B. In addition to presenting the two choices for each choice set, this experiment also included an "opt-out" option to better represent real-world consumer choices, allowing respondents to choose neither option presented to them (Boxall et al., 2009, Campbell & Erdem, 2019). The "opt-out" option was always presented as the third choice. Questions appeared in the form of multiple choice, multiple answer, and rank-order. Text entry was provided for any of the non-choice set questions that offered the answer "other", allowing for respondents to elaborate if this option was chosen. This study did not meet the criteria needed to require a full institutional review board evaluation.

The DCE survey collected 253 total responses from a sample recruited by Qualtrics. The sampling methodology used by Qualtrics- utilizing "panel partners" to contact their respondents- results in a convenience sample, meaning respondents are easy and accessible to contact. As a result, the sample collected is not representative of the population of interest we are trying to examine, that being U.S. consumers. To combat this, we added quotas for gender, age, and race/ethnicity to the respondent sampling which helps to make the population more representative of the actual population of the U.S. While the CBD user quota for this study was 50% of respondents, the actual percentage of the U.S. population which consumes CBD is likely much lower (MRI-Simmons, 2020; New Frontier Data, 2020b). The purpose of oversampling CBD users was to better analyze the preferences of current CBD consumers as well as non-consumers. Displayed in Appendix C are the target quotas for the recruited respondents which are approximately representative of U.S. population distributions of age, gender, and race/ethnicity. While the survey composition may not be generalizable to the population of interest, this study still provides important insights into the preferences of current and potential CBD oil consumers.

The survey completion rate was 85.77%. Of the 217 completed responses, 144 were deemed valid to include our study. To determine which responses were invalid they needed to meet at least one of two exclusion criteria: rapid completion time and choice-dominance violation. Responses were examined for these criteria prior to analysis. Quintile ranks were utilized to create a cutoff for minimal completion time requirements, and respondents who completed in less than 4.20 minutes were dropped from our analysis (43 responses). Additionally, an analysis of the selection of choice-dominance violators

was used. Choice-dominance violation occurred when a “superior” product was not chosen, for example if the product was local, organic, and had a higher CBD concentration but had a lower price than the other choice presented. Those who chose the “inferior” choice two or more times were considered to have failed this attention check and thus dropped from the analysis (30 responses). While there is no consensus on which attention checks are best for DCEs, these two were chosen based on the context and scope of the research study (Pearce et al., 2021).

Table 3 shows the demographics for all respondents who completed the survey, as well as respondents who were deemed as “valid” using the criteria above. The demographics of the respondents who completed the survey are closely representative of the quotas set to better represent the U.S. population regarding age, gender, and race/ethnicity.

Table 3. Participant Demographics

	Completed Survey Respondents (n=217)		Valid Respondents (n=144)	
Variable	**Frequency**	**Proportion**	**Frequency**	**Proportion**
CBD Use (n=217, n=144)				
CBD User	110	.51	63	.44
Non-CBD User	107	.49	81	.56
Gender (n=216, n=143)				
Female	110	.51	77	.54
Non-Female	106	.49	66	.46
Race/Ethnicity (n=217, n=144)				
BIPOC*	76	.35	44	.31
White	141	.65	100	.69
Income (n=201, n=132)				
Low-Income ($0-$25,000)	45	.22	36	.27
Middle-Income ($25,000-$100,000)	93	.46	63	.48
High-Income ($100,000+)	63	.31	33	.25
Education (n=214, n=141)				
Bachelor's Degree or Higher	92	.43	56	.40
Less than Bachelor's Degree	122	.57	85	.60
Political View (n=201, n=135)				
Liberal	74	.37	50	.37
Non-Liberal	127	.63	85	.63
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**
Age (n=217, n=144)	43	17.2	47	17.6

* "BIPOC" represents all respondents who identified themselves as either BIPOC, multiracial BIPOC, or multiracial including White.
- N values represent the number of respondents who provided an answer for each demographic for each group. N values for completed survey respondents are listed first, followed by n values for valid respondents.
- "Liberal" represents the respondents' self-declaration of their political view.

4.5.3 Data Analysis

Various statistical models can be used to analyze DCE data including hierarchal bayes, latent-class finite-mixture, conditional logit models, and multinomial logit models (Hauber et al. 2016; Lancsar et al. 2017; McFadden 1973). After considering the limitations of each statistical model, a mixed logit model was deemed to be the best fit for our study because of its allowance for random variation in taste, unrestricted

substitution patterns, and unobserved correlated factors over time, as well as its ability to be used on non-normal distributions (Train, 2002). Using the cmxtmixlogit command in Stata, a mixed logit model was fit to our DCE data through maximum simulated likelihood which represented the repeated decisions made by respondents (StataCorp LLC, 2019).

Three mixed logit models analyzed valid respondents who fit varying levels of criteria. The first test analyzed all valid respondents, which consisted of the 144 responses that were not removed for violating the exclusion criteria explained above. The second test analyzed 114 interested respondents, where "interested" was defined as the respondent choosing a CBD oil option in at least one of the DCE choice sets instead of choosing the opt-out option for all choices. Lastly, 61 interested CBD oil users were analyzed, which was determined by those who met the criteria for "interested" while also indicating in the survey that they already use CBD oil.

In order to determine consumer WTP for specific CBD oil attributes from these mixed logit models, the coefficients of each attribute from each mixed logit model were used. The coefficients of each attribute were divided by the negative coefficient of the price attribute for each model. This method estimates WTP in preference space, as opposed to the alternative method of estimation in WTP space (Scarpa et al., 2008; Hole & Kolstad, 2010). This resulted in three WTP values for each attribute: one for each mixed logit model.

The second research objective- an examination of consumer demographics- was achieved by using a variety of regression analyses. First, bivariate analyses were conducted to understand who uses CBD products. Second, an Ordinary Least Squares

regression was conducted to understand the relationship between demographic variables and the level of interest in purchasing CBD oil by non-CBD users. Third, a Poisson regression was chosen to analyze the relationship between demographic characteristics and the number of times a respondent chose a CBD oil in the DCE instead of neither choice. Finally, an ordered logit regression was used to determine the relationship between respondent demographics and their ranking of CBD attributes.

4.6 Results

The three mixed logit models concluded that the presence of certain CBD oil attributes influenced the WTP for the product for each respondent group (Table 4). Valid respondents had a comparatively low WTP for each attribute and negatively valued higher CBD concentration. Interested respondents had a positive WTP for all attributes, demonstrating that they value each attribute during product consideration. Organic production elicited the strongest WTP from this group, indicating that organic production was most important to them of the attributes presented in this survey. Interested CBD users had the most substantial positive WTP for all attributes, which is likely tied to their experience using the product. Organic production consistently resulted in the highest WTP premium across all three models. However, when testing the significance of the variation between price premiums we found that, for valid respondents and interested respondents, WTP for local and organic attributes were not significantly different ($p=.788$; $p=.226$). When examining the interested CBD user group, we found a marginal significance of the higher WTP for organic as compared to local ($p=.060$).

Table 4. Mixed Logit Models and Willingness to Pay Results

	Valid Respondents (n=144)			Interested Respondents (n=114)			Interested CBD Users (n=61)		
Attribute	**Coef. (SE)**	**95% CI**	**WTP**	**Coef. (SE)**	**95% CI**	**WTP**	**Coef. (SE)**	**95% CI**	**WTP**
Local	0.317 (0.097)	1.137 - 7.104	+$4.12**	0.382 (0.100)	2.979 - 10.409	+$6.69**	0.326 (0.150)	0.315 - 17.171	+$8.74**
Organic	0.359 (0.102)	2.017 - 7.322	+$4.67**	0.578 (0.097)	5.398 - 14.860	+$10.13**	0.735 (0.148)	9.669 - 29.728	+$19.70**
CBD Concentration	-0.002 (0.003)	-0.100 - 0.055	-$0.02	0.004 (0.003)	-0.067 - 0.219	+$0.08	0.311 (0.189)	-1.727 - 18.427	+$8.35*
Price	-0.077 (0.005)	--	--	-0.057 (0.005)	--	--	-0.037 (0.005)	--	--
	Log simulated-pseudolikelihood:		**Wald chi² (6):**	**Log simulated-pseudolikelihood:**		**Wald chi² (6):**	**Log simulated-pseudolikelihood:**		**Wald chi² (4):**
	-1984.043		104.23	-1898.260		81.20	-952.066		102.36

*Significant at the .10 level
**Significant at the .05 level
- WTP Measured in US Dollars
- + indicates willingness to pay more; - indicates willingness to pay less
- WTP for CBD concentration is measured per 250mg increase

Using the additional regressions described above, we discovered relationships between certain demographic variables and consumer demand for CBD oil. First, we compared the demographics of CBD users versus non-CBD users for our study and found two significant values at the .05 level: age and political view (Table 5). For respondents' political views, there is a significantly greater proportion of non-CBD users who are non-liberal than those who are liberal. In comparison, a near-similar proportion of CBD users identify as liberal and non-liberal. Age is also a significant demographic variable, with a distinctively younger average age for CBD users (39) as compared to non-CBD users (52). This uncovers that those who are CBD users are more likely to be younger than those who do not use CBD.

Table 5. Bivariate Analyses Between Demographics and CBD Use

Variable	**P-Values**	**Test Statistics**
Chi2	**P-Value**	**Pearson Chi2**
Gender	0.755	0.097
Income	0.345	4.481
Race/Ethnicity	0.523	0.407
Education	0.184	8.812
Political View	0.015**	5.910
T-Test		**T Statistic**
Age	<0.001**	4.717

******Significant at the .05 level
-The model for each demographic variable was fit separately

When considering survey respondents who identified themselves as not currently using CBD products, we analyzed the data to determine if there were any demographic characteristics that influenced their level of interest in purchasing CBD oil (Table 6). Our Ordinary Least Squares regression found a significant relationship between gender and level of interest: female respondents showed less interest in purchasing the CBD oil options presented to them.

Table 6. Demographic Analysis Between Non-CBD Users and Level of Interest in CBD Oil

Demographic	Coefficient	SE
Gender	-0.189*	0.107
Income	0.007	0.085
Race/Ethnicity	0.020	0.142
Education	0.015	0.123
Political View	0.085	0.127
Age	-0.004	0.004

- R2 value: .101
*Significant at the .10 level

The Poisson regression used to examine each respondent's number of interested choices and their demographic variables found three significant relationships at the .05 level (Table 7). First, a one-year increase in respondent age is associated with a .01 decrease in the total count of interested responses per individual (as opposed to the percentage of choices). Next, the political view of respondents is also significant, indicating that those who identify as liberal provided a higher number of interested responses than non-liberals. Finally, the significant negative value for gender indicates that, in our study sample, females are less interested in CBD oil than non-females.

Table 7. Poisson Regression Examining Number of Interested Choices and Demographic Variables

Demographic	Coefficient	P-Value
Gender	-0.112	0.011**
Income	0.008	0.828
Race/Ethnicity	-0.094	0.061
Education	0.038	0.450
Political View	0.225	<0.001**
Age	-0.011	<0.001**
Log Likelihood:	**Pseudo R^2:**	**LR Chi^2 (6):**
-864.405	0.064	117.90

****Significant at the .05 level

After completing the DCE choice sets, participants were asked to rank the attributes of CBD oil that were included in this study in order of importance. The most

and least important attributes were determined by looking at the mean response for each of the attribute ranks within each of the three respondent groups (valid, interested, and interested CBD users). The attribute with a mean closest to 1 was ranked highest, and thus most important, by respondents (Table 8). The attribute with a mean closest to 4 is the attribute that was ranked as least important by respondents. Across all three respondent groups price was ranked at the most important attribute, with CBD concentration second, followed by organic as third and local as the least important attribute.

Table 8. Attribute Importance Rank

	Valid Respondents (n=114)		**Interested Respondents (n=92)**		**CBD Users (n=50)**	
Attribute	**Mean**	**Rank**	**Mean**	**Rank**	**Mean**	**Rank**
Price	1.93	1	1.97	1	1.94	1
CBD Concentration	2.58	2	2.53	2	2.42	2
Organic	2.74	3	2.70	3	2.76	3
Local	2.75	4	2.80	4	2.88	4

Next, an ordered logit regression was run to determine any significant relationships between demographic variables and the ranking of the CBD oil attributes. These analyses found that there is a statistically significant association between having a college degree and/or being BIPOC when considering the rank of the organic attribute at the .1 level (Appendix D). Those who are BIPOC are more likely to rank organic as their most important attribute when considering CBD oil. Those with a college education are also more likely to rank organic as their most important attribute for CBD oil. Though the coefficient is negative for these regressions, the highest rank is 1 while the lowest rank is 4, which leads to the negative coefficients representing a positive relationship between these demographics and the ranking of the organic attribute.

4.7 Discussion

The goal of this research study was to examine consumer WTP for CBD oil attributes controlling for consumer demographics and whether participants were current CBD oil users. The WTP analysis of our DCE found different levels of WTP by consumers depending on which group was analyzed: valid respondents, interested respondents, or interested CBD users. The organic attribute elicited the highest WTP in every group, suggesting that this is more important to consumers than local production or CBD concentration when considering which CBD products to buy. These results are similar to Loureiro and Hine's (2002) and de-Magistris and Garcia (2016), where consumers expressed a positive WTP for consumables produced both locally and organically. Specifically, our findings are roughly in line with Vapa-Tankosić et al. (2020), where consumers conveyed a higher WTP for organically produced consumables than locally produced options. However, when considering the results of the rank-order question, organic ranked as the third most important attribute for CBD oil (after price and CBD concentration). This variability presents uncertainty surrounding consumers' true value on organic production for this product.

The demographic analyses found several significant variables which varied depending upon the relationship being explored. The bivariate analysis of demographic variables and CBD use found that respondents' political views and age were significant characteristics that influenced their CBD use. A significantly larger proportion of non-CBD user respondents are non-liberal, whereas there was a near-similar proportion of CBD users who were liberal and non-liberal. These results differ from those of a 2019 study which found that liberals and conservatives did not have a substantial variation

when comparing their CBD usage (Politico & Harvard T.H Chan School of Public Health, 2019).

Furthermore, respondents who identified themselves as CBD users in our research study have a distinctively younger average age (39) as compared to non-CBD users (52). A similar age discrepancy was found in a 2019 Acosta study which noted that 56% of "Millennials" use CBD products as opposed to only 32% of "Gen X" and 15% of "Baby Boomers" (Acosta, 2019). Contradictory results were noted by New Frontier Data (2020a), which found that older consumers (ages 55+) were more likely to consume CBD than younger consumers (ages 18-34). The discrepancies between the results of these two industry data sources highlight the need to explore this demographic more in-depth to discover why particular age groups may be more or less likely to consume CBD. Neither report reveals their data collection methods, pointing to the need for publicly accessible and transparent research on this topic.

The demographic analysis of non-CBD users and their level of interest in CBD oil found a significant relationship between gender and level of interest, where female respondents were less interested in purchasing CBD oil. This finding is related to the findings of the 2019 Acosta study, which indicated that being male is a significant variable contributing to CBD use. However, an additional study had conflicting results, noting a higher use of CBD by females than males (Hyson, 2022). While our results for this study reflect a level of interest in purchasing CBD oil for non-CBD users and not actual use, as represented in these studies, the relationship between CBD oil and gender is still a noteworthy one to consider. The varying results of the influence of gender on CBD oil use and interest again highlight the need for a more in-depth exploration of this

relationship to determine what would motivate a particular gender to consume (or not consume) CBD oil. Further research should use probability sampling methods to explore generalizable results.

Our Poisson regression examining the relationship between the number of "interested" selections and demographic variables found significance in the same three characteristics as the first two tests: age, gender and political view. Higher respondent age is associated with a decreased interest in CBD oil, which is on par with the results found in the first bivariate analysis. Respondents who self-identified as liberal demonstrated more interest in CBD oil than non-liberals, which provides evidence in contrast to the findings of Politico and Harvard T.H Chan School of Public Health (2019). The relationship between gender and interest for the sample population is the same as for non-CBD user gender and interest (a negative relationship).

The negative relationship between females and both CBD use and interest warrants deeper consideration. Previous research has uncovered a similar relationship between gender and CBD use, with males being significantly more likely to regularly consume CBD as compared to females (New Frontier Data, 2020b). However, when considering who does the shopping, prior studies have found that females are the primary shoppers in multi-gender households (Schaeffer, 2019; The Nielsen Company, 2019). To better reach consumers that are more likely to be interested in their product (non-females) producers may look to sell their CBD oil using alternative markets that reach those groups directly. This includes utilizing online shopping platforms, which are one of the most used sources to purchase CBD (New Frontier Data, 2020b).

Finally, the ordered logit regression found a relationship between race/ethnicity and college education and their ranking of CBD oil attributes. Those who identified as BIPOC and/or have a four-year degree are more likely to rank organic as the most important attribute. These findings are similar to those of Vapa-Tankosić et al. (2020) who noted a positive relationship between education and WTP. However, this relationship was between education and local production instead of organic. This presents a thought-provoking parallel between the significance of education and consumer interest in, and WTP for, certain product attributes.

While the findings of this study provide preliminary results regarding consumer preferences for CBD oil, it is important to note that the survey sample is not generalizable to the population of interest, which is U.S. consumers. This is due to our oversampling of CBD users, a result of convenience sampling, which was done intentionally to focus on these users as a subgroup of interest. In addition, while still significant, the significant coefficients observed in this study are relatively small. However, the findings of this study can still be applied and should be considered when continuing to research demand for CBD oil.

While this study provided sufficient data to complete these analyses, to further clarify the relationship between demographic variables and CBD oil consumption a larger sample size would be beneficial. Using what we have learned from this study, a larger initial sample size may have allowed more overall responses to pass the quality control checks, therefore providing more data to utilize. Additionally, including fewer levels for the price attribute would lead to a lower number of DCE choice sets required to reach an adequate D-efficiency, thus reducing the potential for respondent fatigue.

While this analysis provides insight into the preferences of CBD oil consumers, hemp-based products take on many different forms. For example, hemp beauty products likely have different characteristics than CBD oil that would influence a consumer's choice. Since these findings provide valuable consumer information for CBD oil producers, this model has the potential to do the same for other hemp-based products. By providing this information to producers of hemp-based products, this reemerging industry may be better equipped for continual success.

4.8 Conclusion

These findings provide important preliminary information for CBD oil producers about what consumers consider when making purchasing decisions. As demonstrated by the WTP results, different product attributes elicit varying price premiums from consumers. In addition, the attributes of CBD oil are likely valued differently by varying demographic groups. By analyzing this relationship between demographics and CBD interest and use and WTP for certain product attributes, producers can gain insight into how to adjust their production practices to cater to certain consumers. Alternatively, if these production practices are already in place- such as local or organic production- producers should ensure that consumers are aware of these valued attributes. In a market that is already burdened with oversupply, ensuring that a product meets the needs of consumers is essential to promoting business success.

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CHAPTER 5: CONCLUSION

As the United States continues to navigate the reintroduction of hemp as an agricultural product, this thesis serves as a collection of introductory research that can be used to inform actors along the supply chain and the appropriate governing bodies who can aid in its reinstatement. The findings of this thesis can be used to bolster developing areas of current hemp-based research in the United States, thus providing preliminary findings that can be built upon and revisited as the industry continues to take shape.

Chapter 3 provides an overview of the regulatory history of hemp, specifically from its reintroduction in the 2014 Farm Bill, and presents an analysis of the consistency across state and tribal government hemp production plans. While the research team expected to discover that introducing the final rule for hemp production would provide more consistency across plans, this was not the case. This is highlighted by the large number of terms to appear in only one of the analyzed plans as well as the lack of consistency between term names and incongruous definitions. The findings of this study suggest there are significant areas for improvement within federal policy guidelines for hemp production.

Chapter 4 analyzes Willingness to Pay (WTP) for CBD oil attributes and examines the relationship between consumer demographics and CBD oil preferences. The WTP analysis of our Discrete Choice Experiment (DCE) found different levels of WTP by consumers depending on which group was analyzed: valid respondents, interested respondents, or interested CBD users. However, all groups valued organic production the most as demonstrated by the price premium they were willing to pay for CBD oil with this attribute. Demographic analyses found several significant variables that

varied depending upon the relationship being explored. These findings provide important preliminary information for CBD oil producers regarding what consumers consider when purchasing their product.

In sum, the information provided by the research included in this thesis act as a catalyst for deeper exploration into the topics of hemp policy and consumer preferences for hemp-based products. Using the findings of these individual studies, stakeholders throughout the hemp production and consumption channels can make informed decisions and undertake subsequent research to help foster the continued successful reintroduction of hemp in the United States.

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APPENDICIES

Appendix A. Form used to document term, definition, and state/tribal government

Term	Definition	State/Tribal Government

Appendix B. Comprehensive list of terms included in analysis

Term	Number of Plans to Include Term
Acceptable Hemp THC Level	49
Acceptable Industrial Hemp THC Level	1
Acceptable THC Level	5
Administrative License	1
Adulterated	1
Agent	1
Agricultural Hemp Propagule (Propagule)	1
Agricultural Hemp Propagule and Seed Permit (Permit)	1
Agricultural Hemp Seed	2
Agricultural Hemp Seed (Seed)	1
Agricultural Pilot Program	1
Agriculture Office	2
Applicant	43
Application	3
Approved Seed	1
Approved Variety of Industrial Hemp	1
Authorized Agent	1
Authorized Laboratory	1
Batch	1
Bonafide Farmer Certificate	1
Broker	3
Brokering	1
Building	1
Burning	1
Bush Mower/Chopper	1
Cannabidiol or CBD	6
Cannabinoid Profile	2
Cannabinoid(s)	4
Cannabinol (CBN)	1
Cannabis	33
Cannabis Sativa L	1
CBD	15
CBD Biomass	1
CBD Broad Spectrum Oil Distillate	1
CBD Full Spectrum Oil Distillate	1
CBD Seeds (Non-Feminized)	1
CBD/CBG Clones	1

CBD/CBG Isolate	1
CBD/CBG Seeds (Feminized)	1
CBDA	1
CBG Biomass	1
CBG Distillate	1
Certificate	2
Certificate of Analysis (“COA”)	3
Certified Hemp Seed	1
Certified Industrial Hemp Sampler (Certified Sampler)	1
Certified or Approved Hemp Seed	1
Certified Seed	7
Certified Seed/Low THC Seed	1
Certifying Agency	1
Commercial	2
Commercial Sale(s)	18
Commission	1
Commissioner	4
Compliance Transaction	1
Compliant Hemp	1
Compliant Industrial Hemp	1
Condition	1
Consumable	1
Consumable Hemp Product	1
Consumable Product	10
Consumer	1
Container	1
Contiguous	2
Contiguous Field	3
Contiguous Land Area	1
Contiguous Licensing	1
Control Order	1
Controlled Substance	1
Controlled Substance Felony	1
Controlled Substances Act	4
Conviction	24
Corrective Action Plan	20
Corrective Action Plan or CAP	1
Criminal History Record Information	1
Criminal History Report	12
Crop	3
Crop Destruction	1

Crop Site	1
Crop Termination	1
Crude Hemp Oil	1
Culpable Mental State Greater Than Negligence	26
Cultivar	2
Cultivate	19
Cultivate or Cultivating	2
Cultivating	2
Cultivating or Cultivation	4
Cultivation	2
Cultivation License	1
Cultivation Licensing Agreement	1
Cultivation Site	4
Cultivator	1
Date of Harvest	1
DEA Registered Reverse Distributor or a Duly Authorized Federal, State, or Local Law Enforcement Officer	1
Decarboxylated	35
Decarboxylation	17
Deep Burial	1
Delta 9-THC	8
Delta-9 tetrahydrocannabinol	2
Delta-9 tetrahydrocannabinol (THC)	17
Delta-9 tetrahydrocannabinol or THC or Delta-9-THC	4
Delta-9 THC Post-Decarboxylation	1
Delta-9-THC ("THC")	4
Delta-9-THCA ("THC-A")	1
Designated Responsible Party	1
Destroy	1
Destroy(ed)	1
Destruction Report	1
Destruction/Disposal	4
Devitalize	1
Disking	1
Disposal	1
Disqualifying Felony	1
Distribute/Distribution	2
Dried CBD Flower	1
Drug Felony Conviction Report	1
Dry Weight Basis	32
Dwelling	1

Entity	10
Establishment	1
Extractor	1
Extractor or Extraction	1
Facility	2
Familial Interest	1
Federally Defined THC Level for Hemp	4
Federally Defined THC Level for Hemp or Acceptable Hemp THC Level	1
Field	2
Field Average	1
Field Duplicate Sample	1
Final Sample	2
Final Test	2
Financial Interest	6
Fit for Commerce	1
Flowering Plant	1
Fund	1
Gas Chromatography	6
Gas Chromatography and High-Performance Liquid Chromatography	1
Gas Chromatography or GC	12
Gas or Liquid Chromatography with Detection	1
General Permit	1
Genuine Grower's Declaration	1
Governing Person	1
Grain	1
Greenhouse	3
Ground Cover	1
Grow	1
Grow Location	1
Grow or Growing	1
Grow Site	6
Grow Site or Registered Land Area	4
Grower	10
Grower Licensing Agreement	1
Growing Area	5
Growing Area or Site	1
Growing Location or Lot	1
Growing Plant	1
Guarantor	1
Handle	19
Handle or Handling	7

Handler	10
Handling	7
Handling Site	1
Harvest	8
Harvest Certificate	1
Harvest Form	2
Harvest Lot	12
Harvest Lot Identifier	12
Harvest Lot or Lot	1
Harvest/Destruction Report	1
Harvesting	1
HCO	4
Hemp	51
Hemp Activity	2
Hemp Bill of Lading	1
Hemp Business	6
Hemp Comission	2
Hemp Control Officer	2
Hemp Crop	12
Hemp Cultivation	1
Hemp Extract	2
Hemp Grower	5
Hemp Grower and Hemp Producer	2
Hemp Grower License or Grower License	2
Hemp Grower or Licensee	2
Hemp Handling Facility	1
Hemp Ingredient	8
Hemp Oil	1
Hemp or Industrial Hemp	6
Hemp Plan	1
Hemp Plant	1
Hemp Plant Parts	1
Hemp Processor	5
Hemp Processor Permit	1
Hemp Processor Permit/License or Processor Permit/License	1
Hemp Producer	6
Hemp Producer or Licensee	1
Hemp Product or Industrial Hemp Product	1
Hemp Product(s)	23
Hemp Production Site	1
Hemp Program	3

Hemp Propogative Material	1
Hemp Research License	1
Hemp Research Pilot Project Licenses	1
Hemp Researcher	1
Hemp Seller	5
Hemp Site	1
High Performance Liquid Chromatography or HPLC	13
High-performance Liquid Chromatography	3
High-performance Liquid Chromatography (HPLC) or (LC)	1
Immature plant	1
Individual	1
Indoor Crop Site	1
Indoor Cultivation	1
Indoor Production	1
Industrial Hemp	15
Industrial Hemp License or License	1
Industrial Hemp Plant Parts	1
Industrial Hemp Product(s)	5
Industrial Seeds	1
Intended for Consumption	7
Intended for Consumption or Consumable	1
Key Participant(s)	50
Laboratory License	1
Landowner	1
Legal Description	1
Lessee	2
License	26
License Agreement	6
License Application	2
License for the Importation and Distribution of Hemp Products for Consumption	1
License Holder	1
License Holder Who Transplants	2
Licensed Area	3
Licensed Cultivator	1
Licensed Grower	5
Licensed Growing area	1
Licensed Processor	5
Licensed Research Distributor	1
Licensed Research Grower	1
Licensed Research Processor	1
Licensed Research Section	1

Licensee	38
Licensee or Licensed Hemp Producer	1
Licensee or USDA Licensed Hemp Producer	2
Licensee Representative	1
Licensing Agreement	1
Listed Low THC seed	1
Location ID	11
Location or Land	7
Lot	33
Lot Identification	1
Manufacturer	2
Manufacturing License	1
Marihuana	2
Marijuana	15
Marijuana or Marihuana	5
Market or Marketing	1
Marketable Hemp Product	2
Material Change	1
Measure of Uncertainty	1
Measurement of Uncertainty	22
Measurement of Uncertainty or MU	7
Medical Cannabis	1
Mulching/Composting	1
Nebraska Heirloom Cannabis Plant or Seed	1
Negligence	27
Negligence or Negligent	1
Negligence, Negligent, Negligently	4
Negligent Violation	3
Non-commercial Personal Possession or Use	2
Non-compliant Hemp	1
Non-marketable Hemp	1
Non-retrievable	2
Nonconsumable Hemp Product	2
Nonviable Seed	9
Official Sample	3
Official Test Result	1
Outdoor Production	1
Parcel	1
Percentage of THC on a Dryweight Basis	1
Permit	9
Permit Holder	1

Permit or Lot Permit	3
Permitted Farmer or Permitted Hemp Farmer	1
Permitted Handler or Permitted Hemp Handler	1
Permitted Processor or Permitted Hemp Processor	1
Permittee	3
Person(s)	18
Person/s or Individuals	1
Personal Use	1
Pesticide	12
Phytocannabanoid(s)	19
Pilot Program	1
Pilot Project Hemp Cultivar	1
Pilot Project Hemp Seed	1
Plan	1
Plan/Program	1
Plant	3
Plant Health Office	1
Plant Part	1
Planting Form	2
Planting Report	2
Plantlets	1
Plot	3
Plot or Lot	2
Plowing Under	1
Possessor	1
Post-decarboxylation	3
Post-harvest Plant Material Waste	1
Post-harvest Sample	2
Postcarboxylation Test	1
Postdecarbonxylation	1
Postdecarboxylation	15
Postdecarboxylation Value	1
Postharvest Report	1
Pre-harvest Inspection	1
Pre-harvest Plant Material Waste	1
Pre-harvest Report	1
Pre-harvest Sample	5
Pre-harvest Testing	1
Primary Licensee	1
Process	15
Process or Processing	9

Processed Hemp Plant Material	1
Processing	13
Processing Area	2
Processing Locations	1
Processor License	1
Processor Licensing Agreement	4
Processor or Processor Facility	6
Processor-Handler	1
Processor(s)	7
Produce	16
Produce or Producing	5
Produce or Production	2
Producer	18
Producer Licensing Agreement	1
Producer or Licensed Producer	1
Producer Registration	1
Product Lot	2
Production Site	1
Program	7
Program or Hemp Program	1
Prohibited Varity	12
Propagate	1
Propagule(s)	17
Publicly Marketable Hemp Product	8
Puerto Rico Department of Agriculture Hemp Program	1
Puerto Rico Hemp Licensing and Inspection Office	1
QR code	1
Qualified Agricultural Producer	1
Raw Hemp	2
Reasonable Efforts	2
Refined Hemp Oil	1
Registered Land Area	8
Registered Producer	1
Registrant	3
Registration	2
Remediation	1
Render Cannabis Non-Retrievable	1
Representative Sample	1
Research	1
Research Area	1
Research License	1

Reservation	1
Reverse Distributor	10
Sample	6
Sample Collection Date	1
Sampler	1
Sampling	2
Sampling Agent	2
Secondary Pre-Harvest Sample	1
Seed	2
Seed Distributor License	1
Seed Source	5
Sell/Sale	2
Site	2
Smoking	1
Special Hemp Seed Importation Permit	1
Specimen	2
State Plan	1
Sterilization	1
Storage	2
Storage Area	3
Store	4
Strain	1
Subcontractor	3
Temporary Harvest and Transportation Permit	1
Test or Testing	1
Test Sample	1
Testing Facility	2
Testing Laboratory/Laboratory	1
Testing THC Hemp	1
THC	29
THC and THCa	1
THC Concentration	1
THC Free Distillate	1
THC-A	3
THCA	3
Total Delta-9-Tetrahydrocannabinol Concentration	1
Total Delta-9-THC	1
Total THC	3
Transplant	3
Transport	1
Transport Manifest	2

Transporter	1
Tribal Hemp License	1
Tribal Hemp Officer	1
Tribal Hemp Regulation	1
Unprocessed Hemp Plant Material	1
Variety	32
Variety of Concern	4
Variety or Strain	3
Viable Industrial Hemp	1
Viable Seed	1
Volunteer Cannabis Plant	10
Volunteer Industrial Hemp Plant	1
Volunteer Plant(s)	6
Waste	1
Waste Disposal Plan	1
Wild Cannabis	1

Appendix C. Demographic Quotas

Demographic	Proportion of Respondents
CBD Use	
CBD User	.50
Non-CBD User	.50
Gender	
Female	.50
Male	.50
Age	
18-34	.33
35-55	.33
55+	.33
Race/Ethnicity	
Non-Hispanic White	.66
Non-Hispanic Black	.12
Hispanic	.12
Other	.10

Appendix D. Ordered Logit Regression of Relationship Between Attribute Rank-Order and Demographics

	Ordered Logit	
CBD Attribute/Demographic	**Coef.**	**SE**
LOCAL		
Gender	.172	.360
Income		
Low Income	.141	.497
High Income	-.138	.444
Race/Ethnicity	.087	.442
Education	.054	.433
Political View	.111	.400
Age	-.005	.011
ORGANIC		
Gender	-.463	.364
Income		
Low Income	.324	.507
High Income	.013	.432
Race/Ethnicity	-.814*	.466
Education	-.761*	.437
Political View	.086	.380
Age	.005	.012
CBD CONCENTRATION		
Gender	.013	.357
Income		
Low Income	-.278	.499
High Income	.554	.442
Race/Ethnicity	.637	.479
Education	.112	.418
Political View	-.112	.389
Age	.006	.011
PRICE		
Gender	.188	.373
Income		
Low Income	-.123	.487
High Income	-.474	.469
Race/Ethnicity	.258	.469
Education	.470	.428
Political View	-.108	.397
Age	.001	.012

*****Significant at the .10 level