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Challenges, Opportunities, and the Way Forward for the U.S. Hemp Industry

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Abstract

The passage of the 2014 and 2018 Farm Bills generated unprecedented enthusiasm in the U.S. hemp industry. We conduct a comprehensive assessment to identify the challenges and opportunities of this growing industry. The findings indicate that although there is considerable enthusiasm for the hemp industry, there are many challenges that the industry needs to overcome to survive and establish itself. It will require a concerted effort to mitigate the risk and grow the industry. We point out some specific actions that would be helpful for the development of the U.S. hemp industry.

Keywords: U.S. hemp industry, hemp policy, 2018 Farm Bill, Cannabinol (CBD), hemp products, Tetrahydrocannabinol (THC)

JEL Classification: Q18, Q13

The 2014 and 2018 Farm Bills provided a legal foundation for industrial hemp cultivation and generated unprecedented enthusiasm in the U.S. hemp industry. Soon after the 2014 Farm Bill, Colorado, Indiana, Kentucky, and Vermont allowed hemp cultivation under their state pilot programs (Mark et al., 2020). The pilot programs quickly reached 15 states by 2016, and by 2020, 47 states legalized hemp farming (Vote hemp, 2017 and Drotleff, 2020).

Given the enormous interest surrounding the U.S. hemp industry, it is crucial to evaluate its potential and shortcomings to identify future interventions and policy aids. In this article, we discuss the status of the U.S. hemp industry and conduct a comprehensive assessment to identify challenges and opportunities to this industry. Based on the assessment, we point out some policy actions to directly address the challenges and opportunities of the U.S. hemp industry.

The U.S. Hemp Policy and Hemp Industry

The 1937 Marijuana Tax Act is the first law enacted to discourage hemp production by imposing tax and requiring producers of *Cannabis sativa* species to apply for the license (USDA AMS, 2019). After the passage of the 1970 Controlled Substance Act, which regarded hemp as 'Marijuana,' a controlled substance, its production was prohibited for several years (Malone and Gomez, 2019; Vote Hemp, 2020^a). The Agricultural Act of 2014 (2014 Farm Bill) allowed higher education institutions and the state departments of agriculture to cultivate and research hemp under state pilot programs (USDA AMS, 2019). The bill still prohibited independent cultivation of hemp beyond the state pilot

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programs. However, the 2018 Farm Bill legalized industrial hemp farming². The bill distinguished hemp from marijuana by defining it as the variety of *Cannabis sativa L.* with Cannabinoid delta-9 tetrahydrocannabinol (THC) concentration not greater than 0.3% on a dry weight basis. The bill effectively transformed hemp from a controlled substance to a new agricultural crop and allowed commercial production of hemp. The cultivation of hemp with a THC concentration above 0.3% is still prohibited under the law (USDA AMS, 2019)³. Based on the 2018 Farm Bill, the USDA has recently published the final rule that governs domestic hemp production in the United States (USDA AMS, 2021).

U.S. hemp cultivation significantly increased once states began issuing licenses under pilot programs and the state hemp programs. Between 2016 and 2019, the number of hemp licenses issued by the states increased by almost 1,965% and planted acres by 2,284% (Table 1). The sales of hemp products also grew from \$85 million in 2015 (Hemp Business Journal, 2016) to \$820 million in 2017 and are projected to reach \$1.9 billion by 2022 (Hemp Business Journal, 2018). The hemp industry's growth led to a drastic decrease of 57% in U.S. hemp seed imports between 2016 and 2017 (Hemp Business Journal, 2018). The recent data on planted and licensed acres for hemp suggest that Colorado, Kentucky, Montana, and Tennessee are the major U.S. hemp-producing states⁴ (Table 2). Colorado has gone a step further, implementing hemp-focused programs such as the Colorado Hemp Advancement Management Plan (CHAMP) to promote its hemp industry (Hill et al., 2020).

The hemp industry's growth is mainly attributed to the Cannabidiol (CBD) demand, which is allegedly claimed to be effective in treating epilepsy, insomnia, and chronic pain (Grinspoon, 2020). However, so far, the Federal Drug Administration (FDA) has approved Epidiolex, which contains a purified form of CBD for the treatment of seizures (FDA, 2021). CBD is mainly extracted from hemp flowers. The utilization of other hemp plant parts such as hemp seed and hemp fiber is growing. The FDA has issued "generally recognized as safe" notices for hemp seed-derived food ingredients such as hulled hemp seed, hemp seed powder, and hemp seed oil (FDA, 2021). Hemp seed can be consumed as food in granola and cereals or processed into hemp seed oil. Hemp seed is considered to have high nutritional value because of the high amount of Omega 3 and Omega 6 fatty acids, vitamin E, and protein (Small and Marcus, 2002). Hemp oil is used as cooking oil, salad oil, and in the production of industrial products, including lubricants, oil paints, varnishes, and personal hygiene products such as soap, shampoo, and cosmetics (Allen and Whitney, 2019). Hemp fibers extracted from hemp stalk and leaves are used in producing paper, industrial textiles (e.g., ropes, nets, carpets), consumer textiles, and animal bedding materials (Allen and Whitney, 2019).

Hemp Business Journal (2018) reports that in 2017, the United States sold \$820 million hemp-

² In this paper, hemp farming or the U.S. hemp industry refers to the production or marketing of hemp that satisfies the statutory definition of hemp as defined in the 2018 Farm Bill. The bill defines hemp as "the plant species *Cannabis sativa L.* and any part of that plant, including the seeds thereof and all derivatives, extracts, cannabinoids, isomers, acids, salts, and salts of isomers, whether growing or not, with a delta-9 tetrahydrocannabinol concentration of not more than 0.3 percent on a dry weight basis" (USDA AMS, 2019). The term industrial hemp is used interchangeably with the legal hemp in the paper.

³ It is worth noting that this is the case even in states where marijuana is legal. A grower cannot grow marijuana under a hemp license.

⁴ Because the planted acre data for Oregon are not available, we did not include Oregon in the list, but based on licensed acres data reported by Stelton-Holtmeier et al. (2021) for 2019 (51,313 acres) and 2020 (27,434 acres), Oregon is also one of the major states for hemp.

based products consisting of 23% (\$190 million) of CBD products, 22% (\$181 million) of personal care products, 18% (\$144 million) of industrial products, 17% (\$137 million) of food products, and 20% (\$166 million) of other consumer products and textiles, and supplements. They also project sales of hemp-based products to reach \$1.9 billion by 2022, with a 34% (\$646 million) share of hemp-derived CBD sales.

Challenges

Although the number of hemp planting licenses issued by the states increased by 27% between 2019 and 2020, planted acres decreased by 31% in that period (Table 1). In addition, the prices of Cannabinoid biomass dropped by 83% between 2015 and 2020 (Yahn-Grode, 2020). Most recently, the price of Kentucky hemp biomass fell from \$4.35 per percent of CBD content per lb. to \$0.74, a drop of nearly 83% between July 2019 and January 2020 (Yahn-Grode, 2020). Last year, two high-profile U.S. hemp companies based in Kentucky – GenCanna Global and Sustrand, LLC filed for bankruptcy (Grode, 2020). Between April 2019 and March 2020, the publicly traded American Cannabis Operator Index, which includes companies producing industrial hemp products, dropped by 86% (New Cannabis Ventures, 2021). This indicates a volatile hemp market, as predicted by Sterns (2019).

The drop in hemp prices and bankruptcies of hemp companies indicate a challenging time ahead for the relatively young industry. The industry may not be viable in the future if it fails to grow. We highlight below some of the challenges associated with this industry.

Niche market status and the problem of excess supply: The current hemp market is a niche market at best. The current market size is still very small compared to other agricultural markets. For example, per PanXchange estimates, the entire U.S. cannabinoid market would require only 2,819 acres of hemp, which is about 4.4% of the 2020 hemp acreage reported by the USDA Farm Service Agency (PanXchange, 2020). About 85% of U.S. hemp acreage in 2020 was intended for the CBD market (Yahn-Grode et al., 2021), indicating an alarming gap between hemp demand and the planned supply. The gap can potentially further decrease the raw biomass price and the prices of CBD products in the future. The downward spiral of hemp prices will continue until the increased demand matches the excess supply. It is not clear how long it will take to get to that equilibrium point.

Lack of well-established production technologies: Given that hemp is a new agricultural crop, its production-technology is not well established. Little information is available to U.S. hemp farmers regarding seeds, seeding rate, fertilization, pests and pesticides, and other cultural practices that would be suitable for their farm conditions (Mark et al., 2020 and Allen and Whitney, 2019). Some states have certified hemp seeds, but there are no certified seeds for most hemp-producing states or at the national level. Besides, no harvesting equipment is designed specifically for hemp, and most hemp is harvested manually (Yahn-Grode et al., 2021). There is no recommended post-harvest technology for various uses of hemp biomass.

The 2018 Farm Bill explicitly mandates that hemp biomass for CBD extraction cannot exceed 0.3% THC level. The seed and production practices suitable in one region of the country producing biomass with less than 0.3% THC do not guarantee that it will have the same result in other parts of the country with different climatic and soil conditions. The lack of region-specific certified seeds

increases the risk to hemp farmers compared to other farmers. Besides worrying about the production and productivity of their hemp crop, they need to be concerned about the THC level of the produce. Failure to be within the 0.3% THC level means they have to destroy their crop and forego the season's revenue with an additional cost to destroy the crop.

Lack of production management and market information: New hemp producers and processors who want to run a profitable enterprise need to understand production costs and markets clearly to make their business decisions properly⁵. Such business information from public and private sources are minimal (Raszap Skorbiansky et al., 2021). Therefore, it is hard to make projections or to form price expectations.

It is crucial to know the expected revenue and costs of hemp farming to a new hemp producer. There are a few representative hemp budgets available (e.g., Mark and Shepherd, 2020 (for Kentucky); Hanchar, 2019 (for New York); Harper et al., 2018 (for Pennsylvania), but these budgets show quite a variability in returns from hemp production (Tables 3, 4, and 5) and are specific to the eastern/northeastern region of the United States. For example, Kentucky's estimated hemp seed production return is -\$166/acre, while New York and Pennsylvania are \$624 and \$546, respectively; a range of nearly \$800/acre (Table 3). Similar patterns are observed in the case of fiber and CBD budgets (Tables 4 and 5). The CBD budgets in Table 5 show a possibility of \$3,343/acre net return in Kentucky, but a loss of \$1,432/acre in Tennessee, again a range of \$4,775/acre between two budgets. Given the variability in the budgets, it isn't easy for a new farmer to realistically estimate expected returns from hemp farming and decide to start hemp farming.

There seems to be no consensus regarding the hemp industry's outlook. For example, two prominent hemp business information publications, Hemp Industry Daily and Hemp Business Journal differ in industry growth projections. Hemp Industry Daily (2019) projects U.S. CBD sales to be \$5.6-\$6.8 billion by 2022, which is almost nine times higher than the \$646 million projected by Hemp Business Journal (2018). According to the Hemp Business Journal, sales of all hemp-based products are projected to be no more than \$1.9 billion. Given the two contrasting scenarios, it is difficult to gauge how the U.S. hemp market will evolve in the future. Also, most of the growth projections are based on assumed growth in CBD use, the primary hemp product. However, the claimed benefits of CBD products are not yet scientifically verified, which will affect future growth. Given this scenario, it is not realistic to assume widespread use of CBD for medical and food purposes soon, adding another layer of risk to the industry.

Lack of access to market, marketing institutions, and quality standards: There is a lack of established market and marketing channels for the U.S. hemp industry. There is no established spot or cash markets. Forward contracts between producers and processors are rare (Mark et al., 2020). When forward contracts are available, they leave hemp product prices flexible, defeating the purpose of a forward contract to minimize price risks (Raszap Skorbiansky et al., 2021). There are no established marketing channels that link hemp producers with the processors, wholesalers, and retailers and facilitate the flow of hemp products from farms to ultimate consumers. Given the lack of proper market and marketing infrastructures, it is estimated that only 25-33% of hemp output makes it to the market (Allen and Whitney, 2019).

⁵ For example, Lee et al. (2020) explain the impact of marketing channels on farm profitability in Taiwan.

Processing is an essential part of the hemp industry, but very little is known about hemp processors' location and capacities in various states. According to Allen and Whitney (2019) estimates, the U.S. hemp processing capacity is very small to process hemp produced in the country on time. One processor in the United States handles about 100 acres of hemp harvest or about 200,000 lbs. of biomass. Processing the entire output takes on average one to three years, depending upon the type of technology used in processing. As a result, there is significant uncertainty regarding timely hemp processing. Besides inadequate processing capacity, there is no standardization and quality control of processed hemp products. For example, there have been instances of false claims regarding the CBD content of the CBD oil sold in the U.S. market (Allen and Whitney, 2019).

Lack of clarity on the policy for regulating hemp products: The most significant driver of hemp demand is the potential use of hemp-derived CBD for medical and food/food supplement purposes. The 2018 Farm Bill provisions are limited to hemp farming only, and the USDA does not regulate the food and drug uses of CBD as it falls under the purview of the FDA (USDA AMS, 2019). The FDA has yet to provide clear-cut guidance regarding CBD regulations for medical and food/ food supplement purposes. For the FDA to issue any regulations regarding CBD use, it will first look into all the scientific evidence regarding claimed health benefits and its side effects. Given the lengthy process, there is a significant delay in the formulation of the hemp policy by the FDA (Hemp Industrial Daily, 2021^a). If the FDA determines that CBD use does not have the claimed health benefits or, worse, is detrimental to human health, it will negatively impact the U.S. hemp industry. Given the lack of an FDA policy on CBD use, this constitutes the most significant uncertainty regarding the future demand and growth potential for CBD. The negative effect of policy uncertainty on business investment is well documented in the literature (e.g., Gulen and Ion, 2016; Dixit and Pindyck, 1994; Rodrik, 1991 and Bernanke, 1983). The FDA policy uncertainty means that new firms will take time to enter the industry, and existing firms will be hesitant to expand their business.

Import competition: Besides the domestic factors, the established players in the world hemp market, including Canada, Europe, and China, provide competition to the domestic hemp industry (Mark et al., 2020). According to Hemp Industrial Daily (2021^b), "non-CBD imports into the United States grew by 10% in the first ten months of 2020, compared to the same period in 2019." Table 6 shows that the six-year average value (from 2016-November 2020) of various hemp products imported in the United States totaled about \$65 million, which is about 8% of the estimated 2017 final product sales of \$820 million in the domestic market as estimated by the Hemp Business Journal (2018). USDA AMS (2019) estimates the value of the hemp imports to be about 15% of the raw hemp products' value. Although the import value share relative to the domestic hemp market is small, it can grow quite large when the U.S. market expands, given the relatively established hemp industry in the exporting countries. The imports from Canada are among the most competitive, as its share in the total U.S. hemp, hemp seed, and hemp oil imports are about 91, 95, and 78 percent, respectively (Table 6).

Opportunities

Although the U.S. hemp industry faces many challenges, there have been some positive developments to facilitate the industry's growth. We discuss below some of those developments and the opportunities created.

*Projected growth potential*⁶: Although hemp has been grown globally for hundreds of years, its commercial production for CBD and other industrial products has a relatively young history. Therefore, it is a new industry with worldwide growth potential if the benefits of CBD use are scientifically verified in the future. Notwithstanding the pending scientific verification of CBD benefits, optimistic projection suggests that the U.S. CBD market will be \$16.8 billion (Brightfield group, 2020) and the hemp producers' sales to be \$1.29 billion (Hemp Industrial Daily, 2021⁶) by 2025. The USDA AMS (2021) projects the number of U.S. hemp grower licenses to increase annually at a 10% rate to 32,210 licenses, planted acres to be about 1.05 million acres, and producers' sales of \$2.86 billion by 2025.

A global industrial hemp market projection claims a compound annual growth rate of 34% and is projected to reach \$36 billion by 2026 (Facts and Factors, 2021). Following the World Health Organization recommendation of not scheduling CBD as a controlled substance (Open Access Government, 2020) and the subsequent removal of cannabis for medicinal purposes by the United Nations (Hoban, 2020), many countries in the world are expected to relax regulations on CBD and hemp. These developments are expected to expand the global hemp market and create an opportunity of exporting U.S. hemp.

In light of the market potential, retail giants such as CVS, Walgreens, Kroger, and Albertson have started selling CBD products, and Canadian cannabis companies such as Tilray, Aurora Cannabis, and Canopy Growth have entered the U.S. CBD market (Brightfield group, 2020). Such established companies' entry is expected to bring their expertise and develop the U.S. hemp industry. Consumer awareness of CBD products is also increasing, contributing to a further increase in demand for CBD products (Brightfield group, 2020). There are also opportunities to expand the use of hemp products in textiles, personal care products, automobiles, construction materials, and animal feed. Favorable development of the domestic hemp market can make the United States a dominant player in the world hemp market in the future.

USDA Final Hemp Rule: USDA recently finalized the interim hemp rule (USDA AMS, 2021). The final rule has cemented the legalization of hemp in the United States and provides many concessions to hemp farmers by removing some regulatory constraints they face in producing hemp. The rule expands the "negligent violation" error margin of THC level to 1% from 0.5% and prevents farmers from being criminally charged. Also, farmers can't be cited for negligent violation more than once in a calendar year even though they get multiple violation citations for hemp grown in different locations in a single season. The rule also provides flexibility to the states and tribal governments in developing THC testing protocols that would not require 100% testing of all hemp lots if they can demonstrate with 95% confidence that hot hemp is not produced. The rule allows hemp farmers to salvage some of their investment by retaining some part of their hemp plant within the statutory THC limit and destroying the part of the plant (e.g., hemp flower) that exceeds the limit. Also, instead of the previous requirement of disposal by government authorized agents, the final rule provides flexibility in destroying hot hemp by the farmers. These policy changes in the final rule would positively impact the growth of the U.S. hemp industry.

⁶ As explained previously, the growth potential very much hinges on the growth of the CBD market, which is contingent on scientific verification of claimed health benefits. Given this scenario, cautious optimism should be exercised in reading into the industry growth projections.

Improved access to credit and financing: In the past, banks were reluctant to give financial services to hemp-related businesses because of their proximity to marijuana, a controlled substance. Following hemp legalization by the 2018 Farm Bill, the Financial Crimes Enforcement Network, a bureau of the U.S. Department of Treasury, issued guidance to banks that "because hemp is no longer a Schedule I controlled substance under the Controlled Substances Act, banks are not required to file a Suspicious Activity Report (SAR) on customers solely because they are engaged in the growth or cultivation of hemp in accordance with applicable laws and regulations" (FinCEN, 2019). This is a positive development for the hemp industry. The hemp industry is optimistic that the SAFE Banking Act 2021, which was recently passed by the U.S. House of Representatives and is under consideration in the senate, will further facilitate access of hemp businesses to banking services (Smith, 2021). Because access to financial resources is essential for the development of any industry, the policies to facilitate access to financial services contribute to this nascent industry's growth.

Government support programs: With the legalization of hemp farming, U.S. hemp producers can access various farm support programs such as crop insurance, farm loan, and farm conservation programs (USDA, 2021). Until 2019, hemp producers operated without any federal crop insurance program designed to cover hemp crops. Hemp farmers can now participate in various government-provided crop insurance programs such as the Multi-Peril Crop Insurance (MPCI)⁷, Noninsured Crop Disaster Assistance Program (NAP), Whole-Farm Revenue Protection (WFRP), and Nursery Crop Insurance (NCI), and Nursery Value Select (NVS) programs based on the eligibility criteria for each program (Raszap Skorbiansky, 2021). Although hemp producers are expected to benefit from these insurance programs, crop insurance will not alleviate the risk of hot hemp (hemp with >0.3% THC) since hot hemp is illegal and not covered under the programs.

Unlike other businesses, hemp-related businesses have a hard time securing finances for their business, given that hemp businesses are relatively riskier for investment (Allen and Whitney, 2019). The availability of farm loans through the Farm Service Agency (FSA) would provide an alternative source of financing for hemp producers. The availability of crop insurance programs will also make hemp producers competitive with other businesses to secure loans from private banks as the insurance programs minimize the risk in hemp farming.

Growth of the legal marijuana industry: By the end of 2020, there were 37 states that legalized the medical use of marijuana, and 16 states have legalized recreational marijuana (ProCon.org, 2020). There is a bill under consideration in the U.S. Senate to legalize marijuana federally (Lyons, 2021). As more states open legalized marijuana and as long as there is a clear-cut legal separation between hemp and marijuana markets, the hemp industry will benefit from expanding infrastructures such as more processing facilities and new technologies for production and processing. However, it will be exposed to more competition for land, processing facilities, and access to finances from the marijuana industry (Mark et al., 2020).

The Way Forward

Based on the previous discussion on challenges and opportunities, in this section, we point out some

⁷ It is a pilot program available only in select counties in Alabama, Arizona, Arkansas, California, Colorado, Illinois, Indiana, Kansas, Kentucky, Maine, Michigan, Minnesota, Montana, Nevada, New Mexico, New York, North Carolina, North Dakota, Oklahoma, Oregon, Pennsylvania, Tennessee, Texas, Virginia, and Wisconsin (USDA, 2021).

specific actions that would be helpful for the development of the U.S. hemp industry.

Growth and development of alternative industrial products: So far, the entire hemp industry is focused on CBD. Given the optimistic projections and attractive price, many farmers were lured into hemp cultivation for the CBD market, which resulted in an oversupply of hemp and a drastic fall in price in recent years. The enthusiasm was understandable considering the projected growth potential of the industry, but given the drastic fall in price, it is likely that the enthusiasm can quickly dissipate if the supply of hemp is not matched with the increased demand for hemp products. In the absence of adequate demand, the hemp industry can potentially be the next "Emu."

As explained in the previous section, the expansion in CBD demand is contingent on the conclusions of scientific investigation regarding its health benefits and consequent FDA policy on CBD use for medical and food purposes. The FDA might take a long time to issue a policy on hemp-derived products, and there is no guarantee that the policy would favor the hemp industry. Although CBD may continue to dominate the hemp market, the growth of other hemp-derived products for industrial and other uses (e.g., use of hemp oil for producing lubricants, oil paints, varnishes, and personal hygiene products; hemp fiber for textiles, construction, and automobile materials, etc.) is crucial for the survival of this industry. Industrial product growth has been modest. The sales of industrial and other uses of hemp products grew by just 10%, from \$403 million in 2016 to \$446 million in 2017 (Hemp Business Journal, 2017 and Hemp Business Journal, 2018). Given that FDA has greenlighted the use of hulled hemp seed, hemp seed protein, and hemp seed oil as a food ingredient, hemp has a potential market in the form of plant-based protein. The use of hemp for biofuels and animal feed could be the other possibility. However, it should be noted that the research to develop hemp for biofuels and feed purposes is at its preliminary phase and would require several more years of research to develop these products.

Scientific investigation on THC threshold policy: The primary source of risk to hemp producers is the 0.3% THC requirement. The scientific basis of the 0.3% THC rule is not clear. Industry advocates (e.g., Vote Hemp, 2020^b) claim that the requirement is "arbitrarily set" by a Canadian scientist, Dr. Ernest Small, in the 1970s and calls it a very stringent criterion for CBD producers. Contrastingly, many European countries have set even higher standards of 0.2% or less THC requirement for CBD products (e.g., France, 0%; Netherlands, 0.05%; Germany, 0.2%, etc.) (Tomares, 2021). It is not clear which one is scientifically determined between the two opposing THC standards. Given this gap, it is a good time for the U.S. government to commission a study to review the scientific basis of the THC level and incorporate that recommendation in the upcoming farm bill.

Policy segmentation for CBD and non-CBD products: The current hemp policy does not differentiate hemp producers based on their intended products, i.e., all the regulatory provisions are equally applied to CBD, grain, and fiber producers. Given that the cultivation practices, processing methods, and intended use of CBD, grain, and fiber are drastically different, it would make sense that they are treated as separate industries and regulated under separate policies. That way, the regulatory constraint of one product will not be a bottleneck for the growth and development of other products. For example, CBD is extracted mainly from flower buds and floral materials of hemp plants (Johnson, 2019), whereas grain and fiber are produced from the stalks and seeds of the plant. The THC concentration is relatively higher in flower buds than in the stalks and seeds (USDA AMS, 2021; Johnson, 2019). The likelihood of hemp for non-CBD products (grain and fiber) to exceed the

THC requirements compared to CBD is very low (USDA AMS, 2021). Given this fact, it would be arbitrary to impose similar stringent regulations meant for higher THC products on grain and fiber producers primarily using hemp plant parts with less THC concentration.

Public investment in hemp research: The lack of proper development of hemp production technology and region-specific varieties are among the most crucial factors constraining hemp farming. Limited market information and analysis inhibit rapid industry growth. Given that hemp research in the United States is in its infancy, the industry would benefit from more research support and development.⁸ Developing hemp varieties with wider adaptability, developing new harvesting and post-harvest technologies, and market analysis are the current research needs for the U.S. hemp industry. As the research output comes through, it is expected that many research-related problems on hemp production, processing, and marketing will be resolved.

Developing a market information system on hemp: Lack of proper information (e.g., prices, acreage⁹, production, and marketed volume information) is one of the constraints hemp farmers and businesses face when marketing their products. The USDA market report on specialty crops has started publishing hemp seed and oil retail prices, but market information of all hemp products at the farm, wholesale, and retail levels for all regional markets is not available. Such market information is crucial for hemp farmers to get a better price and improve their bottom line. Without readily accessible market information, hemp farmers have to accept the price quoted by the processors, which gives an unfair advantage to the processor in setting the price. Hemp production and market databases will also facilitate accurate production and market analysis and contribute to the development of the industry.

An online platform for hemp trading: As discussed previously, there is a lack of established marketing channels or spot markets for U.S. hemp producers. Given the impact of marketing channels on farm profitability (e.g., Lee et al., 2020), the USDA can take the initiative to help producers create the needed infrastructure to facilitate the trading of hemp. For example, a hemp checkoff program could be initiated to fund an online trading platform and other marketing programs. An inventory of U.S. hemp producers and processors could be built into the platform to induce initial trading. Such an online platform would provide hemp buyers and sellers an additional avenue to find each other and develop a competitive hemp market.

Developing hemp product quality standards: Currently, there is no standard practice of grading hemp products. Consumers of hemp products are left uninformed about the product's quality. Having quality standards for hemp products would be beneficial to both consumers and producers, as it would discourage fraudulent practices, and quality products would fetch higher prices in the market. The USDA can take the lead in developing quality standards for hemp.

Exploring the export potential for U.S. hemp products: Given that many countries are opening up for hemp, there is a growing international market, which the United States can explore to market domestically produced hemp products. Export to the global market would create additional demand

⁸ The USDA has kept hemp as a priority research area in the recent request for proposal for grant funding (USDA-NIFA, 2021^a and USDA-NIFA, 2021^b).

⁹ Currently, the FSA reports planted acres for hemp, but it is argued that many of the planted acres were not reported to FSA (Drotleff, 2020). Recently, the USDA NASS announced that they will start surveying hemp farmers to collect the data on hemp production, yield, acreage, and price.

for U.S. hemp and help to mitigate the excess supply of hemp in the domestic market. The USDA Foreign Agricultural Service (FAS) can take the initiative in this regard.

Concluding Remarks

The above assessment indicates that although there is considerable enthusiasm for the U.S. hemp industry, there are many challenges that the industry needs to overcome to survive and establish itself. The current situation is fluid, and it is not clear how the industry will evolve in the future. These facts make it a high-risk venture for most producers. It will require a concerted effort and work to mitigate the risk and grow the industry. In this regard, implementing the actions discussed in the previous section are only some of the things that would be helpful. Cautious optimism paired with remembering new products may not blossom into what we might hope or expect would be an appropriate approach.

Table 1: Hemp Production in the United States

	2016	2017	2018	2019	2020*
Number of states licensing hemp	15	19	21	34	47
Number of hemp licenses issued	817	1,456	3,546	16,877	21,496
Number of hemp planted acres	9,649	25,713	78,716	230,000	157,082

Source: Vote hemp crop reports based on the data reported by the USDA (Vote Hemp, 2017, 2018, 2019, 2020^c) and Drotleff, 2020 (Hemp Industrial Daily). *June 2020 estimate in Drotleff, 2020 includes New Hampshire, which operates under the USDA plan. The data includes hemp acres under state hemp pilot programs approved after the 2014 Farm Bill and state programs after the 2018 Farm Bill.

Table 2: Hemp Planted and Licensed Acres in the Major Hemp Producing States in the United States

States	Planted Acres		Licensed Acres	
	2019	2020	2019	2020
Colorado	53,222	20,792	87,408	36,225
Kentucky	26,500	5,000	60,000	32,000
Montana	45,000	10,950	60,000	12,675
Tennessee	*	4,754	51,000	15,754

Source: Stelton-Holtmeier et al., 2021. * Not available

Table 3: Hemp Seed Budgets (\$/acre)

Hemp Seed	Mark and Shepherd, 2020 (Kentucky)	Hanchar, 2019 (New York)	Harper et al., 2018 (Pennsylvania)
Yield (lbs./acre)	1,200	1,000	1,400
Price (\$/lbs.)	0.7	1.11	0.7
Revenue	840	1,110	980
Variable cost	735	321	304
Fixed cost	271	164	129
Returns above variable cost	105	789	676
Returns above the total cost	-166	624	547

Sources: Mark and Shepherd, 2020; Hanchar, 2019; and Harper et al., 2018

Table 4: Hemp Fiber Budgets (\$/acre)

Hemp Fiber	Mark and Shepherd, 2020 (Kentucky)	Hanchar, 2019 (New York)	Harper et al., 2018 (Pennsylvania)
Yield (lbs./acre)	10,000	7,940	10,000
Price (\$/lbs.)	0.07	0.10	0.05
Revenue	700	794	500
Variable cost	850	390	280
Fixed cost	272	156	146
Returns above variable cost	-150	404	220
Returns above the total cost	-422	248	74

Sources: Mark and Shepherd, 2020; Hanchar, 2019; and Harper et al., 2018

Table 5: Hemp for CBD (no grain) Budgets (\$/Acre)

CBD	Mark and Shepherd, 2020 (Kentucky)	Cui and Smith, 2020 (Tennessee)
CBD % of dry matter	3.5	10
Price per %	1	0.75
Dry matter yield (lbs./acre)	1,500	1,458
Price (\$/lbs.)	3.5	7.5
Revenue	5,250	10,935
Variable cost	1,301	11,617
Fixed cost	606	749
Returns above variable cost	3,949	-682
Returns above the total cost	3,343	-1432

Sources: Mark and Shepherd, 2020; and Cui and Smith, 2020

Table 6: A Six-Year Average (2015-2020) of U.S. Import of Hemp Products

	Canada				China				Europe				World Total			
	Raw	Proc	Oil	Seed	Raw*	Proc	Oil	Seed	Raw	Proc	Oil	Seed	Raw	Proc	Oil	Seed
Unit Value (\$/kg)	3.35	2.53	10.73	9.15	5.01	10.90	12.96	6.51	1.98	0.83	16.80	7.06	1.67	0.97	9.88	8.37
Qty (tons)	3.9	37.2	677.4	8775.5	4.0	5.5	49	207.3	195.4	482.4	139.5	249.7	212.1	531.6	905.6	9335.6
Total Value (FOB \$ mil)	0.006	0.064	7.012	52.97	0.007	0.014	0.600	1.30	0.147	0.355	1.144	1.50	0.172	0.441	8.928	56.015

Raw = Raw Hemp, Proc = Processed Hemp

Source: Author's calculation based on 2015-November 2020 hemp import data for HS5302100000 (raw/processed hemp), HS5302900000 (processed hemp), HS1515908010 (hemp oil), and HS1207990320 (hemp seed) available at USA Trade Online platform of the United States Census Bureau (2021).

*2018 value for raw hemp for China was excluded in the average calculation due to extreme outlier unit values.

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