CONTRACT PRACTICES AND CONTRACT DESIGN IN THE U.S HEMP INDUSTRY

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The undersigned, appointed by the dean of the Graduate School, have examined the thesis entitled

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a candidate for the degree of Master of Science,

and hereby certify that, in their opinion, it is worthy of acceptance.

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ACADEMIC ABSTRACT

Lack of specific literature on contracting in the new United States' hemp industry is an increasing concern for agricultural economists and market participants. The purpose of this study is to investigate the current state of contracting between farmers and processors of industrial hemp (*Cannabis sativa L.*) and to characterize them with respect to the fundamentals of contracting: Decision Rights, Uncertainty and Value allocations. Primary data was gathered through a nationally distributed survey on hemp processors from February through April 2020. It supports -by unexpected results- that processors originate most of their input materials through the spot market rather than through contracting. It is also shown that processors seek to influence post-harvest perceived attributes through input control at the production stage and that contracts are most frequently of one year of duration. This research paper centers on cannabinoids' processors and definitively illuminates the contract design and practices happening at this time on the market. Further studies are needed for understanding the implications in the long run of some findings, such as widely used cooperative arrangements between the contracting parties.

CHAPTER 1: INTRODUCTION

Hemp used to be long ago a very relevant crop for the young nation of the United States of America, with colonists and many founding fathers growing it for fiber. Even Betsy Ross' home-made American flag was sewn with hemp cloth. Right now, it is trying to come back as a multipurpose crop, dwelling still in a highly regulated environment.

The millennial crop is considered to be one of the firstly cultivated in the globe, and it started to be grown for commercial purposes in the USA back in the seventeenth century. Hemp components were key in the manufacturing of many national products, becoming an input for over thousands of products back in the beginning of the twentieth century.

It is important to comprehend that marijuana and hemp are the same species (*Cannabis sativa L.*), and that Congress defines it as "the plant *Cannabis sativa L.* and any part of that plant, including the seeds thereof and all derivatives, extracts, cannabinoids, isomers, acids, salts, and salts of isomers, whether growing or not, with a delta-9 tetrahydrocannabinol concentration of not more than 0.3 percent on a dry weight basis[1]". If more is found, it is considered marijuana, considered a controlled substance, and the crop must be destroyed accordingly. Certainly in the past, lack of scientific knowledge on the plant -and its chemical components- ended up leading to confusing one with the other.

According to Malone and Gomez (2018), the panorama for the hemp market began to deteriorate in 1937 with the Marijuana Tax Act, which heavily taxed the commodity, allegedly due to the social disapproval of the use of drugs or the humanitarian desire of reducing and discouraging drug use. An important precedent was that all states had begun to directly ban the crop.

[1] Hemp is codified in Section 297A of the Agricultural Marketing Act of 1946 (AMA, 7 U.S.C. 1621 et seq.)

For a short period of time, during World War II, the Federal Government fostered hemp production (important input for the war economy), and that lead to almost 64 million metric tons of hemp harvested between 1938 and 1942. This could be taken as a proof that farmers would sow, cultivate and harvest the crop even in a heavily regulated environment. Production permits were requested back then, as is also the case today, to legally grow the crop.

In 1970, by the Controlled Substances Act the Drug Enforcement Agency was added to the USDA in the regulatory framework for the crop, since it “established that hemp seeds were not fundamentally distinct from marijuana”. Hence, almost every application to the DEA for hemp production was rejected.

From then until the 2014 Farm Bill, the hemp market almost ceased to exist, with extremely high regulations for production, no genetic research and basically no processors. This bill was the first deregulatory step for its comeback, since it allowed cultivation for research, in the states that would decide to permit it. A keystone was that industrial hemp was differentiated from marijuana through the “Legitimacy of Industrial Hemp Research”. This also enabled universities to develop research on industrial hemp, under local regulations.

The 2018 Farm Bill (Agriculture Improvement Act of 2018) went a step further, removing hemp from the Schedule I controlled substances, and thus federally rendering it a common agricultural commodity. There would be two paths for producers to legally produce. Either getting a license from the state, or if the state does not have a proper program on place, a USDA license. The state programs would be monitored and approved by the USDA. Transfer between state borders would also be legal. Even insurance through the Whole Farm Revenue program from the USDA would take place.

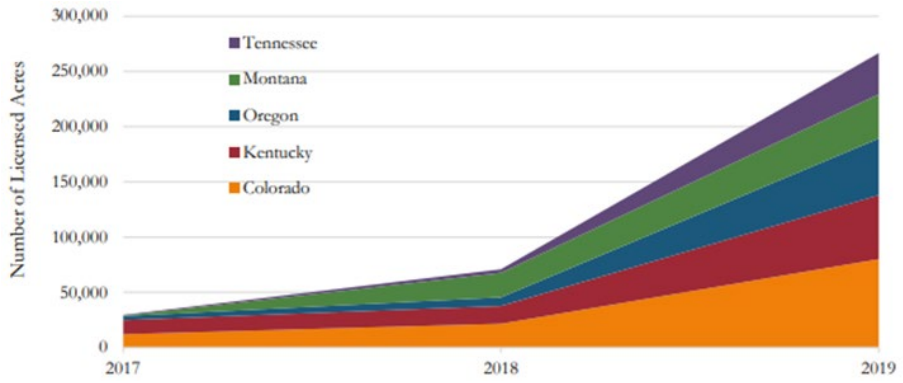
It is now where the market is starting to display impressive growth, by any measure available, such as acreage, pounds of dry matter produced, etc. It is also clear that there are many factors that are generating problems, and even discouraging farmers from entering this promising market.

Table 1. Hemp acreage on selected states.

State	2017	2018	2019[a]
Colorado	12,042	21,578	80,000
Kentucky	12,800	16,100	58,000
Oregon	3,500	7,808	51,313
Montana	542	22,000	40,000
Tennessee	718	3,338	37,416
Wisconsin	0	1,850	16,100
North Carolina	1,930	3,184	11,572
Nevada	490	1,881	9,145
New York	2,000	2,240	5,000
North Dakota	3,100	2,778	2,175
Total	37,122	82,757	310,721

Source: Stern (2019).

Figure 1. Hemp acreage on selected states.



Yet there is no formal literature that addresses contracting in the US hemp market, which is an important matter and it moves forward. Characterizing the contracts and their specifications is going to be key if this market is really here to stay, and it is not a “boom-bust” case, specially the highly volatile cannabidiol (CBD) oil market. It is not only interesting to be working on a nascent industry, but also to contribute to this industry as it moves forwards.

In the past, much research has focused on the agronomic aspects of this crop. There is no further economic research as far as marketing hemp goes in the United States of America. However, there are plenty of informal sources and news commenting on production, marketing, transportation and processing of the dry matter.

Papers focusing on other markets are taken into account as literature references, since even though hemp proves to be a unique crop, there has been other crops and farm products that brought a disruptive effect on markets and maybe in a particular value chain.

The purpose of this study was to investigate the current state of contracting between farmers and processors of industrial hemp (*Cannabis sativa L.*) in the United States, and to contrast these contracts with what other crops' contracting look like with respect to decision rights, uncertainty and value allocations as learned from reviewing the US agricultural sector's contracting. This is addressed in the Literature Review chapter. Hemp has had a burdensome, complex history of regulation and is now becoming a popular topic of debate in the national agricultural sector; and this research proposes to look into the contracts for the crop's three main different sub products: hemp grain, hemp fiber and cannabinoid oil. The research instrument utilized for gathering the primary data was a survey fulfilled by different types of hemp processors across a variety of states. It was done according to the Institutional Review Board standards and the participants were from relevant productive states. Most of the data gathered were from the cannabinoids' oil extractor processors, but not enough for the other two kind of processors: fiber and grain. Therefore, results are presented for the whole sample, with separate comments for cannabinoids' oil extractors. However, the statistical analysis, discussion and conclusion is only performed on the latter kind, as data were not enough for statistical analysis for fiber and grain processors.

CHAPTER 2: LITERATURE REVIEW

Economics of contracting

Following Sykuta and Parcell (2002), a contract is a legally enforceable promise assumed by legally able identified parties in which there must be three elements: offer, acceptance, and consideration. The first one is the proposal of a transfer from one party to the other to accomplish the agreement. Acceptance happens when the other party accepts that offer and the agreement becomes a legal contract if the third element is present. This third element is consideration, which is a legal term that means the parties must exchange something of value.

Each transaction has three fundamental components. The first is the allocation of decision rights, which happens when one party receives rights from the other. Transferring the title for any good constitutes a transfer of decision rights. Full ownership is at the extreme, but there could be middle steps, like leasing or renting a good or property. The second fundamental is value allocation. Since both parties are offering considerations, the allocation of value stands for who gets what out of the deal. As an example, party A gets money for a certain good and party B gets the value from the ownership of the good. Both parties should know about how is the payment calculated, when is it due and how is it to be fulfilled. The third element is the allocation of risk. Risk stands for the negative half of uncertainty, and has the potential to cause negative repercussions for one or both parties involved. It cannot be eliminated, but through strategies it can be reduced or diminished. It will be assigned to a party willing to accept

managing that uncertainty, knowingly or not. It rises as the arrangement takes place over time, as the future value of transacted elements is unknown at the time of designing the deal (Sykuta and Parcell, 2002).

Contracting in the American agricultural sector

The agricultural sector has been in the last decades going through an important transformation that has brought a shift from independent markets to aligned supply chains through contracting (Vavra, 2009). According to the academic literature, contracts are used because transaction costs, information barriers and lack of standardization exist in non-well-functioning markets. Consequently, contract designing cannot rely on surveys or case studies, but they should be based upon economic theory, which leads to the principles through which it is possible to go from a particular case to the generalization (Alexander et al., 2012). According to Vavra (2009), contracting analysis has been mainly approached by two different theoretical frameworks: Transaction Cost Economics and Agency Theory. These two are not necessarily opposed, as they are usually presented, but rather complement each other as two sides of a coin, and as such will be articulated in the literature review.

Transaction costs economics

Transaction costs economics was born in 1937 on a paper called “The Nature of the Firm” by Ronald Coase and furthered by Williamson (1975, 1985) and North (1990, 2004) among others. The main idea behind it is that that the economy has to organize transactions in order to divide labor and enable specialization. This would mean transferring rights of usage, and potentially owning, goods and services among separable economic entities. Engaging in such transactions involves costs, thus the name of the approach. Transaction costs are related to the information, searching, negotiating, enforcing and monitoring of these transactions. The motivation for agents who are creating

new arrangements along the contracting continuum (displayed on Table 1) is to look for the minimization of such costs. However, this process is opposed by the risk of opportunistic behavior between those involved, bringing along contracting hazards. Consequently, there is a clear need for contractual clauses to be part of the contract as safeguards.

Agency theory

Agency theory was initiated by Ross in 1973 and assumes that economic agents have extended rationality, meaning that they are able to fully evaluate gains and costs of alternative arrangements. However, the two parties contracting are not able to access the same information, and this constitutes the main problem according to this theory. The focus is on the contractual relationship between the principal, who is the leading proposer of the contract, and an agent who either accepts or declines its terms. The motivation here to contract lies in incentivizing the agent to behave in benefit of the principal, thus aligning interests and allocating risks in a proper manner.

Contractual completeness

According to Alexander et al. (2012), contract theory has historically had a methodological division, between considering contracts complete or incomplete. Some authors consider the first one to be the most fit for modeling, based on implementation theory, which centers itself on understanding and explaining of how and why implementation succeeds or fails (Nilsen, 2015), or mechanism design (Myerson, 1981), which focuses on contract design that are optimal for optimizing some function subject to certain constraints. This conception of contracts is based on the Revelation Principle, that defines the optimal contract as the one that optimizes the principal's objective, subject to incentive compatibility constraints. The second type of constraint that the authors mention is that of participation, which can also be called reservation payoff or utility. Basically, the contract

must bring to the agent a compensation such that it at least equals the next best use of his assets. In the case of farmers, this would be the payoff of the next best use of land (Alexander et al., 2012). For the hemp market, participation constraints could be low, as high CBD oil prices keep production for CBD hemp far away from the next alternative crop (a commodity index built from data from the corn, soybean, wheat and hay) according to McCarty (2019). He claims that one acre of hemp for cannabinoid's extraction brought to the farmer close to $ 20,000 of revenue in 2019.

In real life, when designing the contract, covering for every possible contingency is too costly, and usually the low probability and low consequence events are left aside for contract enforcement. This implies accepting the other methodological branch that real contracting will be incomplete, and that performance will be guided upon both formal and informal incentives coming from relational contracting. This type of contracting includes informal promises and commitments dealt through handshakes, and by their very nature are not third party enforceable. They are only self-enforcing by the weight future expectations have to each party. This type of contract is viable when, among other factors, the parties have a positive reputation and the environment is stable, i.e. not changing legal environment and normal levels of price volatility. When considering the hemp market it is hard to state that the surrounding environment is stable, due not only to the high price volatility but also to the unfolding regulation panorama. Moreover, reputation and trust are built through time, and most hemp companies are quite young according to the normal agricultural standard[2].

[2] According to FAS-USDA guidelines, a beginner farmers has less than 10 years of experience (https://www.fsa.usda.gov/programs-and-services/farm-loan-programs/beginning-farmers-and-ranchers-loans/index). Although the claim is made on different sectors (primary and secondary) the hemp industry is tightly connected to farming.

Contracting drivers

Coase (1937) and Williamson (1979) developed the theoretical economic relation between transaction costs and market structure, and Frank and Henderson (1992) developed a measure for determining the level of vertical coordination between interdependent firms in the US food sector via nonmarket arrangements. This empirical work is useful for supporting the idea that this scheme reduced transaction costs, especially those related to uncertainty, input supplier concentration, asset specificity and scale economics. As Coase and Williamson claimed, the hypothesis that transaction costs are primarily a motivation for coordinating vertically via nonmarket agreement was proved to be valid.

As developed thus far, reducing transaction cost implies an increase in economic efficiency. Vavra (2009) claims that this is ultimately explained by changes in the incentives, greater coordination and improved management on quality and quantities. Hobbs and Young (2001) discuss the factors that are in the way of achieving incentive alignment between farmers and producers, and these are different risk management tendencies, asymmetric information access and possibility of adverse selection.

Another driver for engaging in contracts is the consolidation the farming sector has been through. According to MacDonald and Korb (2006a), the number of farms has decreased over the last decades and its average size has increased, leading to concentration. This was accompanied by the rise of retail brand names by processors, which now are concerned about their reputation, and consequently display more interest in increasing integration upstream. This reputation issue is related to the changing consumers' preferences. Focus is on parameters such as quality and safety attributes. This reinforces the processors' incentive to have further influence on production. For the US hemp market, one of the aspects to be researched in this paper is exactly this: the allocation of decision rights for production after a contract binds farmer and processor.

Technology changes have also been important at boosting contracting. First, transportation improvements have made possible to overcome distance barriers (Da Silva, 2005), generating wider supplier availability and also pushing for an increased need for coordination. Second, the rise of biotechnology has enlarged the production possibilities, strengthening the idea of protecting research and development with intellectual property rights (Fulton and Giannakas, 2001). This particular topic brings a unique angle, since securing intellectual property rights requires special clauses, which brings further demand for contracting and scaling production becomes critical for lowering the average costs (Johnson and Melkonyan, 2003). In a third place, information technologies have enabled an improvement in planning and controlling of production and have brought a wide tool set for proper decision making, making product traceability possible and lowering costs of contract enforcement (Vavra, 2009). These drivers point in the direction of a transformation on governance, fostering vertical integration. All these progressive steps have influenced the chain of supply and the contract practices and design of the primary sector. The US hemp market is starting its path with years of experienced players in these discoveries. For example, exclusivity clauses concerning the use of transgenics has been around for decades now. Consequently, the learning curve should be flatter that for other crops in the past.

Contracting continuum

Williamson (1979) explained that supply chain coordination varies from spot market transactions all the way to fully vertical integration. Williamson (1996) mentions three broad organizational governances: spot markets, vertically integrated firms and hybrids in between these two extreme states, reached through contracting. MacDonald et al. (2004) describes governance mechanisms along a vertical chain organization continuum:

Table 2. Contracting continuum.

Form of governance	Brief description	Control of production	Payments to farmer
Spot Markets	Commodities are sold for cash and delivered immediately. Price is the primary determinant of the transaction.	Farm operator controls assets and production decisions in agricultural enterprise.	Farm operator receives price for farm output, negotiated at time of sale just prior to delivery.
Marketing Contracts	Refer to sales conditions. Contain estimates of the production under the contract and of delivery times and quantities.	Farm operator controls assets and production decisions in agricultural enterprise.	Farm operator receives a price for farm output, negotiated before or during production of agricultural commodity.
Production Contracts	Refer to sales and production specifications. Producer agrees to deliver a product produced in a manner set forth in the agreement.	Contractor exercises control over some production decisions or farm enterprise assets.	Farm operator is paid a fee for farming services rendered in the production of the commodity.
Vertical integration	Refers to the production control. Price as a determinant is replaced by internal decisions.	Single firm controls assets and production decisions in adjacent farming and processing stages.	Farm operator-manager is compensated for skills and time like other employees.

Source: MacDonald et al. (2004).

Another author also tackles MacDonald's continuum: Hudson (2000) says the first step in the contracting continuum is the spot market, where fully autonomous production is to be sold in the market to the highest bidder. Marketing contracts permit the sale of product with only certain attributes of the product agreed upon before delivery. He claims that production contracts involve not only those attributes to be agreed upon beforehand, but also production practices to be used during the production cycle. This is an example of quasi integration. In the case of full integration, ownership has been taken over the

productive process and almost total control as well. It should be clear by now that the already mentioned technological changes pushed production forwards, and significantly increased opportunities and aspects which have new governance structures, thus increasing the importance and complexity of contracting practices. All this help to re state the importance of Williamson's original findings. These different levels are going to be used for the research survey. Regarding hemp,

Contracting and market power

Some authors investigated contracting and its relationship with market power. Hegreness and Borgen (2003) make the case that many times farmers are left on a compromised position after contracting with local processors. MacDonald et al. (2004) establish that theoretically contracts could be designed to create market power for the buyers. Vavra (2009) also claims that if the spot price is used for reference into the formulae of a contract, and this lacks liquidity, then that market has an important weakness and if properly aligned and motivated, companies can manipulate price to their benefit. Increased contracting does impact the aforementioned spot markets, lowering liquidity and the depth of it, thus rendering them less relevant as a source of information for the different players.

Tsoulouhas and Vukina (2001) working on the US broiler industry explain the performance classification mechanism that processors have used. This so called 'tournaments' rank farmers upon relative performance, rewarding or punishing them based on that. This brings high potential for opportunism [3]on the processors side. Be that as it may, a fixed payment schedule could also bring high potential for opportunism, but on the farmers side. In relationship with price, MacDonald et al. (2004) claim that contracted prices are not necessarily lower than average spot prices, and sometimes prone to be even higher, due

[3] Economic opportunism makes reference to morality and profit, with the first one being subdue to the latter. There exists no agreed general, scientific definition, or theory of economic opportunism.

to certain product characteristics such as special attributes or uniformity, valued by the counterparty.

Transaction costs in screening contracts and monopsonies

Hobbe, Kerr and Klein (1996) establish three main categories of transaction costs related to contracting. The first one is information costs. Basically, for finding a trading partner it is necessary to identify, assess reputation, reach an agreement on price and quality with a potential partner. Organizing the transaction follows and is considered the negotiation cost, through which the legal documents are drawn up. Lastly, monitoring and enforcing the contract is necessary to assure that the counterparty is holding up to their end. Expanding on the first one, Alexander et al. (2012) mention that before contracting, the principal may lack much information regarding the farmers, and so it could look for inducing a heterogenous group to voluntarily choose the right contract for them, by offering them a menu of contracts including pricing and quantitative and qualitative expectation. This are called screening contracts. The principal will indirectly pay in the selected contract an information rent, which is what it takes for the risk neutral agent to reveal himself as so. Goodhue (1999) defines information rents as the excess of the farmer's cost the he/she receives for truthful revelation. Such a practice as screening contracts increases the efficiency of the cost incurred for matching counterparties. It is incentive compatible, as each agent will receive the highest expected payoff under the type of contract most suitable for them. This could have particular relevance for the hemp markets, given the significant changes in planted acreage, with the processing companies hardly able to keep pace. This would take the US market for some time into maybe regional monopsonies. In this particular scenario, screening contract would have a key role to play. This is relevant because negotiation process between the processors and farmers are investigated through the research survey.

Contracting translates to the farmer in lower costs by not needing to monitor the markets or attend events, and gains time for improving production. From a processor perspective, they waste less time finding reliable and quality sources and doing market research, with more time available for decision making.

Asset specificity and bargaining power risk

Another key concept associated with transaction costs economics is asset specificity, which is the degree to which an asset can be used across different circumstances and objectives and is related to the level of fixation an asset has on a certain mode of production. It is the extent to which the investments made to support a particular transaction have a higher value to that transaction than they would have if they were redeployed for any other purpose. The owner has to face the amortization of the investment, through uninterrupted use. This can be achieved through a contract, and also avoids the “hold up” problem, a situation where two parties may be able to work most efficiently by cooperating but refrain from doing so because of concerns that they may give the other party increased bargaining power and thus reduce their own profits. It was posed by Williamson in 1979 and serves as an example of *ex post* opportunism. Due to the cost of conversion to another use, the owner could lower the price of output to the exact value of that cost, resigning in this way the quasi-rent. This quasi rent is nothing but the diminished profit of the owner due to the counterparty bargaining power (Klein, Crawford, and Alchian, 1978).

Bargaining is usually not very relevant in the literature, as take-it-or-leave-it type of contract completely omit this factor. However, the Nash bargaining model establishes that the share of surplus a party gets is proportional to their bargaining power. According to the Alexander et al. (2012), the best solution for overcoming bargaining difficulties regarding participation is to modify the level of payments to the agent, i.e. changing the

base pay. At the same time, incentive compatibility issues must be addressed with changes in the marginal returns to performance, through pay-for-performance premiums. However, there is a tradeoff between these two issues: increasing pay-for-performance increases the agent's risk exposure which in turn increases the participation constraints. For example, for some farmers it might be more attractive to contract for yield, or hemp CBD content, in comparison to acreage. In this scenario, the farmer faces more risk, but is also more incentivized to engage in yield/CBD concentration maximizing practices. The opposite happens if it is an acreage contract.

Knoeber and Thurman (1995) -after discussing the American broiler sector- conclude that for a farmer, risk comes in many different shapes: yield, price, business, financial, etc., and to counter these, farmers engage in cultural practices, insurances and hedging activities. Contracting is seen in this case as yet another of these risk management tools. Just like with option premiums, the difference between the spot price and the contracted one constitutes the risk premium "payed" for lowering the price risk. Once contracted, and with the investments made, the risk of not having a contract on the following marketing cycle constitutes the 'contract risk', assuming the contracted price is lower than the spot's.

Autonomy and the contracting level

Risk associated with uncertainty surrounding sellers' demand assurance, is just the opposite of that of buyers, willing to have stable and ample sourcing. Gillespie and Eidman (1998) talk about autonomy, and how this factor decreases as contracting does the opposite. This autonomy, or independence is related to decision making regarding production and marketing. Even between similar farming companies, the value scales are different, and this difference leads to different levels of integration. It is interesting to ask what the relationship between integration, autonomy and the level contracting is for US hemp processors.

Following Gillespie and Eidman (1998), balancing between autonomy, risk reduction and asset specificity is part of the contracting trade-off every player must face. From the farmer's perspective, contracting will involve economic advantages and disadvantages. Among the first mentioned, the risk borne only by their company just using the spot market for selling their production decreases as the farmers engages in ever more contracted operations. Their management effectiveness usually increases, and this may have the counterbalance of foregoing some price or income in exchange, but it should be more than offset through the efficiency gain in the productive process and the reduced transaction costs. For example, by better access to capital: According to Knight et al. (1989), capital access increases as farmers engage on contracting at any level. Access to financing in the US hemp sector still remains a challenge[4], with most banks displaying reluctancy to lend money to hemp related businesses. Decreased autonomy can be considered as a disadvantage and so is the exposure to 'contract risk'. From the processor's perspective, it is important to secure sufficient supply, suitable as their industrial input. Because of this, seeking to control the production process becomes more attractive and so does the willingness to share risk as well, at a different rate, depending on the contracting level.

Demand driven buyer-specific attributes

Jang and Olson (2010) distill on key factors that explain the recent growth in contracting in the European and US agri-food sectors. They consider that the value of contracting increases as the more specific is the demand from the processor. It is becoming ever more important for processors to receive buyer-specific attributes in the raw materials, especially those ones demanding production practices that cannot be achieved through post-harvest treatment. These buyer-specific attributes are demanded by processors

[4] The U.S. Department of Agriculture (USDA) Farm Service Agency (FSA) is planning on releasing new loan guidance for lenders servicing hemp producers in May 2020.

because they are facing a more intense competition, responding to market segmentation and consumers' preferences. The differentiated input attributes can be of three types. It could be that it has a unique combination of preexisting attributes that stem from both genetics and cultivation practices, or that the buyer-specific attribute only depends on cultivation methods, or that the actual differentiated input attribute is the intertemporal consistency of a set of quality attributes. Market segmentation and consumers' preferences leads this buyer-specific demand from the processors in an upstream direction. The spot marketplace is clearly not the best way to communicate such specialization, and the effectiveness of the markets falls. This will be closely related to the fist hypothesis of this study: Hemp processors will originate most of their input material through contracting rather than from the spot market. Contracting upstream, and/or integrating vertically is the only way to get those inputs, even more so for the last one mentioned, intertemporal consistency. Hemp varieties used for postharvest fiber production, or grain processing or for cannabinoid oil extraction are very different and the quality attributes sought by processors while contracting with farmers will differ substantially. Each type of processor might try to induce some specialization onto the farmer through the contract clauses. This will be related to the second hypothesis to be tested on this study: Hemp processors seek to influence post-harvest perceived attributes through input control at the production stage. For example, in production contracts, cannabinoids processors could include clauses that demand the use of specific varieties that yield high levels of CBD or other cannabinoid.

Empirical studies

Some authors have looked specifically into the US agricultural and food sectors and made significant contributions through empirical explorations. Morrison, Nehring and Banker (2004) develop an empirical model of the US livestock market, using an input distance

function approach to evaluate scale and technical efficiency, and productive effects of contracting. They concluded that smaller operations with lower contracting are less efficient than larger scale and contract intensive firm. James, Klein and Sykuta (2011) suggest than the US pork and poultry markets have been affected by complementary factors, that led genetics improvement, confinement, vertical integration and scale through contracting. All these interacting factors had to be in place for the market to walk on that particular direction. MacDonald and Key (2012) studied the US broiler industry through a nationally representative survey. These authors use the term growing services instead of a production contract, differentiating themselves with regards to other authors. The term seems properly accurate, given the extreme control processors have on the production process. They found that local market for these growers are highly concentrated, leading to noticeable competitions effects: those with a single integrator in the area have 7 % lower revenue on average compared to those with 4 or more. Growers with 2 or 3 integrators nearby have 4 % lower revenue on average than those with 4 or more. This is an example of what has been stated before with regards to the Nash bargaining model. Apparently, in absence of other buyers, farmers lose bargaining power in that area, and this competition effect translates in lower farm revenue.

Sykuta and Cook (2001) discuss the case of sugar beets contracts from an organizational perspective, following the steps of Koenig (1998). According to them, the emergence of the extractable sugar contract (a highly efficient contract that accounts for the quantity and quality of the sugar in the beets), is due to the fact that the cooperative's and the growers' objectives are more closely aligned that in the case of just two regular private firms. Hueth and Melkonyan (2004), instead, reply by saying that this difference in the mode of contracting is due to interregional variations that affects the growers' actual capacity of influencing the crop's quality.

Jang and Sykuta (2009) consider contracting as the consequence of measurement costs and the demand for intertemporal consistency of quality in the hog market, instead of considering the contracting phenomena as a technological and market structure factors associated with asset specificity. Hog meat quality has 3 attributes, which are leanness, meat quality and consistency of size and leanness. The first one would be a health/nutrition attribute, the second one a sensory one and the third a process attribute (Jang and Olson, 2010). Goodhue (1999) reinforces their claim by postulating that one of the reasons for contracting for the processor was to control inputs that affect this particular point. Do hemp processors seek to influence post-harvest perceived attributes through control input at the production stage? This is closely related to the second hypothesis to be tested on this paper.

The increased heterogeneity of specifications in pork processors' expected carcass quality leads- just like in the Jang and Olson case- to a less efficient market. The need of intertemporal quality consistency and the limitation of the spot market in creating a price incentive when certain quality attributes are difficult to measure is the third and last factor to explain packer's use of contracting in the hog industry (Jang and Sykuta, 2009). They postulate that the narrower the margins for hog quality parameters, the less a market performs, and players do not reach a point of having enough incentives to produce such products. The solution is reached through marketing contracts or production contracts and/or vertical integration. Contracting also seems more attractive in a context of high moral hazard risk, for example when quality measurement is done after slaughtering. Consequently, a contract serves to bring down the transaction costs associated with the measurement and price discovery of the carcass. Goodhue (1999)-in the US tomato industry- also mentions that contracting for mitigating the negative consequences of a

moral hazard problem leads to more efficient production, but shifts returns from the farmer towards the processor relative to the case where the latest controls inputs.

The contracting micro-macro conflict

Contracting brings up many issues for the individual firm. Firstly, that of control versus independence, or autonomy. This could even have a social impact: for example, if contracting and vertical integration continues, the family farm agriculture of rural America could be affected. Secondly, the micro-macro conflict of the firm against the industry, since not always the best for the individual firm is the best for the industry as a whole. Ward et al. (2000) propose the example that if a majority of the production is contracted, then that would mean that the alternative of negotiating all transactions is already inferior, and this could terminate the cash market, which ultimately works as the reference. Thirdly, by taking advantage of the legal jargon, packers could transfer risk to producer without them being aware. Fourthly, production standards and its subsequent premiums could be unrealistic, leaving the producer in a situation of becoming a pseudo-employee rather than a businessman. They leave the question mark on whether an increase in contracting is a way to generate market power, by lowering prices on less viable spot markets. Ward, Koontz and Schroeder (1998) found that some relationship between captive fed cattle supply and a decrease in spot price existed. However, Schroeder and Azzam (1999) found that the positive effect on efficiency more than offsets the dead weight of market power losses.

Adverse selection and moral hazard in the hemp market

Concluding this review, the attempt was to survey what has been written until now regarding contract theory and contract design in the agricultural sector that is relevant to this paper. This paper focuses on contracting in the renascent US hemp market. Considering that most companies in the industry are expected to be young, engaging in

contracting for farmers is probably going to be cumbersome, since real world contracts are a combination of legalistic components and verbal implicit agreements, namely relational contracts. This concept of relational contracting, combined with those of incentive compatibility, participation and renegotiation proof constraints constitute the pillars for modern contracting (Alexander et al., 2012). Thus, a contract would be in place for overcoming the agency problem, the conflict of interest between the two parties. Thus, a well-designed contract needs to include proper incentives to both ends to make the interests align. However, reaching such a solution is harder in a context of incomplete information as is the hemp market. This problem could have two faces. One in which the agent has more information than its principal, called Adverse Selection. And another, called Moral Hazard, which is exactly the opposite. In both cases it is necessary to reach interest alignment, but with some differences. In the case of moral hazard, the terms must give incentive to the agent to aim for good practices but not over punish them if they fail to reach certain parameter values due to random factors beyond their control. In the case of adverse selection, the right incentives should be provided with different risk profiles to select a contract that best suits the farmer.

Incentive conflict has different inceptions. If the driving incentives from the parties are independent, then there is absent of a conflict. If these are complementary, then the principal (in this case the processor) needs only reward one for pushing those two up. For example, paying for yield will induce the agent to maximize harvest efficiency. If they are negatively correlated, there is an incentive conflict. Balancing them is a priority for the principal, either by lowering the premiums for both or dismissing them as relevant features in the production contract. The case could be of environmental conservation practices going against yield. In the case of hemp, no chemicals are yet federally approved, so all production as of this time is compulsorily organic. An example of negatively correlated

factors could be that incentivizing for dry matter yield could make the CBD content to decrease. In the case of fiber, the processor will be indifferent to that consequence, but a CBD oil processor will certainly be not, as this tradeoff between the physical yield and the CBD content represents a considerable hazard for them.

Hemp processors will face logistic issues to avoid idling their expensive or yet to be amortized facilities. Investing in storage is usually a way to buffer fluctuations on input inflow. It is generally the case with agricultural products that as time goes by the quality and other characteristics decrease. This is especially true for CBD content after harvesting. Another reason for assuming this task of transportation is to complement storage, further stabilizing the input movement. From a risk management perspective, it is better to originate merchandise from different areas to diminish the weather hazards, but this would increase transportation costs. The trade off in sourcing is ultimately between diversification of systemic risk and keeping average costs low.

Multiyear and one year contracting

It could be the case that some hemp processors might want to engage in longer term contracting than an annual cycle in an attempt to setup multiyear stable inflow of inputs. This type of contracting has further requirements than annual crop contracting. Credibility in this case tends to be fundamental, since parties sign the contract with the information available at that particular time, and some individual future expectations. However, as time goes by, they gain more information and could be tempted to either breach or force the renegotiation of the contract with some updated terms. Consequently, the principal should include some orderly foreseeable renegotiation clause in the initial contract for making the deal less prone to be halted by sudden renegotiation claims. For example, by including a cap on a price index. This clause generates a certain disruption in the pricing mechanism, but in turn, helps to prevent a breach of the contract (Alexander et al., 2012). Basically,

there is a tradeoff between *ex ante* incentives and *ex post* efficiency. For multiyear contracts, the pricing mechanism is less efficient at responding to price changes if there is a cap-price in place, but counterparty risk is reduced, by lowering the incentive of the affected party to renege from the deal.

Contracting for an annual cycle is logically simpler, as this type of crops fit into a traditional rotation, relaxing the participation constraint hemp farmers face. This enables the designer to more easily come up with enough incentives through a pay-for-performance schedule. However, in the case of hemp, a pay-for-performance scheme will necessarily come along with the measurement costs, and credibility factor. On the other hand, all farmers should have a clear idea of quality prior to processing after testing the material, thus increasing the information they have ahead of the processor's final say on the quality and subsequent payment. Considering the current context of high price volatility and a changing legal environment, it would seem more appropriate as a risk management strategy (reducing the length of the commitment) for farmers to seek to engage only in short-term contracting for their hemp production. In agriculture, contracting for one year would be the shortest period of time possible, and this could be reinforced from an agronomical perspective (hemp is an annual crop) and from a financial perspective (annual book-keeping). This will be related to hypothesis 3: Hemp contracts are of one year of duration.

Closing remarks

Transaction Cost Economics (TCE) focusses on organization modes and Agency Theory on the incentive design to lower conflicts between interacting parties. Their depicted motivation for contracting differ quite substantially. Agency theory is for risk transfer and incentive alignment, whilst TCE is for the structure *ex-post* adjustments and limiting rent dissipation on gain distribution, lowering ex-post bargaining, i.e. "hold up" problem and ex-ante exploratory costs. However, the literature provides with the opportunity of

establishing bridges between the two initially mentioned theories. Screening contracts, an agency theory approach helps to bring down information costs, which is a type of transaction cost. Also, concepts like monitoring and enforcement could be claimed to be closer to agency theory than transaction costs, since the contract is designed to reduce the incentive to behave 'badly' (agency theory), which in turn depress monitoring and enforcement costs, which are examples of transaction costs. Another exploration could be that from a transaction cost perspective it is desirable to maintain information search costs low. Affording these costs efficiently eventually leads to a reduced risk of adverse selection (which is an agency theory concept). Articulating these two theories was an important part of this Literature Review.

The contracting literature has an evident gap for the hemp market. This crop is just returning to the light from decades in the illegal status. Hemp contract designs will vary depending on which value stream is analyzed. For example, a CBD oil extractor will probably consider a high level of CBD as their buyer-specific attribute of quality, while a fiber decorticator might consider a high stalk stature/stalk width as their buyer-specific attribute of quality, whilst a seed producer may consider high thousand achene weight as their buyer-specific attribute. It is normal to expect a broad variety of contracts' designs in such a versatile plant.

Also, it brings forth huge legal uncertainties, having regulations that vary significantly from state to state. This is not the common price/quality that the authors in this literature review has commented upon. There is no need for a license to be a farmer, but for growing hemp, there is. Licensing, transporting and testing will have to fit in a context of quality uncertainty, or even counterparty risk or *ex post* opportunism. There will be many angles to tackle these issues, since this is uncharted territory, with no developed markets, and even prison as the potential penalty for infringing rules.

CHAPTER 3: METHODOLOGY AND RESULTS

Since the United States' industrial hemp market is so very recently being developed, there is no literature about it or contracts made available for analysis. This constitutes the research problem: there is exponential growth for this crop with barely any official or scientific data regarding its economic implications, specially the heavily important contracting which is taking place that is key in a highly regulated environment with high risk/high rewards scenario. Moreover, there are widely media-covered cases of contracts failing in this industry. Therefore, the purpose of this study was to investigate the contract practices and design that are currently taking place in this market. Thus, the primary data were gathered through a research survey distributed at a national level. This survey was responded online by 112 processors, from the states of Arizona, California, Colorado, Indiana, Kentucky, Minnesota, Mississippi, Missouri, Montana, Nevada, North Carolina, Oregon, South Carolina, Tennessee, Virginia and West Virginia. The questionnaire was approved by the Institutional Review Board, which is a requirement for any researcher at the University of Missouri who is running this type of investigation. Welfare, rights, and privacy of the human subjects who responded the survey were protected. The complete questionnaire is included in the Appendices. It was distributed online, accessible for hemp processors through an anonymous link powered by Qualtrics Co. through the University of Missouri system.

The questionnaire was designed in such a way that it would be possible to establish correlations between the current state of contracting and some key variables. These key variables were:

- Capacity of processing.
- Years in business.

- Type of contracting.

Selected *ex ante*, these variables will be tested against all other built variables produced from the output of the questionnaire. The rationale is that this will permit to make claims regarding the contracting situation for bigger or smaller processors, with a few or many years in business and with different levels of the contracting continuum.

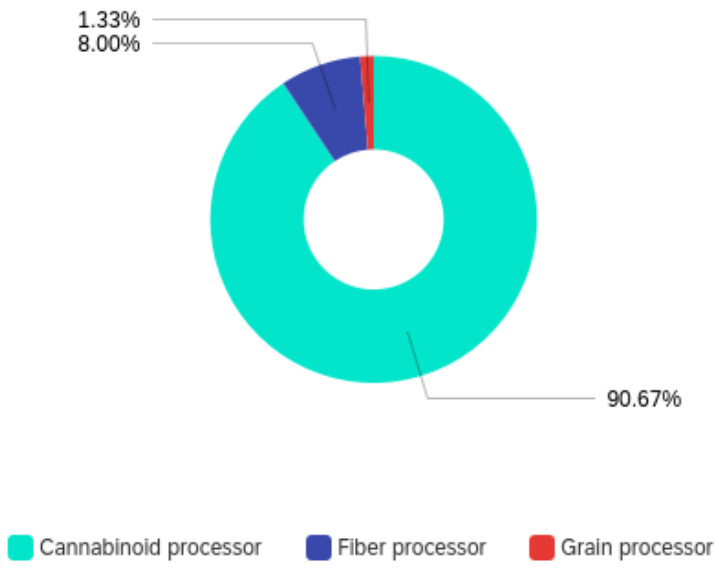
The questionnaire was divided into three blocks: Decision Rights, Value and Risk. This was decided because every contracting decision involves these three fundamental components. First, the Decision Rights block sought to investigate who has the authority to make which decisions that have value and performance implications for the contracting parties. Who decides what on the deal? Who takes responsibility for specific actions established in the contract? Second, the Value block pretended to understand the nature and source of value as it was considered how that generated value is allocated between the parties. How are prices and quantity agreed upon? Are there any value-increasing practices/input demanded to be applied on the contract? Which product attributes are sought and how? Third, the Risk module, not being the same to the more comprehensive concept of uncertainty, investigated how this is allocated between parties for bearing with the risks that come associated with that uncertainty. Is sourcing an issue for the processors, and why? How are potential legal issues addressed? What considerations are contemplated for negative outcomes? These posed questions are merely some of the investigated topics. The full survey can be found in the Appendices.

A database of the hemp processors to be contacted was created, through online research, which was performed state by state, consulting public domain sites, and for the states were processing requires a license, the corresponding institution. The criterion applied was that it had to process hemp for cannabinoid's oil or fiber or grain. The research survey was launched on February 24th 2020 and was active through April 12th 2020 -in the midst

of the Covid-19 pandemic-, via the online surveying system “Qualtrics”. All participants were notified of the anonymity of the survey and the exclusive use of all gathered information for research purposes only. Due to the low initial rate of response, phone calls were made to hemp processors from almost every state, seeking to establish an initial contact before sending them the anonymous link to complete the survey. For such end, more than 1,200 were contacted. Several hundreds more were contacted with no previous phone call via email as well. However, it proved to be key to have the initial phone call with the potential respondents.

A total of 112 responses were recorded, including Cannabinoid, Fiber and Grain processors. Out of these 112 responses, 37 declared not to be hemp processors, even though some of them later declared in a blank that they were, at some level. This translated into a response rate of 6.3 %, which should be considered with research circumstances (no former formal database, short-period of time for running the survey, a significant reluctance to answer to an unknown person and lack of trust for revealing information)

Figure 2. Type of processors surveyed.

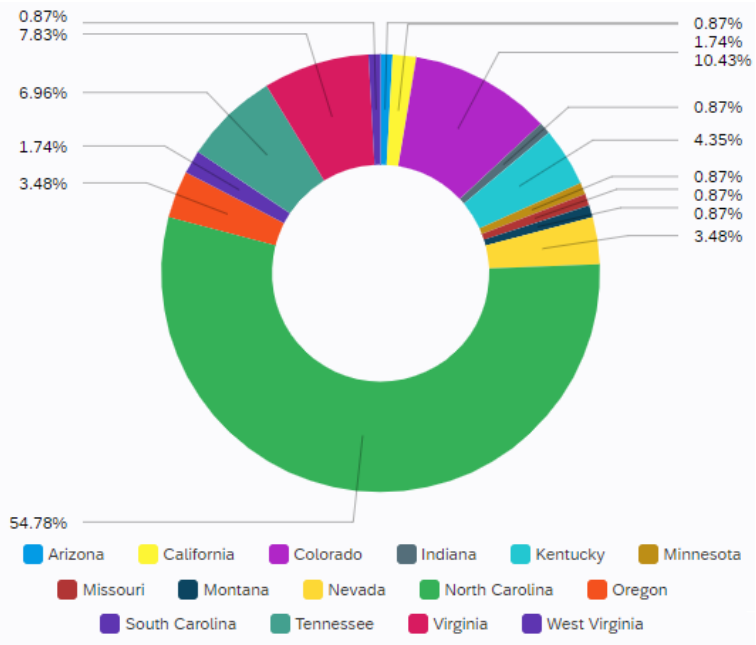


Out of these 75 valid answers, 68 are from cannabinoids processors (91 %), 6 from fiber processors (8 %) and 1 (1 %) from a grain processor. As a consequence of such an imbalance, it was decided only to discuss and make conclusions on the cannabinoids processors. However, this did not come as a surprise, because most of the hemp processors right now in the market are cannabinoids extractors, mostly for CBD oil which is the most important driver of the market at the current time. Although no formal characterization of the hemp market's structure has been done so far, it seems clear -according to the advertising and news media-, that the majority of companies are related to the cannabinoids' sector.

Regarding the geographical distributions of the respondents' hemp processing facilities, 55 % were in NC, 10 % in CO, 8 % in VA, 7 % in TN and 4 % in NE and OR, among many other states with around 1 % each. The skewness in this distribution NC is related to the public access of the licensed hemp processors, through a list on the state's website. A few other states do the same, but two factors were determining for this important gap:

- Updated database: The published list is very much maintained up to date.
- Processors in NC willingness to answer.

Figure 3. Distribution of respondents.



On average, the companies surveyed have 2.46 years of experience in the business. There is some dispersion among this metric, with a standard deviation of 2.04.

Table 3. Years in business.

Years active in business					
#	Field	Minimum	Maximum	Mean	Std Deviation
1	Years	0	10	2.46	2.04

Cannabinoid processors have on average 1,863.5 lb. capacity per day. The median is of 100 lb., less influenced by the presence of outliers.

Table 4. Daily capacity of surveyed processors.

Daily processing capacity (lb/day)					
Median	Average	Confidence Interval of Average	Standard Deviation	Min	Max
100.0	1,863.50	316.28 to 3,410.72	5,884.39	0.5	42,000.0

Regarding the origination of their raw material for processing, on average, 41 % percent is obtained through transactions in the spot market (product is purchased or processing

arrangement agreed upon delivery), 12 % through marketing contracts (production contracted ahead of time specifying quality, quantities and price), 10.23 % through production contracts (production contracted ahead of time specifying quantities, price and quality attributes achieved in a manner set forth in the agreement), and 36.92 % is produced by the own firm, i.e. vertically integrated. It is with this piece of presented evidence that the first hypothesis can be rejected. Indeed, processors do NOT originate most of their input material through contracting rather than from the spot market. It has been shown here that the most important source of raw material for hemp processor is the spot market.

Table 5. Raw material origination.

Sourcing	Minimum	Maximum	Mean	Std Deviation
Spot market	0	100	40.85	43.58
Marketing contract	0	100	12	21.93
Production contract	0	100	10.23	24.92
Vertical integration	0	100	36.92	45.04

Working in a toll scheme is quite common in the upcoming hemp market. Tolling is charging the farmer a fee for processing their hemp into CBD or other cannabinoid oil, distillate, isolate or other products. 58 % declared they do it, and more than a third of these say it was to reduce this risk of unsellable inventory (35 %) by diverting capacity to the toll arrangement. The second reason chosen (19 %) was the possibility of using extra capacity, that would otherwise be normally idle. The third most elected (14 %) choice was that tolling represented a more profitable prospect than normal processing and afterwards selling. Other answers attended the fact that this type of scheme helps to build cooperative structures, helping farmers out, reduce upfront expenditures and diversify revenue source.

In average, processors who engage in tolling practices allocate a third of their capacity into it.

Table 6. Use of tolling arrangements and dedicated capacity.

Tolling arrangements	%		Field	Minimum	Maximum	Mean	Std Deviation
Yes	58.18%		Percentage of capacity	0	100	33.6	31.65
No	41.82%						

Another common arrangement is that of sharing, through which hemp is processed into CBD oil, distillate, isolate or other product and the processor keeps a certain percentage of it before returning the rest to the farmer. More than half (54 %) of the respondents said they worked with this scheme. Some of the reasons are the same as for using toll arrangements, i.e. extra capacity (19 %), reducing the risk of unsellable inventory (19 %), more profitable than processing and then selling afterwards (17 %), earn additional revenue, reduce cost of purchasing material, earnings farmers trust or building a relationship, maintaining relationships with friends and family and helping farmers afford value addition. Regarding the capacity dedicated to a shared arrangement, those who do it dedicate on average a third of their capacity into it.

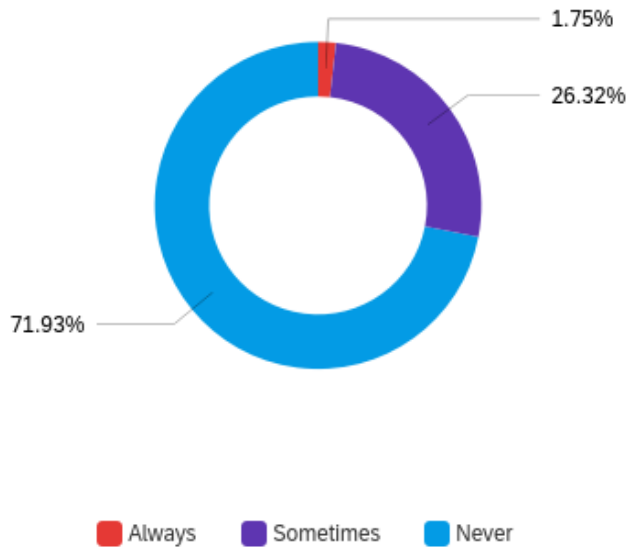
Table 7. Use of sharing arrangements and dedicated capacity.

Sharing arrangements	%		Field	Minimum	Maximum	Mean	Std Deviation
Yes	53.85%		Percentage of capacity	0	100	33.18	28.39
No	46.15%						

Regarding how they establish initial links with farmers, 72 % of the processors claim there is never a broker between them, 26 % said sometimes there is one and only 2 % claimed that there is always a middleman. This are surprising results, due to the normally high

searching cost for finding partners when industries are relatively new. There might be some potential in the future for their service.

Figure 4. Presence of broker.



When asked about if they used an adapted contract for setting up an agreement with farmers, 81 % said they have never used an adapted contract, 13 % said sometimes they would, and only 6 % said they always use an adapted one. The crops mentioned by the few respondents were flaxseed, marijuana and other traditional grain crops (non-specified).

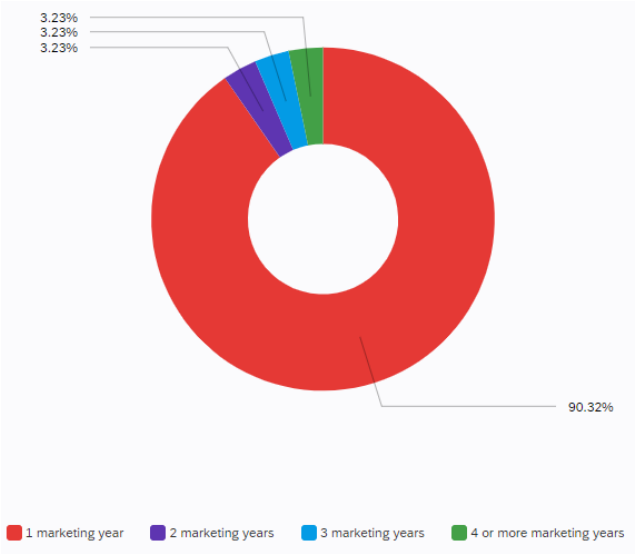
Table 8. Percentage of use of adapted contract and contract's duration.

Use of adapted contract	%		Field	Minimum	Maximum	Mean	Std Deviation
Always	5.66%		Duration	1	4	1.19	0.64
Sometimes	13.21%						
Never	81.13%						

The duration of these contracts is on average 1.2 years. More than 90 % declared they contract for just one year. This piece of evidence allows for the validation of the third hypothesis. Indeed, contracts are of one year of duration. This makes sense from a risk

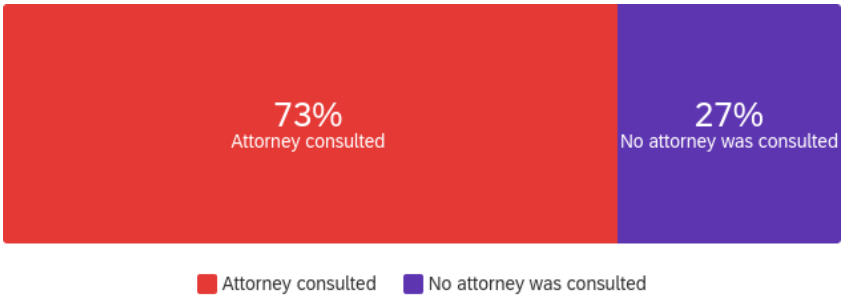
management perspective (no long-term commitment in a low trust environment); from an agronomical perspective (given hemp is an annual crop); and financially (book keeping).

Figure 5. Duration of the contracts.



A vast majority (73 %) declared they contacted an attorney to help them write the contract. Nonetheless, 27 % constitutes a rather high percentage for those processors who are maybe assuming higher legal risk due to the lack of proper assessment.

Figure 6. Attorney's consultation.



The expectation about using the same contract over the years turned out to be a reality, with 24 % of the respondents saying they have used the same contract for 2 years, 14 % for three years and 3 % using the same contract for 5 years or more. This means that more than 40 % of respondents use the same contract over the years.

Table 9. Years the contract is used.

Years the contract is used							
1 year	59.46%		Minimum	Maximum	Mean	Std Deviation	Variance
2 years	24.32%		1	5	1.62	0.91	0.83
3 years	13.51%						
4 years	0.00%						
5 years or more	2.70%						

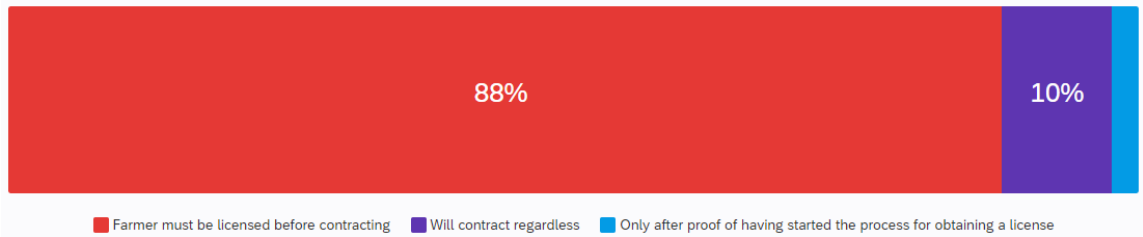
Regarding the negotiation of the terms, 80 % declared they negotiate all terms beforehand, prior to presenting the contract to the farmer, 16 % presents the contract "as is" on a take-it-or-leave-it manner. Very few of the respondents (5 %) accept an initial rejection of the presented contract to then negotiate the terms with the farmer.

Table 10. Negotiation extent.

Negotiation extent	%
Presenting the contracts "as it is" on a take-it-or-leave-it manner	15.91%
Terms are negotiated beforehand	79.55%
Terms are only negotiated after initial rejection of the presented contract	4.55%

Most respondents (88 %) said that offering farmers a contract is contingent of them already having a license for producing hemp. 10 % will contract regardless and 2 % only after being shown some proof of having started the process of obtaining a hemp's producer license.

Figure 7. Demanded level of licensing by processor for contracting.



A vast majority of cannabinoid extractor respondents (80 %) use a uniform quality standard for the contracts, and this could be of value for the overall sector overtime.

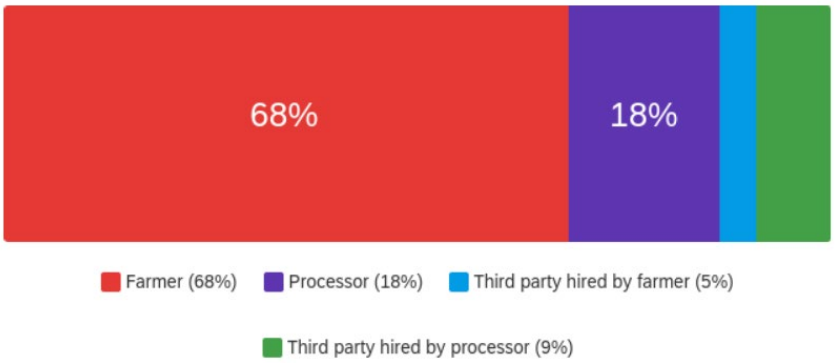
Only 17 % of the processors declared that farmers have a minimal acreage to produce from for engaging in contracting with them. There is wide dispersion about the minimal acreage expressed, going from only 1 to 100 acres. The vast majority (87 %) of the respondents mentioned that in the contract there are specific cultivation practices expected from the farmer. These expected practices are not imposed on the contract (otherwise the percentage of production contracting would be higher) and aim for, in the case of cannabinoid processors, to improve the CBD/THC content (39 % of responses), purity of the material (33 %), other cannabinoid content -not specified- (11 %), lowering the humidity of the content (8 %), maximizing yield (7 %) and enabling a timely delivery of material (3 %). Regarding the planting method, 62 % of the respondents declared that is not established in the contract.

Table 11. Aim of contracted cultivation practices for cannabinoid extraction.

Answer	%
CBD/THC content	39.47%
Purity of material	32.89%
Maximize yield	6.58%
Timely delivery	2.63%
Lowering humidity	7.89%
Other cannabinoid content	10.53%

Harvest is mostly not offered by processors, with only 29 % declaring they offer this service. Transportation of the raw material is most usually (68 %) provided by the farmer. Around a fifth of respondents (18 %) declared they take care of it, and very rarely it is done by a third party hired by the farmer (5 %) or by the processor (9 %). Three quarters of the processors denied offering drying services as well. However, 39 % offer storage services for farmers.

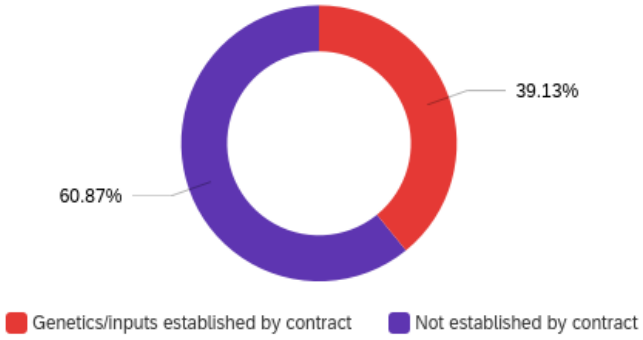
Figure 8. Responsibility for delivery.



While writing the contract, 79 % of the processors declared that it is they who decide the expected *ex ante* delivery period. For deciding the *ex post* actual timing of the material delivery, 42 % declared that it is made in a buyer's call fashion, i.e. the processor calls the seller for arranging delivery. 28 % declared it is done in a harvest delivery fashion, i.e. the seller determines when to harvest and deliver the material. The rest of the answers diverged into other options, such as both (implying differential treatment with different farmers).

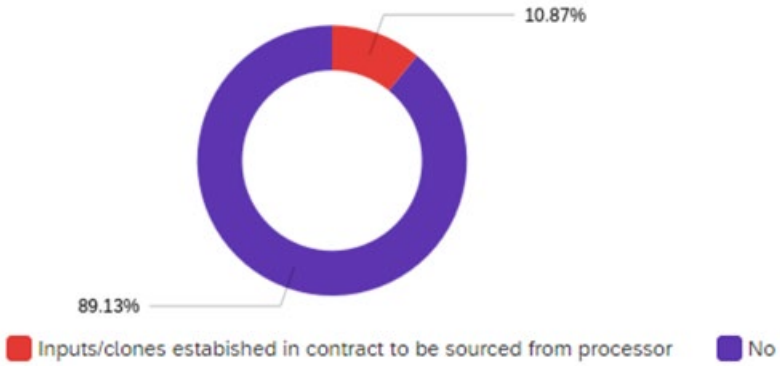
Almost half of the processors (45 %) provide farmers with inputs such as seeds or clones. However, in 61 % of the cases, it is not established in the contract which varieties, clones or other inputs they should use. Even less processors (11%) demand, through a contract clause, that those inputs should be acquired from them. Contractual exclusivity is low, with only 18 % of the processors declaring they include such a clause on the contract. Trade exclusivity is slightly higher yet, with almost one fourth of the processors declaring they indeed include this aspect in their contract.

Figure 9. Inputs and genetics established in contracts.



Considering some of these results, the second hypothesis can be approached. This one postulates that hemp processors seek to influence post-harvest perceived attributes through input control. Therefore, if we consider that in 86 % of the cases some quality increasing practices are expected from the farmer; and more importantly, that in almost 40 % of the cases the clones or varieties and inputs are established in the contract, the second hypothesis stands true, regardless of the fact that in only 11 % of the cases the inputs and genetics are to be sourced from the processor.

Figure 10. Inputs and genetics to be sourced from the processor.



For pricing the material, 40 % of the cannabinoid processors declared it was done according to the CBD content per pound ($/% CBD/lb). 40 % declared it was done by

pound of raw material ($/lb) and 3 % according to CBG or another cannabinoid per pound ($/% CBG or other/lb). The rest of the answers unfortunately relate to toll or sharing arrangements. All processors did declare that for pricing, pounds are considered in a dry basis, i.e. 8 % - 11 % moisture. A vast majority of them do not use any market references for negotiating the price. Those who do (23 %) use Hemp Benchmarks or Hemp Exchange platforms. More than half of the processors (55 %) negotiate their prices making an initial offer, 25 % hinting to the price's references and the rest (21 %) do not offer initial price at all.

Figure 11. Price negotiation.

Figure 12. Terms in which price is negotiated.

Terms in which price in negotiated	%
By CBD content ($/% CBD/lb)	40%
Pound of raw material ($/lb)	40%
By CBG content ($/% CBG/lb)	3%
Unrelated answers	17%

The usage of price indexes for establishing price is rather low, with only 12 % of respondents supporting this, using either Hemp Benchmarks or Hemp Exchange.

Figure 13. Usage of indexes for establishing price.

Quantity is mostly negotiated, with 71 % of the responses being positive.

Figure 14. Negotiation of quantity.

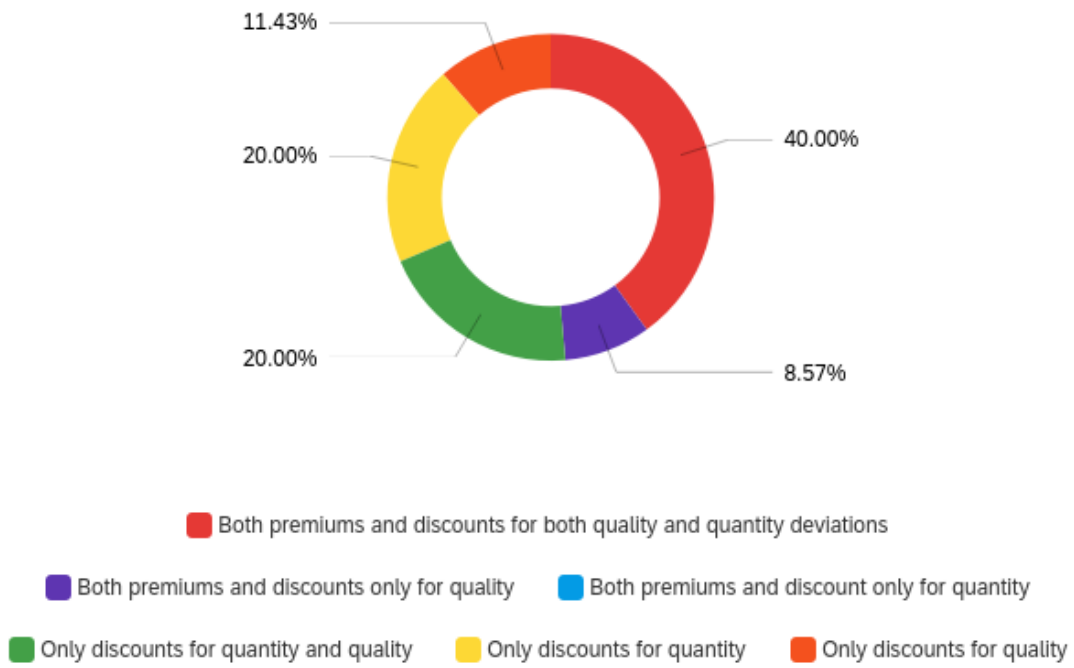
68 % of the respondents said quantity to deliver was defined in a per dry pound basis regardless if it is only floral material or whole plant. This seems completely normal, if compared to most of the other crops in the US agricultural sector.

Table 12. Terms in which the quantity is defined.

Term in which the quantity is defined	
Per acreage production	8.11%
Per dry biomass pounds	67.57%
Per pounds of CBD oil	8.11%
Per pound of dry flower	8.11%
Per pounds of total oil content	8.11%

For premia and discounts regarding quality and quantity, 40 % of processors apply both for quality and quantity deviations. One fifth only discounts on a quantity basis, another 20 % on a quantity and quality basis, 11 % only for quality, and the remaining 9 % discounts and rewards deviations for quality.

Figure 15. Premia/discounts application.



The level of tolerance that the processors apply with regards to the agreed upon quality and quantity before rejecting is on average 20 % and 31 %, respectively.

Table 13. Quality and quantity tolerance levels.

Quality tolerance						Quantity tolerance		
Minimum	Maximum	Mean	Std Deviation		Minimum	Maximum	Mean	Std Deviation
0	70	20.35	18.01		0	90	31.25	21.39

Testing the material for determining quality is taken care according to 50 % of the respondents by the processors through a third party. 24 % declared it is done by farmers through a third party, 15 % done by the USDA approved institution for legal harvest and 11 % done by themselves directly. None of the respondents said it was done by the farmers themselves. On 57 % on the responses it was stated that the farmers afforded the testing and the rest by the processors. On 58 % of the cases, the contract provides for resampling. On top of this analysis, 75 % declared to run tests for finding any chemical

residues before beginning the processing. It is important to understand that the legal testing done to comply with federal rules is not aimed for determining quality of the raw material, but only that the crop is legal, by having 0.3 % or less THC content. However, apparently 15 % of respondents rely on this basic testing for determining quality of the material that triggers payment. This test is only for THC levels, which determines the legality or not of the crop. How this could be used confidently for determining quality remains unclear.

Table 14. Test for quality of the material.

Testing for quality	
Farmers through third party laboratory	23.91%
Farmers' own testing	0.00%
Your business	10.87%
Your business through a third party	50.00%
The legal test performed prior to harvest by an USDA approved institution	15.22%

For storing the material before delivery, most farmers are required to have their own drying facilities (52 %) and exactly half the processors declared that these conditions are specified in the contract. Answers regarding the actual defined conditions are not unified, but in general include a semi sterile environment for reducing mold and controlled temperature and relative humidity of 8 % - 11 %. The almost identical results make it possible to claim that if the storage is required, its conditions will be defined *ex ante* on the contract. However, this argument remains weak since these two answers are not bound.

Table 15. Storage specifications.

Storage facility requirement	%		Storage conditions	%
Required	52.38%		Established in the contract	50%
Not required	47.62%		Not established in the contract	50%

Cannabinoid processors declared that 70 % of them label their product with their own label, 23 % do the same but part of their production is white labelled, and only 6 % declared all of their production is sold under a contracted private label. Regarding the distribution channel, 45 % declared that they sell their production to another wholesale/retail company, 23 % exclusively take care of end-distribution and 31 % do both.

Table 16. Product label and commercialization.

Product label	%		Commercialization	%
Own label	70.21%		Sold to third party	45.83%
Contracted private label	6.38%		Own selling	22.92%
Both	23.40%		Both	31.25%

For finding sources of raw material processing, 91 % of the respondents declared that they do not find any issues. The remaining 9 %, that indicated they were facing issues for finding farmers to source their hemp from, pointed to the lack of growers' experience and their own restrictively high demand for quality as the reasons. On average, they expect to source all of their 2020 raw material from 16 farmers.

Table 17. Number of farmers from which processors expect to source material for 2020.

Number of farmers to source material for 2020				
Minimum	Maximum	Mean	Std Deviation	Variance
0	225	16.21	38.4	1474.88

Geographic diversification is somewhat important for 46 % of the respondents, 37 % said it was not important and 17 % said it was very important. The reason for this were that it helps diminish transportation costs (37 %), diminishes weather risks (34 %), diminishes legal risk by sourcing from different states which differ in some legislation (17 %) among a few others.

Table 18. Level of importance of geographical diversification and its reasons.

Level of importance and reasons for geographical diversification				
Levels	%		Reason	%

Very important	17.07%		Diminish weather risk	34.15%
Somewhat important	46.34%		Diminish transport costs	36.59%
Not important	36.59%		Diminishing legal risk (sourcing from different states which differ in some legislation)	17.07%
			Support local farmers	2.44%
			Local origination for differentiation	2.44%

CHAPTER 4: DATA ANALYSIS AND DISCUSSION

This section proceeds to analyze the results and to establish relationships between the variables surveyed. As mentioned before, considering that only six fiber processors completed the survey, all statistical analysis inferences are done exclusively for cannabinoid processors.

The first interesting relationship that deserves to be mentioned is that engaging in marketing contracts is positively correlated with the daily processing capacity. This was tested with a ranked correlation, because these variables are not normally distributed, and the sample size would make an unranked correlation probably invalid. The ranked correlation is similar to a typical correlation; it tests for whether or not values for one variable get larger, smaller, or stay the same as values for the other variable get larger. Statistical tests on small samples require normally distributed data and no outliers to be accurate. Rank transform is a method for running nonparametric tests when violations of parametric test assumptions are detected (i.e. non-normally distributed data and or presence of outliers). Therefore, some data is treated as ordinal data (i.e. categorical, statistical data type where the variables have natural, ordered categories and the distances between the categories is not known) or continuous data. And then transformed into ranks, and analysis are performed. This constitutes a well-established method for protecting against assumption violations. It is a “nonparametric” method, robust to outliers and non-normally distributed data.

Table 19. Ranked correlations between daily capacity and contracting.

Ranked correlation between daily capacity and marketing contracting	
Statistical Significance (P-Value)	0.009287199
Effect Size (Spearman's Rho)	0.37170443
Confidence Interval of Effect Size	0.098 to 0.593
Ranked correlation between daily capacity and production contracting	

Statistical Significance (P-Value)	0.017118789
Effect Size (Spearman's Rho)	0.342664477
Confidence Interval of Effect Size	0.065 to 0.571
Ranked correlation between daily capacity and vertical integration	
Statistical Significance (P-Value)	0.01442884
Effect Size (Spearman's Rho)	-0.351043772
Confidence Interval of Effect Size	-0.578 to -0.074

Spearman's rho is a nonparametric measure of rank correlation which is the statistical dependence between the rankings of two variables. It assesses how well the relationship between two variables can be described using a monotonic function. The Spearman correlation between two variables is equal to the Pearson correlation between the rank values of those two variables; while Pearson's correlation assesses linear relationships, Spearman's correlation assesses monotonic relationships (whether linear or not). It measures the strength and direction of association between two ranked variables.

The same was found for production contracts, which are positively correlated with the daily capacity. The same type of correlation was used for the same reasons. Interestingly, there is a negative correlation between vertical integration and daily capacity. Consequently, it could be concluded that as non-integrated cannabinoid processors increase in capacity, they tend to rely more on contracted governances (such as those built through marketing and production contracts), whereas integrated ones when they increase in capacity have to rely less on their own autonomous supply of raw material, thus demanding input from other sources through the spot market or contracting.

As shown in the results, tolling and share arrangements are quite relevant. It was found that those who work in toll arrangements tend to have much higher capacity than those who do not. A ranked T-test was used for relating these two variables, because of the

presence of an outlier. The ranked t-test is similar to a typical T-test; it tests for whether one group tends to have higher values than the other.

Table 20. Ranked T-test between daily capacity and toll arrangements.

Capacity (lb/day). Tolling?	Median	Average	Sum	Confidence Interval	Standard Deviation
Yes	450.0	3,083.96	86351	-30.92 to 6,198.85	8,033.02
No	8.0	27.85	557	9.44 to 46.26	39.33
Ranked T-Test – Daily capacity and tolling.					
Statistical Significance (P-Value)					8.77053E-09
Effect Size (Cohen's d)					2.0057
Difference Between Averages (No - Yes)					-3056.1143
Confidence Interval of Difference					-6171.038 to 58.809

Also, those working in such an arrangement tend to have less integration, meaning that for both marketing contracts and the spot market, the use of toll schemes tend to have higher, and much higher use. Moreover, there is another significant relationship between higher levels of integration and denying participating in toll arrangements. Therefore, the conclusion is that less integrated businesses use the tolling scheme significantly more than those fully integrated.

Table 21. Ranked T-tests between use of the contracting continuum and tolling.

Spot market (%). Tolling?	Median	Average	Sum	Confidence Interval	Standard Deviation
No	0.0	20.96	503	5.57 to 36.34	36.43
Yes	65.0	51.89	1453	35.23 to 68.56	42.98
Ranked T-test – Use of spot market and tolling					
Statistical Significance (P-Value)					0.011071
Effect Size (Cohen's d)					0.7402

Difference Between Averages (No - Yes)				-30.9345	
Confidence Interval of Difference				-53.054 to -8.815	
Marketing contract. Tolling?	Median	Average	Sum	Confidence Interval	Standard Deviation
No	0.0	5.22	120	0.13 to 10.30	11.75
Yes	8.0	16.13	516	6.40 to 25.85	26.97
Ranked T-test – Use of marketing contracting and tolling					
Statistical Significance (P-Value)				0.029793	
Effect Size (Cohen's d)				0.6032	
Difference Between Averages (No - Yes)				-10.9076	
Confidence Interval of Difference				-21.705 to -0.110	
Integrated (%). Tolling?	Median	Average	Sum	Confidence Interval	Standard Deviation
No	100.0	59.39	1366	38.64 to 80.14	47.98
Yes	0.0	23.66	757	9.80 to 37.51	38.42
Ranked T-test – Vertical integration and tolling					
Statistical Significance (P-Value)				0.005172	
Effect Size (Cohen's d)				0.8535	
Difference Between Averages (No - Yes)				35.7351	
Confidence Interval of Difference				11.310 to 60.160	

Similar results are obtained when looking into the sharing arrangements.

Table 22. Ranked T-test between use of the spot market and sharing.

Spot market (%). Sharing?	Median	Average	Sum	Confidence Interval	Standard Deviation
No	0.0	20.96	503	5.57 to 36.34	36.43
Yes	65.0	51.89	1453	35.23 to 68.56	42.98
Ranked T-test – Use of spot market and sharing					

Statistical Significance (P-Value)					0.011071
Effect Size (Cohen's d)					0.7402
Difference Between Averages (No - Yes)					-30.9345
Confidence Interval of Difference					-53.054 to -8.815
Statistical Significance (P-Value)					0.011071
Marketing contract. Sharing?	Median	Average	Sum	Confidence Interval	Standard Deviation
No	0.0	6.67	160	-0.07 to 13.40	15.95
Yes	8.0	13.14	368	4.73 to 21.56	21.71
Ranked T-test – Use of marketing contracting and sharing					
Statistical Significance (P-Value)					0.044285
Effect Size (Cohen's d)					0.5804
Difference Between Averages (No - Yes)					-6.4762
Confidence Interval of Difference					-17.001 to 4.049
Integrated(%). Sharing?	Median	Average	Sum	Confidence Interval	Standard Deviation
No	98.0	60.50	1452	40.64 to 80.36	47.04
Yes	0.0	23.89	669	8.83 to 38.95	38.84
Ranked T-test – Vertical integration and tolling					
Statistical Significance (P-Value)					0.004067
Effect Size (Cohen's d)					0.8721
Difference Between Averages (No - Yes)					36.6071
Confidence Interval of Difference					12.261 to 60.954

Those who participate in sharing arrangements tend to have much higher capacity. The same type of test was used for investigating this correlation (ranked T-test). Consequently, the same conclusion applied for toll arrangements applies to the share ones. This comes as no surprise at all, considering the similar structure of these schemes, which are both cooperative in nature.

Table 23. Ranked T-test between daily capacity and share arrangements.

Capacity(%). Sharing?	Median	Average	Sum	Confidence Interval	Standard Deviation
No	10.0	908.10	19070	-221.13 to 2,037.32	2,480.74
Yes	135.0	2,609.08	67836	-713.06 to 5,931.22	8,224.97
Ranked T-Test					
Statistical Significance (P-Value)				0.004509924	
Effect Size (Cohen's d)				0.9282	
Difference Between Averages (No - Yes)				-1700.9817	
Confidence Interval of Difference				-5173.611 to 1771.648	

Transportation is quite an issue for the US hemp market, with different state laws regulating this aspect, even regardless of the federal guidelines. There is a strong statistically significant relationship between who takes responsibility for the delivery of the raw materials to the processing facilities and the capacity of the cannabinoid processor. The data were analyzed utilizing a ranked ANOVA, which is similar to the typical ANOVA; it tests whether the two variables are statistically related. The ranked ANOVA is robust to outliers and non-normally distributed data. According to this, as processor increase on average on their capacity, they rely more on the farmer to take care of transporting the raw material. This appears to make sense, since as the processor scales up, they concentrate more resources on processing more, originating more material from more farmers, which are asked to take care of this logistic component in turn. Jacob Cohen has suggested that Cohen's d values of 0.10, 0.25, and 0.40 represent small, medium, and large effect sizes, respectively.

Table 24. Ranked ANOVA between daily capacity and responsibility for delivering.

Ranked ANOVA – Daily capacity and delivery responsibility	
P-Value	< 0.00001
Effect Size (Cohen's f)	0.432

Capacity(lb/day). Responsible.	Average	Median	Sum	Confidence Interval of Average	Standard Deviation
Farmer	2,586.71	110.0	67255	-739.01 to 5,912.43	8,233.83
Processor	258.25	87.5	2066	-196.26 to 712.76	543.66
Third party hired by farmer	8,000.00	8,000.0	16000	-17,412.41 to 33,412.41	2,828.43

Through another ranked ANOVA it was found that there is a statistically significant relationship between the extent to which contract are negotiated and the years in business the processors have. Particularly, those respondents who declared that the contract terms are only negotiated after initial rejection of the presented contract are on average significantly more experienced than those who declared either that the contract terms were negotiated beforehand or presented on a take-it-or-leave-it manner. However, it is important to remember that most of the respondents (95 %) average 2.17 years, compared to the "experienced" group (5 %) which averages 4.5 years in business.

Table 25. Ranked ANOVA between years in business and extension of the contract negotiation.

Ranked ANOVA – Years operating and extent of negotiation					
P-Value	0.003				
Effect Size (Cohen's f)	0.296				
Years in business. Negotiation extent.	Average	Median	Sum	Confidence Interval of Average	Standard Deviation
Terms are only negotiated after initial rejection of the presented contract	4.50	4.5	9	-1.85 to 10.85	0.71
Terms are negotiated beforehand	2.83	2.0	85	1.84 to 3.82	2.65
Presenting the contracts "as it is" on a take-it-or-leave-it manner	2.17	1.5	13	0.49 to 3.85	1.60

The number of farmers to which the processors expect to source all of their material for the 2020 season is positively correlated with their capacity. This was tested through a ranked correlation, a typical correlation and a simple linear regression. The best model

was the ranked correlation, because of the absence of normal distribution and the presence of at least one outlier. This conclusion is quite natural, because of how atomized farmers seem compared to a large processor. For the latter, diversifying their source translates into reduced risk, and more importantly because of potential monopsonic behavior, in market power which could translate into the negotiation of the terms. Another factor that adds to this is that in areas where there is no buying competition for the material, transporting the bulky raw material for processing is only profitable for certain mileage. However, the potential for exploitation of market power that a large processor could do in an area faces the risk that with all that installed capacity installed it may not find convenient and reliable sources for the next year. This is where the difference of investment horizons become clear: agricultural farmers can, after a failure, decide to accept the loss and not produce the crop the following year, while a processor certainly cannot adapt on a yearly basis due to its high level of asset specificity. The incentive then is to, in the presence of a monopsonic position, not taking advantage of it, for the sustainable future of the inflow of input. Conflicting short term and long-term incentives bring balance to the negotiation.

Table 26. Correlations and linear regression between daily capacity and numbers of farmers for sourcing 2020 material.

Ranked Correlation – Capacity and number of farmers sourcing	
Statistical Significance (P-Value)	0.007544535
Effect Size (Spearman's Rho)	0.4439902
Confidence Interval of Effect Size	0.130 to 0.677
Correlation - Capacity and number of farmers sourcing	
Statistical Significance (P-Value)	< 0.00001
Effect Size (Pearson's r)	0.929
Confidence Interval of Effect Size	0.862 to 0.964
Linear regression - Capacity and number of farmers sourcing	
R-Squared	0.862

Line of Best Fit	Farmers as source for 2020 = (0.00540 x Capacity) + 5.46

For the labeling the product, there is a strong statistically significant relationship between the election of the type of the branding (own label, contracted private label or both) and their processing capacity. This was tested through a ranked ANOVA. Those with high capacity (on average 6,510 lb/day) tend to rely more on a mixed type of labelling than those averaging 678 lb/day which opted for labelling exclusively their own brand. This makes sense from a risk management perspective. Having much more output, large processors diversify their risk by selling under more than one name.

Table 27. Ranked ANOVA between daily capacity and brand name.

Ranked ANOVA – Capacity and labeling					
P-Value	0.005				
Effect Size (Cohen's f)	0.554				
Summary					
Capacity (lb/day). Labeling.	Average	Median	Sum	Confidence Interval of Average	Standard Deviation
Contracted private label	120.00	120.0	120	120.00 to 120.00	NaN
Both	6,510.10	1,800.0	65101	-2,588.40 to 15,608.60	12,718.82
Own brand	678.31	50.0	19671	-89.67 to 1,446.29	2,018.98

Another related interesting relationship is found between the channel for distributing the end product and the number of years working in the industry, with those with more time in

business showing a more diversified distribution on average, with own retail selling and third party retail and whole sellers. This was tested through a ranked ANOVA, since there are outliers in the data. There is no statistically significant relationship between the variables capacity and years in business. Therefore, connecting the last two conclusions is not possible.

Table 28. Ranked ANOVA between years in business and channel for distributing.

Ranked ANOVA – Years operating and distribution channel					
P-Value	0.028				
Effect Size (Cohen's f)	0.327				
Summary					
Years operating. Distribution channel	Average	Median	Sum	Confidence Interval of Average	Standard Deviation
Both	2.92	3.0	38	2.21 to 3.64	1.19
Own selling	1.78	2.0	16	1.27 to 2.29	0.67
Wholesale/retail	2.52	2.0	53	1.47 to 3.58	2.32

Through a ranked T-test it was found that those contracts that provide a resampling tend to have processors with higher capacity that the contracts which do not. In 58 % of the cases, it is the farmer who pays for the testing (and it is assumed that if there is a retesting it is paid again by them) and 55 % of the contracts include the possibility of retesting. Therefore, retesting does not in most cases translate into higher costs for the processor, thus allowing the farmer to retest is beneficial for both parties, increasing overall value of the deal.

Table 29. Ranked T-test between daily capacity and resampling.

Ranked T-Test – Capacity and resampling	
Statistical Significance (P-Value)	0.033171338

Effect Size (Cohen's d)	0.8092				
Difference Between Averages (No - Yes)	-3937.051				
Confidence Interval of Difference	-9172.547 to 1298.445				
Capacity (lb/day). Resampling.	Median	Average	Sum	Confidence Interval	Standard Deviation
No	100.0	540.07	8101	-116.00 to 1,196.13	1,184.70
Yes	500.0	4,477.12	76111	-730.95 to 9,685.18	10,129.41

Those processors who do not offer drying services tend to rely more on the spot market, making less use of contracts for sourcing their inputs than those who actually offer this service to farmers. Therefore, it could be inferred that normally those processors who are less integrated-thus making more use of the spot market- lack of the infrastructure necessary for drying material in scale.

Table 30. Ranked T-test between spot market use and providing drying services.

Ranked T-Test – Spot market and drying services					
Statistical Significance (P-Value)	0.002752				
Effect Size (Cohen's d)	0.9713				
Difference Between Averages (No - Yes)	39.8438				
Confidence Interval of Difference	16.789 to 62.898				
Spot market usage (%). Drying services provided.	Median	Average	Sum	Confidence Interval	Standard Deviation
No	60.0	49.84	1595	34.29 to 65.40	43.14
Yes	0.0	10.00	110	-8.43 to 28.43	27.43

For the origin of the inputs used by farmer, which may be specified on the contract, only those vertically integrated tend on average to provide the farmers they engage in contracting with the inputs. Since more integrated processors have their own farming, they would naturally seek to have the farmers they contract with for completing their input inflow to produce in a similar fashion to what they do, making the overall raw material “mix” more homogeneous and uniform.

Table 31. Ranked T-test between vertical integration and providing farmers with inputs.

Ranked T-Test – Vertical integration and input providing					
Statistical Significance (P-Value)	0.048676				
Effect Size (Cohen's d)	0.6917				
Difference Between Averages (No - Yes)	-30.8846				
Confidence Interval of Difference	-58.891 to -2.878				
Higher vertical integration (%). Inputs provided?	Median	Average	Sum	Confidence Interval	Standard Deviation
No	0.0	20.12	523	4.03 to 36.20	39.83
Yes	50.0	51.00	765	26.97 to 75.03	43.39

On average, those respondents who declared to engage in production contracts (i.e. production contracted ahead of time specifying quantities, price and quality attributes achieved in a manner set forth in the agreement) responded positively when asked if the varieties/clones and inputs used by farmers are defined by the contract; which truly servers as an internal validation checkpoint, since this type of contract demands defining those attributes in the contract clauses, to eventually obtain the quantities and more importantly, the quality attributes desired. The decision rights allocation of a production contract certainly relies more heavily on the knowledge and access to resources by the processors, which are seeking to obtain an “specialized” product as input for processing.

The allocation of risk is heavier on the farmers side, since although many factors can be controlled to obtain the mentioned quality attributes, it could happen that because of uncontrollable factors those levels are not reached. In this case it would be interesting to investigate if the tolerance for quality for this type of contract is different than from the rest. In this survey this was investigated, but for the whole continuum on integration, not for a particular level.

Table 32. Ranked T-test between production contracts use and defined use of inputs on the contract.

Ranked T-Test – Use of production contract and defined inputs					
Statistical Significance (P-Value)	0.015869				
Effect Size (Cohen's d)	1.0025				
Difference Between Averages (No - Yes)	-20.1923				
Confidence Interval of Difference	-41.096 to 0.712				
Production contract (%). Inputs specified in contract.	Median	Average	Sum	Confidence Interval	Standard Deviation
No	0.0	5.31	138	-1.59 to 12.20	17.07
Yes	5.0	25.50	357	5.41 to 45.59	34.79

Very interestingly, not demanding trade exclusivity in the contract is more common among those processors who engage in production contracts, in which segment it could be expected to find such kind of clauses. It could be said this comes as a surprise because the farmer is explicitly requested to produce in a specific manner for reaching a certain level of a valued attribute. And he could easily take advantage of this instruction or outsourced knowledge to produce more of that and seek another buyer who values this sought attribute as well. The risk is run by the processor who does not include the clause. In the end, the competitors could end up winning if there is production surplus, because

they can find high quality material in the spot market. It would be interesting to investigate this aspect with more depth. Is this the only way that farmers accept to contract with these kind of processors? According to the literature farmers tend to dislike engaging in contracting that provides exclusivity constraints. It is clear, however, that for that party providing the know-how, namely the processor, they have more to lose in this type of contract.

Table 33. Ranked T-test between production contracts use and trade exclusivity.

Ranked T-Test – Use of production contracts and trade exclusivity					
Statistical Significance (P-Value)	0.032695				
Effect Size (Cohen's d)	0.6456				
Difference Between Averages (No - Yes)	14.3793				
Confidence Interval of Difference	2.463 to 26.296				
Use of production contract (%). Trade exclusivity clause.	Median	Average	Sum	Confidence Interval	Standard Deviation
No	0.0	16.38	475	5.09 to 27.67	29.68
Yes	0.0	2.00	20	-2.52 to 6.52	6.32

The number of farmers necessary to source all of the raw material for the 2020 season is positively correlated with the increase of the percentage of use of the spot market. In other word, those who depend mostly on the spot market for sourcing, will buy the material from more farmers. This is a logic conclusion, since originating material from the spot market will clearly demand making many purchases to different farmers, than it would be the case if the processor had a higher level of production contracted or was more integrated.

Table 34. Ranked correlation between spot market use and numbers of farmers needed for 2020 material.

Ranked Correlation – Use of spot market and farmers for sourcing	Farmers needed is positively correlated with the increase of spot market use
Statistical Significance (P-Value)	0.031266
Effect Size (Spearman's Rho)	0.354635
Confidence Interval of Effect Size	0.035 to 0.609

The contrary is the case for higher levels of integration: there is a negative correlation between the number of farmers used as sources and increased vertical integration. If we take into consideration the thirdly mentioned found correlation (vertical integration negatively correlated with capacity) it could be stated that vertically integrated processors generate an improvement in their autonomy by keeping the percentage of their extrinsically generated material at low levels. This conclusion comes from understanding that vertical integration is not necessarily found at higher levels of capacity (first developed correlation) and that at the same time it does not imply sourcing from a large number of farmers.

Table 35. Ranked correlation between integration and farmers needed for 2020 material.

Ranked Correlation	Farmers needed is negatively correlated with the increase of integration
Statistical Significance (P-Value)	0.034103
Effect Size (Spearman's Rho)	-0.34927
Confidence Interval of Effect Size	-0.605 to -0.028

CHAPTER 5: CONCLUSION

With no specific literature available on hemp contracting, no available contracts for doing economic research on, and a shifting regulation environment, contracting for hemp has taken place in a rather unclear environment. For tackling this research problem, the purpose of this paper was to investigate the current state of contracting between farmers and processors, through a survey on the latter ones. The three axes for the questionnaire were decision rights, value and uncertainty. The following would be the main findings from this paper and future research questions are proposed as well.

From a decision rights perspective, it can be concluded from this research that all terms of the contract are normally to be discussed beforehand prior to presenting the contract. Specially at this early stage, in which processors are quite aware that this industry needs to attract farmers to enter and remain. And their adoption, in terms of acres dedicated to the crop by each farmer, could be considered to have a slower pace than industrial investments for processing. Almost always there are specific cultivation practices expected from the farmer. For this highly labor-intensive crop, it would seem more natural that farmers accept, and processors propose, to have certain specific tasks be performed upon cultivation. Will that be the case in the future? Is this only due to the fact that most farmers are on the lower side of the learning curve for cultivating hemp?

It was expected to find much more exclusivity clauses in the hemp market due to the low level of knowledge of cultivation. However, this was not the case. As mentioned in the literature review, different value scales translate into different levels of acceptance of such clauses, which hemp farmers would seem to consider to be unacceptable constraints.

Regarding uncertainty, and its more relevant half, risk, the time horizon for contracting was in line with the expectations. It seems like a one-year contract is most usually what the parties are looking for when entering into a new crop (considering the results), where

there is a sharp learning curve for success. At the same time, even if they produce for a year only, farmers will need to obtain a license. Hardly any processor engages in business with someone who is not authorized to produce hemp.

An overwhelming majority of processors claimed that they face no issues finding hemp farmers. It would be really interesting to investigate in the future for the cannabinoids' industry, if this changes as CBD prices continue to fall.

Processors are willing to display quite some tolerance for both quality and quantity thus far. This is expected to fade away as technology improves. How far behind is technology in the USA with regards to Germany or the Netherlands? How much time will it take to reduce the gap? Will the extensive farmers of the Midwest ever be able to fully adopt this crop, be it for CBD, fiber or grain?

For processor not highly integrated, more capacity demands a diversification of their sourcing: more use of contracting and cooperative schemes. This is heightened as capacity increases. The use of share and toll arrangements did not come as a surprise. Farmers and processors decide to indulge in a cooperative arrangements if the market is uncertain. What are the implications for the market of the development of such arrangements? Why do they cooperate under certain scenarios and engage in regular transactions or contracting in others? Further research is needed on cooperative schemes.

Mixed labeling, usually one of their own and another contracted, as performed by larger processors, constitutes a useful risk management tool. The same is the case for more experienced processors, which display full downstream integration and also selling to other companies for retailing or wholesale.

Concerning value allocation, more experienced processors know better where the value lies for them in the contract, and thus are more aggressive when negotiating as they present the contract, and only negotiate after initial rejection.

The industry seems to be walking towards standardization: processors use uniform quality standards in all their contracts. Whether this in time will translate into the commoditization of different hemp material constitutes an interesting research question to investigate in the future. How long does it take from widely used contracted specifications to develop into widely use standards (potentially like USDA's grades)?

Providing for resampling in the contract (proved to be used by more experienced processors), increases the overall value of the deal. It provides for both parties by allowing the payment of a fair price, established in the contract. Nor the processor wants low quality material, nor the farmer wants an unfair price.

It was found that more vertically integrated processors provide contracted farmers with selected inputs. This is a value increasing clause: the processor has the know-how and probably the autonomous production of clones or other key inputs.

The contract probably demands specific attributes that can normally be achieved with those inputs and some cultivation practices. Famers obtain knowledge at a crop there are getting to know, and the materials for reaching the potential demanded. This can be of use in following marketing years, constituting a successful base for expanding acreage and increasing production.

Limitations

Reliance on a single study to make generalization about the research problem constitutes an important limitation of the conclusions here presented, especially considering that a total of 112 respondents at a national level is quite low. Even more so if we consider that

37 answers were not valid. From the 75 valid answers, the 68 which correspond to the cannabinoids' processors were used for the discussion and conclusion. A larger sample would be required for the statistical analysis performed to be stronger. That is why many ranked types of analysis had to be used.

Another limitation was the geographical skewness of the data. More than half the respondents were from North Carolina. Although it is an important state for hemp production, it would have definitively been better to have less of a skew in this regard. Moreover, this skewness could have negative ramifications on the results due to the historic presence of tobacco crops (not only in NC but also in V, which could affect farming practices, thus potentially being an influence factor on the responses from the processors from that state contracting with those farmers.

Lastly, the Covid-19 pandemic could have affected the response. A considerable amount of business that were contacted were closed and would not respond. This could be explained by the shutdowns caused by the pandemic fallout.

Final remarks

The industrial hemp agricultural complex is at a nascent stage and doing research at any level is key as it moves forwards. The hypothesis posed by Coase and Williamson has been found to be true as the development of the American agricultural sector is studied: transaction costs are primarily a motivation for coordinating vertically via nonmarket agreement. Contracts are pieces of legal and economic engineering that allow the economy to further improve its coordination.

This wonderful crop has already taught a very valuable lesson for what is coming. The World War II patriotic act of producing hemp by American farmers, fostered by the USDA's short-lived project "Hemp for Victory", has proved that farmers can produce hemp in a

highly regulated sphere. Hemp, yesterday and today, has a lot of potential for the American agriculture sector. The reasons for accepting it are not short-term, like the loss of trade with the Philippines and East Indies was in 1942. At this time there are three different kinds of varieties and cultivation but endless potential after processing it.

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* Citations presented in the American Psychological Association style format

APPENDIX

Research Survey Questionnaire

Start of Block: Introduction

Q1.1 You are being invited to participate in a research study that involves participation in an anonymous survey.

Completing this questionnaire should only take about 10 minutes. As pioneers in the industry, your input is highly valuable for the development of the US Hemp Market! Your participation in this survey is entirely voluntary and by completing it you agree to be a participant. You may drop out anytime and are free to decline to answer any particular question for any reason.

Principal investigator is Mariano Bignon, and this survey is part of his Master's Thesis. If you have any questions regarding the research please reach out to +1 573 529 4796 or write an email to mb3gv@mail.missouri.edu. This information will be displayed again at the end of the questionnaire. Thank you!

Q1.2 How would you define your main activity?

- ○ Cannabinoid processor (1)
- ○ Fiber processor (2)
- ○ Grain processor (3)
- ○ Business is not of processing hemp (4)

Q1.3 How many years have you been active in this business?

_____ Years (4)

Q1.4 Where is/are the processing facility/ies located? Check all that apply.

- ☐ Alabama (1)
- ☐ Alaska (2)
- ☐ Arizona (3)
- ☐ Arkansas (4)
- ☐ California (5)
- ☐ Colorado (6)
- ☐ Connecticut (7)
- ☐ Delaware (8)
- ☐ District of Columbia (9)
- ☐ Florida (10)
- ☐ Georgia (11)
- ☐ Hawaii (12)
- ☐ Idaho (13)
- ☐ Illinois (14)
- ☐ Indiana (15)
- ☐ Iowa (16)
- ☐ Kansas (17)

- [ ] Kentucky (18)
- [ ] Louisiana (19)
- [ ] Maine (20)
- [ ] Maryland (21)
- [ ] Massachusetts (22)
- [ ] Michigan (23)
- [ ] Minnesota (24)
- [ ] Mississippi (25)
- [ ] Missouri (26)
- [ ] Montana (27)
- [ ] Nebraska (28)
- [ ] Nevada (29)
- [ ] New Hampshire (30)
- [ ] New Jersey (31)
- [ ] New Mexico (32)
- [ ] New York (33)
- [ ] North Carolina (34)

- [ ] North Dakota (35)
- [ ] Ohio (36)
- [ ] Oklahoma (37)
- [ ] Oregon (38)
- [ ] Pennsylvania (39)
- [ ] Puerto Rico (40)
- [ ] Rhode Island (41)
- [ ] South Carolina (42)
- [ ] South Dakota (43)
- [ ] Tennessee (44)
- [ ] Texas (45)
- [ ] Utah (46)
- [ ] Vermont (47)
- [ ] Virginia (48)
- [ ] Washington (49)
- [ ] West Virginia (50)
- [ ] Wisconsin (51)

☐ Wyoming (52)

Q1.5 What is your daily processing capacity at this time, in pounds of raw material?

_____

End of Block: Introduction

Start of Block: DECISION RIGHTS

Q2.1 How do you originate the raw material for your business?

_____ Spot market (Product is purchased or processing arrangement agreed upon delivery) (1)
_____ Marketing contract (Production contracted ahead of time specifying quality, quantities and price) (2)
_____ Production contract (Production contracted ahead of time specifying quantities, price and quality attributes achieved in a manner set forth in the agreement) (3)
_____ Vertical integration (Fully owned farm origin) (4)

Q2.2 If you use contracts, how long is their duration?

○ 1 marketing year (1)

○ 2 marketing years (2)

○ 3 marketing years (3)

○ 4 or more marketing years (4)

Display This Question:

If How would you define your main activity? = Cannabinoid processor

Q2.3 Do you also work with farmers in a toll arrangement, i.e. charging the farmer a fee for processing their hemp into CBD oil, distillate, isolate or other products?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If Do you also work with farmers in a toll arrangement, i.e. charging the farmer a fee for processin... = Yes

Q2.4 What is the reason you provide toll processing?

- ☐ Extra capacity (1)
- ☐ More profitable than processing and then selling afterwards (2)
- ☐ Reduce risk of unsellable inventory (6)
- ☐ Other: (3) _____
- ☐ Other: (4) _____
- ☐ Other: (5) _____

Display This Question:

If Do you also work with farmers in a toll arrangement, i.e. charging the farmer a fee for processin... = Yes

Q2.5 If yes, how much of your daily processing capacity do you plan to use for tolling processing? Please answer in percentage or pounds.

_____ Percentage of capactiy (2)

Display This Question:

If How would you define your main activity? = Cannabinoid processor

Q2.6 Do you also work with farmers in a sharing arrangement, i.e. you process hemp into CBD oil, distillate, isolate or other product and keep a certain percentage of it before returning the rest to the farmer?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If Do you also work with farmers in a sharing arrangement, i.e. you process hemp into CBD oil, disti... = Yes

Q2.7 What is the reason you provide share processing?

- ☐ Extra capacity (1)
- ☐ More profitable than processing and then selling afterwards (2)
- ☐ Reduce risk of unsellable inventory (6)
- ☐ Other: (3) _____
- ☐ Other: (4) _____
- ☐ Other: (5) _____

Display This Question:

If Do you also work with farmers in a sharing arrangement, i.e. you process hemp into CBD oil, disti... = Yes

Q2.8 How much of your daily processing capacity do you destine sharing processing? Please answer in percentage or pounds.

_____ Capacity used for sharing processing (2)

Q2.9 Is there a broker between you and the farmers?

- ○ Always (1)
- ○ Sometimes (2)
- ○ Never (3)

Q2.10
Is the contract you use adapted from a contract for different crop, such as flaxseed or marijuana?

- ○ Always (1)
- ○ Sometimes (2)
- ○ Never (3)

Display This Question:

If Is the contract you use adapted from a contract for different crop, such as flaxseed or marijuana? != Never

Q2.11 Which crop was the original contract designed for?

- ○ Marijuana (1)
- ○ Flaxseed (2)
- ○ Other: (3) _____

Q2.12 How many years have you used that contract?

- ○ 1 year (1)
- ○ 2 years (2)
- ○ 3 years (3)
- ○ 4 years (4)
- ○ 5 years or more (5)

Q2.13
Did you consult an attorney when writing the contract?

- ○ Yes (1)
- ○ No (2)

Q2.14 To what extent are contracts negotiated?

- ○ Presenting the contracts “as it is” on a take-it-or-leave-it manner (1)
- ○ Terms are negotiated beforehand (2)
- ○ Terms are only negotiated after initial rejection of the presented contract (3)

Display This Question:

If How would you define your main activity? = Cannabinoid processor

Q2.15 Do you use a uniform quality standard for cannabinoid, foreign matter, moisture, etc.?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If How would you define your main activity? = Fiber processor

Q2.16 Do you use a uniform quality standard for fiber content/quality?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If How would you define your main activity? = Cannabinoid processor

And Do you use a uniform quality standard for cannabinoid, foreign matter, moisture, etc.? = No

Q2.17 Which are negotiated?

- ☐ Cannabinoid content in the delivered material (1)
- ☐ Moisture content (2)
- ☐ Foreign matter (3)
- ☐ Other (4) _____
- ☐ Other (5) _____
- ☐ Other (6) _____
- ☐ Other (7) _____
- ☐ Other (8) _____

Q2.18 Are specific cultivation practices expected from the farmer?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If How would you define your main activity? = Cannabinoid processor

And Are specific cultivation practices expected from the farmer? = Yes

Q2.19 To which characteristic/s are those cultivation practices aimed to?

- ☐ CBD/THC content (1)
- ☐ Other cannabinoid content (6)
- ☐ Purity of material (2)
- ☐ Maximize yield (3)
- ☐ Timely delivery (4)
- ☐ Lowering humidity (5)

Display This Question:

If How would you define your main activity? = Fiber processor

Q2.20 To which characteristic/s are those cultivation practices aimed to?

- ☐ Fiber content (1)
- ☐ Purity of material (2)
- ☐ Yield maximization (3)
- ☐ Timely delivery (4)
- ☐ Lowering humidity (5)

Q2.21 Is the planting method specified in the contract?

- ○ Yes (1)
- ○ No (2)

Q2.22 Who takes responsibility for delivering the raw material to the processing facilities?

- ○ Farmer (1)
- ○ Processor (2)
- ○ Third party hired by farmer (3)
- ○ Third party hired by processor (4)

Q2.23 Do you also offer harvest services?

- ○ Yes (11)
- ○ No (12)

Q2.24 Do you also provide drying services?

- ○ Yes (1)
- ○ No (2)

Q2.25 Do you also provide storage services?

- ○ Yes (1)
- ○ No (2)

Q2.26 Is the time of delivery established on the contract through a buyer's call (i.e., the contract specifies a window of time for the processor to call the seller for arranging delivery) or a harvest delivery (the seller determines when to harvest and deliver the material); and if it's none, what's the agreement?

- ○ Buyer's call (1)
- ○ Harvest delivery (2)
- ○ Other: (3) _____

Display This Question:

If Is the time of delivery established on the contract through a buyer's call (i.e., the contract sp... != Buyer's call

And Is the time of delivery established on the contract through a buyer's call (i.e., the contract sp... != Harvest delivery

Q2.27 Who determines delivery date?

- ○ Farmer (1)
- ○ Processor (2)
- ○ Broker (3)

Q2.28 Do you provide farmers with inputs, such as seeds or clones, etc.?

- ○ Yes (1)
- ○ No (2)

Q2.29 Is it established in the contract which varieties, clones, inputs should they use?

- ○ Yes (1)
- ○ No (2)

Q2.30 Are farmers required to buy these inputs from you?

- ○ Yes (1)
- ○ No (2)

Q2.31 Are there any clauses in the contract for exclusivity, meaning the farmers cannot contract with other buyers?

- ○ Yes (1)
- ○ No (2)

Q2.32 Are there any clauses in the contract for trade exclusivity, meaning the farmers cannot trade with other buyers?

- ○ Yes (1)
- ○ No (2)

End of Block: DECISION RIGHTS

Start of Block: VALUE

Display This Question:

If How would you define your main activity? = Fiber processor

Q3.1 Are you exclusively a decorticator, that is, you mainly separate the bast (skin or bark) and hurd (core) fibers in a hemp stem?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If How would you define your main activity? = Cannabinoid processor

Q3.2 How is the raw material priced?

- ○ $/%CBD/pounds (1)
- ○ $/%CBG or other cannabinoid/pounds (4)
- ○ $/pounds of raw material (2)
- ○ Other: (3) _____

Display This Question:

If How would you define your main activity? != Cannabinoid processor

Q3.3 How is the raw material priced?

- ○ $/dry pound (1)
- ○ $/wet pound (2)
- ○ Other: (3) _____

Q3.4 Do you use an index or publicly available market price to establish a price in your contract language?

- ○ Yes: (Please specify) _____ (1)
- ○ No (2)

Q3.5 Is price negotiated?

- ○ Yes, starting with an initial offer (1)
- ○ Yes, starting with a referencial price or index (2)
- ○ No (3)

Q3.6 Are the quantities negotiated?

- ○ Yes (1)
- ○ No (2)

Q3.7 Do you offer premiums or discounts for deviations from the quality/quantity terms?

- ○ Both premiums and discounts for both quality and quantity deviations (1)
- ○ Both premiums and discounts only for quality (2)
- ○ Both premiums and discount only for quantity (3)
- ○ Only discounts for quantity and quality (4)
- ○ Only discounts for quantity (5)
- ○ Only discounts for quality (6)

Display This Question:

If Do you offer premiums or discounts for deviations from the quality/quantity terms? = Both premiums and discounts for both quality and quantity deviations

Or Do you offer premiums or discounts for deviations from the quality/quantity terms? = Both premiums and discounts only for quality

Or Do you offer premiums or discounts for deviations from the quality/quantity terms? = Only discounts for quality

Q3.8 Normally, which is the tolerance (%) to which you extend the discounts in quality before rejecting the material?

_____ Limit is (%) (1)

Display This Question:

If Do you offer premiums or discounts for deviations from the quality/quantity terms? = Both premiums and discounts for both quality and quantity deviations

Or Do you offer premiums or discounts for deviations from the quality/quantity terms? = Both premiums and discount only for quantity

Or Do you offer premiums or discounts for deviations from the quality/quantity terms? = Only discounts for quantity

Q3.9 Normally, which is the tolerance to which you extend the discounts in quantity before rejecting the material?

_____ Tolerance (%) is (1)

Q3.10 Are storage conditions specified in the contract? If yes, what would those be like, i.e. moisture, temperature, etc.?

- ○ Yes (1) _____
- ○ No (2)

Q3.11 Is there a minimal acreage farmers must plant in order to sign according to the contract? If yes, what is usually it?

- ○ Yes (1) _____
- ○ No (2)

Q3.12 Do you require farmers to have their own drying facilities?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If How would you define your main activity? = Fiber processor

Q3.13 Which product brings more revenue?

- ○ Bast fiber (1)
- ○ Hurd (2)
- ○ Other: (3) _____

Display This Question:

If How would you define your main activity? = Fiber processor

Q3.14 Which are you end products?

- ☐ Textiles (1)
- ☐ Paper (2)
- ☐ Industrial products (3)
- ☐ Building materials (4)
- ☐ Animal bedding (5)
- ☐ Insulation (8)
- ☐ Rope (9)
- ☐ Other (6) _____
- ☐ Other (7) _____

Display This Question:

If How would you define your main activity? = Grain processor

Q3.15 Which are your end products?

- ☐ Hemp oil (1)
- ☐ Hemp meal/seed cake (2)
- ☐ Whole seed (5)
- ☐ "Hemp hearts" (removed hull) (6)
- ☐ Other: (3) _____
- ☐ Other: (7)
- ☐ Other: (4) _____

Display This Question:

If How would you define your main activity? != Cannabinoid processor

Q3.16 Which one is sold at usually the highest price?

_____

End of Block: VALUE

Start of Block: RISK

Q4.1 Have you had issues finding sources of raw material?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If Have you had issues finding sources of raw material? = Yes

Q4.2 Why did you find these issues?

_____

Q4.3 From how many farmers do you expect to source all of your material for the 2020 season?

_____

Q4.4 If you sell your products under a brand name, which type is it?

- ○ Own brand (1)
- ○ Contracted private label (2)
- ○ Other: (3) _____

Q4.5 Do you sell to a wholesale/retail business or sell it on your own?

- ○ Wholesale/retail (1)
- ○ Own selling (2)
- ○ Other: (3) _____

Display This Question:

If How would you define your main activity? = Grain processor

Q4.6 Which percentage of your production is food level?

_____ Percentage of production (1)

Display This Question:

If How would you define your main activity? = Grain processor

Q4.7 Are there any minimum levels of oil content pre established in the contracts?

- ○ Yes (18)
- ○ No (19)

Display This Question:

If How would you define your main activity? = Grain processor

Q4.8 Which process do you apply to the grains?

- ☐ Hulling (1)
- ☐ Crushing (2)
- ☐ Both, separately (3)
- ☐ Other: (4) _____

Display This Question:

If How would you define your main activity? = Grain processor

Q4.9 Do you use a uniform quality standard for oil content?

- ○ Yes (18)
- ○ No (19)

Q4.10 Who tests the materials for determining the payments post-harvest?

- ○ Farmers through third party laboratory (1)
- ○ Farmers's own testing (2)
- ○ Your business (3)
- ○ Your business through a third party (4)
- ○ The legal test performed prior to harvest by an USDA approved institution (5)

Q4.11 Who pays for the testing?

- ○ Farmer (1)
- ○ Processor (2)
- ○ Broker (3)

Q4.12 Does the contract provide for resampling?

- ○ Yes (1)
- ○ No (2)

Q4.13 Is your contract contingent on having a license?

- ○ Farmer must be licensed before contracting (1)
- ○ Will contract regardless (2)
- ○ Only after proof of having started the process for obtaining a license (3)

Q4.14 How important is geographic diversification in your sourcing decision?

- ○ Very important (1)
- ○ Somewhat important (2)
- ○ Not important (8)

Q4.15 Why is this geographical diversification important?

- ☐ Diminish weather risk (1)
- ☐ Diminish transport costs (2)
- ☐ Diminishing legal risk (sourcing from different states which differ in some legislation) (3)

Q4.16 Do you test for any chemical residues before processing?

- ○ Yes (1)
- ○ No (2)

Q4.17 In which terms is the quantity to deliver defined?

- ○ Per acreage production (1)
- ○ Per dry biomass pounds (2)
- ○ Per pounds of CBD oil (3)
- ○ Per pounds of other cannabinoid oil (5)
- ○ Other: (4) _____

End of Block: RISK
