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Examining Consumer Perceptions And Behaviors Toward Hemp-Based Products

Hannah Lacasse
University of Vermont

EXAMINING CONSUMER PERCEPTIONS AND BEHAVIORS TOWARD HEMP-BASED PRODUCTS

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Thesis Examination Committee:

Jane Kolodinsky, Ph.D., Advisor
Heather Darby, Ph.D., Chairperson
Travis Reynolds, Ph.D.
Cynthia J. Forehand, Ph.D., Dean of the Graduate College

ABSTRACT

Although its relevance has ebbed and flowed, hemp production has persisted over several centuries. Over time, its popularity has been interrupted by competing products, public health concerns and regulatory barriers. A renaissance of hemp production has emerged in the U.S., particularly after regulatory barriers fell in 2014 and 2018. This has given rise to a growing market of diverse hemp-based food, medicinal, textile and industrial products. Adding to the political, technological and financial challenges facing this nascent industry is a demonstrated need for consumer behavior research on how products made with hemp-based ingredients are received, if at all, by consumers.

Existing research on hemp consumption largely focuses on hemp cannabidiol products, which have gained substantial popularity since hemp's legalization. However, this represents just one of the thousands of products that can be processed from hemp and cannabidiol alone cannot sustain the industry. As such, further examination of the hemp consumer is necessary. Peer reviewed literature points to the need for analyses that specifically address the many products that hemp can produce and that evaluate characteristics beyond consumer demographics.

Therefore, this thesis examines data collected from a survey of Vermont residents on their perceptions of hemp as an innovative input. We first examine how perceptions of hemp influences consumer propensity to choose or reject each of eight hemp product categories. We then analyze cumulative adoption behavior, modeling the total use of hemp products as innovations diffusing through the marketplace. Findings contribute to a more comprehensive understanding of the hemp consumer and examine how that behavior can be employed by industry and policy stakeholders.

ACKNOWLEDGEMENTS

A sincere thank you to my committee members for their support throughout this research. Thank you to the Little Hemp grant team for introducing me to this new world of hemp and learning with me along the way.

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1.1. A History of Hemp

Hemp-based products have been reintroduced to the market landscape over the last few decades. From milk alternatives, granola, and food grade oils to insulation and plastics, the opportunity for hemp products is vast and growing. However, hemp is not entirely new; its involvement in human history is long and tangled. Before we can evaluate the modern hemp market, a necessary first step is to understand hemp's historic role.

Hemp has been present throughout human history. Remnants of hemp cloth were found in ancient Mesopotamia as early as 8,000 BCE (Ministry of Hemp, 2019). The crop originated in Eastern and Central Asia (Fike, 2019), with China having cultivated hemp for over 6000 years – the longest period of hemp cultivation (The Thistle, 2000). As hemp made its way across the world, it gained cultural significance in religious and spiritual practices (Ministry of Hemp, 2019; Robinson, 1996) and contributed to the necessities of daily life through food, clothing, paper and medicine (Ministry of Hemp, 2019; The Thistle, 2000; van Roekel, 1994). Hemp oil and seeds became a source of health and healing in Chinese and Indian medicine as early as 2300 BCE (Fike, 2019; Robinson, 1996). Hemp seed has been used as a food source for centuries and historically served as a staple for the poor and lower class (Fike, 2019; Robinson, 1996), serving as a substantial source of nutrition as raw, cooked or pressed into oil (Callaway, 2004; Matthäus & Brühl, 2008).

In 1500 BCE, hemp was introduced to Europe (Fike, 2016), where it eventually became highly valued for its use as a salt-resistant canvas and durable rope for sailing ships and naval expeditions (Meijer et al., 1995). Throughout North America in the 16th and 17th centuries, hemp cultivation was highly encouraged, and sometimes mandatory, in order to supply the paper, rope and textile industries (Robinson, 1996). Despite hemp's historic importance, the crop's significance began to fall in the 20th century for a variety of reasons: development of the cotton synthetic fiber industries, technological advances in the shipping industry, and the emphasized connection between the crop and marijuana leading to public health concerns (Micu, 2021; Raymunt, 2020).

Hemp production was prohibited in most of North America through the Marijuana Tax Act of 1937 in the United States and the Opium and Narcotic Act of 1938 in Canada because of its ties to marijuana (Alberta Government, 2015; Fortenbery & Bennett, 2004; Tourangeau, 2015). Both countries saw a brief resurgence in production when World War II required hemp-based supplies, but then resumed prohibition when the war ended (Kolosov, 2009; The Thistle, 2000). Many European countries also began to outlaw hemp production in the 1920s (Bewley-Taylor et al., 2014). India considered responding to hemp production as well and created a hemp commission in the 1890s to determine the public health threat of hemp and whether it caused "lunacy" when used (Ayonrinde, 2020).

India ultimately decided to pursue regulation and taxation of the crop rather than outright prohibition, but there is speculation that this decision was less motivated by minimal public health concern and more due to political and economic interests of

the commission members (Hall, 2019). Similarly, there is skepticism regarding the United States' concern for the health effects of hemp. Though 1937 restrictions were framed as protection of public health and safety, there is conjecture that investors in the upcoming plastic, pulp-paper and petroleum industries pushed for hemp prohibition to limit competition (Robinson, 1996). In addition to economic and ethical rationale, motives to prohibit hemp were also fraught with racist and xenophobic tensions. Prohibition efforts across the world were likely used to scapegoat people of color, immigrants, and other minority groups (Bewley-Taylor et al., 2014; Gray, 1998; Robinson, 1996).

As fear of marijuana fueled prohibition of hemp production around the world, hemp declined further with the introduction of new, more cost-effective technologies and fibers: the cotton gin reduced labor costs in the south, steamboats replaced sailboats and the market for marine cordage and cloth, and abaca and jute were imported at a lower price (Fortenbery & Bennett, 2004; Meijer et al., 1995). As a result, global production of hemp tow waste, or fiber, and hemp seed both experienced overall declines from the 1960s until the 1990s (Figure 1).

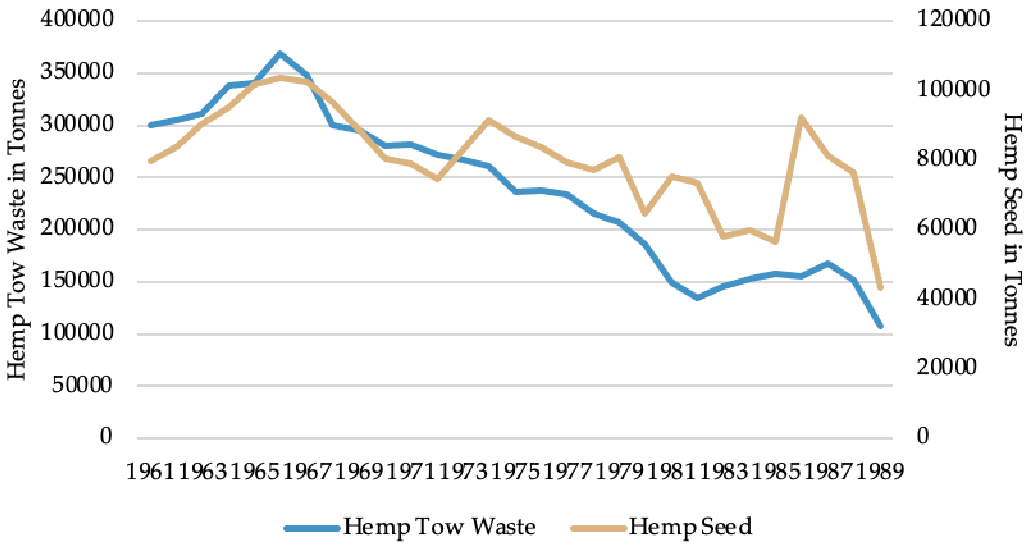

Figure 1. Global production of hemp tow waste and hemp seed from 1961 through 1989 (Food and Agriculture Organization of the United Nations, 2020).

1.2. A Renewed Interest in Hemp

Despite barriers to production in the 19th and 20th centuries, attitudes toward hemp have shifted (Cherney & Small, 2016). With the distinction between hemp and marijuana becoming clearer to the public, as well as a growing demand for sustainable products and cannabidiol (CBD) in general, production for hemp returned (T. Mark et al., 2020). Bans on hemp production were lifted across Europe in the 1990s (Johnson, 2018). In 1994, Canada legalized hemp production for research purposes and fully legalized production in 1998 (T. Mark et al., 2020). The United States followed a similar path, though was slow to follow suit. It wasn't until 2014 that the U.S. legalized hemp production for research purposes, fully legalizing the crop's production in 2018 (T. Mark et al., 2020).

As such, hemp has experienced a revival in the last several years. Chinese production doubled from 2015 to 2017 to 125,000 metric tons annually and Canadian

hemp acreage has been on the rise since 2010 (T. Mark et al., 2020). There is a resurgence in consumer interest towards hemp and CBD appears to be the catalyst (Adesina et al., 2020). A search of news articles throughout the world using Nexis Uni, a database of news, law and business sources, show that discourse regarding hemp and CBD had been relatively static in 2015 and 2016 but began to rise from 2017 through 2019 (Figure 2) (LexisNexis, 2021). We find similar trends when analyzing hemp and CBD using Google Trends, which pulls a representative sample of normalized search data and provides the term's relative search interest based on the proportion of searches on all topics for that time period (Google Trends, 2021). When viewing searches for hemp and CBD from 2015 through 2018, we see that, like news sources, search interest is relatively low through 2016 and rises steadily from 2017 to 2019 (Figure 3 and Figure 4). During this time, people appear to be seeking information on hemp.

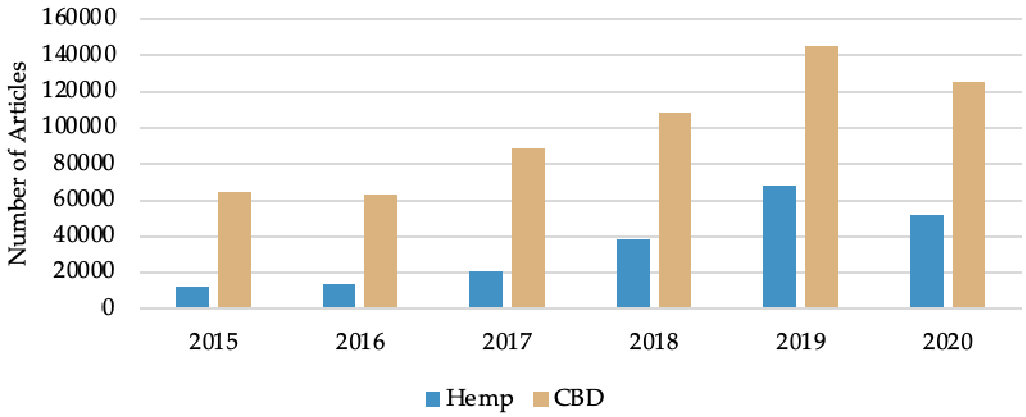

Figure 2. Mentions of "hemp" and "CBD" in news outlets across the world from 2015 to 2020 (LexisNexis, 2021).

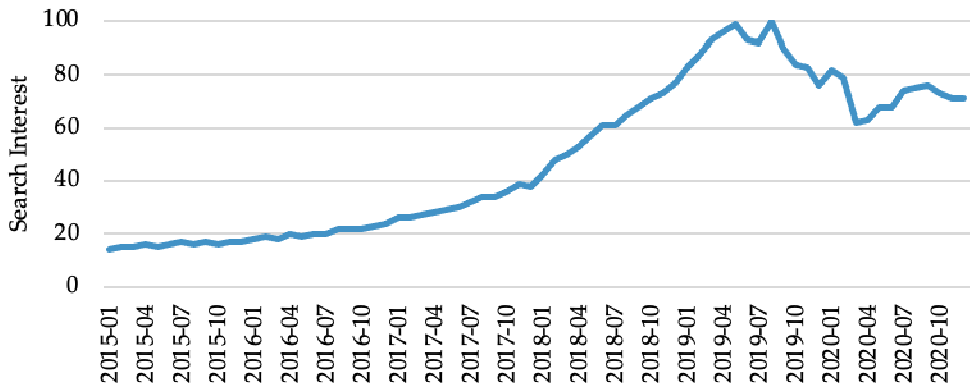

Figure 3. Global Google searches of "hemp" from 2015 through 2020 (Google Trends, 2021).

Figure 4. Global Google searches of "CBD" from 2015 through 2020 (Google Trends, 2021).

However, CBD is not the only hemp product influencing this growing market. Hemp CBD made up just 23% of hemp-based product sales in 2017, with lower but present interest in personal care products, industrial applications, food products and textiles (Hemp Business Journal, 2018). Industry predicts that fiber sales will escalate in the next few years (Hemp Industry Daily, 2021), as well as demand for hemp seed (Adesina et al., 2020). A survey of Vermont consumers also finds that, though use of CBD is most common, there are many other types of hemp products in use including

clothing, personal care products, rope and food products (Figure 5). It is clear that attention should be paid to the variety of products that hemp can produce.

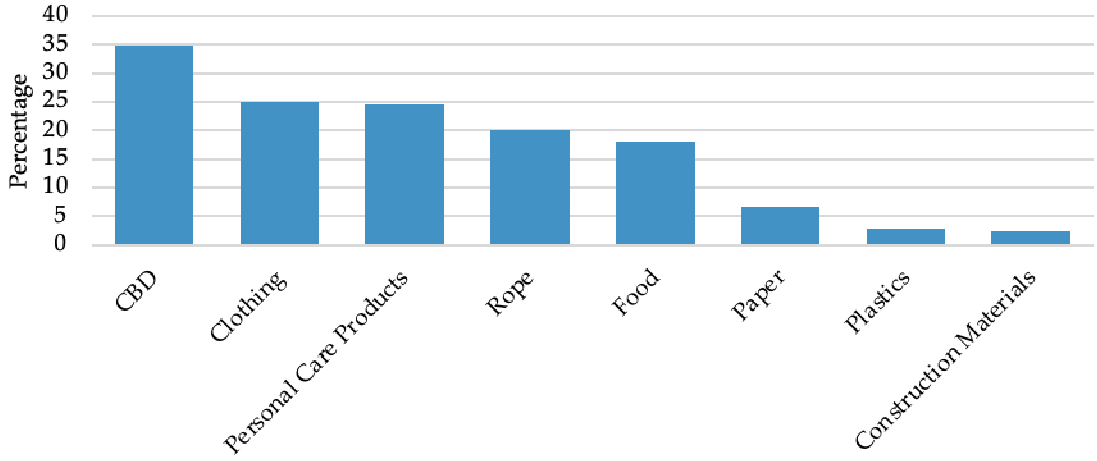

Figure 5. Use of hemp-based products by Vermont consumers in 2020 (University of Vermont Center for Rural Studies, 2020).

1.3. A Review of Hemp Products

Throughout its existence, hemp has been processed into thousands of different products, with more coming onto the market seemingly every day. Hemp's versatility lies in the ability to process each part of the plant, including the stalk, seeds and flower. Hemp seeds can be pressed for oil and used in a variety of products (Johnson, 2018; Schluttenhofer & Yuan, 2017). Hemp seed is lauded for its healthy oil and protein content (Adesina et al., 2020; Pihlanto et al., 2017; Schultz et al., 2020), and can be processed into food products like flour, pasta, hemp-seed butter, protein powders and bars, milk alternatives and granola (Borkowska & Bialkowska, 2019; Brzyski & Fic, 2017; Johnson, 2018). The oil can also be applied to cosmetics, like soaps and shampoos, as well as to medicinal and therapeutic products (Adesina et al., 2020; Johnson, 2018; Thompson et al., 1998). The byproduct of the pressing process, also

known as hemp seed cake, can be used as a source of animal feed (Schluttenhofer & Yuan, 2017).

The stalk of the hemp plant can be processed into multiple types of products using the bast and hurd fibers. Bast fibers are harvested from the outer stalk, while the hurds are sourced from the stalk's inner core (Johnson, 2018). These fibers can then be processed into traditional hemp products like clothing, rope and paper. Clothing, rope and other textiles made from hemp are stronger than cotton and resistant to water and saline damage (Kraenzel et al., 1998; S Montford & Small, 1999). Hemp paper has been used for thousands of years and is competitive with wood pulp paper in terms of lifecycle length and recyclability (Bouloc & Werf, 2013; Miritoiu et al., 2019). Hurd fibers can also be used as animal bedding (Schluttenhofer & Yuan, 2017).

More recent innovations for hemp fiber include auto parts, composites, insulation materials, concrete alternatives, and plastics. Hemp-based building composites are comparable to the strength and insulation of commercial product alternatives, with a lower environmental impact and no negative human health effects (Sassoni et al., 2014; Väisänen et al., 2018). Concrete alternatives made from hemp are feasible for green building (Jami et al., 2019; Maalouf et al., 2018). Hemp plastic innovations have been manufactured for long term use in the automotive industry (Pervaiz & Sain, 2003), as well for daily, single use as a bio-composite (Brzyski & Fic, 2017).

The hemp female flower produces cannabinoids - a class of terpenophenolic compounds - with cannabidiol (CBD) as the major cannabinoid and a non-psychoactive component (Adesina et al., 2020). There are over 100 known cannabinoids but two are

most common: tetrahydrocannabinol (THC) and CBD (Aizpurua-Olaizola et al., 2016). THC has psychoactive properties that are associated with marijuana and occur in the plant at higher concentrations than do hemp (Hložek et al., 2017). Hemp primarily produces CBD, a non-psychoactive cannabinoid that can be used for therapeutic, medicinal and recreational purposes (Andre et al., 2016; World Health Organization, 2018). CBD has been used to aid ailments such as arthritis, epilepsy, inflammation, anxiety and pain (Evans Schultes et al., 1974; Pertwee, 2004; Rosenberg et al., 2015; World Health Organization, 2018).

1.4. Communicating Hemp: The Need for a Lasting Narrative

Regulatory changes reduced barriers to hemp production and set the stage for rising demand, sending a global spotlight to the crop. Though hemp has been a part of human history for thousands of years, release from production prohibition across the world reintroduced hemp to the market in a way it had not seen in decades. Excitement surrounding the opportunity to bolster farmer incomes and profit from thousands of potential product alternatives fueled dialogue and demand for hemp. But as regulatory, financial and logistic realities set in for the industry (T. Mark et al., 2020), the dazzle of the crop may be waning.

Dialogue surrounding hemp in the media is likely to have been a source of publicity and information conveyance to consumers over the last few years. But the buzz of this “new” industry appears to be fading. Hemp and CBD as mentioned in the news and in internet searches have declined since 2019 (Figure 2, Figure 3, and Figure 4). Both terms saw a small resurgence in April 2020, which may be attributed to the

global COVID-19 pandemic. There is conjecture that sales for CBD products fared relatively well during this time, particularly via online shopping, as consumers sought to cope with the stress associated with quarantining, isolation and generally living through this global disaster (Convenience Store News, 2021; Prosser, 2020; P. Williams, 2021; Wright, 2020). However, this trend may reflect an increase in current users of CBD rather than new users (Wright, 2020). After a relative peak in April 2020, search interest continues to veer downward (Figure 3 and Figure 4), indicating that less consumers are searching for information regarding hemp and CBD.

Given historic regulatory controversy, hemp's reentry into the market received more attention than most new products would. Producers who depend on media buzz to carry the advertising weight of hemp-based products may soon find that this reliance cannot be sustained. Though demand for hemp-based products is growing (T. Mark et al., 2020; Wheeler et al., 2020), these search results show that public attention toward hemp may be phasing out, limiting the ease of information access consumers and producers once had.

Just as consumers can learn about new-to-market hemp products, they can quickly forget. Consumer forgetting behavior occurs when they are unable to, or imperfectly, remember the quality or information regarding a product that they had once learned (Song & Fai Tso, 2020; Zhao et al., 2011). Forgetting can take place when advertising subsides (K. Kogan et al., 2020), or in the case of hemp, when the media moves on to other headlines. For hemp to succeed, the industry must pay attention to the hemp consumer and keep hemp-based products in their line of sight. Otherwise,

consumers may forget and move onto the next innovation, or stick with the conventional product alternative they currently use.

To market hemp, we need to understand who the hemp consumer is and what qualities about hemp products appeal to them. A study by Ellison (2021) revealed that economics and marketing were the most prioritized areas of research for hemp stakeholders. Despite this expressed need for market research, there is limited peer-reviewed literature on the hemp consumer market (T. Mark et al., 2020).

Preliminary research exists that evaluates hemp consumption based on consumer demographics. Demographic characteristics of hemp consumers provide stakeholders with a starting point in such a nascent market. Similar to other literature regarding sustainable products or behaviors (Bhaskaran & Hardley, 2002; de Medeiros et al., 2014; Ha□Brookshire & Norum, 2011; Hustvedt & Bernard, 2008; Panzone et al., 2016; Tan et al., 2016; Verain et al., 2012; Verbeke, 2005), findings for demographic influence on hemp product consumption is varied. Higher incomes are associated with consumption of hemp-based cereal brands and hemp nuts (G. Kim & Mark, 2018). Older consumers are more likely to consume CBD (New Frontier Data, 2020), but less likely to consume hemp foods (G. Kim & Mark, 2018). Higher levels of education are associated with hemp nuts, but not hemp-based cereal brands (G. Kim & Mark, 2018). Men are more likely than women to consume CBD products (New Frontier Data, 2020). However, two studies of Vermont consumers do not find any significant association between general hemp consumption, or hemp CBD consumption, and demographic variables (J. Kolodinsky et al., 2020; J. Kolodinsky & Lacasse, 2020). The variation in findings points to a need for hemp consumption

research that is tailored to specific products and is more holistic in its ability to describe variation of consumption of those products.

A frequently cited limitation of the hemp industry is the cost of production (Amaducci et al., 2015; Bouloc & Werf, 2013; Cherney & Small, 2016). Hemp products are more expensive than their conventional alternatives, so it is necessary to determine what qualities make the product worth purchasing, or what is inherent about a consumer that make the product appealing. Hemp retailers, for example, identify quality as their most important differentiator (Hemp Industry Daily, 2021). But it is critical that producer and retailer perceptions of consumer values are accurate reflections of the consumer.

Literature regarding the consumer perceptions of hemp products is limited but beginning to emerge, particularly for CBD and food products. There appears to be low consumer likeness for hemp food based on studies with pork and bread made hemp ingredients (Hayward & McSweeney, 2020; Zając et al., 2019), indicating the importance of palatability. Perceptions of hemp-based food products that incorporate a cannabis leaf in its branding include associations with marijuana and drugs (Pozo, 2020), highlighting the need for intentional marketing depending on the intended conveyance of hemp's use. Perceived health benefits also appear influential in consumer likeness for hemp products, including for food and for CBD for both pet and human uses (L. R. Kogan et al., 2016; Metcalf et al., 2021; Wheeler et al., 2020).

1.4.1. Hemp or Marijuana? Considerations for Consumer Research

Hemp has been inextricably linked to marijuana since the early 1900s and was only recently released from prohibitive regulation in 2014 (*Legitimacy of Industrial Hemp Research*, 2014). For nearly 80 years, hemp had been coupled with marijuana under U.S. regulation and classified as a Schedule I substance (*Marihuana Tax Act of 1937*, 1937). Though it has since been determined that the two crops are genetically distinct, particularly in their ability to induce a psychoactive response (World Health Organization, 2018), it would be natural for the general population to maintain this association. A representative panel of Americans found that one third of surveyed respondents believe hemp and marijuana to be the same (Lusk, 2017). This association may influence the potential viability of a hemp product market. It is, therefore, necessary to contextualize the trajectory of marijuana support in the United States and how that may be reflected by hemp consumers.

There is an abundance of literature that analyzes perceptions towards marijuana, especially among youth, and how those perceptions change after policy implementation by way of medicinal or recreational marijuana legalization. These studies are frequently framed by early adopters of marijuana legislation, such as California and Colorado, and compare public opinion to that of non-medicinal marijuana states. Policy change appears to relate strongly to perceptions of and support for marijuana. Literature comparing perceived risk of marijuana use, find that perceived risk decreases within a state before and after policy change, as well as when comparing states with marijuana legislation to those without (Khatapoush & Hallfors, 2004; Maxwell, 2016; Miech et al., 2015; Schuermeyer et al., 2014). Studies also find higher support for, or lower

disapproval of, use of marijuana in states where medicinal or recreational marijuana has been legalized compared to non-medicinal marijuana states (McGinty et al., 2017; Miech et al., 2015; Schuermeyer et al., 2014).

Although the impacts of policy implementation on marijuana use are mixed, they offer important insight to hemp use. Incidents of marijuana use are found to increase after policy change compared to non-medicinal marijuana states among both youth and adults (Maxwell, 2016; Miech et al., 2015; Schuermeyer et al., 2014). However, other studies focused on youth outcomes do not find a significant impact on marijuana-related behavior afterwards (Khatapoush & Hallfors, 2004; Maxwell, 2016). In a study of Nielsen Homescan data, Kim and Mark (2018) find that consumers in hemp-legalized states are more likely to purchase hemp-based cereal products than consumers in non-hemp states. This difference between use impacts of marijuana and hemp may be due to the fact that the hemp product at hand is food-based and the connotation of drugs is lessened. However, Kim and Mark (2018) also found that hemp states are less likely to consume hemp nut products compared to non-hemp states. These findings highlight the importance of evaluating consumer perceptions across the many products for which hemp can be processed, particularly when assessing the connotation of marijuana or when attitudes might be shaped by mistaken associations with marijuana.

The importance of positive public opinion is cited as a motivator for state-based marijuana legalization (Cruz et al., 2016; Johns, 2015). Given that many referendums were led by grassroots efforts, these findings imply that public support for marijuana came before legalization (Cruz et al., 2016). Increased use of marijuana has been found

to precede state policy implementation as well (Maxwell, 2016; Schwadel & Ellison, 2017). However, policy change does not appear to be the singular driver of rising marijuana support.

There appear to be two other determinants of support, or lack thereof, for marijuana use and legalization. The first are the economic benefits that accompany legalization. A study by McGinty et al. (2017) reveals that Americans find pro-legalization arguments surrounding economic benefits as more persuasive compared to anti-legalization arguments that frame marijuana as a public health risk. Though not the primary factor for city adoption of marijuana policy in Colorado, Johns (2015) cites the ability of economic benefits to change perceptions of former opposition and the importance of understanding community perceptions of the extent of these economic outcomes. Therefore, consumer perceptions of how hemp contributes to, or detracts from, the local economy may be an important factor in their consumption of hemp-based products.

Finally, a major correlate to marijuana support appears to be political affiliation. Democrats are more likely to support marijuana legalization and pro-legalization arguments than Republicans (Denham, 2019; McGinty et al., 2017; Schwadel & Ellison, 2017). It appears that this trend is historic, with studies finding higher Democrat support as early as 1973 (Schwadel & Ellison, 2017). However, this disparity appears to widen in the 21st century, with Republicans expressing significantly less support than both Democrats and Independents beginning in 2004 (Denham, 2019; Schwadel & Ellison, 2017). These findings indicate growing partisanship and politicization of marijuana policy across the U.S. (Denham, 2019).

Though hemp policy has received bipartisan support and conversations surrounding hemp aren't as heavily politicized as conversations about marijuana, the crops' close ties make political affiliation a likely determinant of hemp acceptance and use (Malone & Gomez, 2019; Steenstra, 2018). This link has been confirmed in studies of Vermont consumption of hemp-based products, where Independent and Progressive respondents were more likely to support and use hemp products compared to Republican respondents (J. Kolodinsky et al., 2020; J. Kolodinsky & Lacasse, 2020).

These findings indicate that hemp may continue to be associated with marijuana by the public, translating to political disparities regarding its approval. This could have important implications for other countries across the world who have similar historic tensions between hemp and marijuana. Given the context of marijuana support and recommendations from hemp consumer behavior findings, a greater understanding of consumer perceptions of hemp's relationship to marijuana, as well as the role of political affiliation and associated ideology toward the hemp industry, may be of consequence to comprehensively understand the hemp consumer.

Chapter 2: Consumer Perceptions of Hemp Products: An Application of the Theory of Buyer Behavior and Diffusion of Innovations

2.1. Introduction

After its legalization in 2014 and 2018 (*Legitimacy of Industrial Hemp Research*, 2014; *Agricultural Improvement Act of 2018*, 2018), hemp re-emerged in the United States as a crop with untapped potential that could contribute to on-farm biological diversity and farmer financial security, as well as provide new sustainable product alternatives to consumers (Finnan & Styles, 2013; Fortenbery & Bennett, 2004). This opportunity was seized upon by hundreds of new growers across country (T. Mark et al., 2020). While the industry faces a number of supply chain challenges, it also has been hindered by a lack of research focused on consumer demand for hemp-based products (Ellison, 2021; T. Mark et al., 2020). Existing industry research on hemp consumption has been largely limited to the relationships between consumer demographics and CBD products (G. Kim & Mark, 2018; New Frontier Data, 2020). Recent peer reviewed research on consumer behavior in Vermont, however, emphasizes (1.) that demographic data alone appear insufficient to fully understand the hemp consumer and (2.) that there may be meaningful variation in attitudes toward the variety of products into which hemp can be manufactured (J. Kolodinsky et al., 2020; J. Kolodinsky & Lacasse, 2020). This study builds upon the hemp consumption literature using an extended application of the Theory of Buyer Behavior, modified with the Diffusion of Innovations Theory, and survey data applied to eight categories of hemp products in Vermont.

2.2. Literature Review

2.2.1. Considering the Influence of Marijuana Regulation

For nearly 100 years, hemp and marijuana have been entangled under prohibitive regulation. Though hemp was legalized in the U.S. in 2014 (*Legitimacy of Industrial Hemp Research*, 2014) and its distinction from marijuana continues to be demonstrated (Malone & Gomez, 2019; Thompson et al., 1998; World Health Organization, 2018), these historic tensions persist. Recent studies find that U.S. respondents continue to associate hemp with marijuana (Colclasure et al., 2021), and even believe the crops to be the same (Lusk, 2017). Understanding how knowledge of the differences between hemp and marijuana, as well as general marijuana support, influence hemp consumption in the U.S. is absent from the current literature.

Though hemp policy has received bipartisan support and conversations surrounding hemp don't appear as heavily politicized as conversations about marijuana, close perceived ties between the two plants make political affiliation a likely determinant of hemp acceptance and use (Malone & Gomez, 2019; Steenstra, 2018). This link has been confirmed in studies of Vermont consumption of hemp-based products, where Independent and Progressive respondents are more likely to support and use hemp products compared to Republican respondents (J. Kolodinsky et al., 2020; J. Kolodinsky & Lacasse, 2020). These findings indicate that hemp may continue to be associated with marijuana by the public, translating to political disparities regarding its approval.

Given the context of marijuana support and recommendations from hemp consumer behavior findings, a greater understanding of consumer perceptions of hemp's relationship to marijuana, as well as the role of political affiliation and associated ideology toward the hemp industry, are of consequence to comprehensively understand the hemp consumer.

2.2.2. Hemp as a Sustainable Product Alternative

Hemp's seed, fiber and flower can each be processed into thousands of different products, (Johnson, 2018; Suzanne Montford & Small, 1999; Popular Mechanics Magazine, 1938). Dialogue surrounding hemp's market potential frequently includes its potential to produce sustainable alternative products, particularly when compared to its conventional counterparts. For example, interview findings reveal that respondents view hemp fiber as an alternative to conventionally produced cotton, equating hemp's benefits to that of organic cotton (Cervellon & Wernerfelt, 2012). Hemp is also researched as a resilient and recyclable paper product (Bowyer, 2001; Da Silva Vieira et al., 2010), an energy-efficient insulation alternative (Miritoiu et al., 2019; Papadopoulou et al., 2015) and a natural therapeutic treatment (World Health Organization, 2018).

An analysis of peer-reviewed literature and news articles find a rise in popularity for content containing the word hemp and other sustainability-related terms after the Farm Bill is passed in 2018 (Figure 6). This content peaks for news articles in 2019 and decreases in 2020, while peer-reviewed articles maintain an upward trajectory through 2020. Similarly, U.S. internet search interest for hemp and other sustainability-

related terms rises steadily from 2015 through 2019 but have dropped since (Figure 7) (Google Trends, 2021). Thus, there is evidence that the discourse regarding hemp's potential does include components of sustainability and environmental friendliness in both the academic and public spheres. However, there is an absence of research on the influence of such characteristics on consumer motivations to purchase hemp products. The extent to which sustainability influences consumer behavior may play an important role in understanding the hemp consumer.

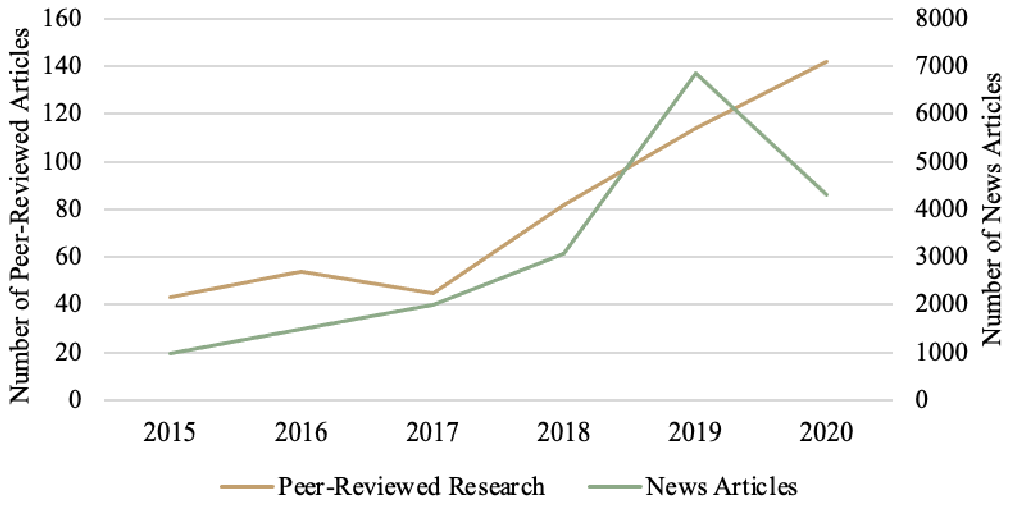

Figure 6. Results of peer-reviewed literature via Web of Science (*Web of Science*, 2021) and U.S. news articles via NexisUni (LexisNexis, 2021) containing search terms for that include 'hemp' AND "environmentally friendly" OR sustainable OR sustainability OR organic OR "ecologically friendly" from 2015 to 2020.

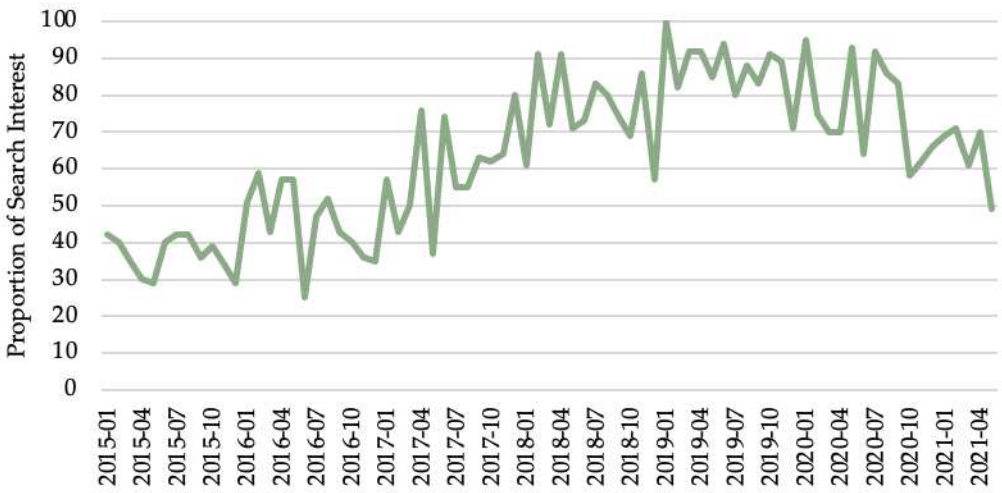

Figure 7. Results of Google Trend search (Google Trends, 2021) for hemp sustainable + hemp sustainability + hemp organic + hemp environmentally friendly in the U.S from 01/01/2015 through 05/15/2021. Google Trends data pull a representative sample of normalized search data and provide the term's relative search interest based on the proportion of searches on all topics for that time period.

2.2.3. Theory of Buyer Behavior

The Theory of Buyer Behavior is a model originally conceived to elucidate choices between brands of a given product. The theory asserts that a buyer's decision to choose a specific brand out of a set of known options is systematic (Howard & Sheth, 1969). The model was later generalized to product categories, which is the application of this study (W. Kim et al., 2012; J. Kolodinsky et al., 2020; Steiner et al., 2016). The total set is considered all products that are on the market for a consumer to be aware of and purchase. If a consumer is aware of a product, that product is in their awareness set. Products that a buyer is unaware of are in the unaware set; here, there is no chance for the buyer to consider it for purchase. Narayana and Markin (1975) acknowledge that awareness of a product does not necessarily correspond to consumer consideration for purchase. Thus, they expand upon the original model and break awareness into three subsets: evoked, inert and inept.

The evoked set contains products that a buyer is aware of and considers for purchase. It is asserted they have a positive assessment from the consumer. The inert set contains products that have neither a positive nor a negative assessment and a consumer is unsure about considering them for purchase. The inept set contains rejected products that have a negative assessment from the consumer and are not considered for purchase. For greater clarity, the remainder of this article refers to the evoked set as the choice set and the inept set as the rejection set.

Categorizing possible products into these three sets is determined by consumer information, prior experience and satisfaction with the current product used (Narayana & Markin, 1975). Consumer assessment of products is not static and can change based on commercial and public information, as well as new experiences (Howard & Sheth, 1969; Narayana & Markin, 1975). However, a change in consumer preference is typically required to move a product out of the rejection set and is thus more difficult to achieve relative to the fluidity of the inert and choice sets (Howard & Sheth, 1969). Preference change is beyond the scope of this study, which, instead, focuses on static decision of rejection versus choice.

The conceptual model used for this study (Figure 8) builds upon Kolodinsky et al.'s (2020) application of the Theory of Buyer Behavior to hemp consumption in Vermont. The model originates from Narayana and Markin's (1975) alternative conceptualization of Howard and Sheth's (1969) theory. This study improves upon the limitations of the previous study in three ways.

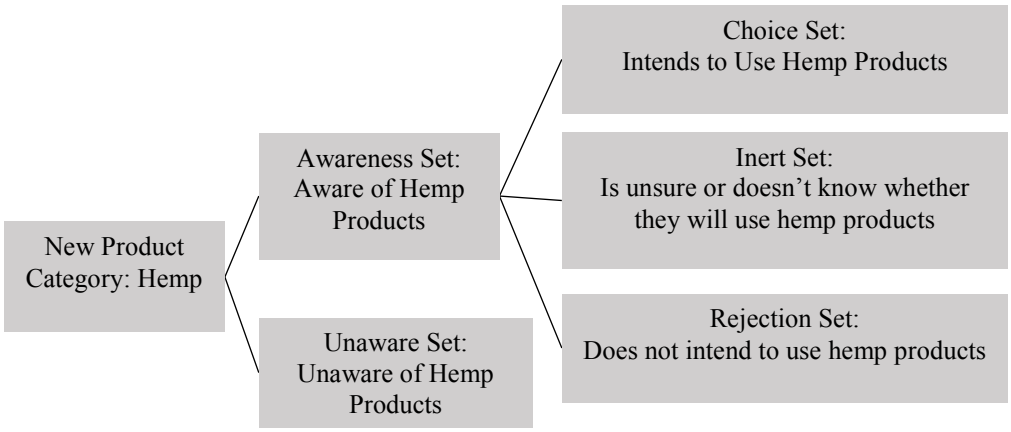

Figure 8. Conceptual model of consumer behavior and product performance as applied to new hemp products. Adapted from Kolodinsky, Lacasse & Gallagher (2020) and Narayana & Markin (1975).

First, the model captures all three awareness sets (choice, inert and rejection) through a measurement of intention to use. Second, the study expands upon the product categories analyzed. Kolodinsky et al. (2020) apply the conceptual model to hemp products generally and to hemp CBD products. As demonstrated above, hemp can be processed into several types of products and consumer implications for consumption and behavior towards those products is likely to vary (J. Kolodinsky & Lacasse, 2020). Therefore, this study applies the buyer behavior theory to eight categories of hemp-based products. Lastly, in response to recommendations from Kolodinsky, Lacasse and Gallagher (2020), our expansion of the original model includes perception and knowledge statements regarding hemp. Howard and Sheth (1969) note that consumer motives behind consumption decisions are specific to the type of product in question. Therefore, perceptions regarding specific product categories are also included in each model.

2.2.3. Incorporation of the Diffusion of Innovations Theory

Though hemp has been cultivated across the world for centuries, regulation effectively erased the crop from the market landscape of the U.S. for over 75 years (Malone & Gomez, 2019; *Marihuana Tax Act of 1937*, 1937) and its recent legalization positions hemp as a relatively new input for product alternatives. As such, this study analyzes hemp product categories as discrete innovations compared to their conventional alternatives through an adaptation of Diffusion of Innovations in the Buyer Behavior models. The Diffusion of Innovations models consumer decision making towards innovative products or behaviors (Rogers et al., 1983). Consumer perceptions for innovations of all types can be universally described using Rogers' (1983) innovation attributes: relative advantage, compatibility, complexity, trialability and observability.

How much better an innovation is perceived to be compared to its alternative is referred to as relative advantage. An innovation is compatible if it operates comparably to the alternatives available. If an innovation is difficult to use or comprehend then it is considered complex. Trialability indicates that an individual has had opportunity to experiment with the innovation. The ability to try a new product or behavior before fully committing to it reduces the uncertainty accompanied with its newness. If an individual can witness a product or behavior in action, it is observable. The five attributes of innovations influence adoption or, in the case of this study, consumer decision to choose or reject a hemp-based product.

2.3. Materials and Methods

2.3.1. Materials

This study uses data from a statistically representative online survey of Vermont residents conducted by the University of Vermont's Center for Rural Studies. Approved by the Institutional Review Board at the University of Vermont, the study was conducted in February and March of 2021 using randomly sampled email lists. Respondents identifying as current Vermont residents over the age of eighteen are eligible to participate. IBM® SPSS® Version 27 (*SPSS V27*, 2021) and LIMDEP (Econometric Software Inc., 2021) are used to conduct statistical analyses. Results have a margin of error ranging from ±3.801% to ±4.017% with a confidence interval of 90%.

2.3.2. Variables and Measurements

This study models consumer behavior towards eight categories of hemp-based products: CBD; clothing, shoes and textiles (referred to as clothing for the remainder of the article); construction or industrial materials (referred to as construction materials for the remainder of the article); food products; paper; personal care products; plastics; and rope. Categories are derived from sales data of hemp-based products (Hemp Business Journal, 2018) and prior research (J. Kolodinsky et al., 2020). Questions regarding awareness and intention to use each hemp product are used to categorize respondents into the Theory of Buyer Behavior sets. Respondents are included in the choice set if they indicate being aware of a given hemp product category and demonstrate intention to use that product in the coming year. The inert set is measured by respondents who are familiar with a given hemp product category but who are neutral about, or do not

know, their intention to use that product in the following year. Respondents are categorized into the rejection set if they are familiar with the hemp product category but do not intend on using it in the coming year.

Each model incorporates a set of perception statements as explanatory variables. All models include five statements regarding hemp generally, including THC content, input requirements, environmental friendliness, regulatory impact, and interest in the purchase of local-made hemp products (Table 1). All respondents are asked these general hemp statements regardless of product awareness. In addition, we include a range of product-specific questions that capture the attributes of innovations. Product-specific questions are only asked if the respondent is aware of the given product. All perception statements are asked as 5-point Likert scales, ranging from strongly agree (1) to strongly disagree (5). "I don't know" responses are recoded as "no opinion". Statements are recoded as binary variables that compare the positive response towards hemp to all other responses.

Table 1. Independent variables included in this study.

Survey Question	Answer Options
General Hemp Statements	
Hemp and marijuana contain the same amount of THC, which is the compound that gets you high Compared to hemp, other crops require more inputs like fertilizers and pesticides Hemp products are more environmentally friendly than non-hemp products The current regulatory environment is hindering the economic opportunity of hemp I would purchase hemp products made in Vermont to support my local economy	Strongly Agree Somewhat Agree No Opinion Somewhat Disagree Strongly Disagree
Product-Specific Statements [a]	
For me, hemp products are difficult to find I can afford hemp products I have seen people using hemp products Hemp products are stronger and more durable than non-hemp products [b] Hemp products are less appetizing and palatable than non-hemp-based products [b] Hemp products are stronger and more durable than non-hemp products [b] Using hemp products is difficult I've had the chance to try hemp products	Strongly Agree Somewhat Agree No Opinion Somewhat Disagree Strongly Disagree
Control Variables	
Indicate your level of support/opposition to the legalization of medicinal marijuana Indicate your level of support/opposition to the legalization of recreational marijuana	Strongly Agree Somewhat Agree No Opinion Somewhat Disagree Strongly Disagree
Select your age category	18-34 35-54 55-74 75 and older
What is the highest level of education that you have completed?	Some college or more Less than some college
With what gender do you most identify?	Female Male
What category best represents your total annual household income?	Less than $50,000 More than $50,000
Politically do you consider yourself to be…	Republican Democrat Independent Progressive Not Politically Affiliated

[a] Questions are asked specifically regarding eight categories of hemp products but are generalized as "hemp products" in this table for succinctness; [b] Questions are asked for relevant products.

In addition, we ask respondents about their level of support for medicinal and recreational marijuana legalization. These statements are asked as 5-point Likert scales and recoded as binary variables comparing those supportive of legalization to all other responses. Lastly, we include respondent demographic characteristics and political affiliation. Due to limited variation and collinearity, age is recoded into a dummy

variable for those 75 and older compared to everyone else. This is considered the normative group given previous research finding higher likeliness of unawareness of hemp products with older ages (J. Kolodinsky et al., 2020; J. Kolodinsky & Lacasse, 2020). The sample is representative of Vermonters of this age bracket, but over represents ages 55 to 74 and underrepresents ages 18 to 34 (±0.1) (United States Census Bureau, 2019). Education compares those with some college or more to those with lower educational attainment. Income compares those with annual household incomes of $50,000 or greater to those with less than $50,000, representing the approximate 50th percentile of income in Vermont (United States Census Bureau, 2019). The education and income levels of our sample are higher than the state averages (United States Census Bureau, 2019). Gender compares females to males and is representative of the gender breakdown in Vermont (±0.1) (United States Census Bureau, 2019). Respondents are asked their political affiliation and given five answer options: Republican, Democrat, Independent, Progressive and not politically affiliated. Due to limited variation and collinearity, and the literature reviewed in the above sections (J. Kolodinsky et al., 2020; J. Kolodinsky & Lacasse, 2020), political affiliation is analyzed as a dummy variable for Republican affiliation compared to everyone else. Only cases without missing variables are included in each model.

2.3.3. Methods

Univariate statistics describe the categorization of the consumer behavior model for each product category and confirm variation in responses. Bivariate analyses are used to examine the association between each product category's set and the

explanatory variables. Given the variation in demographic characteristics of the surveyed respondents, we apply post processing weighting during descriptive analyses to ensure that the sample population is as representative as possible to the known population characteristics of Vermont (Mercer et al., 2018; United States Census Bureau, 2019).

Multivariate analysis is used to predict awareness and, if aware, placement into the three choice set categories. Consumers must first be aware of a product before they can decide to choose or reject it (Narayana & Markin, 1975). Therefore, we treat intention to use as a limited dependent variable and apply a two-step model to each of the eight hemp products (William H Greene, 2016). The first step in the model is a probit regression to determine the probability of awareness of any hemp product. Independent variables include all questions described above, excluding product-specific variables. We then calculate the Inverse Mills ratio, or lambda, from the probit regression results to account for the impact of awareness and for potential sample selection bias (William H Greene, 2016). A multinomial logit is then conducted to ascertain the probability of consumer placement into the choice, inert and rejection sets given their relationship with the independent variables, including all questions described above, as well as lambda from the probit results.

The literature points to partial effects and average marginal effects as best practice for interpretation of nonlinear regressions and is thus the focus of our analyses (W.H. Greene, 2003). Marginal effects are a function of the parameter estimates and depict how the probability of an outcome changes by magnitude and direction given an independent variable at a specific value (Bartus, 2003; W.H. Greene, 2003). When

marginal effects are calculated for each observation and then averaged, we get average marginal effects.

2.4. Results

The distribution of aware/unaware respondents varies by hemp product category

(

Table 2). More than nine out of ten of respondents are aware of hemp CBD (93.3%). Almost nine out of ten of the sample are aware of hemp clothing (88.4%), rope (84.7%) and personal care products (82.3%). Nearly two thirds of respondents are aware of food (63%) and paper (56.5%) Half of the sample is aware of hemp construction materials (50%) and more than one third are aware of hemp plastics (35.7%).

Table 2. Frequencies of total and awareness sets for eight hemp product categories.

Independent Variables		CBD		Clothing		Construction		Food		Paper		Personal Care		Plastic		Rope	
		Total Set (%)	Awareness Set (%)	Total Set (%)	Awareness Set (%)	Total Set (%)	Awareness Set (%)	Total Set (%)	Awareness Set (%)	Total Set (%)	Awareness Set (%)	Total Set (%)	Awareness Set (%)	Total Set (%)	Awareness Set (%)	Total Set (%)	Awareness Set (%)
n		468	451	461	419	434	213	420	288	427	236	443	366	419	115	467	424
Aware		91.9	-	88.4	-	50.0	-	63.0	-	56.5	-	82.3	-	35.7	-	84.7	-
Rejection		-	33.9	-	38.2	-	36.4	-	29.6	-	32.7	-	31.0	-	28.0	-	45.0
Inert		-	26.5	-	45.6	-	56.5	-	46.5	-	52.4	-	38.9	-	63.2	-	43.6
Choice		-	39.6	-	16.2	-	7.2	-	24.0	-	14.9	-	30.1	-	8.8	-	11.4
THC		70.7	76.5	69.8	75.6	69.1	82.6	68.5	82.3	69.1	88.5	69.1	77.9	68.5	89.1	69.3	75.8
Inputs		25.4	27.2	24.3	27.1	25.2	35.0	24.5	31.3	24.7	35.0	25.5	29.7	25.9	31.3	24.3	26.8
Environment		42.4	46.1	42.6	47.1	42.8	60.3	41.0	52.3	41.8	60.9	41.8	48.5	43.2	71.9	41.3	45.9
Regulation		44.0	47.9	42.7	46.9	43.5	62.4	41.9	54.4	43.3	61.4	43.3	50.2	43.6	68.7	43.4	48.3
Local		61.5	66.0	60.4	66.3	60.0	77.3	61.2	76.5	60.5	83.6	59.3	67.4	59.6	86.2	61.4	66.8
Compatible	Available	-	43.4	-	11.4	-	1.9	-	34.1	-	6.4	-	40.3	-	4.5	-	8.0
	Affordable	-	42.2	-	30.7	-	9.7	-	43.0	-	37.8	-	39.8	-	38.3	-	32.4
Observable		-	64.7	-	28.6	-	9.3	-	29.2	-	13.5	-	43.1	-	13.1	-	16.6
Relative Advantage	Healthy	-	27.0	-		-		-	19.4	-		-	17.7	-		-	
	Palatable	-	23.1	-		-		-	10.6	-		-		-		-	
	Durable	-	-	-	27.4	-	6.6	-	-	-	9.8	-	-	-	4.4	-	14.1
Simple		-	51.2	-	18.1	-	4.8	-	33.0	-	14.9	-	45.4	-	9.5	-	16.0
Trial		-	62.3	-	18.6	-	1.3	-	29.5	-	17.8	-	47.3	-	4.4	-	16.6
Medicinal Marijuana		81.5	86.1	80.6	86.5	80.5	90.7	80.6	88.5	80.9	90.1	79.5	86.4	81.7	93.4	81.0	86.9
Recreational Marijuana		64.3	68.9	64.2	71.0	64.0	78.2	63.3	71.3	63.6	79.7	61.6	70.3	64.9	88.7	64.0	70.7
75 and older		11.7	11.6	10.1	8.4	11.9	10.7	11.3	9.8	11.6	4.9	13.6	12.1	11.6	1.5	11.5	11.6
Education		64.9	68.7	64.8	67.9	64.2	74.1	62.6	76.5	64.6	72.6	63.8	68.6	65.3	75.9	64.1	69.0
Female		63.0	60.5	64.5	64.0	65.2	50.8	62.7	53.8	63.6	52.2	65.1	62.9	64.0	43.4	63.6	58.1
Income		56.4	59.8	56.0	58.8	54.6	60.4	56.8	66.9	56.9	67.7	54.4	58.0	54.3	69.1	56.9	61.5
Republican		13.1	13.6	12.8	11.1	11.9	12.7	12.6	14.2	12.4	12.0	14.5	14.1	11.1	7.6	13.3	13.8

Note: Analyses are subject to weighting.

2.4.1. Hemp CBD

Bivariate results lead us to reject the null hypothesis that there is no relationship between hemp CBD awareness and all variables except for being 75 and older and identifying as a Republican (Table 3). We also reject the null hypothesis that there is no relationship between categorization within the aware set and all variables, with the exception of age and Republican affiliation.

Table 3. Bivariate results comparing the total set of aware and unaware respondents (n=468), as well as comparing within the aware set (n=451) for the hemp CBD model.

Independent Variable		Total Set			Aware Set				
		Aware (%)	df	$\chi 2$	Reject (%)	Inert (%)	Choice (%)	df	$\chi 2$
THC		76.6	1	61.279***	57.3	90.0	84.2	2	33.261***
Inputs		27.3	1	6.945***	21.6	12.3	41.7	2	23.414***
Environment		46.1	1	21.548***	26.2	53.1	58.7	2	25.676***
Regulation		47.9	1	23.048***	28.2	60.0	56.7	2	24.481***
Local		66.0	1	31.557***	29.1	77.5	90.0	2	97.936***
Compatible	Available	-	-	-	30.4	25.0	66.7	2	44.502***
	Affordable	-	-	-	17.5	52.5	56.7	2	39.578***
Observable		-	-	-	36.3	75.0	82.5	2	56.591***
Relative Advantage	Healthy	-	-	-	1.9	2.5	64.5	2	143.424***
	Palatable	-	-	-	1.9	42.0	29.2	2	44.337***
Simple		-	-	-	21.4	60.0	70.2	2	56.743***
Trial		-	-	-	23.3	68.8	91.7	2	112.266***
Medicinal Marijuana		86.1	1	52.538 [a]	71.6	93.8	93.4	2	27.343***
Recreational Marijuana		69.0	1	36.137***	51.5	77.8	77.7	2	21.946***
75 and older		11.6	1	< 0.001 [a]	12.7	6.3	14.2	2	3.137
Education		68.8	1	23.583***	60.2	80.0	69.2	2	8.258**
Female		60.5	1	10.382***	64.1	37.5	73.3	2	26.578***
Income		59.7	1	17.124***	50.0	76.5	56.7	2	14.003***
Republican		13.5	1	0.820 [a]	19.4	4.9	14.2	2	8.226**

Notes: Analyses are subject to weighting; *p < 0.10, **p < 0.05, ***p < 0.01; [a] more than 20% of cells have an expected value of less than 5.

Due to limited variation among the sample, position on environmental friendliness and regulation are removed from the probit regression. Results then explain 33.2% of the variation in awareness of CBD products ($p < 0.001$). Partial effects lead us to reject the null hypothesis that there is no relationship between CBD awareness and position on THC content ($p=0.003$). The multinomial logit explains 33.9% of the variation within the awareness set ($p < 0.001$). Once aware of hemp CBD products, respondents have a 36% probability of being in the rejection set, a 25% probability of being in the inert set and a 39% probability of being in the choice set.

Average marginal effects reveal that interest in purchasing local hemp products decreases the probability of rejection by 19 percentage points ($p < 0.001$) and increases the probability of choice by 14 percentage points ($p= 0.001$) (Table 4). The probability

of rejection decreases by 27 percentage points ($p < 0.001$) if the respondent thinks hemp CBD has more health benefits than non-hemp alternatives; this position increases the probability of choice by 35 percentage points ($p < 0.001$). If a respondent has had a chance to try hemp CBD, the probability of rejection decreases by 13 percentage points ($p < 0.001$) and the probability of choice increases by 27 percentage points ($p < 0.001$).

Table 4. Results for the probit (n=468) and multinomial regressions (n=451) for hemp CBD.

Independent Variables		Probit Partial Effects	Multinomial Logit Averaged Marginal Effects		
			Reject	Inert	Choice
THC		0.111***	0.101	-0.122	0.020
Inputs		0.011	0.087	-0.110**	0.023
Environment		-	0.064	-0.047	-0.017
Regulation		-	-0.019	0.044	-0.025
Local		0.012	-0.192***	0.049	0.143***
Compatible	Available	-	0.043	-0.069	0.025
	Affordable	-	-0.067	0.052	0.015
Observable		-	-0.001	0.035	-0.034
Relative Advantage	Healthy	-	-0.271***	-0.080**	0.351***
	Palatable	-	-0.139	0.152**	-0.014
Simple		-	0.007	-0.041	0.033
Trial		-	-0.128***	-0.144***	0.273***
Medicinal Marijuana		-0.016	-0.111	0.119	-0.008
Recreational Marijuana		0.024	0.001	0.025	-0.026
75 and older		0.011	-0.030	-0.047	0.076
Education		0.049	0.063	-0.105	0.042
Female		0.008	-0.006	-0.040	0.047
Income		0.025	0.003	-0.017	0.014
Republican		0.005	0.018	-0.080	0.062
Lambda		-	0.463	-0.529	0.066

*p < 0.10, **p < 0.05, ***p < 0.01

2.4.2. Hemp Clothing

Bivariate results for the hemp clothing model lead us to reject the null hypothesis that there is no relationship between awareness and all variables, except for gender (Table 5). We reject the null hypothesis that there is no relationship categorization within the aware set and all variables, with the exception of age.

Table 5. Bivariate results comparing the total set of aware and unaware respondents (n=461), as well as comparing within the awareness set (n=419) for the hemp clothing model.

Independent Variable		Total Set			Aware Set				
		Aware (%)	df	χ^2	Reject (%)	Inert (%)	Choice (%)	df	χ^2
THC		75.5	1	38.498***	55.0	85.4	4.3	2	41.548***
Inputs		27.0	1	10.886***	20.4	25.4	46.8	2	11.932***
Environment		47.0	1	20.282***	24.8	60.0	63.8	2	35.765***
Regulation		46.9	1	18.103***	27.5	59.2	57.4	2	26.473***
Local		66.3	1	35.778***	35.8	83.8	89.4	2	74.686***
Compatible	Available	-	-	-	7.3	7.7	30.4	2	20.309***
	Affordable	-	-	-	19.3	33.8	48.9	2	14.631***
Observable		-	-	-	20.2	22.3	67.4	2	40.051***
Relative Advantage	Durable	-	-	-	6.4	35.4	54.3	2	45.105***
Simple		-	-	-	11.9	11.5	50.0	2	38.488***
Trial		-	-	-	6.4	12.3	66.0	2	82.722***
Medicinal Marijuana		86.7	1	53.664***	75.2	93.1	95.7	2	20.176***
Recreational Marijuana		70.9	1	48.534***	58.7	76.3	83.0	2	12.995***
75 and older		8.4	1	6.376** [a]	8.3	8.5	8.5	2	0.004
Education		68.1	1	10.896***	56.9	73.8	78.3	2	10.472***
Female		64.0	1	0.288	71.6	58.5	60.9	2	4.62*
Income		58.6	1	6.441**	47.7	65.4	65.2	2	8.628**
Republican		11.2	1	6.803*** [a]	18.3	4.6	13.0	2	11.540***

Notes: Analyses are subject to weighting; *p < 0.10, **p < 0.05, ***p < 0.01; [a] more than 20% of cells have an expected value of less than 5.

The probit regression results explain 22.5% of the variation in awareness of hemp clothing ($p < 0.001$). Partial effects lead us to reject the null hypothesis that there is no relationship between awareness of hemp clothing and position on THC content ($p=0.003$) and local purchase ($p=0.021$), as well as being female ($p=0.041$) and Republican affiliation ($p=0.012$). Republican affiliation is the only significant variable with a negative relationship to awareness.

Step two of the model explains 25.4% of the variation between choice, inert and rejection sets ($p < 0.001$). Once aware of hemp clothing, respondents have a 40% probability of being in the rejection set, a 47% probability of being in the inert set and a

14% probability of being in the choice set. Marginal effects reveal that agreeing that non-hemp crops require more inputs increases the probability of being in the rejection set by 11 percentage points (p=0.056) (

Table 6). Respondent interest in purchasing local hemp products decreases the probability of rejection by 22 percentage points (p=0.002). The probability of rejection decreases by 21 percentage points (p=0.002) and the probability of choice increase by 23 percentage points ($p < 0.001$) if respondents have had a chance to try hemp clothing previously. The probability of choice increases by 9 (p=0.029) and 8 (p=0.030) percentage points if respondents find hemp clothing affordable and durable, respectively. Support for medicinal marijuana legalization decreases the probability of rejection by 12 percentage points (p=0.081). A higher level of educational attainment decreases the probability of choice by 10 percentage points (p=0.074). A higher income increases the probability of rejection by 9 percentage points (p=0.091) and decreases the probability of choice by 9 percentage points (p=0.017).

Table 6. Results for the probit (n=461) and multinomial regressions (n=419) for hemp clothing.

Independent Variables		Probit Partial Effects	Multinomial Logit Averaged Marginal Effects		
			Reject	Inert	Choice
THC Content		0.098**	0.064	-0.146	0.082
Input Requirements		0.027	0.111*	-0.122**	0.012
Environmental Friendliness		0.040	0.016	-0.059	0.043
Regulatory Impact		0.003	-0.019	0.019	0.000
Local Purchase		0.072**	-0.217***	0.135*	0.082
Compatibility	Availability	-	-0.008	0.006	0.003
	Affordability	-	0.072	-0.165**	0.093**
Observability		-	0.017	-0.008	-0.009
Relative Advantage	Durability	-	-0.103	0.020	0.084**
Simplicity		-	0.017	-0.053	0.037
Trialability		-	-0.214***	-0.015	0.229***
Medicinal Marijuana		-0.012	-0.120*	0.162*	-0.042
Recreational Marijuana		-0.001	-0.004	-0.012	0.016
75 and older		-0.037	-0.093	0.113	-0.020
Education		0.010	0.099	-0.003	-0.096*
Income		0.025	0.089*	0.003	-0.092**
Female		0.054**	0.016	0.025	-0.041
Republican		-0.088**	0.028	-0.098	0.070
Lambda		-	0.589	-0.563	-0.026

*p < 0.10, **p < 0.05, ***p < 0.01

2.4.3. Hemp Construction Materials

Bivariate results lead us to reject the null hypothesis that there is no relationship between awareness of hemp construction materials and all variables except for age and Republican affiliation (Table 7). We reject the null hypothesis that there is no relationship between categorization within the awareness set and all variables, with the exception of simplicity, age, gender and income.

Table 7. Bivariate results comparing the total set of aware and unaware respondents (n=434), as well as comparing within the awareness set (n=213) for the hemp construction materials model.

Independent Variable		Total Set			Aware Set				
		Aware (%)	df	χ^2	Reject (%)	Inert (%)	Choice (%)	df	χ^2
THC		82.4	1	27.120***	72.4	87.8	100.0	2	8.323**
Inputs		35.0	1	15.643***	44.8	26.7	45.5	2	5.758*
Environment		60.4	1	40.290***	44.8	68.5	75.0	2	9.413***
Regulation		62.3	1	46.087***	46.6	73.3	54.5	2	11.067***
Local		77.4	1	39.657***	60.3	85.6	100.0	2	16.258***
Compatible	Available	-	-	-	3.4	0.0	8.3	2	5.220* [a]
	Affordable	-	-	-	20.7	2.2	16.7	2	14.006***
Observable		-	-	-	17.2	1.1	36.4	2	20.771***
Relative Advantage	Durable	-	-	-	3.4	5.6	27.3	2	9.094** [a]
Simple		-	-	-	5.2	4.4	0.0	2	0.589 [a]
Trial		-	-	-	1.7	0.0	9.1	2	6.682** [a]
Medicinal Marijuana		90.6	1	20.516***	81.0	96.7	91.7	2	10.161***
Recreational Marijuana		78.1	1	27.978***	67.2	84.4	83.3	2	6.314**
75 and older		10.7	1	0.478	6.9	13.3	9.1	2	1.562
Education		74.2	1	14.002***	58.6	82.2	90.9	2	11.988***
Female		50.9	1	29.409***	56.9	47.8	45.5	2	1.316
Income		60.4	1	4.112**	51.7	65.2	63.6	2	2.708
Republican		12.6	1	0.120	22.4	4.4	27.3	2	12.677***

Notes: Analyses are subject to weighting; *p < 0.10, **p < 0.05, ***p < 0.01; [a] more than 20% of cells have an expected value of less than 5.

The probit regression explains 9% of the variation in awareness of hemp construction materials ($p < 0.001$). Partial effects lead us to reject the null hypothesis that there is no relationship between awareness of hemp construction materials and position on THC content (p=0.069), regulatory impact (p=0.013) and local purchase (p=0.072), as well as being female (p=0.012) and Republican affiliation (p=0.084) (Table 8). Being female is the only significant variable with a negative relationship to the awareness of hemp construction materials. Due to the presence of collinearity and limited variation within our sample, we are unable to run the multinomial regression.

Table 8. Results for the probit regression (n=434) for hemp construction materials.

Independent Variables	Probit Partial Effects
THC Content	0.115*
Input Requirements	0.060
Environmental Friendliness	0.035
Regulatory Impact	0.145**
Local Purchase	0.108*
Medicinal Marijuana	0.066
Recreational Marijuana	-0.013
75 and older	-0.066
Education	0.023
Income	0.011
Female	-0.121**
Republican	0.112*

*p < 0.10, **p < 0.05, ***p < 0.01

2.4.4. Hemp Food

Bivariate results for the total set lead us to reject the null hypothesis that there is no relationship between awareness of hemp food products and all variables, except for age and Republican affiliation (

Table 9). We fail to reject the null hypothesis that there is no relationship between categorization within the awareness set and all variables, with the exception off position on regulatory impact.

Table 9. Bivariate results comparing aware and unaware respondents (n=420), as well as comparing within the awareness set (n=288) for the hemp food products model.

Independent Variable		Total Set			Aware Set				
		Aware (%)	df	χ^2	Reject (%)	Inert (%)	Choice (%)	df	χ^2
THC		82.2	1	46.181***	72.4	91.2	77.1	2	9.717***
Inputs		31.5	1	13.531***	40.7	24.2	34.0	2	4.709*
Environment		52.3	1	28.001***	37.9	59.8	55.3	2	7.036**
Regulation		54.3	1	33.920***	49.2	60.4	48.9	2	2.557
Local		76.6	1	52.527***	39.0	93.5	89.4	2	64.812***
Compatible	Available	-	-	-	19.0	51.6	19.1	2	23.029***
	Affordable	-	-	-	17.2	48.9	63.8	2	25.311***
Observable		-	-	-	13.8	19.8	66.0	2	41.379***
Relative Advantage	Healthy	-	-	-	12.1	6.5	55.3	2	49.744***
	Palatable	-	-	-	12.1	2.2	25.0	2	17.328***
Simple		-	-	-	17.2	20.7	76.6	2	53.264***
Trial		-	-	-	13.6	16.3	76.6	2	64.65***
Medicinal Marijuana		88.3	1	20.683***	69.0	95.6	100.0	2	33.043***
Recreational Marijuana		71.1	1	14.423***	43.1	84.6	80.9	2	32.600***
75 and older		9.6	1	1.265	15.5	4.3	12.8	2	5.783*
Education		76.6	1	44.700***	75.9	83.7	63.8	2	6.888**
Female		53.8	1	17.637***	51.7	44.0	74.5	2	11.714***
Income		67.0	1	22.265***	62.1	79.1	48.9	2	13.585***
Republican		14.2	1	0.980	32.2	4.3	10.6	2	23.596***

Note: Analysis subject to weighting; *p < 0.10, **p < 0.05, ***p < 0.01.

The probit regression model explains 10.2% of the variation in awareness of food products ($p < 0.001$). Partial effects lead us to reject the null that there is no relationship between awareness of hemp food and position on environmental friendliness (p=0.079) and regulatory impact (p=0.025), as well as education (p=0.029), income (p=0.041) and Republican affiliation (p=0.055) (Table 10). The multinomial logit explains 42.5% of the variation in respondent categorization into the choice, inert and rejection sets ($p < 0.001$). Once aware of hemp food products, respondents have a 35% probability of being in the rejection set, a 48% probability of being in the inert set and an 18% probability of being in the choice set.

Marginal effects reveal that position on regulatory impact increases the probability of rejection by 33 percentage points (p=0.068). If a respondent has observed

someone else using hemp food products, the probability of rejection decreases by 12 percentage points (p=0.063). Support for the legalization of recreational marijuana decreases the probability of rejection by 29 percentage points (p=0.009). The probability of choice increases by 10 (p=0.017), 12 (p=0.038) and 9 (p=0.099) percentage points if a respondent finds hemp food affordable, healthy or palatable, respectively. If hemp food is perceived as simple, the probability of choice increases by 9 percentage points (p=0.039). The probability of choice increases by 13 percentage points if respondents have tried it before (p=0.021).

Table 10. Results for the probit (n=420) and multinomial regressions (n=288) for hemp food products.

Independent Variables		Probit Partial Effects	Multinomial Logit Averaged Marginal Effects		
			Reject	Inert	Choice
THC Content		0.092	0.111	-0.304	0.193
Input Requirements		-0.020	0.042	0.063	-0.105*
Environmental Friendliness		0.098*	0.245	-0.408**	0.164
Regulatory Impact		0.120**	0.326*	-0.416*	0.089
Local Purchase		0.082	-0.225	0.100	0.125
Compatibility	Availability	-	-0.003	0.058	-0.055
	Affordability	-	-0.076	-0.020	0.096**
Observability		-	-0.123*	0.086	0.037
Relative Advantage	Health	-	-0.095	-0.023	0.118**
	Palatability	-	-0.120	0.033	0.087*
Simplicity		-	-0.026	-0.067	0.093**
Trialability		-	0.097	-0.224***	0.127**
Medicinal Marijuana		0.070	0.050	-0.220	0.170
Recreational Marijuana		-0.021	-0.155***	0.157**	-0.002
75 and older		-0.069	-0.075	0.163	-0.088
Education		0.167**	0.342	-0.461	0.119
Female		0.001	-0.046	0.052	-0.006
Income		0.109**	0.247	-0.243	-0.004
Republican		0.107*	0.271	-0.524**	0.253
Lambda		-	1.205	-1.897	0.692

*p < 0.10, **p < 0.05, ***p < 0.01

2.4.5 Hemp Paper

Bivariate results lead us to reject the null hypothesis that there is no relationship between awareness of hemp paper and all variables except for Republican affiliation

(Table 11). We fail to reject the null hypothesis that there is no relationship between categorization within the aware set and all variables, with the exception of availability and age.

Table 11. Bivariate results comparing aware and unaware respondents (n=427), as well as comparing within the awareness set (n=236) for the hemp paper model.

Independent Variable		Total Set			Aware Set				
		Aware (%)	df	χ^2	Reject (%)	Inert (%)	Choice (%)	df	χ^2
THC		88.3	1	73.303***	71.2	96.8	100.0	2	28.065***
Inputs		35.0	1	22.919***	39.0	25.5	59.3	2	11.1***
Environment		60.9	1	62.723***	42.4	67.0	81.5	2	14.813***
Regulation		61.5	1	55.714***	40.7	70.2	76.9	2	16.421***
Local		83.8	1	92.913***	59.3	93.6	100.0	2	36.684***
Compatible	Available	-	-	-	5.2	4.3	14.8	2	4.196 [a]
	Affordable	-	-	-	23.7	43.6	51.9	2	8.521**
Observable		-	-	-	16.9	4.3	37.0	2	20.500***
Relative Advantage	Durable	-	-	-	6.8	2.1	44.4	2	42.745***
Simple		-	-	-	19.0	6.4	33.3	2	13.634***
Trial		-	-	-	18.6	7.4	53.8	2	29.902***
Medicinal Marijuana		90.0	1	22.559***	74.6	96.8	100.0	2	23.437***
Recreational Marijuana		79.9	1	46.484***	61.0	88.3	92.6	2	20.009***
75 and older		5.0	1	17.761***	8.5	2.1	7.4	2	3.462 [a]
Education		72.6	1	11.394***	64.4	79.8	63.0	2	5.632*
Female		52.2	1	22.856***	58.6	43.6	66.7	2	5.991*
Income		67.8	1	19.948***	52.5	81.9	51.9	2	18.009***
Republican		12.2	1	0.048	27.1	5.3	7.4	2	16.278***

Notes: Analyses are subject to weighting; *p < 0.10, **p < 0.05, ***p < 0.01; [a] more than 20% of cells have an expected value of less than 5.

The probit regression explains 14.6% of the variation in awareness of hemp paper products (p < 0.001). Partial effects lead us to fail to reject the null hypothesis that there is no relationship between awareness and position on THC content (p=0.005), regulatory impact (p=0.083), local purchase (p < 0.001), support for medicinal marijuana (p=0.015), and age (p=0.012) (Table 12). Support for medicinal marijuana and age are the only significant variables with a negative relationship to awareness of hemp paper.

Due to presence of collinearity, support for medicinal marijuana is removed from the second step multinomial regression. The model then explains 28.2% of the variation in the categorization of respondents into the choice, inert and rejection sets ($p < 0.001$). Once aware of hemp food products, respondents have a 38% probability of being in the rejection set, a 54% probability of being in the inert set and an 8% probability of being in the choice set.

Averaged marginal effects reveal that position on THC content decreases the probability of hemp paper rejection by 25 percentage points ($p=0.097$) and increases the probability of choice by 36 percentage points ($p=0.080$) (Table 12). Position on input requirements increases the probability of rejection by 17 percentage points ($p=0.011$). Interest in purchasing local hemp products decreases the probability of rejection by 58 percentage points ($p < 0.001$). Perception of hemp paper as durable increases the probability of rejection by 27 percentage points ($p=0.028$). If a respondent perceives hemp products as environmentally friendly, the probability of hemp paper choice increases by 20 percentage points ($p=0.011$). The probability of choice increases by 22 percentage points if a respondent has seen someone use hemp paper before ($p=0.029$). Being female decreases the probability of choice by 11 percentage points ($p=0.052$).

Table 12. Results for the probit (n=427) and multinomial regressions (n=236) for hemp paper.

Independent Variables		Probit Partial Effects	Multinomial Logit Averaged Marginal Effects		
			Reject	Inert	Choice
THC Content		0.174***	-0.254*	-0.102	0.356*
Input Requirements		-0.007	0.174**	-0.162**	-0.012
Environmental Friendliness		0.062	-0.126	-0.070	0.196**
Regulatory Impact		0.099*	-0.129	-0.038	0.167
Local Purchase		0.264***	-0.578***	0.131*	0.448
Compatibility	Availability	-	0.072	-0.072	0.000
	Affordability	-	0.005	0.016	-0.021
Observability		-	-0.099	-0.118	0.217**
Relative Advantage	Durability	-	0.273**	-0.389**	0.116
Simplicity		-	0.052	-0.094	0.042
Trialability		-	-0.178	0.173	0.004
Medicinal Marijuana		-0.146**	-	-	-
Recreational Marijuana		0.036	-0.085	0.013	0.072
75 and older		-0.176**	0.174	0.052	-0.226
Education		0.009	0.007	0.062	-0.069
Female		0.020	-0.010	0.120	-0.110*
Income		-0.033	-0.108	0.064	0.044
Republican		-0.019	0.115	-0.063	-0.052
Lambda		-	-0.509	-0.308	0.817

*p < 0.10, **p < 0.05, ***p < 0.01

2.4.6. Hemp Personal Care Products

Bivariate results lead us to reject the null hypothesis that there is no relationship between awareness of hemp personal care products and all variables, except for Republican affiliation (Table 13). We reject the null hypothesis that there is no relationship between categorization within the aware set and all variables, with the exception of position on inputs, age and gender.

Table 13. Bivariate results comparing aware and unaware respondents (n=443), as well as comparing within the awareness set (n=366) for the hemp personal care products model.

Independent Variable		Total Set			Aware Set				
		Aware (%)	df	χ^2	Reject (%)	Inert (%)	Choice (%)	df	χ^2
THC		77.9	1	54.665***	62.2	88.3	81.3	2	18.926***
Inputs		29.7	1	14.798***	24.4	28.8	36.3	2	2.878
Environment		48.5	1	27.819***	28.9	56.7	57.5	2	18.161***
Regulation		50.2	1	30.110***	27.7	60.6	60.0	2	24.344***
Local		67.4	1	41.822***	25.3	81.6	92.5	2	99.108***
Compatible	Available	-	-	-	22.9	50.0	46.3	2	15.678***
	Affordable	-	-	-	17.1	43.3	58.0	2	29.452***
Observable		-	-	-	16.9	47.1	65.0	2	39.626***
Relative Advantage	Healthy	-	-	-	1.2	8.7	46.3	2	66.036***
Simple		-	-	-	22.9	47.1	66.3	2	31.126***
Trial		-	-	-	15.7	45.6	82.5	2	73.197***
Medicinal Marijuana		86.5	1	44.381***	71.1	90.3	97.5	2	26.392***
Recreational Marijuana		70.4	1	48.442***	56.6	74.0	80.0	2	11.758***
75 and older		12.0	1	3.043*	8.4	13.5	14.8	2	1.753
Education		68.5	1	15.2***	62.7	78.8	61.7	2	8.216**
Female		62.9	1	3.24*	62.2	56.7	71.3	2	4.097
Income		58.1	1	8.516***	49.4	68.0	54.3	2	7.169**
Republican		14.2	1	0.092	22.0	12.5	7.5	2	7.345**

Note: Analysis subject to weighting; *p < 0.10, **p < 0.05, ***p < 0.01.

The probit regression explains 14.9% of the variation in awareness of hemp personal care products ($p < 0.001$). We fail to reject the null that there is no relationship between hemp personal care products and position on THC content (p=0.001), regulatory impact (p=0.065), and local purchase (p=0.006) (Table 14). The multinomial logit model explains 32.8% of the variation in the categorization of respondents into the rejection, inert and choice sets ($p < 0.001$). Once aware of hemp personal care products, respondents have a 30% probability of being in the rejection set, a 46% probability of being in the inert set, and a 24% probability of being in the choice set.

Average marginal effects reveal that position on THC content increases the probability of choice by 33 percentage points (p=0.054). Position on input requirements decreases the probability of choice by 10 percentage points (p=0.049). Environmental friendliness increases the probability of hemp personal care rejection by 13 percentage

points (p=0.034). Interest in purchasing local hemp products decreases the probability of hemp personal care rejection by 37 percentage points (p < 0.001) and increases the probability of choice by 27 percentage points (p=0.004). Perceiving hemp personal care products as healthier alternatives decreases the probability of rejection by 20 percentage points (p=0.014) and increases the probability of choice by 23 percentage points (p < 0.001). If respondents perceive hemp personal care products as affordable or they have had the chance to try them before, the probability of choice increases by 8 (p=0.087) and 24 (p < 0.001) percentage points, respectively. Being female decreases the probability of rejection by 14 percentage points (p=0.014).

Table 14. Results for probit (n=443) and multinomial regressions (n=366) for hemp personal care products.

Independent Variables		**Probit Partial Effects**	**Multinomial Logit Averaged Marginal Effects**		
			Reject	**Inert**	**Choice**
THC Content		0.181***	-0.061	-0.273	0.334*
Input Requirements		0.018	0.043	0.054	-0.097**
Environmental Friendliness		-0.029	0.130**	-0.130**	0.000
Regulatory Impact		0.077*	-0.055	-0.049	0.104
Local Purchase		0.097**	-0.369***	0.098	0.270***
Compatibility	Availability	-	-0.045	0.005	0.040
	Affordability	-	-0.003	-0.072	0.075*
Observability		-	-0.032	0.062	-0.029
Relative Advantage	Health	-	-0.202**	-0.028	0.229***
Simplicity		-	0.039	0.006	-0.045
Trialability		-	-0.048	-0.195***	0.243***
Medicinal Marijuana		-0.026	-0.075	0.088	-0.012
Recreational Marijuana		0.051	-0.082	0.038	0.044
75 and older		-0.052	-0.076	0.170*	-0.094
Education		0.059	0.079	-0.065	-0.013
Female		0.046	-0.139**	0.118*	0.021
Income		0.043	0.018	0.025	-0.043
Republican		0.034	0.006	-0.107	0.101
Lambda		-	-0.230	-0.591	0.821

*p < 0.10, **p < 0.05, ***p < 0.01

2.4.7. Hemp Plastic

Bivariate results lead us to reject the null hypothesis that there is no relationship between awareness of hemp plastics and all variables, except for position on inputs and Republican affiliation (Table 15). We reject the null hypothesis that there is no relationship between categorization within the aware set and all variables, with the exception of affordability, durability, age and gender.

Table 15. Bivariate results comparing aware and unaware respondents (n=419), as well as comparing within the awareness set (n=115) for the hemp plastics model.

Independent Variable		Total Set			Aware Set				
		Aware (%)	df	χ^2	Reject (%)	Inert (%)	Choice (%)	df	χ^2
THC		88.9	1	32.812***	66.7	98.5	0.0	2	24.352*** [a]
Inputs		31.5	1	2.547	40.0	20.6	77.8	2	13.827***
Environment		72.2	1	57.458***	43.3	81.2	100.0	2	18.689***
Regulation		68.5	1	42.504***	40.0	82.4	66.7	2	17.535***
Local		86.1	1	49.628***	66.7	92.8	100.0	2	13.747*** [a]
Compatible	Available	-	-	-	13.3	1.4	0.0	2	7.276** [a]
	Affordable	-	-	-	29.0	44.1	22.2	2	3.090
Observable		-	-	-	33.3	4.4	10.0	2	15.518*** [a]
Relative Advantage	Durable	-	-	-	10.0	2.9	0.0	2	2.865 [a]
Simple		-	-	-	6.5	7.4	40.0	2	10.874*** [a]
Trial		-	-	-	3.3	1.5	22.2	2	9.530*** [a]
Medicinal Marijuana		93.5	1	15.384***	80.0	98.6	100.0	2	12.729*** [a]
Recreational Marijuana		88.9	1	42.047***	74.2	94.1	100.0	2	9.786*** [a]
75 and older		1.8	1	15.731***	3.2	1.5	0.0	2	0.570 [a]
Education		75.9	1	8.294***	53.3	85.3	88.9	2	12.7***
Female		43.5	1	30.643***	46.7	38.2	70.0	2	3.746
Income		69.4	1	15.202***	40.0	80.9	70.0	2	16.14***
Republican		7.4	1	2.099	16.7	4.3	0.0	2	5.412* [a]

Notes: Analyses are subject to weighting; *p < 0.10, **p < 0.05, ***p < 0.01; [a] more than 20% of cells have an expected value of less than 5.

The probit regression explains 14.7% of the variation in awareness of hemp plastic ($p < 0.001$). Partial effects lead us to reject the null hypothesis that there is no relationship between awareness of hemp plastic and position on THC content (p=0.001), local purchase (p=0.023), support for the legalization of medicinal

(p=0.069) and recreational (p=0.084) marijuana, age (p=0.001) and gender (p=0.005) (Table 16). Due to high collinearity and limited variation within our sample, we cannot execute the multinomial regression.

Table 16. Results for the probit regression (n=419) for hemp plastics.

Independent Variables	Probit Partial Effects
THC Content	0.162***
Input Requirements	0.019
Environmental Friendliness	0.080
Regulatory Impact	0.069
Local Purchase	0.117**
Medicinal Marijuana	-0.141*
Recreational Marijuana	0.093*
75 and older	-0.169***
Education	-0.014
Female	-0.124***
Income	-0.002
Republican	-0.017

*p < 0.10, **p < 0.05, ***p < 0.01

2.4.8. Hemp Rope

Bivariate results lead us to reject the null hypothesis that there is no relationship between awareness of hemp rope and all variables, except age and Republican affiliation (

Table 17). We fail to reject the null hypothesis that there is no relationship between the categorization within the aware set and all variables, with the exception of position on inputs and age.

Table 17. Bivariate results comparing aware and unaware respondents (n=467), as well as comparing within the awareness set (n=424) for the hemp rope model.

Independent Variable		Total Set			Aware Set				
		Aware (%)	df	χ^2	Reject (%)	Inert (%)	Choice (%)	df	χ^2
THC		75.7	1	36.346***	60.3	91.7	78.1	2	33.481***
Inputs		26.9	1	6.566**	28.6	24.0	31.3	2	1.017
Environment		45.9	1	15.609***	30.2	62.3	43.8	2	25.851***
Regulation		48.4	1	18.099***	34.1	63.9	43.8	2	22.345***
Local		66.8	1	22.813***	43.7	88.5	75.0	2	57.366***
Compatible	Available	-	-	-	4.8	4.9	31.3	2	27.311***
	Affordable	-	-	-	21.4	40.2	46.9	2	13.321***
Observable		-	-	-	14.3	9.8	53.1	2	35.035***
Relative Advantage	Durable	-	-	-	15.2	5.8	40.6	2	25.728***
Simple		-	-	-	7.9	15.6	53.1	2	38.069***
Trial		-	-	-	8.0	14.8	56.3	2	43.55***
Medicinal Marijuana		87.1	1	42.379***	80.0	93.4	90.3	2	10.229***
Recreational Marijuana		70.6	1	34.833***	60.3	82.0	68.8	2	14.096***
75 and older		11.5	1	0.092	11.1	9.8	21.9	2	3.634
Education		68.9	1	18.796***	58.7	77.0	78.1	2	11.139***
Female		58.1	1	23.631***	65.6	53.7	46.9	2	5.502*
Income		61.6	1	16.123***	49.2	73.0	65.6	2	15.018***
Republican		13.9	1	0.567	21.4	7.4	9.4	2	10.833***

Note: Analysis subject to weighting; *p < 0.10, **p < 0.05, ***p < 0.01

The probit regression explains 19.1% of the variation in awareness of hemp rope ($p < 0.001$). Partial effects lead us to fail to reject the null hypothesis that there is no relationship between awareness of hemp rope and position on THC content ($p=0.022$), education ($p=0.098$) and being female ($p < 0.001$) (Table 18). The multinomial logit explains 18.3% of the variation in the categorization of respondents into the choice, inert and rejection sets for hemp rope ($p < 0.001$). Once aware, respondents have a 45% probability of being in the rejection set, a 41% probability of being in the inert set and a 14% probability of being in the choice set.

Average marginal effects reveal that position on input requirements increases the probability of rejection by 14 percentage points ($p=0.025$). Interest in purchasing local hemp products decreases the probability of rejection by 26 percentage points ($p <$

0.001) and increases the probability of choice by 6 percentage points (p=0.091). Simplicity and durability of hemp rope lead to a 15 (p=0.074) and 12 (p=0.006) percentage point decrease in the probability of rejection, respectively. If respondents have had a chance to try hemp rope before, the probability of rejection decreases by 12 percentage points (p=0.028). The availability of hemp rope leads to a 12-percentage point increase in the probability of choice (p=0.010). Age leads to an 18-percentage point decrease in the probability of rejection (p=0.060), while Republican affiliation increases the probability of rejection (p=0.026).

Table 18. Results for the probit (n=467) and multinomial regressions (n=424) for hemp rope.

Independent Variables		Probit Partial Effects	Multinomial Logit Averaged Marginal Effects		
			Reject	Inert	Choice
THC Content		0.088**	-0.094	0.120	-0.026
Input Requirements		0.049	0.142**	-0.115*	-0.027
Environmental Friendliness		0.026	-0.001	0.029	-0.028
Regulatory Impact		0.043	0.012	-0.007	-0.006
Local Purchase		-0.013	-0.261***	0.199***	0.062*
Compatibility	Availability	-	-0.020	-0.104	0.124**
	Affordability	-	0.011	-0.021	0.009
Observability		-	0.028	-0.089	0.061
Relative Advantage	Durability	-	0.064	-0.180**	0.116***
Simplicity		-	-0.152*	0.091	0.061
Trialability		-	-0.120**	0.149*	0.050
Medicinal Marijuana		0.017	-0.055	0.070	-0.015
Recreational Marijuana		0.017	-0.017	0.020	-0.003
75 and older		-0.029	-0.138*	0.084	0.054
Education		0.086*	0.018	-0.021	0.003
Female		-0.104***	-0.082	0.125	-0.043
Income		0.010	-0.015	0.024	-0.010
Republican		0.018	0.146**	-0.085	-0.061
Lambda		-	-0.059	0.106	-0.047

*p < 0.10, **p < 0.05, ***p < 0.01

2.5. Discussion

Since its legalization in the U.S. in 2014 (*Legitimacy of Industrial Hemp Research*, 2014), hemp has been touted for its sustainability as a crop and its versatility as a product (Finnan & Styles, 2013; Fortenbery & Bennett, 2004). Given the variety of items that hemp can be processed into, which require a range of cultivation and processing strategies, it is critical for stakeholders across the supply chain that analyses address hemp as discrete product categories in order to comprehensively meet the needs of this industry (J. Kolodinsky & Lacasse, 2020). Results from this study provide a more comprehensive understanding of consumer awareness and intention to use eight product categories. Several themes emerge from this analysis.

Prior studies have flagged the importance of conducting consumer behavior research on discrete product types (J. Kolodinsky et al., 2020; J. Kolodinsky & Lacasse, 2020). This study supports previous research recommendations and finds variation in propensity of choice and influence of perceptions across products (Table 19). We find that respondents have the highest probability of choosing hemp CBD once they are aware of it. This is reflective of the current market for CBD (T. Mark et al., 2020). The highest probability is rejection of hemp rope once respondents are aware. For the remaining products, the highest probability, once aware, is placement into the inert set, indicating that respondents don't have enough information to make a decision about them. This presents an opportunity for producers and other hemp stakeholders to provide information or experience to potential consumers that move them towards choice.

Table 19. Significant variables that either decrease the probability of being in the rejection set or increase the probability of being in the choice set for each product analyzed.

	CBD			Clothing			Construction	Food			Paper			Personal Care			Plastics	Rope		
Probabilities[1] (%)	Reject	Inert	Choice	Reject	Inert	Choice	---	Reject	Inert	Choice	Reject	Inert	Choice	Reject	Inert	Choice	---	Reject	Inert	Choice
	36	25	39	40	47	14		35	48	18	38	54	8	30	46	24		45	41	14
Multinomial Results[2]	Local ↓↑ Health ↓↑ Trial ↓↑			Local ↓ Affordable ↑ Durable ↑ Trial ↓↑ Md. Mar. ↓			---	Afford ↑ Observable ↓ Health ↑ Palatable ↑ Simple ↑ Trial ↑ Rc. Mar. ↓			THC ↓↑ Environment ↑ Local ↓ Observable ↑ Female ↑			THC ↑ Local ↓↑ Affordable ↓ Health ↓↑ Trial ↑			---	Local ↓↑ Available ↑ Durable ↑ Simple ↓ Trial ↓ Age ↓		
Probit Results[3]	THC			THC Local Female			THC Regulation Local Republican	Environment Regulation Education Female Republican			THC Regulation Local			THC Regulation Local			THC Local Rc. Mar.	THC Education		

[1] Probability of placement into the rejection (R), Inert (I) and choice (C) sets once aware of the given hemp product;
[2] Significant variables that decrease the probability of rejection (↓) or increase the probability of choice (↑);
[3] Significant variables that increase the probability of awareness.

In addition to variation in propensity to choose, this study finds that characteristics influencing hemp consumption also vary by product category (Table 8). This highlights the necessity of developing targeted marketing strategies for particular hemp-based products, not just a single strategy reliant on the fact that products contain hemp. Within the variation of characteristics, however, there are some consistencies. Relative advantage and trialability appear to be particularly important in predicting intention to use hemp products. This demonstrates marketing opportunities on how hemp products may be preferable to their conventional alternatives, such as greater health benefits or durability. Providing opportunities for consumers to sample hemp

products also appears influential in moving consumers to the choice set, likely reducing the uncertainty associated with a new product or input (Rogers et al., 1983).

Background literature suggests that hemp's association with marijuana may influence hemp consumption (Colclasure et al., 2021; Lusk, 2017). Results from this study demonstrate the importance of maintaining the distinction between the two plants. Awareness for nine out of ten hemp product categories is positively influenced by position on THC content, indicating that an understanding of hemp and marijuana's differences leads to an increased probability of hemp product awareness. Colclasure et al. (2021) finds that educational campaigns positively influence student knowledge of hemp's differences from marijuana, as well as attitudes towards hemp. Continuing to emphasize these distinctions through public education may enable higher consumer awareness across a variety of hemp products and establish hemp's role as a product separate from marijuana.

Considering the country's history with marijuana, political affiliation is a potential determinant of propensity to adopt hemp products (Denham, 2019; McGinty et al., 2017; Schwadel & Ellison, 2017). Results reveal variation in the influence of Republican affiliation across product categories. Republican affiliation increases the probability of hemp rope rejection and decreases the probability of hemp clothing awareness. However, Republican affiliation increases the probability of awareness for hemp construction materials and food products. Though the overall influence of Republican affiliation is inconclusive, and may indicate a movement toward hemp's acceptance overall, findings do point to specific products that may require greater sensitivity when marketed.

Support for medicinal and recreational marijuana legalization have relatively minimal impacts on the hemp product models. Medicinal marijuana support decreases the probability of hemp clothing rejection and recreational marijuana support decreases the probability of hemp food rejection. These are the only occurrences of marijuana support significantly influencing choice of products. This may be indicative of its larger acceptance across the country. More than 90% of U.S. adults support some form of marijuana legalization (van Green, 2021), and this study finds that approximately 80% of respondents support marijuana legalization for medicinal use.

Though hemp production has been dormant in the United States for the past several decades, there have been recent active efforts to legalize marijuana (Cruz et al., 2016). It may be that efforts to generate public acceptance of marijuana minimize the remaining stigmas associated with hemp, reducing the potential burden the crops' confusion could impose on this nascent hemp market or, alternatively, making misleading associations with hemp a nonissue for those who support marijuana legalization and use. Though marijuana's influence over hemp consumption is not constant nor definitive, these findings demonstrate marijuana's influence on a given set of products and provide targeted considerations for hemp producers. Findings also point to a necessity for continued inclusion of marijuana's influence during hemp consumption research.

Branded Vermont-made products, such as maple syrup (McCracken, 2020) and dairy products (Conner et al., 2018), are used to convey a sense of high production standards and product quality (J. Kolodinsky & Smith, 2011; UVM Center for Rural Studies, 2011). Consumers are observant of the Vermont-made label and the standard

with which it is affiliated appears to extend to emerging hemp products. Interest in purchasing local hemp products leads to a higher probability of awareness for four of the eight products, as well as a reduced probability of rejection or an increased probability of choice, for five of the six products. This indicates the presence of origin-based branding on hemp products catching the eye of consumers who value this attribute and demonstrate the potential value of local in the greater market landscape.

There are concerns regarding the ability of states, such as Vermont, with relatively small scales of production to compete with other hemp state behemoths like Colorado or Kentucky (Allen, 2019; T. B. Mark & Snell, 2019). Postulated solutions include developing niche markets to capture consumer values and needs (Cherney & Small, 2016; Sterns, 2019). Consumer gravitation toward local products may indicate an opportunity for state producers to create reliable production standards and develop niche, origin-based markets to command price premiums to thrive in this otherwise turbulent landscape.

Though the narrative surrounding hemp inevitably includes elements of sustainability and environmental friendliness, this importance does not appear to translate to the consumer. Position on hemp environmental friendliness and input requirements do not move consumers toward awareness or choice for the majority of products. In fact, these positions increase the probability of rejection for half of the product categories. Producers may be tempted to translate the agronomic appeal of hemp to its resulting products. However, this study does not indicate that perceptions of hemp's environmental qualities positively influence consumer awareness and choice. This is supported by results for popularity of internet searches (Google Trends, 2021)

and news articles (LexisNexis, 2021) that include hemp and sustainability-related terms, which have declined since 2019. This may demonstrate an attitude-behavior gap for hemp purchases based on green behavior, where consumers' attitudes toward environmentally friendly products do not always lead to purchase behavior of such products (Johnstone & Tan, 2015a, 2015b; Jung et al., 2020). In this case, maintaining the environmental angle on hemp products may not be necessary to move consumers into the choice set and producers may find more success when pursuing other marketing angles for hemp products.

A myriad of variables influence the decision to use hemp products – the fact that they contain hemp ingredients may not be enough to move consumers into the choice set. This will require discrete marketing and targeted messages tailored to the product characteristics valued by consumers. This study provides a starting point for hemp stakeholders to generate comprehensive strategies to aid the success of emerging hemp product markets.

Chapter 3: Modelling Hemp as an Innovative Input: An Application of the Diffusion of Innovations

3.1. Introduction

Hemp has been a staple throughout human history, serving as a therapeutic treatment, durable textile and paper product, and nutritional food source (Fike, 2019; Ministry of Hemp, 2019; Robinson, 1996; The Thistle, 2000; van Roekel, 1994). Despite the plant's historic significance, its production was interrupted in the U.S. by regulatory barriers which considered hemp and marijuana to be the same (Johnson, 2018). This virtually erased hemp production from the U.S. for several decades and limited access and exposure to hemp-based products in the marketplace (Malone & Gomez, 2019).

Attitudes towards hemp have since shifted and a renewed interest in the crop's potential led to staggered legalization in 2014 (*Legitimacy of Industrial Hemp Research*, 2014) and 2018 (*Marihuana Tax Act of 1937*, 1937). Now, hemp products that have existed for centuries are being marketed in modern, inventive ways. In addition, new hemp-based innovations are emerging that seek to replace conventional inputs with hemp-based alternatives, from concrete and recyclable plastics to protein powders and carbonated beverages (Borkowska & Bialkowska, 2019; Brzyski & Fic, 2017; Jami et al., 2019).

These innovations are driven by the many attributes that make hemp an appealing ingredient for thousands of products (Popular Mechanics Magazine, 1938). Hemp fibers are lauded for their strength and resilience as paper and textiles (Bouloc & Werf, 2013; Suzanne Montford & Small, 1999) which were historically processed into nautical canvas and rope (Meijer et al., 1995; Robinson, 1996). The seeds are rich in healthy oils and

proteins (Adesina et al., 2020; Pihlanto et al., 2017; Schultz et al., 2020), which are applied to cosmetic products as a therapeutic agent (Adesina et al., 2020; Thompson et al., 1998) and to food products for added nutrition (Borkowska & Bialkowska, 2019; Brzyski & Fic, 2017). However, recent consumption literature indicates that hemp as a food ingredient may be less palatable compared to equivalent alternatives (Hayward & McSweeney, 2020; Zając et al., 2019). The driver of recent hemp demand is cannabidiol (CBD) (T. Mark et al., 2020), which is used for therapeutic, medicinal and recreational purposes (Andre et al., 2016; Rosenberg et al., 2015; World Health Organization, 2018) and applied to tinctures, supplements, edibles, food products, and pet treats (Ministry of Hemp, 2021).

Though the applications of hemp appear endless, they are not without limitations. Similar to hundreds of years ago, hemp must compete with the cost efficiency of conventional alternatives (Cherney & Small, 2016; Fike, 2016). The production efficiencies championed by cotton and petroleum-based products helped to push hemp out of production in the 19th and 20th centuries (Fortenbery & Bennett, 2004; Meijer et al., 1995). Now, too, processing limitations for hemp fiber and oil make them a relatively more expensive alternative (T. Mark et al., 2020; T. B. Mark & Snell, 2019; Sterns, 2019). Production constraints may influence the ability of products to make it to store shelves, limiting availability for consumer purchase.

Another consideration for hemp as a product input is its ties to marijuana. Hemp's production restrictions in the U.S. were fueled by fear of marijuana as a drug and public health threat (Micu, 2021; Robinson, 1996). The two were linked under federal regulation for decades and categorized as controlled substances (*Marihuana Tax Act of 1937*, 1937).

Though their differences continue to be demonstrated (World Health Organization, 2018), consumers may still confuse hemp and marijuana (Colclasure et al., 2021; Lusk, 2017). As such, the influence of marijuana on how hemp products are received is a necessary consideration.

3.1.1. Diffusion of Innovations

Given hemp's relative newness in the U.S. market landscape, modeling hemp-based products using an innovation framing is appropriate. Rogers' (1983) Diffusion of Innovations is a model of the consumer decision process for adopting innovative products or behaviors. A buyer is presented with a product or practice that is new in relation to the alternatives previously known. In the case of this study, hemp as an ingredient in otherwise conventional products is the innovation.

Innovations are accompanied by uncertainty and overcoming newness does not happen overnight (Dearing & Cox, 2018; Rogers et al., 1983). As such, consumer levels of innovativeness are a function of time. The Diffusion of Innovation categorizes individuals as innovators, early adopters, early majority, late majority or laggards, depending on the time taken to navigate the innovation-decision process (Rogers et al., 1983). Innovators are the first to adopt an innovation, while laggards are the last. Sociodemographic characteristics are identified as key indicators of innovative levels and are thus incorporated into the model of this study (Rogers et al., 1983). All innovations are not received equally; some succeed, and others fail. Adoption occurs at different speeds for different innovations. As such, time alone cannot predict rate of adoption. However, the Diffusion of Innovations allows us to universally describe consumer

perceptions of any given innovation as a proxy for rate of adoption with five attributes: relative advantage, compatibility, complexity, trialability and observability.

Relative advantage refers to the "degree to which in innovation is perceived as being better than the idea it supersedes" (Rogers et al., 1983, p. 214). An innovation with relative advantage may have time, monetary, labor, convenience, or social benefits (J. M. Kolodinsky et al., 2004; Rogers et al., 1983; Warner et al., 2020). If an innovation functions comparably to its alternatives, it is compatible. Compatibility can manifest in consumer values, needs, current habits or prior experiences (J. M. Kolodinsky et al., 2004; Rogers et al., 1983). A complex innovation implies that it is difficult to understand or use compared to the existing alternatives (Rogers et al., 1983). Alternatively, a simple innovation is easier to understand, or use, compared to its alternatives. Trialability refers to the ability of an individual to experiment with the innovation. Trying a new product or behavior limits the uncertainty associated with its newness. The final attribute is observability, which is the extent to which the innovation is visible to an individual. Observability includes an implication that the product is communicable to buyers and is socially acceptable. These five attributes influence adoption of an innovation (Figure 9).

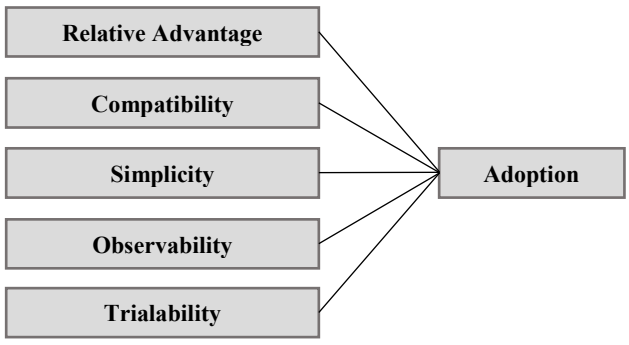

Figure 9. Conceptual model based on the Diffusion of Innovations (Rogers et al., 1983), with modifications from the Theory of Planned Behavior (Ajzen, 1991).

The current literature cites a single study applying the Diffusion of Innovations to hemp products. Metcalf, Weiner and Saliba (2021) model early adopters of newly legal hemp-based food products in Australia. They find that consumer associations with hemp and marijuana do not significantly influence adoption, but that consumers do value health and ethical sourcing of hemp food products. However, there is an absence of literature that evaluate hemp as an innovative input across products via the Diffusion of Innovations, and that measure the influence of innovation attributes on propensity to use hemp products. Therefore, this study models the influence of perceived innovation attributes to the cumulative use of eight hemp product categories.

3.2. Materials and Methods

3.2.1. Materials and Methods

This study uses data from a statistically representative online survey of randomly sampled Vermont residents conducted by the University of Vermont's Center for Rural Studies. The survey is approved by the Institutional Review Board at the University of Vermont and conducted in February and March of 2021. Respondents identifying as current Vermont residents over the age of eighteen are eligible to participate. IBM® SPSS® Version 27 (*SPSS V27*, 2021) and LIMDEP (Econometric Software Inc., 2021) are used to conduct statistical analyses. Results have a margin of error of ± 3.92% with a confidence interval of 90%.

This study includes survey questions related to each of the Diffusion of Innovations attributes as applied to eight categories of hemp-based product: CBD; clothing, shoes and textiles (referred to as clothing for the remainder of the article);

construction or industrial materials (referred to as construction materials for the remainder of the article); food products; paper; personal care products; plastics; and rope. Products are chosen based on recent sales data for hemp-based products (Hemp Business Journal, 2018) and data collected in previous surveys (J. Kolodinsky et al., 2020; J. Kolodinsky & Lacasse, 2020). Respondents are asked a series of questions related to their awareness of, intention to use and perceptions of each product category (

Table 20). If a respondent indicates that they are not aware of a given hemp product, they are not asked the remaining questions regarding that product.

Table 20. Survey questions included in this study.

Diffusion Attribute	**Survey Question**	**Answer Options**
Awareness	Are you aware of hemp products?	Yes No
Adoption	Do you intend to use hemp products in the next year?	
Relative Advantage	Hemp products can provide me with more health benefits than non-hemp-based product alternatives.*	Strongly Agree Somewhat Agree No Opinion Somewhat Disagree Strongly Disagree
	Hemp products are less appetizing and palatable than non-hemp-based products.*	
	Hemp products are stronger and more durable than non-hemp products.*	
Compatibility	For me, hemp products are difficult to find.	
	I can afford hemp products.	
Simplicity	Using hemp products is difficult.	
Observability	I have seen people using hemp products.	
Trialability	I have had the chance to try hemp products.	

Notes: Questions are asked specifically regarding eight categories of hemp products (CBD, clothing, construction materials, food products, paper, personal care products, plastics and rope) but are generalized as "hemp products" in this table for succinctness; * questions are only asked for relevant products.

Awareness and intention to use hemp products are asked as yes (=1) or no (=0) questions. These variables are then aggregated to an 8-point scale representing the number of products aware of or used. Because those who are unaware of all hemp products are never asked about their use or perceptions, and because that number represents less than 2% of our sample, we remove all cases where total awareness equals zero. This study is therefore based on a sample of those who are aware of at least one

hemp product category. Cumulative intention to use serves as a proxy for hemp adoption. The influence of cumulative awareness on use is evaluated in the model.

Given hemp's historic and evolving use as a durable fiber (Bouloc & Werf, 2013) and medicinal ingredient (Adesina et al., 2020; Andre et al., 2016), and that recent consumption studies indicate that consumers may find hemp-based food unpalatable (Hayward & McSweeney, 2020; Zając et al., 2019), we measure relative advantage through the health benefits, palatability and durability of hemp products compared to non-hemp alternatives. The nascency of the hemp industry and the processing limitations that accompany it may result in more expensive products that may not be readily available (Hellwinckel, 2020; Sterns, 2019). Therefore, compatibility is measured by whether the consumer perceives hemp products as difficult to find and as affordable. Simplicity, observability and trialability follow previous applications of the diffusion attributes (Rogers et al., 1983). Perception statements are collected as 5-point Likert scales, ranging from strongly disagree (=1) to strongly agree (=5). "Don't know" responses are recoded as "no opinion" (=3). We then measure the average value of the attribute, where the representative variables are summed and divided by the total number of products a respondent is aware of. This results in a 5-point scale for each attribute.

In addition, we account for the associations between hemp and marijuana found in previous studies (Colclasure et al., 2021; Lusk, 2017) by controlling for the support of medicinal and recreational marijuana legalization, comparing those supportive of legalization to everyone else. Age is categorized into 4 groups: 18 to 34, 35 to 54, 55 to 74, and 75 and older. These are recoded into dummy variables, with the 75 and older category left out for reference (J. Kolodinsky et al., 2020; J. Kolodinsky & Lacasse,

2020). Education compares those with some college or more to those with lower educational attainment. Income compares those with annual household incomes of $50,000 or higher to those with less than $50,000. Gender compares females to males. Respondents are asked to identify their political affiliation from five options: Republican, Democrat, Independent, Progressive and not politically affiliated. These are recoded into dummy variables, with Republican affiliation left out as the reference group (J. Kolodinsky et al., 2020).

This study analyzes the diffusion of hemp-based products within our sample through perceived innovation attributes. Those who do not intend to use any hemp products represent 52.7% of the sample, demonstrating a corner solution response (Wooldridge, 2013). To address the prevalence of zeros, we run a Heckman two-step regression, where the first step probit for selection estimates the probability that respondents adopt at least one hemp product. The second step is an OLS model which measures the intensity of adoption once at least one product is chosen, while accounting for the correction factor, or inverse Mills ratio, from step one (W.H. Greene, 2003). Results will reveal the influence of innovation attributes on propensity to use at least one hemp product as well as on intensity of use.

The demographic characteristics of our sample population are compared to the Census Bureau's 2019 American Community Survey (United States Census Bureau, 2019) estimates and subject to post process weighting. Demographic weighting ensures that survey responses are representative of the known population characteristics (Mercer et al., 2018). Table 21 outlines the distribution of our sample population by control variables. The distribution of age, education and income for the sample is representative

of those in Vermont within a margin of error of ±6.2%. Gender is slightly less representative of the state, with a margin of error of ±11.1%. The majority of respondents are supportive of both medicinal (80.4%) and recreational (62.8%) marijuana legalization. Respondents who identify as Independents have the highest frequency in our sample (37.3%), followed by not politically affiliated (22.4%), Democrat (21.2%), Republican (13.5%) and Progressive (5.7%).

Table 21. Demographic variability within the sample (n=465).

Control Variable	(%)
Medicinal Marijuana	84.9
Recreational Marijuana	66.6
Age	
18-34	25.2
35-54	29.2
55-74	33.4
75 and older	12.3
Education	31.9
Gender	61.7
Income	59.5
Political Affiliation	
Republican	13.5
Democrat	21.2
Independent	37.3
Progressive	5.7
Not politically affiliated	22.4

Note: Analysis subject to weighting.

3.3. Results

The average total awareness of our sample is 5.66 out of a possible 8 products (Table 22). Approximately 70% of our sample is aware of at least five types of hemp-based products (Figure 10). Nearly half of our sample does not intend to use any hemp products (52.7%). Of those who intend to use at least one hemp product, most use just one; total use then declines as the number of products rises (Figure 11). Of the innovation attributes, simplicity has the highest mean score (3.29), followed by compatibility (3.14), observability (3.12), and relative advantage (3.09) (Table 22). Trialability has the lowest

mean score (2.83). CBD has the highest frequency of use (38.6%), followed by personal care products (29.2%) and food (24.0%).

Table 22. Frequencies and means of the independent variables included in the model.

Independent Variable	(%)	Mean	SD	n
Awareness: Total Products	-	5.66	1.98	465
CBD	95.3	-	-	465
Clothing	91.5	-	-	465
Rope	90.0	-	-	465
Personal Care	83.6	-	-	465
Food	61.6	-	-	465
Paper	57.0	-	-	465
Construction	51.4	-	-	465
Plastics	35.6	-	-	465
Use: Total Products		1.12	1.59	464
CBD	38.6	-	-	441
Personal Care	29.2	-	-	356
Food	24.0	-	-	285
Clothing	14.6	-	-	412
Paper	13.2	-	-	232
Rope	11.3	-	-	419
Plastics	8.2	-	-	116
Construction	5.7	-	-	211
Relative Advantage	-	3.09	0.50	463
Compatibility	-	3.14	0.54	463
Simplicity	-	3.29	0.61	463
Observability	-	3.12	0.74	464
Trialability	-	2.83	0.91	464

Note: Analyses are subject to weighting.

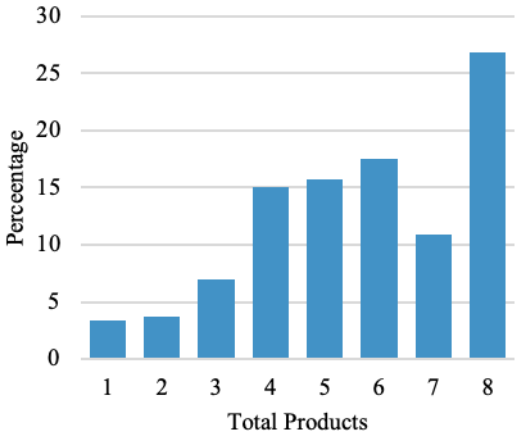

Figure 10. Frequency of total awareness of hemp-based products (n=465).

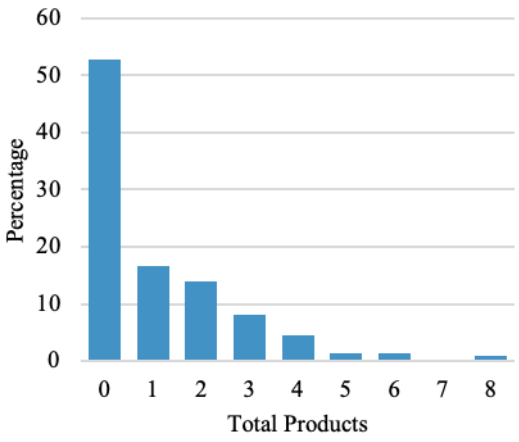

Figure 11. Frequency of total use of hemp-based products (n=464).

The step one probit explains 16% of the variation in hemp use ($p < 0.001$). Partial effects lead us to reject the null hypothesis that there is no relationship between adoption of hemp products and compatibility, simplicity, trialability, total awareness, medicinal marijuana and being age 18 to 34 (

Table 23). A higher ranking for perceived compatibility decreases the probability of use by 10 percentage points (p=0.044). Higher perceived simplicity and trialability lead to a 10 (p=0.045) and 17 (p < 0.001) percentage point increase in the probability of use, respectively. Higher total awareness of hemp products leads to a 5-percentage point increase in the probability of use (p < 0.001). Support for medicinal marijuana legalization leads to a 16-percentage point increase in the probability of use (p=0.022). Compared to those 75 or older, being age 18 to 34 increases the probability of use by 31 percentage points (p=0.006).

Table 23. Results for the step one probit (n=462) and step two OLS (n=237) of the Heckman two-step.

Independent Variables	Step One		Step Two
	B (SE)	Partial B (SE)	B (SE)
Constant	-3.084*** (0.565)	-	-12.061* (7.060)
Relative Advantage	0.268 (0.166)	0.088 (0.054)	1.106* (0.626)
Compatibility	0.305** (0.153)	-0.101** (0.050)	-0.785 (0.565)
Simplicity	0.302** (0.152)	0.100** (0.050)	0.609 (0.570)
Observability	-0.120 (0.120)	-0.039 (0.040)	-0.147 (0.418)
Trialability	0.502*** (0.110)	0.166*** (0.034)	1.450* (0.838)
Total Aware	0.145*** (0.037)	0.048*** (0.011)	0.645*** (0.242)
Medicinal Marijuana	0.470** (0.207)	0.158** (0.069)	1.470 (1.098)
Recreational Marijuana	0.011 (0.157)	0.003 (0.052)	0.280 (0.496)
18-34	1.066** (0.513)	0.309*** (0.112)	1.027 (1.7211)
35-54	0.066 (0.249)	0.022 (0.082)	0.276 (0.787)
55-74	0.038 (0.205)	0.013 (0.068)	-0.081 (0.661)
Education	-0.144 (0.238)	-0.047 (0.078)	-0.423 (0.734)
Gender	-0.058 (0.142)	-0.019 (0.047)	-0.355 (0.438)
Income	-0.118 (0.159)	-0.039 (0.052)	-0.244 (0.500)
Democrat	0.292 (0.214)	0.096 (0.070)	0.240 (0.799)
Independent	0.148 (0.203)	0.049 (0.066)	-0.046 (0.679)
Progressive	0.150 (0.302)	0.049 (0.099)	-0.688 (0.929)
Not Politically Affiliated	0.138 (0.243)	0.045 (0.079)	-0.179 (0.808)
Lambda	-	-	3.905 (2.577)

*p < 0.10, **p < 0.05, ***p < 0.01

The second step OLS explains 36% of the variation in intensity of use among hemp product users. A one-point increase in the average perceived relative advantage of hemp products leads to a 1.1 increase in total products used (p=0.077). A one-point increase in the average perceived trialability of hemp products leads to a 1.5 increase in total products used (p=0.084). Each additional hemp product a respondent is aware of leads to a 0.6 increase in total products used (p=0.008).

3.4. Discussion

This study finds that age has the largest relative impact on hemp use compared to non-use, with 18- to 34-year-olds increasing the probability of use compared to those 75 or older. This finding is consistent with previous applications of demographic influence, where the oldest age groups are more likely to be unaware of hemp products (J.

Kolodinsky et al., 2020; J. Kolodinsky & Lacasse, 2020). However, this finding is contrary to industry data that identify older consumers as more likely to consume CBD (New Frontier Data, 2020) and points to the importance of avoiding the conflation of CBD findings to the broader hemp consumer. Older consumers may be more frequent users of CBD, but our study finds that younger consumers have a higher probability of using hemp overall. Inclusion of hemp in the marketplace may require different marketing strategies than CBD alone and this study identifies important segmentation opportunities for hemp as a broader input.

In addition to age, simplicity of hemp products is also an important consideration for marketing strategies. The simpler hemp products are perceived, the higher the probability of adopting at least one product. Emphasizing the ease with which a hemp product can be used, particularly compared to its conventional alternatives, is critical to reduce the uncertainty associated with hemp as an innovative input and normalize it in the marketplace (Rogers et al., 1983).

Another clear influence on adoption is the support for medicinal marijuana legalization, which increases the probability of hemp use. This may relate to the background literature's suggestions that hemp and marijuana are linked in the public eye (Colclasure et al., 2021; Lusk, 2017), where acceptance of marijuana leads to acceptance of hemp. However, our study is unable to tease out the motivation of medicinal marijuana supporters in relation to hemp adoption. Future research should continue to evaluate the influence of marijuana, particularly on whether consumers adopt hemp *because* they believe it is related to, or will normalize the acceptance of, marijuana. This study's contrary findings compared to those of Metcalf et al. (2021) indicate the varied influence

of policy on crop or product acceptance. Understanding how policy influences hemp acceptance across a range of geographical and government contexts may be a valuable contribution to the hemp consumption literature.

Compatibility of hemp products in terms of availability and affordability is the only variable with a significantly negative influence on use. Higher perceived compatibility leads to a decrease in the probability of using at least one product. This points to hemp as a specialty product, where consumers are willing to go out of their way, in terms of time and cost, to adopt it (Gold et al., 2004). This has important implications for hemp's potential role in smaller, niche markets, particularly for areas with relatively smaller scales of production, like Vermont. As the market for hemp beyond CBD develops and grows, research should elaborate on hemp as a specialty product and gain a fuller understanding of which hemp products consumers perceive as "special" and which may be more suited for commodification.

Our findings reveal that awareness of more types of hemp-based products leads to the use of at least one hemp product and to a higher number of total products. This may reflect reduced consumer uncertainty as they gain knowledge about all the ways hemp can be used (Rogers et al., 1983). This indicates the importance of demonstrating the swath of products hemp can be processed into to normalize hemp in the marketplace. Though the current market is largely focused on CBD products (T. Mark et al., 2020) and availability of many product types are limited (T. B. Mark & Snell, 2019), inclusion of all types of hemp-based products may increase the overall awareness of consumers, leading to greater acceptance and use. Considering that awareness within our sample is lowest for hemp food products, construction materials, paper and plastics, emphasizing these

product categories may have the greatest impact on increasing total hemp awareness and, subsequently, use.

Consumers are more likely to adopt an innovation if it possesses advantages compared to its alternatives (Rogers et al., 1983). Results find that higher perceived relative advantage of hemp-based products leads to an increase in total products used. This indicates that the healthier, more palatable, and more durable hemp products are perceived to be, the more likely consumers are to use more of them. These findings help direct the hemp industry two-fold. First, they emphasize the importance of continued research on the health and nutritional benefits of hemp, as well as on how to enhance palatability and durability in innovative products. In addition, findings point to targeted marketing opportunities for hemp stakeholders to continue the diffusion of hemp in the marketplace.

The ability to try a product before adoption allows consumers to gain experience, begin to understand how it would work in their own lives and minimize the uncertainty associated with its newness (Rogers et al., 1983). Trialability of hemp products has the greatest influence on cumulative hemp adoption, leading to the use of nearly 1.5 more products. Providing opportunities for potential consumers to try hemp products should be offered where possible. This can manifest as company offerings through product coupons and samples, or may include institution-led demonstrations at community events to bolster awareness and education. For example, agricultural extension could hold demonstrations of hemp plastics and rope and a community fair. This would provide consumers who have not encountered all types of hemp products, or none at all, to gain awareness and confidence through trialability.

3.5. Conclusion

Hemp's newly legal status positions the crop as a new and innovative input for product alternatives. This study models the diffusion of hemp-based products as innovations through the Diffusion of Innovations theory. Results lend insight to how attributes of innovations influence cumulative hemp use and provide a snapshot of how hemp is diffusing in the U.S. market landscape. Though CBD is the leader of awareness and use among our sample, other product types follow closely behind and there is a large segment of the market left to capture. This study suggests that if hemp is to be accepted as an innovative product input, then all types of hemp products must be included in public education and marketing strategies. In particular, generating awareness across products, emphasizing advantageous qualities, and providing opportunity for product trial are critical to increasing cumulative hemp product adoption. Findings providing a starting point for stakeholder strategy development and research on hemp consumption studies moving forward. In addition, this study contributes to seminal models of hemp as an innovative product as applied through the Diffusion of Innovations.

Chapter 4: Conclusion

As the U.S. reintegrates hemp into its production and marketing landscapes, an understanding of consumer perceptions and behaviors toward hemp-based products is critical for industry success. Considering the crop's historic production prohibition and its recent legalized status, this research evaluates hemp as new, innovative product ingredient.

In Chapter 2 we model specific hemp products as unique innovations. Results reveal that consumer perceptions of hemp, as well as product-specific innovation attributes, vary across product type and suggest an industry necessity for targeted marketing strategies based on the hemp product at hand. Chapter 3 evaluates hemp more broadly as an innovative input across product categories. Findings highlight the importance of framing trialability and relative advantage in marketing strategies to increase cumulative hemp use. In addition, we find that the role of awareness is critical for the diffusion of hemp products at large.

In both chapters we see that awareness of products is critical. Awareness enables access to specific hemp product types and allows a consumer to make a decision regarding choice or rejection. In addition, awareness has implications for adoption beyond a single product and critical for the diffusion of hemp products at large. This indicates that diversification of hemp products in marketing and public education is critical to enabling successful diffusion.

Overall, this research draws attention to two contrasting paths the hemp market can take. Chapter 3 indicates that hemp may be viewed as a specialty product and Chapter 2 outlines ways producers can market specific hemp products in a niche market.

However, it does not appear that those attributes would also lead to high total hemp use and, therefore, may not contribute to hemp as a normalized input for product alternatives or commodification. Instead, Chapter 3 demonstrates the importance of awareness and trialability in the cumulative diffusion of hemp. As such, findings from this thesis can assist strategy development for hemp stakeholders as they determine how to interact with this new market.

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